

**AMENDMENT 23**  
**to the**  
**Northeast Multispecies Fishery Management Plan**

Including a  
Draft Environmental Impact Statement (DEIS)

**Volume II - Appendices**

Prepared by the  
New England Fishery Management Council  
in cooperation with the  
National Marine Fisheries Service

## **VOLUME II – AMENDMENT 23 APPENDICES**

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**Amendment 23**

**To the**

**Northeast Multispecies Fishery Management Plan**

**Appendix I**

**Summary of Public Scoping Comments**



## New England Fishery Management Council

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### MEMORANDUM

**DATE:** May 9, 2017  
**TO:** Groundfish Committee  
**FROM:** Groundfish Plan Development Team  
**SUBJECT:** **Summary of Public Scoping for Amendment 23/Groundfish Monitoring**

The Groundfish Plan Development Team (PDT) met on April 11 and 12, 2017 in Portland, Maine to summarize the public scoping comments received on Amendment 23 (A23)/Groundfish Monitoring. Between February 17 and April 3, 2017, the Council accepted written and oral comments on A23. The following summarizes the PDT's discussion and recommendations.

#### **A. Public Scoping Comments Summary**

The PDT summarized the public scoping comments received on A23 (Attachment 1). Several attachments are included that support the summary (Attachments 2 and 3).

1. **Attachment 1:** Summary of Public Comment Period for Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan
2. **Attachment 2:** Summaries of the 5 public hearings
3. **Attachment 3:** Written comments received during the scoping period.

#### **B. PDT's Recommended Draft Purpose and Need Statement for A23**

The *purpose* of Amendment 23 is to implement measures to improve reliability and accountability of catch reporting and to ensure an accurate representation of catch (landings and discards).

The *need* of Amendment 23 is to improve the accuracy of collected catch data. Accurate catch data are necessary to ensure that catch limits are set at levels that prevent overfishing and to determine when catch limits are exceeded. A second need is to create fair and equitable catch reporting requirements for all fishermen, while maximizing the value of collected catch data and minimizing costs for the fishing industry and the National Marine Fisheries Service.

## **1.0 SUMMARY OF PUBLIC COMMENT PERIOD FOR AMENDMENT 23 TO THE NORTHEAST MULTISPECIES (GROUND FISH) FISHERY MANAGEMENT PLAN**

### **1.1 INTRODUCTION**

Between February 17 and April 3, 2017, the Council accepted written and oral comments on Amendment 23 to the Northeast Multispecies Fishery Management Plan. This report provides a summary of the demographics of the commenters and the key themes that emerged from the comment period.

The following questions were presented in the scoping document and at the scoping hearings and served to guide the public in commenting on Amendment 23:

- What alternatives should the Council consider in Amendment 23 to change the groundfish monitoring program?
- What specific issues are most important when evaluating the tradeoffs associated with monitoring discards at sea using at-sea monitors?
- Should the Council consider changes to the way landings information for groundfish is provided?

### **1.2 DESCRIPTION OF COMMENTERS**

#### ***Oral commenters***

The six public hearings were attended by 89 unique stakeholders (11 duplicates removed) and 25 individuals provided oral comments (Table 1). For the webinar hearing, there were 6 people registered for and signed in to the webinar; there may have been additional people who called in but there is no record for them. There were no commenters at one meeting. Oral comments were received by commercial fishermen (11, 44%), seafood dealers (2, 8%), sector managers (3, 12%), representatives of non-governmental organizations (NGOs; 8, 32%), and other interested individuals (1, 4%) (Table 2). Of the six people who attended more than one hearing, two commented once and four did not comment.

**Table 1 – Public hearing attendance**

<b>Location</b>	<b>Attendees*</b>	<b>Speakers</b>
Rockland, ME	50	6
Portsmouth, NH	6	2
Gloucester, MA	10	2
Plymouth, MA	10	5
Groton, CT	18	10
webinar	6**	0
<b>Total</b>	<b>100***</b>	<b>25</b>
* Not including Council members or staff ** Number of attendees registered for and signed into the webinar. Any additional people who called in could not be accounted for. *** 89 total attendees if duplicates removed.		

**Table 2 – Stakeholder type of speakers**

<b>Stakeholder Type</b>		<b>Speakers (n,%)</b>	
Commercial fisherman		11 (44%)	
	Groundfish fisherman		9 (36%)
	Other		2 (8%)
Seafood dealer		2 (8%)	
Sector manager		3 (12%)	
Non-governmental organization		8 (32%)	
	Environmental		5 (20%)
	Commercial fisheries		3 (12%)
Interested public		1 (4%)	

***Written commenters***

Twenty written comments were received during the comment period. Letters or e-mails were received from individuals (8, 40%), groups of individuals (2, 10%), businesses (1, 5%), non-governmental organizations (8, 40%), and a state agency (1, 5%). The state agency (Commonwealth of Virginia Dept. of Environmental Quality) indicated they have no substantive comments on Amendment 23. Thus, their letter is not considered further in this summary, which focuses on the stakeholders providing substantive comment.

The nineteen letters with substantive comments were identified by stakeholder type (Table 3). Of the eight individual letters, five were from commercial fishermen (four were groundfish fishermen and one said he previously held a groundfish permit), one was from a State Senator, and two were from other interested members of the public. One of the group letters was signed by 12 commercial fishermen; it was not determined how many of those actively groundfish, but many are known to hold groundfish permits. The other letter was a form letter from Pew Charitable Trusts containing the signatures of 7,618 members of the public.

**Table 3 – Stakeholder type of letters, by number (n) and percentage (%)**

<b>Stakeholder Type</b>		<b>Letter (n,%)</b>	
Commercial fisherman		6 (32%)	
	Groundfish		5 (26%)
	Other		1 (5%)
Non-governmental organization		8 (42%)	
	Environmental		5 (26%)
	Commercial fisheries		3 (16%)
Seafood dealer/processor		1 (5%)	
State Senator		1 (5%)	
Other public		3 (16%)	

***Oral and written commenters combined***

Through the 44 comments (i.e., 25 oral and 19 written, including one letter signed by 12 people), 48 people gave input on Amendment 23, removing duplicates (seven people both spoke at a hearing and signed a letter), plus an additional 7,618 signed a letter organized by Pew Charitable Trusts, with 669 of those providing additional personal comments. Of these additional comments, 87 were determined to be relevant to Amendment 23, and included themes such as “increased monitoring will improve accountability in the groundfish fishery” and “better monitoring will bring back cod from overfishing”;

comments related to other fishery management plans or general fishery management practices are not considered further. Home state could be determined for all but one commenter; for those representing an NGO, the NGO's physical address was a proxy for home state (Table 4).

**Table 4 – Home state of commenters**

State	Stakeholders	
	#	%
ME	18	38%
NH	1	2%
MA	15	32%
RI	5	11%
CT	5	11%
NY	1	2%
CA	1	2%
Unknown	1	2%
<b>Total</b>	<b>47</b>	<b>100%</b>

Of the 7,618 people who signed the letter from Pew Charitable Trusts, home state could be assigned for all but two commenters (Table 5). New England coastal states are highlighted first.

**Table 5- Home state of commenters who signed the Pew letter, with New England coastal states highlighted.**

State	Stakeholders	
	#	%
ME	63	0.8%
NH	64	0.8%
MA	273	3.6%
RI	41	0.5%
CT	120	1.6%
AK	21	0.3%
AL	70	0.9%
AR	23	0.3%
AZ	174	2.3%
CA	1488	19.5%
CO	220	2.9%
DC	22	0.29%
DE	14	0.2%
FL	494	6.5%
GA	103	1.4%
HI	36	0.5%
IA	46	0.6%
ID	33	0.4%
IL	244	3.2%
IN	92	1.2%
KS	43	0.6%
KY	51	0.7%
LA	36	0.5%
MD	138	1.8%
MI	207	2.7%
MN	115	1.5%
MO	104	1.4%

State	Stakeholders	
	#	%
MP	1	-
MS	10	0.1%
MT	25	0.3%
NC	173	2.3%
NJ	239	3.1%
NM	85	1.1%
NV	52	0.7%
NY	626	8.2%
OH	179	2.4%
OK	25	0.3%
OR	306	4.0%
PA	336	4.4%
PR	8	0.1%
SC	54	0.7%
SD	14	0.2%
TN	82	1.1%
TX	298	3.9%
UT	44	0.6%
VA	168	2.2%
VT	37	0.5%
WA	322	4.2%
WI	140	1.8%
WV	14	0.2%
WY	10	0.1%
Unknown	2	-
<b>Total</b>	<b>7618</b>	<b>100%</b>

There were eight NGOs represented, three representing commercial fishing interests and a broad and diverse membership within industry, and five representing environmental interests (Table 6).

**Table 6- List of NGOs that commented on A23**

Commercial fisheries	
	Long Island Commercial Fishing Association
	Maine Coast Fishermen's Association
	Northeast Seafood Coalition
Environmental	
	Conservation Law Foundation
	Environmental Defense Fund
	Oceania
	Pew Charitable Trusts
	The Nature Conservancy

### 1.3 COMMENT SUMMARY

The Groundfish Plan Development Team (PDT) identified the following general themes within the comments:

1. Perceptions of the Existing Monitoring Program
2. Purpose and Need
3. Costs/Benefits
4. Approach to Monitoring that is Not “One Size Fits All”
5. Electronic Monitoring in Place of At-Sea Monitors
6. Target Monitoring Coverage Levels
7. Dockside Monitoring
8. Streamlining Landings Reporting
9. Accuracy of Reporting
10. Other Comments

The PDT also summarized the benefits of various suggested changes to the monitoring program identified in the comments, as well as ideas for incentives offered. A table summarizing all suggested alternatives is also provided.

11. Benefits and Incentives
12. Suggested Alternatives

#### *1) Perceptions of the Existing Monitoring Program*

Comments generally acknowledged that the current monitoring system is expensive and ineffective and there is a need for improvement. Some commenters from industry said there should be no additional monitoring requirements. Several eNGOs recognized the current monitoring system as being inequitable for smaller vessels. Speaking to the dockside monitoring program in the past, several commenters from industry who had experience with it said it was ineffective and identified numerous problems with it.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All current problems combined</b>	<b>14</b>	<b>19</b>	<b>12</b>	<b>33</b>
2. Current monitoring not adequate to ensure accountability	2	5	0	7
3. Current system is expensive	3	2	2	6
4. Current system is inequitable for smaller vessels	2	2	2	2
5. Current system does not provide flexibility	2	1	3	2
6. Current system does not work to prevent overfishing or adhere to catch limits	0	4	0	6
7. Current system is not providing information needed for stock assessments	1	4	1	6
8. Current system is burdensome and outdated	0	1	0	4
9. Concern that some vessels are being monitored at a higher rate than 14%, the FY 2016 total coverage rate, because very few vessels in the sector are still actively fishing.	2	0	2	0
10. Previous dockside monitoring program was ineffective	2	0	2	0

## 2) Purpose and Need

For reference, the current purpose and need statement is:

*“The purpose of Amendment 23 is to adjust the groundfish monitoring program to improve reliability and accountability.”*

There were a handful of comments offering changes to consider for the purpose and need statement.

An industry member suggested changing the primary need of the amendment to “promote cost effectiveness” and the secondary need to “promote compliance.”

One commercial fishing NGO suggested including “the purpose of A23 is to reevaluate A16 and FW48 monitoring measures,” and “measures are sought that not only improve reliability and accountability across all segments of the monitoring program but also directly take into account measureable cost and benefits to the fishery while meeting requirements in the most cost effective manner possible.”

One eNGO defined accountability as “the ability to ensure that all landings and discards occurring within a fishery are accurately and reliably accounted for in order to ensure that annual catch limits are adhered to and that the best available information is included in stock assessments.”

There was also support offered for the purpose and need statement from both eNGOs and a commercial fishing NGO.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All purpose and need comments combined</b>	<b>4</b>	<b>5</b>	<b>2</b>	<b>7</b>
2. Promote cost effectiveness	2	0	1	1
3. Define accountability in the context of costs/benefits across all parties (industry and NMFS)	1	0	0	1
4. Promote compliance	1	0	1	0
5. Prevent overfishing	0	1	0	1
6. Support stock assessments	0	1	0	1
7. Ensure annual catch limits are adhered to	0	2	0	2
8. Reliability, accountability, and data accuracy should be primary goals	0	1	0	1

## 3) Costs/Benefits

There is concern that the industry cannot afford to pay for monitoring, particularly the small boat fleet. Many commenters from industry said they are fine with having monitoring as long as the government pays for it. Industry would like a clear definition of benefits along with a list of measurable and provable metrics, and would like to give input on this process. Costs should not exceed mutually agreed upon benefits.

One eNGO acknowledged the tradeoff between costs of monitoring paid by the industry and the benefits to scientists, managers, and fishermen from improved accuracy of catch and discard reporting; these benefits include reduced volatility in the annual quota setting process and improved accuracy in stock assessment results. Another eNGO said bio-economic tradeoffs of low monitoring coverage should be considered, including increased risk of overfishing, increased risk of abandoning analytical models in assessments due to retrospective error, and inefficient quota markets.



Several eNGOs recognized the current monitoring system as being inequitable for smaller vessels. One eNGO encouraged the Council to analyze the disproportionate impact of monitoring costs per unit of catch with the fleet to ensure smaller day boats that land a small fraction of total groundfish catch are not bearing the bulk of monitoring program costs relative to larger trip boats.

Some ideas for ways to offset monitoring costs were offered by eNGOs, and include quota auctions, quota set asides, subsidized upfront equipment costs for EM, and increasing value of well-documented catches in the market. One eNGO supports the Council evaluating the use of public-private partnerships to help fund increased monitoring coverage.

There were comments from both industry and eNGOs that electronic monitoring (EM) is a cost-effective alternative to current monitoring systems. One eNGO recommended using the most recent EM reports when analyzing costs. There are concerns from industry with costs of EM, specifically video review and equipment installation.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All cost comments combined</b>	<b>28</b>	<b>6</b>	<b>18</b>	<b>18</b>
2. Industry cannot afford to pay for monitoring	9	0	5	4
3. Cost effectiveness/value of monitoring can be improved	7	2	5	5
4. Current system is inequitable for smaller vessels	2	2	2	2
5. EM is a cost-effective option	3	2	1	4
6. EM is too expensive	7	0	5	3

#### ***4) Approach to Monitoring that is Not “One Size Fits All”***

This theme appeared numerous times throughout the comments – the idea that different segments of the fleet, namely small boats versus large boats, operate differently, and there should be flexibility and the option to tailor a monitoring program to these different needs. Interest in sector-specific monitoring programs was also raised, as well as gear-specific monitoring. These comments came from both industry and eNGOs. Several NGOs recommended approval of a maximum retention EM model, which is suitable to high volume vessels where an audit model might be difficult to implement. However, industry pointed out that maximum retention may not be practical for small vessels with limited hold capacity.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All “one size does not fit all” comments combined</b>	<b>13</b>	<b>9</b>	<b>11</b>	<b>18</b>
2. Monitoring should not be “one size fits all”	4	4	3	6
2. Allow flexibility for sectors to design their own monitoring programs; this includes ASM and/or EM, and require a universal set of standards for all programs	1	2	2	3
3. Allow sectors to develop sector specific ASM programs through their operations plans	2	0	2	1
4. Utilize a fixed discard rate with lower ASM coverage	1	0	0	1
5. Use a fixed ASM coverage rate	1	0	0	1
6. Consider sector or vessel specific discard rates	2	0	0	2
7. Consider gear specific ASM coverage rates	0	1	1	1
8. Vessels can take a higher ASM coverage rate in exchange for lower management uncertainty buffers	2	2	3	3

### 5) *Electronic Monitoring in Place of At-Sea Monitors*

Comments were a mix of those in favor of and against electronic monitoring (EM). Those who spoke against EM (generally commercial fishermen) raised concerns about the costs, logistics (for installation, sampling operation, etc.), and privacy concerns. Those who spoke in favor of EM (generally NGOs, both environmental and commercial fisheries, as well as fishermen currently participating in EM projects) described it as a valuable tool to be used as an alternative to human monitors, and as an opportunity to get fishermen's data directly into the stock assessment process. Some comments from industry said EM would increase accountability and encourage fairness among vessels. Most commenters said EM should be voluntary, not mandatory, and there should be incentives to encourage participation (example ideas included gear exemptions, additional quota, and closed area access).

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All electronic monitoring (EM) comments combined</b>	<b>17</b>	<b>19</b>	<b>19</b>	<b>28</b>
2. Vessels should have the option to use EM in place of at-sea monitors (ASM)	5	7	7	11
3. EM instead of ASM on selected trips, where EM is used to directly estimate discards consistent with current EM exempted fishing permits	0	3	0	3
4. Audit based approach for EM where EM runs on 100% of trips and a subset of hauls or trips is reviewed to verify VTR-reported discards	0	3	2	3
5. Maximum retention approach for EM where EM verifies that all groundfish are landed and uses dockside monitoring (DSM) to sample catch	1	4	2	5
6. Formally approve EM as a monitoring tool	0	2	1	2
7. Concern that problems with administration of current program will not be solved with EM technology	1	0	0	1
8. Opposition to EM	9	0	7	2
9. NEFOP should be the only program used to observe the groundfish fishery (no ASM or EM)	1	0	0	1

### 6) *Target Monitoring Coverage Levels*

Several eNGOs spoke in favor of 100% monitoring for all commercial groundfish trips. Other eNGOs recommended 100% coverage (whether EM or ASM) for particular circumstances, namely for high volume/high discards fisheries for vessels fishing in multiple broad stock areas on the same trip, to address problems with misreporting of catch area, or with exemptions to fish with multiple mesh sizes on the same trip (e.g., redfish exemption). No industry members commented in support of high levels of monitoring on groundfish trips or for specific types of trips.

Also, issues with ASM administration were raised by industry, including:

- Review of Pre-Trip Notification System (PTNS), specifically reexamine the time to notify requirement.
- Alternatives to A16 provisions that filter trips that are not targeting groundfish but are on days-at-sea (DAS) (e.g., monkfish, skates, dogfish) to reduce their priority for ASM selection.
- Require Dec. 31 deadline for NMFS to release analysis for determining at sea coverage monitoring requirements.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All monitoring coverage comments combined</b>	<b>3</b>	<b>11</b>	<b>6</b>	<b>16</b>
2. Support for 100% monitoring on all groundfish trips	0	3	2	6
3. Support for 100% monitoring (ASM or EM) for vessels fishing in more than one broad stock area on same trip	0	4	1	4
4. Analyze a range of ASM coverage rates from 5-100%, and thorough assessment of costs to industry associated with various rates and methods	0	1	0	1
5. Set goal of groundfish monitoring program to meet SBRM standards, to achieve 30% CV standard at fishery level rather than at the stock level	1	0	0	1
6. Re-examine metric used for measuring monitoring coverage (ex. volume of catch instead of number of trips)	1	0	0	1
7. Use discard-proportional observer coverage	0	1	0	1
8. Methodologies for setting ASM coverage rates that take into account “observer effects” to ensure accurate catch accounting	0	1	0	1
9. Concern that vessels on the “do not deploy” list do not receive observer coverage	0	1	1	1
10. ASM program should be voluntary	1	0	2	0

### **7) Dockside Monitoring**

There were several commenters speaking against a dockside monitoring (DSM) program – these were from industry and were from individuals who had experience with the previous groundfish fishery program and they identified numerous problems with it. There was consistent agreement that if a dockside monitoring program were to be instated, that the problems with the previous DSM be acknowledged, and that the lessons learned be used to develop a DSM that is more effective and efficient.

There is interest in having a DSM program used in conjunction with a maximum retention model for EM. One eNGO proposed DSM to monitor 100% of vessel landings.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All dockside monitoring comments combined</b>	<b>7</b>	<b>4</b>	<b>6</b>	<b>8</b>
2. Opposition to a dockside monitoring program	4	0	4	0
3. Support for a dockside monitoring program	2	1	1	4
4. Support for dockside monitoring used with maximum retention based electronic monitoring	1	3	1	4

### **8) Streamlining Landings Reporting**

Commenters were generally in favor of streamlining the reporting for landings data. Many were in favor of using electronic reporting for all reporting, and recommended having a single source for all data (i.e., dealer, vessel, observer) to reduce reporting redundancy. Many industry comments expressed a need for better accountability and timeliness by NMFS with dealer reporting and in following up with sectors.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All landings reporting comments combined</b>	<b>9</b>	<b>8</b>	<b>9</b>	<b>11</b>
2. Streamline landings reporting/reduce redundancy	5	3	6	4
3. Expand electronic reporting	2	4	1	5
4. Improve timeliness by NMFS of data processing with dealer reporting	2	1	2	2

### 9) Accuracy in Reporting

#### Spatial Reporting:

There were comments in favor of improving spatial resolution of catch reporting, in order to report catch location at a finer scale than broad statistical areas. Some recommended requiring all reporting to be at a haul by haul level (currently only required for EM). Comments suggested improving current vessel monitoring systems (VMS), which is necessary to allow haul by haul reporting.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All spatial reporting comments combined</b>	<b>2</b>	<b>6</b>	<b>4</b>	<b>7</b>
25. Improve spatial resolution of catch reporting (require catch reporting at finer scale)	0	1	0	1
25. Improve/replace VMS to allow haul-by-haul reporting	2	3	3	4
26. Require haul-by-haul reporting on all trips	0	2	1	2

#### Observer Bias:

There were several comments on “observer bias.” Comments from industry suggest the observer effect may be due to annual catch limits that are out of scale with actual abundance. One commercial fishing NGO argues the observer effect would be mitigated if quotas reflected reality, and attributes this to problems with stock assessments. Industry also recommended increasing enforcement of existing regulations to reduce observer bias. ENGOS also recognize that there are strong economic incentives for fishermen to fish differently with an observer on board and acknowledge observer bias is an issue that may impact accurate catch accounting.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All observer bias comments combined</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>4</b>
2. Explore alternative methodologies for setting ASM coverage rates that take into account “observer effects” to ensure accurate catch accounting	0	1	0	1
3. Include simulation analyses which incrementally increase ACLs for constraining stocks to detect the point at which the “observer effect” is mitigated	1	0	1	1
4. Increase enforcement of existing regulations to reduce the effect of observer bias	1	0	1	1
5. Management uncertainty buffers should be increased until issues with observer effects are eliminated	0	1	0	1

### Other Concerns:

A number of “other concerns” related to accuracy of reporting were included in the comments and are summarized below.

Topic	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>1. All other concerns comments combined</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>6</b>
2. Develop an Arbitration Board for sector ASM data to establish a better process by which captains receive a summary of their trip by monitors prior to leaving vessel and or captains and their respective managers to vet data.	1	0	0	1
3. Review the protocols associated with the “volumetric approach” when estimating catch and discards by observers	1	0	0	1
4. Review the “K-all” approach, whereby discards are extrapolated stratum wide	1	0	0	1
5. A more thorough review of the “transitional rate” applied to discards for a sector when sectors are unable to increase coverage due to PTNS vessels selection protocols	1	0	0	1
6. Alternatives for modifications to satisfy the Standardized Bycatch Reporting Methodology (SBRM) guidelines	0	1	1	1
7. Include a performance review of the Groundfish FMP catch and bycatch monitoring program	0	1	1	1

### ***10) Other Comments***

#### Public Hearing Locations:

There were complaints that no public hearings were scheduled in New Bedford, and less so, Rhode Island.

#### Council Process:

There were concerns expressed from industry that the Council does not address stakeholders’ concerns and does not take into consideration the status of the fleet.

### ***11) Benefits and Incentives***

#### **Benefits:**

##### Electronic Monitoring:

- Allows fishermen’s data to be verified, improving accuracy of fishery-dependent data.
- Allows fishermen’s data to become a part of the scientific process, increasing industry trust in stock assessments.
- Increases accountability and encourage fairness among vessels.

##### 100% Monitoring:

- Increases reliability of data for quota monitoring and assessments.

- Eliminates potential bias due to observer effects.
- Increases vessel incentives to avoid bycatch and accurately report catch.
- Improves confidence in data used for management decision.
- Simplifies program logistics.

100% monitoring with DSM for high volume/high discard fisheries for vessels that fish in more than one broad stock area on same trip:

- Improves accuracy of fishery-dependent information.
- Improves fleet-wide accountability.
- Addresses problem of misreporting of catch by broad stock area.
- Allows sale of small fish to be kept and help pay for monitoring costs.

Changes to Landings Reporting:

- Expands electronic reporting to improve reporting accuracy and provide more timely data.
- Requires haul by haul reporting for all trips to improve spatial resolution of reporting.
- Reduces reporting redundancy resulting in less data reconciliation for sector managers and faster processing time to get data back to sectors.

### **Incentives:**

Electronic Monitoring – additional incentives or fishing exemptions for those who agree to use EM and be 100% accountable:

- Additional quota set aside
- Access to additional quota bank
- Additional carryover allowances
- Exempted use of certain gear/mesh size (e.g. allowance to use 5.1 inch square mesh cod end to target healthy haddock stocks)
- Exemptions to fish multiple gear types on the same trip (e.g. groundfish and tuna gear)
- Exemptions from PTNS
- Subsidized upfront equipment costs for EM
- Access to special closed areas

100% Accountability

- Gear/mesh size exemptions
- Special access programs
- Lower uncertainty buffers
- Exemptions from certain reporting requirements

## 12) Suggested Alternatives

Below is a summary of suggested alternatives included in the comments. Suggested alternatives coming from industry are designated with an “\*”.

Suggested Alternatives	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
<b>Costs and Incentives</b>				
1. All industry funded costs should be removed*	3	0	2	2
2. Cost of monitoring based on percentage of gross profit from a given fishing trip, rather than a set fee*	1	0	0	1
3. Offer incentives to vessels that adopt EM and are 100% accountable, including: additional quota set aside, access to additional quota bank, additional carryover allowances, gear/mesh size exemptions, access to special closed areas, exemptions from PTNS, subsidized upfront equipment costs for EM, and lower uncertainty buffers	1	2	1	3
4. Consider funding alternatives for monitoring, including: quota auctions, quota set asides, revenue from quota leasing/sales, increasing value of well-documented catches in the market, and sale of undersized fish retained under maximum retention	0	1	1	1
<b>Not “One Size Fits All”</b>				
5. Allow flexibility for sectors to design their own monitoring programs; this includes ASM and/or EM, and require a universal set of standards for all programs*	1	2	2	3
6. Allow sectors to develop sector specific ASM programs through their operations plans*	2	0	2	1
7. Utilize a fixed discard rate with lower ASM coverage*	1	0	0	1
8. Use a fixed ASM coverage rate*	1	0	0	1
9. Consider sector or vessel specific discard rates*	2	0	0	2
10. Consider gear specific ASM coverage rates	0	1	1	1
11. Vessels can take a higher ASM coverage rate in exchange for lower management uncertainty buffers*	2	2	3	3
<b>Electronic Monitoring</b>				
12. Vessels should have the option to use EM in place of ASM	5	7	7	11
13. Use of electronic monitoring (EM) instead ASM on selected trips, where EM is used to directly estimate discards	0	3	0	3
14. Audit based approach for EM where EM runs on 100% of trips and a subset of hauls or trips is reviewed to verify VTR-reported discards	0	3	2	3
15. Maximum retention approach for EM where EM verifies that all groundfish are landed and uses dockside monitoring (DSM) to sample catch	1	4	2	5
16. Formally approve EM as a monitoring tool	0	2	1	2
17. NEFOP should be the only program used to observe the groundfish fishery (no ASM or EM)*	1	0	0	1
<b>Target Monitoring Coverage Levels</b>				
18. 100% monitoring on all groundfish trips	0	3	2	6
19. Analyze a range of ASM coverage rates from 5-100%, and thorough assessment of costs to industry associated with various rates and methods	0	1	0	1
20. 100% monitoring (ASM or EM) for vessels fishing in more than one broad stock area on same trip	0	4	1	4

Suggested Alternatives cont.	People commenting (#)		Comments (#)	
	Industry	eNGO	Oral	Written
21. Set goal of groundfish monitoring program to meet SBRM standards, to achieve 30% CV standard at fishery level rather than stock level*	1	0	0	1
22. Re-examine metric used for measuring monitoring coverage*	1	0	0	1
23. Use discard-proportional observer coverage rates	0	1	0	1
24. ASM program should be voluntary*	1	0	2	0
25. 100% monitoring for those caught doing something wrong (i.e., punitive monitoring)*	1	0	1	0
26. Prioritize monitoring of a “high risk stock” (e.g., Gulf of Maine cod) over a “low risk stock” (e.g., Georges Bank haddock)*	1	0	1	0
27. Explore alternative methodologies for setting ASM coverage rates that take into account “observer effects” to ensure accurate catch accounting	0	1	0	1
<b>Dockside Monitoring</b>				
28. Dockside monitoring used with maximum retention based electronic monitoring	1	3	1	4
29. 100% dockside monitoring	0	1	0	1
<b>Landings Reporting</b>				
30. Streamline reporting into a single source (vessel, dealer, observer); eliminate logbooks*	1	0	1	0
31. Renewed process for reducing reporting redundancies*	5	3	6	4
32. Expand electronic reporting	2	4	1	5
33. Improve timeliness by Agency of data processing with dealer reporting	2	1	2	2
<b>Other Reporting Issues</b>				
34. Improve spatial resolution of catch reporting (require catch reporting at finer scale)	0	1	0	1
35. Improve/replace VMS to allow haul-by-haul reporting	2	3	3	4
36. Require haul-by-haul reporting on all trips	0	2	1	2
37. Increased use of verified fishery-dependent catch information in stock assessment process*	3	1	2	3
38. Develop an Arbitration Board for sector ASM data to establish a better process by which captains receive a summary of their trip by monitors prior to leaving vessel and or captains and their respective managers to vet data*	1	0	0	1
39. Include simulation analyses which incrementally increase ACLs for constraining stocks to detect the point at which the “observer effect” is mitigated*	1	0	1	1
40. Increase enforcement of existing regulations to reduce the effect of observer bias*	1	0	1	1
<b>ASM Administrative Issues</b>				
41. Review of PTNS system, specifically reexamine time to notify requirement*	2	0	1	1
42. Alternatives to A16 provisions that filter trips that are not targeting groundfish but are on DAS (e.g. monkfish, skates, dogfish) to reduce their priority for ASM selection*	1	0	0	1
43. Require Dec. 31 deadline for NMFS to release analysis for determining at-sea coverage monitoring requirements*	1	0	0	1
<b>Other</b>				
44. Consider annual landings limits*	2	0	2	0
45. Review the protocols associated with the “volumetric approach” when estimating catch and discards by observers*	1	0	0	1



<b>Suggested Alternatives cont.</b>	<b>People commenting (#)</b>		<b>Comments (#)</b>	
	<b>Industry</b>	<b>eNGO</b>	<b>Oral</b>	<b>Written</b>
46. Review the “K-all” approach, whereby discards are extrapolated stratum wide*	1	0	0	1
47. A more thorough review of the “transitional rate” applied to discards for a sector when sectors are unable to increase coverage due to PTNS vessels selection protocols*	1	0	0	1
48. Alternatives for modifications to satisfy the Standardized Bycatch Reporting Methodology (SBRM) guidelines	0	1	1	1
49. Include a performance review of the Groundfish FMP catch and bycatch monitoring program	0	1	1	1



New England Fishery Management Council

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## SCOPING MEETING SUMMARY

**Northeast Multispecies Fishery Management Plan  
Amendment 23  
March 3, 2017  
Samoset Resort  
220 Warrenton Street  
Rockport, ME 04856**

The Council held a scoping hearing to accept public comments on the intended scope of Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan. The purpose of Amendment 23 is “to adjust the groundfish monitoring program to improve reliability and accountability.” Copies of the scoping document were available at the meeting and the Council website.

**MEETING ATTENDANCE:** Terry Stockwell (Groundfish Committee Chair); and Jamie Cournane and Robin Frede (Council Staff). In addition, approximately 50 members of the public attended, including Ben Martens (Groundfish Advisory Panel Chair) and several GARFO and NEFSC staff.

*The meeting began promptly at 9:00 am.*

Hearing Chairman Terry Stockwell began the meeting with a brief introduction, explaining the procedure for public scoping. Dr. Jamie Cournane gave a brief presentation, detailing the public scoping process, explaining the purpose and need of Amendment 23, and highlighting some relevant questions from the public scoping document. After addressing clarifying questions, Mr. Stockwell opened the hearing for public comments.

### **Comments:**

Those who commented were generally in favor of the development of this amendment. Most gave initial comments and said to expect further comments, likely in written format.

**Ms. Libby Etrie**, with the Northeast Sector Service Network, commented that as it relates to this monitoring amendment, it will be critical that the Council look at ways to improve the shoreside data reconciliation process and to streamline the weekly reporting process for sectors to make it more effective. She stated that currently managers are taking the majority of NMFS data,

repackaging it, and turning it over to them, and there have been some discussions on ways to make this more efficient, but this has been stalled based on language in Amendment 16. Ms. Etrie again emphasized the need to look at shoreside reporting in addition to seaside data and ways that it can be improved.

**Mr. Geoffrey Smith**, Marine Program Director for The Nature Conservancy in Maine and member of the Groundfish Advisory Panel, said The Conservancy is strongly in support of the Council's development of this monitoring amendment. He agreed with the amendment's fundamental goal of improving the groundfish monitoring program, and stated that timely and accurate reporting is critical to the success of the groundfish management program. He thought that better reporting can help ensure compliance with annual catch limits, ensure the best information is available to inform stock assessments, and will hopefully lead to more efficient utilization of fishing quotas. Mr. Smith expressed concern that the current monitoring program at the 14% observer coverage rate is failing to provide the Council and the agency (NMFS) the information they need to manage the fishery well, and also recognized that there are strong economic incentives for fishermen to fish differently with an observer on board (observer bias). He recognized serious problems with retrospective patterns in stock assessments, which is resulting more and more in the rejection of assessments in the peer review process, and noted that improvements in the monitoring program will help to solve some of those problems.

Mr. Smith urged the Council to develop a range of alternatives through this amendment that will improve the monitoring program, in particular, to evaluate significantly increasing the coverage rates, and to consider electronic monitoring (EM) as an addition to human observers. He recognized that any alternatives that increase coverage rates will likely result in economic impacts to the industry, and urged the Council to carefully look at what these impacts will be, but said he also thinks it's equally important to consider the potential benefits from increasing coverage rates, such as removing wild swings in assessments with better data and ensuring the fishery is being managed better, which will hopefully result in quicker recovery of stocks and lead to better performance of the fishery. Mr. Smith also recommended the Council consider the broader use of EM systems, pointing to the Conservancy's ongoing EM projects, and said he hopes the Council will consider EM as both an audit and maximum retention-based approach. He also thought this amendment provides the opportunity to take the steps to formally approve EM as an alternative tool and not just use through an exempted fishing permit.

**Mr. Vito Giacalone**, with the Gloucester Fishing Community Preservation Fund and the Northeast Seafood Coalition, was in support of moving forward with the amendment. He said that improvements to the groundfish monitoring program are needed, and specifically there needs to be a focus on getting the most important data for the least amount of cost possible. For these same reasons, he had supported the stop-gap measures in Framework 55, but emphasized the need for more comprehensive changes that will be lasting for the fishery. Mr. Giacalone commented that the fleet is fishing at 10% capacity of the past (10-15 years ago), and to consider the fact that the monitoring system is causing fishing behavior to change. He stated that it's important to question whether the fleet is fishing in different areas than before and changing their fishing behavior slightly, or whether there is a disconnect in the allowable quota from what it should be. He commented that when the quotas do not reflect reality, you will get the response of

changes in fishing behavior. He recommended that the Council conduct a sensitivity analysis to determine how much the quota would have to move for this fishing behavior concern to be removed.

**Ms. Allison Lorenc**, with the Conservation Law Foundation (CLF), was in full support of the amendment. She said CLF has been observing overfishing of Atlantic cod since the 1990s and would like to get to the bottom of this, and that begins with more accurate and reliable data collection at sea. She stated CLF would be in full support of considering an alternative for 100% monitoring with maximum retention, and moving towards better utilizing EM.

**Mr. Hank Soule**, with the Sustainable Harvest Sector, thought this amendment should look at the quality of landings data since landings make up 95% of catch. He recommended the Council ask NMFS how they confirm landings. He emphasized cost consideration, in particular, the potential of prioritizing the monitoring of a “high risk stock” like Gulf of Maine cod over “low risk stocks” such as Georges Bank haddock. Mr. Soule also asked that if the Council proceeds with a dockside monitoring program (such as the one that existed in 2010), that they analyze how a dockside monitoring program might add value to dealers, NMFS, and fishermen. Speaking about the use of increased VMS polling to track catch data, he pointed out that there might be less expensive ways of gathering position information for catch attribution by using different technologies that allow the data to be stored and offloaded at the end of the trip, as opposed to using real-time polling, which is expensive and serves the main purpose of monitoring boats to make sure they are not going into closed areas.

**Ms. Etrie** also commented on the issue of VMS polling, and recommended that the Council should start by working with the agency (NMFS) to determine what type of system they can automate to review VMS activity and match it to VTR data, especially since NMFS is already looking at this with the scallop fishery and this could be rolled over to the groundfish fishery. Ms. Etrie suggested that it may be that NFMS can adopt an additional review process when entering VTR data, rather than using more VMS polling.

**Mr. Ben Martens**, with the Maine Coast Fishermen’s Association, spoke of the question of fairness, in making sure that fishermen are all working off of the same set of standards. He emphasized that the idea of accountability in this fishery is something that is discussed a lot amongst fishermen and at Council meetings and this needs to be a major part of the amendment. Mr. Martens stated that it’s important that we know what is going on out on the water, and fishermen should be able to have trust in what is happening on other boats that are fishing in the same areas. He commented that the monitoring system has been operating under a “one-size-fits-all” approach - which is not effective, and pointed to analysis that the Gulf of Maine Research Institute (GMRI) has done to look at how to potentially do cost-effective monitoring by prioritizing trips that are catching the most fish. He said that it’s time to address the fact that the current monitoring program doesn’t work for everybody in the fleet, and this amendment provides the opportunity to reimagine a better monitoring program.

Mr. Martens spoke of the use of cameras as an opportunity to not only replace human observers but to provide a better data stream into the management process, and noted that this agrees with

Mr. Giacalone on the need for cost-effective data. Mr. Martens pointed to the problem of retrospective patterns in stock assessments resulting in these assessments being thrown out, the most recent example being witch flounder, and to mistrust in the assessment process, and suggested that having additional verifiable sources of fisheries data should help reduce these problems. He stated that the use of EM will allow fishermen's data to be a piece of the scientific process, as it will provide a way to verify this data source and add value to it. Mr. Martens added that anything that can be done to streamline landings reporting is very important to the fleet. He also brought up the point that monitoring should not be confused with enforcement, explaining that monitors are often put in a position of enforcement, when instead there should be better enforcement and actual consequences.

*The scoping hearing adjourned at approximately 9:35 am.*



## New England Fishery Management Council

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# SCOPING MEETING SUMMARY

## Northeast Multispecies Fishery Management Plan

### Amendment 23

March 21, 2017

Portsmouth Library

175 Parrott Avenue

Portsmouth, NH 03801

The Council held a scoping hearing to accept public comments on the intended scope of Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan. The purpose of Amendment 23 is “to adjust the groundfish monitoring program to improve reliability and accountability.” Copies of the scoping document were available at the meeting and the Council website.

**MEETING ATTENDANCE:** Terry Stockwell (Groundfish Committee Chair); and Jamie Cournane and Robin Frede (Council Staff). In addition, 6 members of the public attended.

*The meeting began at 2:15 pm.*

Hearing Chairman Terry Stockwell began the meeting with a brief introduction, explaining the procedure for public scoping. Dr. Jamie Cournane gave a brief presentation, detailing the public scoping process, explaining the purpose and need of Amendment 23, and highlighting some relevant questions from the public scoping document. After addressing clarifying questions, Mr. Stockwell opened the hearing for public comments.

### **Comments:**

**Mr. David Goethel**, F/V Ellen Diane, Hampton, NH, clarified that these comments are his own and do not represent either the Northeast Seafood Coalition or Cause of Action. He began with a general comment regarding the current political situation. He said the Council and National Marine Fisheries Service (NMFS) will need to change how they do business in light of what will be the largest dissolution of government in years and will need to plan for large funding cuts and elimination of entire programs. He said he has heard of many fishermen writing letters to President Trump complaining about NMFS, and particularly at-sea monitors.

Mr. Goethel thought that the primary need of the amendment should be changed to “promote cost effectiveness” and the secondary need changed to “promote compliance,” and not “enhance compliance” as it is written in the scoping document. He said he does not think there will be enough money to enhance compliance, and said the way to promote compliance is through programs that people want to comply with. He said that some of the statements about the goals of monitoring in the scoping document should be reexamined, specifically that “the at-sea monitoring program provides the highest quality data,” as he pointed to high error rates in observer data and said this data can be skewed in either direction (observers sympathetic to the crew or recording very high, untrue discard numbers). He also pointed to the statement that “there is evidence of fishing behavior differences when an observer is onboard” as being untrue, and said there has been extensive analysis that has proved otherwise, and that this statement is problematic because it infuriates and alienates fishermen.

Mr. Goethel said the current data stream is inefficient and employs too many people, and there is a need to simplify it. He said reporting should start with the dealer, as the dealer is the most accurate source of data since they actually weigh the catch, and this should be the only data stream; there should be no logbooks, the fisherman should fill out his information on the dealer report, and if the trip is observed then the observer should enter the data on the same dealer report. This practice, he said, will allow everyone to certify the accuracy of the data and simplify it into one data stream. Mr. Goethel was opposed to a dockside monitoring program, and said there were problems with the previous program as it was another place for data errors due in large part to catch being weighed in partial amounts, and said he had issues with fish spoiling in the hold while waiting for a monitor. He explained that joint enforcement compliance is the current dockside monitoring system, the difference being they don’t keep a separate tally of the catch. He said he would also like to see changes with the Pre-Trip Notification System (PTNS) call-in system since weather forecasts are not accurate enough to predict conditions 48 hours in advance, and he thought it should be 12 hours or even 24 hours.

Mr. Goethel said that civil liberties will have to be considered with this amendment, and that the current treatment of fishermen is that they are considered guilty until proven innocent, when it should be the opposite. He stated that putting cameras on boats would be a violation of civil liberties and he would challenge this in court. He said if someone is proven guilty, then they should pay the cost in the form of 100% observer and dockside monitoring coverage. He said other fishermen should not pay the price, and instead increased monitoring should apply only to those who are guilty. He was opposed to dockside monitoring unless it is for someone who is guilty, and they should have to pay for it. Mr. Goethel thought this system would promote compliance. He also emphasized that anything done should prove that it enhances information for management, unlike the intensive monitoring the groundfish fishery has experienced since 2010, which has not met the stated goal in Amendment 16 of improving stock assessments.

**Mr. Daniel Salerno**, sector manager for Northeast Fisheries Sector 11 and 5, New Hampshire and Rhode Island based, opened with a general comment that industry is trying to do the right thing, and that the bulk of the industry should not pay for what a few do. He emphasized the fact that no two sectors are the same, and that any changes to monitoring should provide flexibility for sectors operating differently, as the current system does not allow for that. He pointed to

issues with observers, not only the costs but also problems with data quality because this varies by observer, and explained some internal analysis he has done to compare observer and dealer data which found observers tend to overestimate weight. With respect to landings data, Mr. Salerno said the Council cannot develop another reporting system as there are already problems with reconciling data, and explained as a sector manager he has to reconcile 3-4 datasets every day, but said that a change to this system would be a good idea. He also talked about management and biological uncertainty buffers, and suggested perhaps developing a monitoring program that is less robust but with a tradeoff of higher uncertainty buffers.

**Mr. Goethel** spoke again saying he was in favor of annual landing limits. He explained the problem with sector monitoring is that it is adversarial because crew see any fish recorded as a discard as costing them money, and that an annual landings limit would remove this adversarial relationship between the observer and crew. He thought that discards could disappear with how many uncertainty buffers there are in place, pointing out that there are no discard rates of groundfish with an assumed discard rate over 4%, and that both scientific and management uncertainty are greater than this and should cover for it.

**Mr. Salerno** spoke against having a dockside monitoring program, at least one that is mandatory across the board. He said it could be a choice for a sector to use, but thought that it was a worthless data stream that resulted in more conflict. He explained the problem with the previous dockside monitoring program, and the reason it was suspended, was the lack of confirmation that all fish had been offloaded because the dockside monitors were not authorized to thoroughly inspect the fish holds, which resulted in inaccurate counts.

**Mr. Goethel** again emphasized the need for a single stream of data, and said along with that, he would like to see more samples taken at the co-op, and to have a port sampler enter that data into the single stream. He also spoke of the differences he has seen in how Europe handles fisheries science, where there are no third party observer providers and instead scientists collect the data. He thought scientists and managers here should spend more time at sea to understand the difficulty in collecting this data so they would not accept inaccuracies in weight measurements, and to see what is going on out on the water.

*The scoping hearing adjourned at approximately 2:52 pm.*





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## SCOPING MEETING SUMMARY

### Northeast Multispecies Fishery Management Plan Amendment 23 March 21, 2017

NOAA Greater Atlantic Regional Fisheries Office  
55 Great Republic Drive  
Gloucester, MA 01930

The Council held a scoping hearing to accept public comments on the intended scope of Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan. The purpose of Amendment 23 is “to adjust the groundfish monitoring program to improve reliability and accountability.” Copies of the scoping document were available at the meeting and the Council website.

**MEETING ATTENDANCE:** Terry Stockwell (Groundfish Committee Chair); and Jamie Cournane and Robin Frede (Council Staff). In addition, 10 members of the public attended, including several GARFO staff.

*The meeting began at 6:05 pm.*

Hearing Chairman Terry Stockwell began the meeting with a brief introduction, explaining the procedure for public scoping. Dr. Jamie Cournane gave a brief presentation, detailing the public scoping process, explaining the purpose and need of Amendment 23, and highlighting some relevant questions from the public scoping document. After addressing clarifying questions, Mr. Stockwell opened the hearing for public comments.

#### **Comments:**

**Ms. Katharine Deuel**, Pew Charitable Trusts, said that the sector system and annual catch limits that were implemented in Amendment 16 were steps in the right direction, but lack of monitoring and accountability are preventing the broader recovery for the overfished groundfish stocks. Ms. Deuel explained that Pew thinks that a monitoring program that records and verifies 100% of landings and discards on all fishing trips is the best option for a truly accountable fishery that uses best available science, and that this would generate vital data to improve stock assessments and set appropriate catch limits. Ms. Deuel stated that 100% monitoring should capture all fishing activity, accurately record all discards at sea, and verify landed catch, and that this can be

achieved through a variety of tools designed to be cost effective, efficient, and make best use of monitoring technology. She recommended that a wide variety of options and combinations including electronic monitoring, at-sea and dockside monitors, and improved enforcement measures be analyzed in Amendment 23. She stated that improved monitoring will lead to improved scientific information and hopefully a more accountable and sustainable era for this region's iconic fishery.

**Ms. Jackie Odell**, Northeast Seafood Coalition, recommended that Amendment 23 reexamine provisions in Amendment 16 related to administration requirements, and specifically look at ways to provide guidance to the Agency (National Marine Fisheries Service) to reduce reporting redundancy. She explained that while Framework 55 did examine ways to meet coefficient of variation (CV) requirements, there needs to be more statistical analysis done to create more stability in monitoring coverage, as there have been huge swings in coverage from year to year for many of the stocks, Georges Bank winter flounder and redfish being recent examples, depending on the activity of the fishery. She said that it is important to look at other statistical analysis that would consider smoothing for the coverages, particularly given that the industry is now paying for monitoring. Ms. Odell spoke on the timeline requirements for industry to submit their operations plans, and said that the industry would like this to go both ways and to see a more timely nature of when they receive reports from the Agency for what they can expect for coverage rates for the following fishing year, and this would be greatly appreciated as it would help them better consider sector rosters in time for the fishing year. She emphasized the importance of improving reliability and accountability not only with catch monitoring and reporting with the industry, but also with reconsidering elements of the monitoring and reporting requirements that could be more streamlined.

Ms. Odell referred to recent discussions of the costs and benefits of the monitoring program and said this should be looked at very closely, to consider what information is being acquired, how it is being used in science and management, and what the tangible benefit is to the fishing industry in paying for the at-sea monitoring program. She explained there has also been some discussion of diminishing returns where the costs far exceed any benefit of monitoring discards, and that this amendment should examine that and expand on the preliminary discussion in the [Groundfish Plan Development Team] white paper. She thought that whether using at-sea monitoring or electronic monitoring, there should be basic standards to be achieved regardless of the technology or program used, and that a one-size-fits-all approach does not work for monitoring since some technology may be better suited for some in industry and not work for others. She said this amendment should provide guidance and standards to sectors so they can tailor a monitoring program most appropriate for their operations. Ms. Odell also spoke on the observer effect, and recommended analysis and alternatives that would look at this with a different perspective to examine at what point the observer bias comes into play when considering stock assessments (as in, when there are few fish there should be less concern with having an observer onboard), and to examine whether the assessments are accurate or are unrealistic compared to what is seen on the water, halibut being one example.

*The scoping hearing adjourned at 6:32 pm.*



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## SCOPING MEETING SUMMARY

### Northeast Multispecies Fishery Management Plan

#### Amendment 23

March 22, 2017

Hilton Garden Inn

4 Home Depot Drive

Plymouth, MA 02360

The Council held a scoping hearing to accept public comments on the intended scope of Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan. The purpose of Amendment 23 is “to adjust the groundfish monitoring program to improve reliability and accountability.” Copies of the scoping document were available at the meeting and the Council website.

**MEETING ATTENDANCE:** Terry Stockwell (Groundfish Committee Chair); and Jamie Cournane and Robin Frede (Council Staff). In addition, 10 members of the public attended.

*The meeting began at 6:03 pm.*

Hearing Chairman Terry Stockwell began the meeting with a brief introduction, explaining the procedure for public scoping. Ms. Robin Frede gave a brief presentation, detailing the public scoping process, explaining the purpose and need of Amendment 23, and highlighting some relevant questions from the public scoping document. After addressing clarifying questions, Mr. Stockwell opened the hearing for public comments.

#### **Comments:**

Those who commented were generally not in favor of Amendment 23. Comments generally reflected a concern over the cost of monitoring, particularly for the small boat fleet, and a strong opposition to electronic monitoring.

**Mr. Ed Barrett** began by referencing a line from the presentation outlining the purpose of the amendment, “necessary to manage the fishery efficiently,” and said his concern is that efficiency in fishery management means having a big boat fleet with a small number of boats operating, where costs aren’t as important to them, and that many small boats will go out of business. He thought that efficiency in monitoring would be to take all the information that has been gathered

for the past 20 years, collate it and analyze it, and said that there has been enough data collected and there is no need for monitors because this knowledge already exists, and that there are specific percentages that industry could agree on. He said this would be efficient, if the data already collected were used, so that he would not have to install expensive electronic monitoring on his boat or pay for a monitor, and would not have to pay for data that's not really used. He explained that the monitoring coverage rate is 15%, but said they have been getting monitored at higher rates, and said at times being the only member of his sector fishing he has been getting closer to 30% or 40% coverage. He said this is a problem that some boats are monitored a lot and others not at all, and he should not pay for this many observers.

Mr. Barrett said that monitoring became the big issue when catch shares failed, that groups like the Moore Foundation, Pew, Environmental Defense Fund, and Oceania got involved and debated monitoring instead of the failure of catch shares, and he pointed to Gulf of Maine cod crashing following a rebuilding period as an example where catch shares failed but problems with monitoring were blamed, which he said was a falsehood. He stated that monitoring has become a money-making grab for the private [observer] companies, including one that the ex-Regional Administrator used to own, and said he gets marine mammal observers (from MRAG) for state fishery trips in a fishery that doesn't catch marine mammals. He also pointed out that at this public hearing for all of the South Shore, Cape, and New Bedford, only three boats were present, and said that if the Council wants a small boat fleet they will have to manage so they can economically survive, which means not having to pay for observers on five out of six trips and not putting a \$60,000 electronic monitoring system on their boats that can't tell the difference between a blackback, a yellowtail, a grey sole, and a dab, and is not efficient.

**Ms. Maya Barrett**, wife of Ed Barrett who sometimes fishes with him, pointed out that at these meetings there are more people in the front of the room than in the back [attending the meeting], and said this doesn't make sense.

**Mr. Steve Welch**, commercial fisherman, said he is okay with taking monitors but just cannot pay for them. He was strongly against having cameras on boats, and said it would take too long to stop the fishing process to hold the fish in front of the camera. He said he cannot afford to take a monitor out for \$750 a day, and said he is at 25% monitoring coverage. He said as a fisherman he has to constantly pay for more and more, and that the government should pay to put someone on his boat or he will be put out of business.

**Mr. Ron Burgerson**, a commercial fisherman from Plymouth for 46 years, said he agrees with everything the previous speakers have said, and said this amendment is a disgrace, particularly with regard to observers because they cannot afford to pay for them. He said because of the expense of monitoring the vessels left in the industry are not getting the necessary maintenance as they become aged and are becoming dangerous, and this is all due to lack of income, which he said is due to catch shares. He thought dockside monitors would just be another expense and another set of eyes that take hardworking people and portray them as public enemy #1. He said he already has to pay for VMS (\$70-120 a month depending on the time of year), which he sees as another useless piece of equipment he is mandated to have. Mr. Burgerson said that the Council is not looking at the state of the fleet or seeing how people are being put out of business,

and there is no attention paid to what fishermen need just to get by with the bare minimum. He said next year he may not break even, although the increase in grey sole and dabs will help, but that the Council needs to take this into consideration. He stated that everything in Amendment 23 is more fleecing and harassment of fishermen, and he does not want to see this go further. He thought there should be no at-sea monitoring, no electronic monitoring, no dockside monitoring, and no VMS, because he cannot afford it.

**Mr. Tim Barrett**, F/V Odessa and president of Northeast Fishing Sector X, said he agrees with what everyone else has said, and said electronic monitoring is not going to help the fleet because it will be an expensive system between the costs for installation, costs for data processing, and the resources for the electrical systems needed on the boats, and they cannot pay for it. He thought there already are enough layers of monitoring between having to call in 48 hours in advance of fishing, dealing with the assigned observer, calling out the intention to go fishing, calling when coming back in, filing VTRs, having environmental enforcement at the dock, and filling out dealer reports, and said he has never seen any of this data used. Mr. Barrett said there has been talk of having full retention of discards with electronic monitoring, but explained this will not work for small boats because they do not have the capacity to hold these additional fish that they do not make money on, and that it will require more work. He pointed to cod as a species that is break even at best for him, and said he has to sell leased cod usually at a loss, and that this is similar for other species as well. He explained that this means the lease that he has to buy in order to fish is already taxed at 35% off the top, adding another expense to his business.

Mr. Barrett emphasized what everyone else said about the small boat fleet barely surviving, and said they have a very thin margin of profit. He said they spend all their time running from choke species, especially cod, and spending so much time dealing with fish he can't make any money on has caused him to become disenchanted with the system. He thought the monitoring level is more than sufficient and said that this particular group of small boat fishermen cannot afford to pay for monitoring, and that any increase in costs will put them in the red.

**Mr. Ed Barrett** spoke about the failure of monitoring in the bigger boat fleet, to consider what one of the big operators did to get around the law, and that the costs of monitoring can only be borne by the big operators. He said that between the VTRs, environmental police, and monitors, that should be enough to monitor the catch, and said he is frustrated by the waste and inefficiencies in a system that puts honest people out of business and empowers those who are not honest.

**Mr. Ron Burgerson** pointed out that there are only five people left in the fleet and they are all at this hearing. He asked how the Council will weigh the comments, as he doesn't think they take what fishermen say into account.

*The scoping hearing adjourned at approximately 6:45 pm.*



## New England Fishery Management Council

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# SCOPING MEETING SUMMARY

## Northeast Multispecies Fishery Management Plan

### Amendment 23

**March 23, 2017**

Hilton Garden Inn

224 Gold Star Highway

Groton, CT 06340

The Council held a scoping hearing to accept public comments on the intended scope of Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan. The purpose of Amendment 23 is “to adjust the groundfish monitoring program to improve reliability and accountability.” Copies of the scoping document were available at the meeting and the Council website.

**MEETING ATTENDANCE:** Terry Stockwell (Groundfish Committee Chair) and Robin Frede (Council Staff). In addition, 18 members of the public attended.

*The meeting began at 6:02 pm.*

Hearing Chairman Terry Stockwell began the meeting with a brief introduction, explaining the procedure for public scoping. Ms. Robin Frede gave a brief presentation, detailing the public scoping process, explaining the purpose and need of Amendment 23, and highlighting some relevant questions from the public scoping document. After addressing clarifying questions, Mr. Stockwell opened the hearing for public comments.

### **Comments:**

Some comments were in favor of Amendment 23 while others were not. Comments generally reflected an acknowledgment that the current monitoring system is expensive and inefficient. There were also concerns raised about the costs of monitoring, particularly for electronic monitoring, as well as a mix of comments in favor of or against electronic monitoring.

**Mr. Gary Yermen**, New London Seafood, stated that he has no confidence in National Marine Fisheries Service (NMFS), and said NMFS should be defunded since fishermen are facing further cutbacks and monetary hardships. He said after 30 years of NMFS putting observers on fishermen’s boats, collecting data, and mismanaging fisheries, why should the commercial

fishing industry accept electronic monitoring, or have to pay for a system that is inefficient at best, and said he has no confidence that NMFS will be able to get anything right now. He stated he was 100% against anything and everything (monitors, electronic monitoring) in the [scoping] document and said it is a mistake that it is being accepted.

**Mr. Joel Hovanesian**, Point Judith commercial fisherman, said that while he does not currently have a groundfish permit, he knows how this process works and knows that other fisheries, including scup, fluke, squid, and sea bass, will be affected next. He commented on some of the example ideas of potential changes to monitoring, beginning by stating that the observer program is a waste of time, and that he feels bad for the observers and the animosity they face, and the fact that their data isn't being used properly. He did not support electronic monitoring in place of at-sea monitors, and said this is un-American. Commenting on the idea of tracking sector discards, he said that no one wanted sectors, except for NMFS. He thought that setting total allowable landings limits might work if done properly, and that the system they used to have before with trip limits worked, but said there is not enough fish given as quota to divvy up amongst those left in the business. He did not support a dockside monitoring program, and said this would create more government jobs while the industry goes out of business. Mr. Hovanesian said that the current monitoring system is fraught with problems, and said he agrees with Mr. Yerman that he has no confidence in any of the programs and thinks the funding should be pulled. He said these problems started a long time ago when the former Regional Administrator, who now runs one of the observer companies, pushed for increased monitoring, and described this action as crony capitalism and said it's despicable that these companies are now making money off fishermen. He said people should know about these conflicts of interest.

**Mr. Mike Gambardella**, Gambardella Wholesale Fish in Stonington, first said he supports the comments of both Mr. Yerman and Mr. Hovanesian, and said his family-run business that has been around for 100 years is now at risk of going out of business because of all the regulations, and said it is a shame what the government has done to the industry. He pointed to the 60% reduction in fluke in two years, and asked if anyone in the Council and NMFS would accept a 60% pay reduction, and if so he will accept this reduction. He also said the consumer is suffering with these restrictions.

**Mr. Rob Simmons**, Stonington First Selectman, began by pointing out that Stonington has one of the last fishing fleets in Connecticut, and spoke of the fleet's important contributions to the culture, history, and economy of the region, and noted these fishing families are business men and women, paying taxes and contributing to the town. He also spoke of the importance of Stonington and Groton (Mystic is a village included within these) as the tourist capitals of Connecticut, and said that many tourists come for fresh local seafood, and said that if the fleet is driven out of business then this will drive out the local seafood. He said he has been personally involved with the industry for 70 years, and professionally for 30 years, and that it has been an uphill fight against state and federal regulation every step of the way. He stated that monitoring costs, which are mandatory costs, are putting fishermen out of business. He spoke of "compliance monitoring" mentioned in the [scoping] document, and while he thought monitoring the location of boats, discards, and gear type is okay, he said he was bothered by the idea of compliance monitoring as it suggests non-compliance, that fishing families are breaking the law.

He thought this expectation of non-compliance is unfair, and that if someone has a record of violations then these monitoring measures, which he considers punitive and discriminatory, might make sense, but said they should not be a mandate for the fleet.

Mr. Simmons thought the at-sea monitoring program should be voluntary, and not mandatory as it currently is, and should be available at no cost to fishermen. He stated that the current at-sea monitoring program is an unreasonable search and violates the Fourth Amendment in the Constitution, and that this prejudicial view of fishing families is unconstitutional. He also said he is in touch with Senator Richard Blumenthal, former AG of the state of Connecticut, and the law offices of Attorney Jason Crance, who operates out of New Hampshire and has written legal papers about the Fourth Amendment concerns he has with at-sea monitoring, regarding the constitutionality of at-sea monitoring. Mr. Simmons spoke of his 10 years of experience with the CIA during which he was involved in what he thought was important work to protect Americans from those who were engaged in activities that threatened national security, and pointed to how the monitoring program that is being considered has measures that would constitute spying on the fishing citizens who have been working hard, placing their lives at risk, and contributing positively to the country, and said that asking them to pay for the costs of monitoring is wrong.

**Mr. Brian Loftes**, F/V Evan Christine, Point Judith, Rhode Island, said that he has fished his whole life but now he is at the point that his boat is for sale. He referenced a line from the scoping document that described “successful management,” and said that the National Marine Fisheries Service has never had successful management and said that starting with Amendment 5 it has only taken away from fishermen and never given anything back, and now there is nothing left to take. He thought there was no accountability in government, pointing to regulatory discards that fishermen are forced to throw over, and said this has turned fishermen into killing machines particularly since they are no longer allowed to use gear with different mesh sizes on the same trip to be selective in what they catch. He said he hates fishing now, and can’t even get out because no one will buy his boat.

Mr. Brian Loftes talked about the problems he sees with observers, that boats are charged \$600-800 per day for someone to watch them work and that this is not creating anything useful. He said that these businesses work off the backs of the fishermen, who now can’t make a living, and said academia is funded to do research, and that if all this money from the universities and environmental groups was all taken away in one year it would save money, but said instead these people produce nothing but hardships for those who do produce. He said he is not taking observers, and said he was already fined a couple of years ago for not taking one when his life raft had expired and he was unable to have it inspected since it was the weekend, but he needed to fish then to catch his quota. He said he doesn’t want observers on his boat, that they don’t belong there and that it is dangerous, and said most observers become disillusioned when they see all the discards and wonder how this can be allowed. He also pointed out that the highest groundfish total annual catch (TAC) in the last 10 or 15 years is 40% of the quotas, because they can’t catch more because of all the regulations, which leaves a lot of fish unharvested. He said the industry has nothing left and that the big boats from the west coast are going to buy up all the permits. Mr. Loftes said that if the government keeps doing what it’s doing, the fishing industry will be out of business, and thought that this comes down to ideology, not science, of the



environmental groups who don't want any commercial boats on the water. He said that we should look at all the groups making a living on the backs of the fishing industry, which is shrinking while these groups keep getting bigger, and to consider that we are upside down.

**Mr. Brent Loftes**, business owner in Galilee, Point Judith, Rhode Island, said he agrees with what everyone else has said, and said he is strongly opposed to cameras, saying they are expensive to maintain, and asking how anyone has the audacity to make people put a \$60,000 piece of equipment on their boats that no one can afford. He said he would need to know the costs of electronic monitoring but is strongly opposed to it, and is strongly opposed to the government strong-arming people into paying for observers. He emphasized that 94% of seafood in this country is imported (another member of the public clarified that it's closer to 96% now) and that this is because of regulation, and said this number will rise if regulations are not changed.

**Mr. Dick Grachek**, F/V Anne Kathryn, first stated that it was absurd not to have a scoping meeting in New Bedford since it is the groundfish capital of the world and said this was cowardly. He was opposed to the process by which the Council and the Agency (National Marine Fisheries Service) conducts its public scoping, and more generally thought that the 15 minute public comment period at Council meetings is not adequate enough for what he said are the people affected, not just the public. Speaking about observers, he said the idea of discards and bycatch is false, that fishermen spend more time avoiding fish than actually catching them and it is too expensive to work on fish they cannot keep. He said that bycatch is a fabrication by the environmental groups who accuse fishermen of throwing fish over because they aren't worth as much, but said it is actually a product of restrictions on abundant stocks, and is a result of not being allowed to keep fish that are found together. Mr. Grachek said 20 years of negative campaigns by Oceania, Environmental Defense Fund, and Pew have portrayed fishermen as villainous and untrustworthy. He said the idea that fishermen are guilty until proven innocent is getting old, because fishermen are doing everything they can to comply with regulations.

Mr. Grachek stated that fishermen having to be watched by monitors and having to pay for them is an insult. He also said the costs of observers are ridiculous and the data is not accurate and is useless, and said observers get seasick and do not take data or extrapolate data. He explained how he bought his fishing permit in 2005 worth \$475,000 and now it is only worth \$180,000, and that the Federal government has taken away his scallop incidental permit and Connecticut took away his lobster permit. Mr. Grachek said he has fished before and after Magnuson Stevens, and remembers fishing with foreign fleets offshore in the 70s, but said that now the fishermen who remain are getting choked out by regulation. He said if he has to pay another \$700-800 a day then he will go out of business. He explained that he fishes for squid now, because groundfish has been taken away because of catch shares and fluke has also been reduced, but said if there is a year when the squid don't come in then he will be done.

**Mr. Josh Wiersma**, Environmental Defense Fund (EDF), began by describing a project EDF has been working on for the past year working with four high volume draggers, using a full-retention model in which the participating vessels are allowed to keep all groundfish landed and may discard some other species (skates, monkfish, dogfish). He explained there is a dockside

monitoring program associated with it for catch accounting and reporting as well as cameras for discard compliance that are on the vessels designed so they are monitoring specific discard chutes and are running only some of the time. He also said EDF has been reaching out to the service providers to get information on costs, including one of the service providers they are hoping to work with who offers a package system for \$10,000 that includes the cameras and equipment as well as an updated broadband VMS system that allows the vessel to receive wireless internet at-sea along with other benefits to the crew including cellphone, text, and email, and wireless transmittal of data, which cuts down on costs of data storage.

Mr. Wiersma stated that EDF acknowledges the importance of the Council's monitoring amendment, and agrees that the current monitoring system is broken and extremely expensive and the data is not accurate, and so why not try something new. He pointed out some of the problems with the current monitoring system: that it is contributing to significant management uncertainty, is not providing the level of accurate and reliable catch accounting necessary to ensure that catch limits are adhered to and overfishing is not occurring, has issues with observer effects (identified in analysis by both the Groundfish Plan Development Team (PDT), the Northeast Fisheries Science Center, and external reports), has serial misreporting and underreporting in Vessel Trip Reports (VTRs) in broad stock areas (described in a paper released by Mike Palmer recently), has issues with significant observer selection bias from the Pre-Trip Notification System (PTNS) (vessels on the "Do not deploy" list never taking observers because they are considered too dangerous, or "Keep active" lists where vessels are monitored every single time for compliance issues), and has issues with internal trip accounts and pre-trip cancellations, to the point where keeping accurate observer information is highly uncertain. He said that Amendment 16 and Framework 48 introduced the goal of a cost-effective program, but instead the current monitoring system has proven extremely expensive (Chad Demarest's work has demonstrated this) and inequitable, particularly because smaller vessels have to pay a lot more for the same coverage than larger high-volume vessels. He stated that while EDF recognizes that there may not be universal agreement in all these analyses and conclusions, they do highlight a critical need to think about monitoring in a better way to meet the needs of successful management and science in the groundfish fishery.

Mr. Wiersma said the new alternatives that the Council considers should not be a one-size-fits-all solution, and as an example, said there could be full retention with dockside monitoring for a portion of the fleet, especially for high-volume, high-discard fisheries, and should be mandated for those vessels that want to fish in more than one stock area on the same trip. He thought the costs should be subsidized through this monitoring alternative so that the possession and sale of small fish allowed to be kept under a full retention model could help pay for the cost of monitoring, and said the upfront costs of the equipment should all be subsidized so fishermen do not have to bear that cost, and they should look to advance new equipment with new broadband VMS systems to eliminate the costs of old narrowband VMS and give additional crew benefits. He stated that electronic monitoring (EM) should be required for vessels fishing in multiple broad stock areas in one trip but voluntary for those fishing in only one stock area and could use either the maximum retention or audit method, and said there could be incentives for those who adopt EM, including additional quota through set-aside programs that gives back management uncertainty to vessels who adopt these methods, additional quota banks, exempted use of certain

gear (for example, this has been looked at on the west coast), exemption from PTNS call-in, potential access to special closed areas, and subsidized EM review rates.

Mr. Wiersma also recommended that the Council consider modifications to the reporting of landings data to make it less redundant and more streamlined and to provide higher utility of fisheries independent data for science, to sectors, and for fishermen. He said that catch reporting should start at the vessel level where all fishing effort should be required to be reported electronically, consistent with the data modernization efforts happening at NOAA, and noted that while currently only vessels using EM are required by NOAA to do haul-by-haul reporting, this requirement should be extended to all of the fleet, as this is the only way to get the type of spatially specific information needed to effectively manage fisheries and give fishermen the option to be able to develop catch per unit effort models based on their own fishery landings information. He thought that for some EM models new broadband VMS units are capable and should be used for official reporting direct from the fishing grounds from the vessel, and this should be a goal to amend the NOAA fishery dependent data modernization work to promote this. He emphasized the importance of having electronic reporting that starts at the vessel level and flows directly to NMFS, the dealers, and the sector managers so that it is simultaneously integrated in real time and ready to be disseminated back to sectors for weekly reports and real time updates for annual catch entitlement (ACE) accounts for members, and said reconciliation should be automatic. He also said if dockside monitoring is used for a portion of the fleet this data should be reported electronically and available in real time, and should be acceptable for management and science reporting, and said that data confidentiality restrictions should be modified to allow for third party verification for full system traceability so that data can be used through the supply chain for value added purposes.

**Mr. Gib Brogan**, Oceania, began by saying it is good to see a full amendment for monitoring and not just having it included in a framework as has been done before. He said Oceania is grateful for the strong purpose and needs statement outlined in the [scoping] document, particularly the inclusion of the importance of accuracy in the current monitoring program, and said this should guide this process. He recommended the first step is for the Council to review the performance of the current monitoring program, because the current monitoring program is not working, and said this could build off of some of the work the Groundfish Plan Development Team (PDT) has done looking at issues of accuracy and bias, and should look at problems with catch information and stock assessments and the disconnect that has happened there, including the retrospective patterns that are causing many of the assessments to fall apart, as well as ultimately look at the biological outcomes of the Fishery Management Plan (FMP) and ask questions such as whether the FMP is delivering on its goals and what the role of catch monitoring is within the FMP.

Mr. Brogan recommended a range of alternatives to consider in the amendment, including modifications to the at-sea monitoring (ASM) program to provide accurate and precise information to support management, whether this is for in-season management, ongoing assessments, or Council management actions, as these all depend on robust information collected by the ASM program, and said all of these alternatives should lead to that and demonstrate that they will achieve that goal. He said the Council should look at other catch share fisheries around

the country and the world to see what worked for them and what could be adopted here. Speaking on coverage rates, he said Oceania encourages the Council to look at sector specific monitoring, not a one-size-fits-all approach, and said sectors should be allowed to tailor their operations and monitoring to their needs, and said the Council should also look at gear-specific monitoring, since currently all gear types are treated as having the same level of bycatch. He said coverage rates should be tied to management buffers to allow for tradeoff and flexibility, so that if a boat agrees to take a higher level of observer coverage they should have less uncertainty in their information and their buffers should be less, and pointed to work done by Tom Nies in Framework 48 that investigated this but was not fully developed. Mr. Brogan said this work should be picked back up and that this approach will give the industry flexibility and a clear selection tradeoff. He thought that electronic monitoring (EM) should be an option and not be mandatory, and that Amendment 23 should include performance standards for EM sampling design, data quality and accuracy, and that there should be consideration for compliance monitoring, especially with a full-retention approach. He emphasized the importance of spatial monitoring, and pointed to work from the Northeast Fisheries Science Center that is showing that self-reporting of catches in multiple stock areas is not working and that catches are being mis-assigned to stock areas and this is having effects on the management of these stocks. He said that Amendment 23 should look at new options for reporting in stock areas, including looking at new technologies that provide low cost, high resolution information about spatial activities, such as an application called Pelagic Data Systems that uses a cellphone based system, and one that uses technology for AIS (the technology for collision avoidance) that looks at spatial information, and said the Council should explore all of these alternatives to improve the catch allocation and assignment so that each stock's specific annual catch limit (ACL) is respected.

Mr. Brogan said that with the current budget Amendment 23 should anticipate no government subsidy for monitoring costs and should explore options to offset the costs, and said the fishery under the catch share model cannot operate without robust monitoring. He offered potential ideas for funding alternatives, including exploring quota set-aside and quota auctions (similar to what is done in the Mid-Atlantic with their RSA program), analyzing value of quota, or annual catch entitlement (ACE), leasing (currently assumed to have no value, but it could have value that would offset monitoring costs), and exploring alternatives to increase the value of catch, including traceability in the market. He explained that programs around the country have demonstrated that well-documented and traceable catch have increased value in the market, in some cases up to 20%, and this is something the Council can develop and help New England catch get into the market to add value that could offset monitoring costs. Mr. Brogan also noted that the Standardized Bycatch Reporting Methodology (SBRM) national guidance requires a five-year review for every FMP, and suggested using this amendment to serve as that review.

**Mr. Chris Brown**, Point Judith commercial fisherman for 40 years, said he can't stand having to take observers, and said that he doesn't make enough money to pay the daily rate associated with groundfishing if it goes up any further, adding to the fact that the fluke fishery is a third of what it should be. He stated there is no bigger waste of money than sending an at-sea monitor onto a groundfish boat and that the program should not be a part of the fishery, but that the fishery does not operate in the absence of sound data, and he added that he cannot afford to pay for something with no value. He also said that everybody in the industry is frustrated by the fact that the fishery

is screwed up and the science that governs the fishery is misinformed and does not listen to fishermen, and that he would like to try to bridge the gap so that fishermen's input can be seen not just as anecdotal and could be used in assessments.

Mr. Brown explained that he has been participating in a pilot program to investigate the plausibility of using cameras on vessels, and said he sees cameras as a tool, not a destination, to help fishermen better themselves and get out of a lot of problems. He said there is an enormous gap between the scientific perception of a number of stocks and what fishermen see on the water, and said they should be able to substitute old inaccurate data with better data to change the outcome of the assessments. As an example, he said he has seen juvenile fluke where they shouldn't normally be, when the stock assessment has said there is a failed recruitment event, and said that instead these fish are moving to new areas north and east. He said these small fish are recorded on his cameras and they have lengths recorded, and said this will do more to modify the fluke assessment in the last two weeks of fishing than the entire ASM program in the last two years. Mr. Brown also said that he recorded a juvenile blackback flounder recruitment event on his cameras and that this should inform the assessment. He emphasized that cameras will allow fishermen's observations to be viewed as more than anecdotal. He explained how the Vessel Trip Report (VTR) data is not used in assessments, when many fishermen think that it is included, and acknowledged that people do report poorly because they don't believe in the value of the program. He said for the pilot EM study, there is an agreement that their data will go directly into the assessment, and that for the first time fishermen's data will be included.

Mr. Brown said that fishermen need flexibility in fishing, particularly, he said being able to use multiple gear types on the same trip to target different fish, as they were able to do in the past, is important for efficiency and is what makes money, and also helps reduce discards. He stated that cameras will allow fishermen to get this flexibility, and should not be seen as punitive, but instead as a way to disprove the misconception that everything fishermen do is a bad thing. He recommended fishermen be given the opportunity to explore cameras as an option, and said he was told his system costs \$15,000. He thought that the data collected from cameras and verified on VTRs should go into assessments and not data from the Bigelow [survey], as he said Bigelow data is misused and is intended to be used as a comparison of abundance from one stock to another rather than to determine absolute abundance, and said instead assessments should use fishermen's vessels as scientific gathering platforms while they are fishing. Mr. Brown said that fishermen should be given the opportunity to get away from the costs of a useless human monitoring system in the groundfishery, and given the opportunity at the government's expense to put cameras on their boats, for the purpose of allowing some flexibility and helping them to the abundance of stocks that are abundant in the ocean but not on paper. He said fishermen cannot keep throwing fish overboard and that he would rather fish less days and save every fish than throw them overboard, and is hoping cameras will allow fishermen the chance to do that. He stated there should be no more cuts in allocation based on holes in the science, and there should be an effort to plug the holes in the science using fishermen's information. He recommended the Council support making cameras available as an option, and said that if a fisherman does not take a monitor voluntarily than they shouldn't have to because it alters their fishing behavior and it is waste of both their day and the program.

*The scoping hearing adjourned at approximately 7:26 pm.*



New England Fishery Management Council

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## SCOPING MEETING SUMMARY

### Northeast Multispecies Fishery Management Plan Amendment 23 March 28, 2017 Webinar

The Council held a scoping hearing to accept public comments on the intended scope of Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan. The purpose of Amendment 23 is “to adjust the groundfish monitoring program to improve reliability and accountability.” Copies of the scoping document were available at the meeting and the Council website.

**MEETING ATTENDANCE:** Terry Stockwell (Groundfish Committee Chair); and Jamie Cournane and Robin Frede (Council Staff). In addition, 6 members of the public attended. These were people who were registered and signed into the webinar; there may have been additional people who called in, but we would not have a record of their attendance. According to diagnostics within GoToWebinar, 263 people clicked the registration link with 11 of those people registering for the webinar.

*The meeting began promptly at 6:00 pm.*

Hearing Chairman Terry Stockwell began the meeting with a brief introduction, explaining the procedure for public scoping. Dr. Jamie Cournane gave a brief presentation, detailing the public scoping process, explaining the purpose and need of Amendment 23, and highlighting some relevant questions from the public scoping document. There were no clarifying questions, so Mr. Stockwell opened the hearing for public comments.

#### **Comments:**

No comments were offered and Mr. Stockwell closed the meeting.

*The scoping hearing adjourned at approximately 6:12 pm.*



April 3, 2017

Thomas A. Nies, Executive Director  
New England Fishery Management Council  
50 Water Street, Mill #2  
Newburyport, MA 01950



Re: Northeast Multispecies Amendment 23 Scoping Comments

Dear Tom,

The Northeast Seafood Coalition ("NSC") submits the following comments to the scoping process initiated for Amendment 23 to the Northeast Multispecies Fishery Management Plan.

The NSC comments below have been divided into four separate sections. The first section provides NSC's interpretation of the purpose and need for Amendment 23 which expands upon the language offered by the scoping document. The second section addresses the questions asked by the Council in the scoping document. The third section includes NSC's general input for regulatory improvements to be considered for this Amendment. The last section incorporates a sample of programmatic and administrative enhancements that have been raised to NSC leadership through the Northeast Sector Service Network (NESSN) and the Northeast Fishery Sectors (NEF sectors). It would be helpful if the Agency could clarify which programmatic elements are within their existing administrative authority and or which would require Council action.

#### **Section 1: Purpose and Need for Action**

The current purpose and need statement does not adequately reflect NSC's interpretation of why an Amendment action is necessary to modify and improve current monitoring policy.

Therefore, NSC recommends, first and foremost, the Council further define the purpose and need statement. NSC offers the following for discussion and consideration by the Council:

The purpose of Amendment 23 is to reevaluate Amendment 16 and Framework 48 monitoring measures while taking into account over seven years of fishery, administrative and programmatic experience. Measures are sought that not only improve the reliability and accountability across all segments of the monitoring program but also directly take into account measurable costs and benefits to the fishery while meeting requirements in the most cost effective manner possible.

It is NSC's understanding that an Amendment action is required to make changes to key elements of the groundfish sector at sea monitoring program (ASM) that otherwise would be considered beyond the scope of a framework adjustment.

NSC has been supportive of measures adopted under Framework 55 that clarified goals, sought efficiencies and took advantage of the incremental benefits of additional years of data and knowledge

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gained since the inception of the ASM program. But modifications that truly address the known limitations of ASM data in both the scientific and management process have not yet been truly achieved.

NSC acknowledges that the most valuable scientific data is presently generated through the Northeast Fishery Observer Program (NEFOP). Data acquired through this program has served as a valuable asset to the stock assessment process and therefore should receive the highest priority by the Agency in terms of monitoring coverage, funding and other programmatic attention. Unlike NEFOP data, ASM data is limited in its scientific utility beyond estimating discards and verifying catch. NSC comments in more detail about this issue in Section 3, General Comments below.

For NSC, any monitoring program that provides coverage beyond that which is provided by NEFOP and is funded by industry needs to meet a cost vs benefit standard. To do this, it is not only important to develop mutually agreed upon costs but it is vital that the definition of “benefits” be vetted through the Council process with industry input at every level including PDT and other third party consultants that may be tasked with evaluating the efficacy of industry funded ASM programs.

This vital aspect of “benefit” has never been clearly identified to date. NSC strongly believes that unless and until the definition of benefits is codified along with a list of clear measurable and provable metrics, any cost-benefit analyses will be left open to subjective determinations that will ultimately have no bearing on program accountability.

Directly to the purpose and need of this Amendment, the term “accountability” needs to be defined and vetted in the context of clearly defined costs and benefits as we noted above, especially when the industry is taking on the responsibility of funding a program.

Furthermore, “accountability” needs to be defined in terms of all parties and elements involved in the monitoring program. *In other words, accountability does not apply to the industry only.* It needs to be addressed throughout the reporting and management design currently administered by the Agency which impacts the costs, both monetary and on limited human resources, for the industry.

In summary, any industry funded component of a monitoring program must be designed with clear and measurable metrics for benefits to the industry. The value and scale of the benefits should be sufficient to justify the costs of the program.

## **Section 2: Scoping Comments**

Council Question #1: What alternatives should the Council consider in Amendment 23 to change the groundfish monitoring program?

NSC response / Develop Alternatives that:

- Sets the goal of the groundfish monitoring program to meet SBRM standards, to achieve a 30% CV standard at the *fishery level*.
- Allows for sectors to develop unique sector specific ASM programs through their operations plans. For example, utilizing a fixed DISCARD rate in combination with lower ASM coverage.

Another example, use a **fixed ASM COVERAGE rate**. This would provide cost and administrative stability as a tradeoff with assumed discard rates that may become more broad and variable - and CV's at the individual stock levels are allowed to be variable.

- Re-examines the metric used for measuring monitoring coverage. For example, analysis could consider changing the metric for measuring monitoring coverage from numbers of trips to volume of catch.
- Alternatives to A16 provisions that cause trips that are not targeting groundfish but are on a DAS are filtered to reduce their priority for ASM selection (e.g. trips targeting monkfish, skates or dogfish.)

Council Question #2: What specific issues are most important when evaluating the *tradeoffs* associated with monitoring discards at sea using at-sea monitors?

NSC response:

- Safety at sea and physical logistics on small vessels.
- The realities of forecasting weather, crew availability and other variables fishermen must deal with for trip scheduling as it relates to advance notice periods for human monitors.
- Not allowing costs of the monitoring program to outweigh any mutually agreed upon benefits. For example, "monitoring dollars measuring discarded pennies". Due to mesh size and minimum fish sizes requirements, and high monitoring rates since 2010, the knowledge of discards of undersized fish has been greatly expanded. The costs to monitor these regulatory discards should not exceed programmatically designed thresholds for proportional costs of monitoring / value of discards.
- A monitoring program should define benefits from multiple viewpoints including the development of measurable and provable metrics for benefits from the industry's perspective. NSC believes that without clear and measurable metrics the concept of "tradeoffs" will be meaningless to the fishing stakeholders.

Council Question #3: Should the Council consider changes to the way landings information for groundfish is provided?

NSC response:

- There should be a close examination of data reporting with a *renewed attempt* at reducing reporting redundancies.
- In general, although reporting has improved since the inception of sectors, there continues to be issues for some with the timeliness of dealer reporting. Sectors are hopeful the Agency can address this during the fishing year rather than waiting until the dealer permit renewal process.

### Section 3: NSC General Comments

#### Observer Effect / Science

Perhaps the most profound revelation industry has learned from these years of high coverage rates and mostly single digit realized CV's, is that throughout the develop of A16 and up until only recently, the industry has been naïve to the true limits of how the ASM data would be used.

We now know definitively that no matter how high the ASM coverage rate is (even 100%) or how low the realized CV's become, the data is never compiled or analyzed in a way that could positively alter the scale of a stock biomass. For this reason, the value of at sea monitoring, human or electronic, is limited to the weight of removals and worse, it is without the benefits of biological sampling.

### Observer Bias

To the issue of "observer bias" that is described in the first paragraph of the "Purpose and Need for Action" in the Scoping Document, NSC is concerned that the most important factor continues to be overlooked.

The gap is widening between abundance estimates derived from stock assessments and the abundance as encountered first hand on the water. NSC is gravely concerned that the scale of this difference has only gotten worse over the past few years. Unfortunately, when the scale of the underestimated biomass is allowed to go unchecked, a problem surfaces which is far greater than simply monitoring "low" quotas - it is about monitoring quotas that do not reflect reality.

As continuously reported through letters, written and oral testimony, fishermen are spending more time while at sea avoiding fish rather than catching fish.

To NSC, we see an inconsistency in a process that on the one hand is accepting of historically low abundance estimates based on stock assessments while on the other it expresses concerns over the potential for fishermen to be interacting with these "scarcely" populated species at a phantom CPUE rate that would be more consistent with a much larger stock size.

NSC believes that we should not embark upon an effort to improve the reliability of the monitoring program without acknowledging the linkage between the degree of accuracy for a given stock size estimate and the potential for observer bias. There needs to be broader agreement on abundance estimates that serve as the basis for the monitoring program.

Our recommendation is that analysis, either ongoing or currently contemplated, needs to include simulation analyses which incrementally increase the ACL's for constraining stocks in an effort to detect a point at which any signal of "observer effect" is mitigated. Our hypothesis is that the closer the ACL is based upon a properly scaled biomass the lesser any real or perceived observer bias.

Coverage rates were between 24% and 38% from 2010 to 2013. This period saw much higher ACL's that later declined but the declines in ACL coincided with low catches that were the result of two consecutive record warm winters. The time period from 2010 to 2013 would be good years to evaluate to see if behavior on observed and unobserved trips was more similar than perhaps it is now that quotas have been allowed to decrease to levels never seen in the fishery even when 10 times more effort was occurring.

The industry that is only 15% of what it was just 20 years ago and less than 50% of 2010 activity, should not be constrained by observers if the stock assessments for some stocks were even remotely close to the true abundance estimates. We offer that when the data from this diminished fleet indicates there is different behavior on trips with and without observers, a most plausible reason is that ACL's may be grossly out of scale with actual abundance.

This Amendment is a good time for the Council to take a step back and examine the fishery from a historical perspective. Problems that exist today may not actually stem from monitoring issues but rather could be reflective of an underlying assessment problem. Groundfish assessments are dependent upon fishery independent data being fed into models. Estimates generated from this method have not only fallen out of scale but have created untenable CPUE conditions on vast portions of the region as a result of stock abundance calculations that are underestimated exponentially. NSC believes this is the case for both cod stocks, witch flounder, American plaice, winter flounder, yellowtail flounder, both windowpane flounder stocks and Atlantic halibut.

#### Electronic Monitoring

The operation of fishing members in each groundfish sector is different. Requiring a broad-scale application or a “one size fits all” monitoring program is not only unrealistic but is ill-advised. Such an action would discourage sector and fleet diversity. This Amendment should focus on retaining consistency among standards and allowing the sectors the flexibility of designing a monitoring program that works for their membership. This includes either ASM and / or electronic monitoring (EM).

To date, some NSC members have participated in electronic monitoring pilot programs with a desire to design cost-effective alternatives to the existing fishery monitoring program. NSC is supportive of efforts that advance technology and aim to reduce costs. However, many NSC members remain extremely concerned about the potential for escalating costs of the program (e.g. % of video viewing). NSC members are also concerned that many problems that exist with the administration of the existing program will not be solved with technology alone nor will the data, similar to ASM data, be adequate for biological sampling to positively influence or change an estimate of stock abundance or scale as is sometimes implied by EM supporters. For these reasons, NSC recommends retaining flexibility for the individual sectors to design a monitoring program that best meets their needs while requiring a universal set of standards that all programs must meet.

NSC strenuously encourages the Agency and the Council to inform the public at the outset of this Amendment that there will be no double standards among different types of monitoring tools (human and electronic).

#### Other General

NSC also encourages the Council, under this Amendment, to continue to explore approaches to evolve the target coverage rate approach used to achieve the coefficient of variance (CV) requirement. Framework 55 measures increased the statistical strength of the program by utilizing multiple years’ worth of ASM data that lessened the volatility in inter-annual changes in coverage rates generated. The most recent analysis conducted by the Agency for 2017 coverage rate requirements, yet again, clearly show the volatility of one years’ worth of data. It also clearly shows that reductions in the allowable catch for some stocks and or availability of a given stock is having a negative consequence on the number of trips per stock area which is then impacting coverage rate requirements for all in future years.

#### **Section 4: Programmatic and Administrative Enhancements**

Over the years, the Agency has reached out to groundfish sectors, their representatives and ASM providers in a reported attempt to improve administrative elements of the monitoring program. But

NESSN and NEF Sectors continue to identify program changes or enhancements either through reporting, operations plans and or exemption requests that have not been supported by the Agency because of the Agency's interpretation of existing policy requirements. It would be helpful for the Agency to clearly identify which policies may need Council action to allow for greater administrative flexibility and cost reductions for the sectors.

Additionally, NSC recommends the following be considered:

- *NSC recommends this Amendment require a deadline of December 31<sup>st</sup> for the Agency to release their analysis for determining at sea coverage monitoring requirements for multispecies sectors for the upcoming fishing year.* This year, the Agency did not release this report until March 13<sup>th</sup> which was two days before sector contract deadlines and roasters.
- *NSC recommends the Agency develop an Arbitration Board for Sector ASM Data.* There continues to be great consternation over the recorded catch by species and stock onboard vessels by monitors. A better process needs to be established whereby captains receive a summary of their trip by monitors prior to leaving the vessel and or for captains and their respective managers to vet data.
- *NSC recommends a renewed process to reduce reporting redundancies.* Although the Agency has held workshops over the years, this continues to be an issue with little resolution.
- *NSC recommends a thorough review of the protocols associated with the "volumetric approach" when estimating catch and discards by observers.* An evaluation of the frequency of use on vessels by gear and vessel size should be examined in addition whether it is appropriate on groundfish vessels.
- *NSC recommends a thorough review of the PTNS system.* The Agency has to allow individual sectors and providers the ability to design monitoring improvements that will help to reduce costs to the sector. For example, ASM should target groundfish specific trips not sector trips simply on a DAS that otherwise are targeting monkfish, skates or dogfish. Furthermore, the pre-trip notification time requirement should be re-examined for efficiency purposes.
- *NSC recommends a more thorough review of the "K-all" approach, whereby discards are extrapolated stratum wide.*
- *Related to both K-all and PTNS, NSC recommends a more thorough review of the "transitional rate" applied to discards for a sector when sectors are unable to increase coverage due to the PTNS vessel selection protocols. This also relates to discards rates that are applied to non-directed groundfish trips.*

NSC appreciates the opportunity to offer comments on this important Amendment action.

Sincerely,



Jackie Odell, Executive Director



The Commonwealth of Massachusetts  
SENATE MINORITY LEADER  
MASSACHUSETTS SENATE

SENATOR BRUCE E. TARR  
First Essex and Middlesex

STATE HOUSE, ROOM 308  
BOSTON, MA 02133-1053  
TEL. (617) 722-1600



April 3, 2017

Thomas A. Nies, Executive Director  
New England Fishery Management Council  
50 Water Street, Mill #2  
Newburyport, MA 01950

Re: Northeast Multispecies Amendment 23 Scoping Comments

Dear Executive Director Nies, <sup>Tom</sup>

I appreciate the opportunity to submit the following comments regarding the scoping process initiated for Amendment 23 to the Northeast Multispecies Fishery Management Plan. The comments submitted by the Northeast Seafood Coalition on April 3, 2017 are important and warrant the attention of the Council. I urge you to give each of them careful consideration, and to incorporate the results of that consideration in the development of the proposed document for amending the Northeast Multispecies Management Plan.

Thank you for your attention to this matter.

Sincerely,

Bruce Tarr  
State Senator

CC: JC 41517



April 3<sup>rd</sup>, 2017

Thomas Nies  
Executive Director  
New England Fishery Management Council  
50 Water Street, Mill 2  
Newburyport, MA 01950



Dear Mr. Nies,

As fishermen, we would like to submit these comments for scoping on Amendment 23.

We have been using the sector system for six years, and there are now fewer fishermen on the water than at any other time in our lives. For many reasons, the groundfish industry in Maine is seriously struggling. The groundfish monitoring amendment gives us the opportunity to address some of the problems that are plaguing management, fisheries science, and our fishing businesses. Here are a few issues that we would like to see addressed in this amendment:

1. Fairness: We need to know that the boat next to us is playing by the same rules. If rules are being broken, it undermines the entire management system. The current level of accountability does not tell us if regulations are being followed. We need to create incentives for information sharing between fishermen and management to break down current distrust on all sides. Higher levels of accountability must be part of rebuilding our fish stocks and leveling the playing field.
2. Stock assessment data: Every year we are shocked to hear the results of the stock assessment. Many of the stock assessments seem to be backwards. Finding ways to get better data from fishermen into the system in a timely manner will help make sure that the stock assessment is based on what is happening on the water. We need to show that data from fishermen is trustworthy and valuable, and can be used in the scientific process.
3. Adaptability: We cannot have a one-size-fits-all approach to monitoring. A policy that works for a large offshore dragger doesn't work for most smaller boats. We must recognize that dockside monitoring doesn't work for remote ports, but it might for larger cities. We should encourage the use of new technology when it is useful and more efficient. Finally, focusing monitoring efforts on landings, instead of trips, may be a way to help balance the costs and benefits received from this fishery.

We need to create a monitoring system that protects our small fishing ports, recognizes and respects the differences between fishing businesses, and quickly gets fisheries data to the people making management and science decisions. This Amendment is important. Please address these issues so that our fishing businesses can embrace the potential that we see in our oceans.

Thank you very much for your attention.

Sincerely,  
The Undersigned

Name: BRYAN KELLEY

F/V: AOA E LAURA

Town: FIVE ISLANDS

Name: Craig Durant

F/V: MARIE ANN

Town: HARPSWELL

Name: Thom McCann

F/V: Theresa Drenell

Town: SACO

Name: Steve Linn

F/V: WILD IRISH ROSE

Town: Long Island

Name: BRIAN DURANT

F/V: FREE BIRD

Town: CUNDYS HARBOR

Name: Eben Nieuwenh

F/V: Flying Dutchman

Town: WELLS

Name: Justin Lobb

F/V: Capt'n Lee

Town: Port Clyde

Name: Phil Spinkham

F/V: Royal American

Town: BOOTHBAY



Name: Steve Benner

F/V: High Roller

Town: Warren

Name: Alex Todd

F/V: Jacob and Joshua

Town: Chebeague Island

Name: Russell Daggett

F/V: Sarah Gale

Town: Arundel

Name: Gerry Cushman

F/V: Bug Catcha

Town: Port Clyde

April 2, 2017

Mr. Thomas A. Nies  
New England Fisheries Management Council  
50 Water Street, Mill #2  
Newburyport, MA 01950



Re: Amendment 23 to the Northeast Multispecies Fishery Management Plan – Scoping Comments

Dear Tom:

Please accept The Nature Conservancy's (Conservancy) comments regarding the scoping process for Amendment 23 to the Northeast Multispecies Fisheries Management Plan. The Conservancy is a non-profit organization whose mission is to conserve the lands and waters on which all life depends. We are best known for our science-based, collaborative approach to developing creative solutions to conservation challenges. Our on-the-ground and in-the-water conservation work is carried out in all 50 states and more than 69 countries and is supported by approximately one million individual members.

### **Purpose**

The Conservancy strongly supports the New England Fishery Management Council's (Council) efforts to develop Amendment 23 to refine the groundfish monitoring program to provide the accurate catch information needed to effectively manage the fishery. The Conservancy and many of our industry partners recognize the numerous benefits that accurate and reliable fishery-dependent data can provide our nation's fisheries, including:

- improved compliance with annual catch limits,
- improved conservation and protection of vulnerable stocks,
- better data to inform stock assessments, and
- improved economic performance that can result from more efficient quota utilization.

Improving fishery monitoring systems is a top priority for the Conservancy. We have committed significant staff and financial resources to working with the National Marine Fisheries Service at the regional and national levels to improve fishery monitoring and reporting systems through greater use of modern technology and innovation. We appreciate the Council's commitment to undertake this critically important fishery management plan amendment.

### **Need**

The Council and NMFS have recognized the importance of an accurate and reliable fishery monitoring program since the inception of the groundfish sector management program in 2010. Amendment 16 to the groundfish plan expanded the use of NEFOP observers and at-sea

monitors with the explicit goal of verifying area fished and catch and discards by species and gear type. Through subsequent Framework actions (FW-48 and FW-55), the Council adopted additional goals for the catch monitoring program, including improving documentation of catch and providing additional data streams for stock assessments, and emphasized the importance of achieving those goals in the most cost-effective manner possible.

Despite these efforts by the Council, there is mounting evidence that existing monitoring program is falling short of achieving these important outcomes. The September 2017 Council motion initiating this amendment explicitly recognized the need to adjust the groundfish monitoring program to improve reliability and accountability. Additionally, numerous analyses conducted by the Council, NMFS, and Northeast Fisheries Science Center (NEFSC) staff have raised significant concerns about the adequacy of the current monitoring program and at-sea monitoring coverage rates given the strong economic incentives for fishermen to fish differently when an observer is onboard the vessel and to misreport discards and area fished when on is not. For example:

- In its November 5, 2014 memo<sup>1</sup> to the Groundfish Committee, the Groundfish Plan Development Team concluded that:

“it remains concerned about the ability for the fishery to stay within the very low GOM cod ACL in FY 2015 and the potential a low ACL creates for misreporting or discarding. It is not as concerned with the catch being met on paper but it is concerned with the large incentive for observer effects that a low ABC produces... The PDT recognizes that increasing observer coverage to 100% for the commercial fleet in the GOM would likely be the best way to directly account for all catch in the commercial fishery.”

“The PDT is very concerned about the potential magnitude of unaccounted discarding that will likely occur without the additional protections that are needed with such a low ABC. The lack of additional protection could undermine the hope for rebuilding this stock.”

- In an analysis of the Economic Impacts of Measures Considered in NEMS Framework 53<sup>2</sup>, NOAA Economist Chad Demarest found that:

“Because GOM Cod is the primary constraint on fishing in the GOM, vessels will fish under two very different sets of incentives depending on whether or not a trip is observed. If a trip is observed, the primary incentive for captains will be to minimize cod as a percent of the total catch... Unobserved trips have no such incentive. Rather these trips will maximize revenues on all species irrespective of GOM cod catch.”

“The net effect will be two-fold: 1) true discards are likely to be many multiples for imputed discards, rendering – through absolutely no fault of the fishing industry - the

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<sup>1</sup> Development of Framework Adjustment 53 to the Multispecies Fishery Management plan. New England Fisheries Management Council Groundfish Plan Development Team. November 5, 2014.

<sup>2</sup> Economic Impacts of measure considered in NEMS Framework 53. Chad Demarest, Northeast Fisheries Science Center – Social Science Branch.

catch data an incomplete picture of true fishing mortality; and 2) gross revenues will be substantially higher than predicted for all aspects of the GOM fishery, as the nominal cod constraint is essentially relaxed through a combination of observer effect and mandated regulatory discards on unobserved trips.”

- In a recent analysis of errors in reporting area fished on Vessel Trip Reports<sup>3</sup>, NEFSC scientist Mike Palmer’s found that:

“For some stocks the estimated errors are large (greater than two times the VTR reported landings), and an increase in the magnitude of the errors appears to coincide with the shift to sector management in 2010 or when quotas for certain stock were reduced or became limited for the fishery” (p. 11)

“the problem of catch area reporting errors could also be solved through changes in fisheries management measures; these measures could include restricting vessels to fishing in only one statistical area unless carrying an observer or requiring 100% observer coverage” (p.12)

#### Data to inform Stock Assessments

We are also concerned that the current monitoring and reporting system is not providing the information needed for the scientific stock assessment process. In 2015, the Operational Assessment of 20 Northeast Groundfish Stocks<sup>4</sup> found that a majority of groundfish stock assessments demonstrate persistent retrospective patterns where stock biomass is overestimated and fishing mortality is underestimated. Retrospective patterns were identified in twelve of the assessments, with seven of them requiring an adjustment in the assessment results to account for the pattern. This is especially concerning given that the number of assessments requiring retrospective adjustments increased from two in the previous assessment to seven in the 2015 Operational Assessments.

In several of these assessments, issues associated with catch reporting (i.e., mis-reported/under-reported catch) were identified as a potential source of uncertainty in the assessment. Retrospective patterns are causing significant challenges for fisheries managers and the fishing industry. Recent stock assessment models have been rejected in peer-review, forcing fishery managers to set Annual Catch Limits with incomplete information and undermining fishermen’s faith in the science used to manage the fishery. Moreover, the drastic swings in allowable catch from year to year and the lack of predictability that results makes it increasingly difficult for fishermen to plan their businesses.

The Conservancy is encouraged that the Council has recognized these serious problems and initiated this Amendment process to adjust the groundfish monitoring program to improve

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<sup>3</sup> Palmer MC 2017. Vessel trip reports catch-area reporting errors: Potential impacts on the monitoring and management of the Northeast United States groundfish resource. US Dept. of commerce, Northeast Fish Sci Cent Ref Doc. 17-02; 47 p.

<sup>4</sup> Northeast fishery Science Center 2015. Operational Assessment of 20 Northeast Groundfish Stocks, Updated Through 2014. US Dept. of commerce, Northeast Fish Sci Cent Ref Doc. 15-24; 251 p.

reliability and accountability in the fishery. We believe developing a comprehensive monitoring program that provides accurate catch accounting is critical to the future of the fishery. While the information provided by the existing monitoring program may represent the best scientific information available, it is insufficient to meet management needs in the fishery. We believe strongly, as do many fishermen we work with, that a better monitoring program will benefit both fishery managers and fishermen in the long run.

## **Alternatives**

In order to achieve the monitoring goals adopted in the Groundfish Fishery Management Plan, we request the Council develop and analyze the following alternative in the Amendment process:

- A broad range of at-sea monitoring coverage rates from 5%-100%. Analysis should include a thorough assessment of the costs to industry associated with various coverage rates and methods (including both human observers and Electronic Monitoring Systems), and in each case, be compared to the benefits that a more comprehensive monitoring program can provide assessment scientists, fishery managers, and fishermen.
- Expanded use of Electronic Monitoring (EM) systems in the fishery. Alternatives should include 1) use of EM Systems instead of at-sea monitors on selected trips consistent with requirements in current EM Exempted Fishing Permits; 2) audit-based approaches where EM systems run on all trips and a subset of hauls or trips are reviewed to verify VTR-reported discards; and 3) maximized retention approaches where EM systems verify that all groundfish are landed.
- Improved spatial resolution of catch reporting. Current regulations require catch reporting by broad statistical areas which masks finer-scale variability in species abundance and distribution. We recommend analysis of modifications to the existing reporting program that would require catch reporting at finer-scale, e.g.: by 10-minute squares.
- Increased use of verified fishery-dependent catch information (including area fished, Catch Per Unit Effort, and size composition of discarded fish) in the stock assessment process. There is a growing concern that current stock assessment results do not accurately reflect fishermen's observations on the water. Alternatives that better incorporate fishery-dependent data that has been verified by human monitors or Electronic Monitoring Systems into the assessment process should be developed.
- Alternative methodologies for setting at-sea monitoring coverage rates. The Council's current setting at-sea monitoring program uses a sub-sampling approach based on the fundamental assumption that fishing behavior and catch rates are the same on observed and unobserved trips. Assessments cited above demonstrate that there are significant problems with "observer effects" in the groundfish fishery which undermines the effectiveness of the current monitoring program. As such, alternative methodologies for setting at-sea monitoring coverage rates that ensure accurate catch accounting should be explored.

- Differential observer coverage rates based on proportional harvest volume. In her 2016 paper in Marine Policy, Dr. Jenny Sun<sup>5</sup> found that at-sea monitors have not been deployed in a cost-effective manner because coverage rates based on the CV 30 deploys observers/at-sea monitors at an equal coverage rate across strata, regardless of their volume of landings or discards. Alternatives that use a discard-proportional observer allocation approach that weights stocks with high ACE utilization should be explored.
- Alternatives to improve/replace the current Vessel Monitoring Systems. The Vessel Monitoring Systems currently required in the fishery are expensive and pose numerous logistical challenges for fishermen in remote ports who do not have constant power to their boat or only participate in the fishery seasonally. Simpler, more cost-effective technological solutions that are capable of collecting the same or better information as the current VMS systems be explored.

## Tradeoffs

The Conservancy recognizes that numerous tradeoffs need to be considered as the monitoring program is updated to ensure it provides accurate catch accounting and the best data possible to inform stock assessments. When doing so, we urge the Council to carefully consider the following.

- The tradeoff between the costs of monitoring paid by the fishing industry and the benefits to scientists, managers, and fishermen from improved accuracy of catch and discard reporting. These benefits could include reduced volatility in the annual quota setting process and improved accuracy in stock assessment results. We recognize that quantifying the costs and benefits will be challenging, but it is essential for good decision making. Existing cost estimates, such as the 2015 NMFS report<sup>6</sup> on electronic monitoring costs, should be re-examined and updated with more recent cost information before incorporation into this amendment.
- The Council should also consider tradeoffs between maintaining the existing monitoring program and making changes to improve its reliability and accountability. We believe the current science and management uncertainty buffers used in the annual quota setting process are inappropriate given the evidence of observer effects in the fishery and retrospective patterns in stock assessments. The Council should consider significant increases in these buffers until retrospective patterns in assessments are resolved and issues associated with observer effects are eliminated through implementation of a more comprehensive and effective monitoring program.

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<sup>5</sup> A cost-effective discards-proportional at-sea monitoring allocation scheme for the groundfish fishery in New England. Chi—Hwa Jenny sun, Leah Fine 2016. Marine Policy 66 (2016) 75-82.

<sup>6</sup> A Preliminary Cost Comparison of At Sea Monitoring and Electronic Monitoring for a Hypothetical Groundfish Sector. NOAA Fisheries Greater Atlantic Regional Fisheries Office and the Northeast Fisheries Science Center. June 10, 2015.

- We also believe several existing exemptions for sector vessels should be re-examined in light of the valid concerns about the existing monitoring program. For example, current regulations allow fishermen to fish in multiple broad stock areas on the same trip and to fish with multiple mesh sizes on same trip (redfish exemption). Given the evidence of mis-reporting catch by stock area on multi-areas trips identified in Palmer 2017, we believe these exemptions should be revisited and request the Council consider alternatives that require human observers or operating EM systems in order to qualify for those exemptions.
- Lastly, we believe the Council and NMFS should use this Amendment process to formally approve Electronic Monitoring Systems for use in the groundfish fishery. Amendment 16 provided a framework for EM systems to be used in place of observers or at-sea monitors when the technology is deemed sufficient for a specific trip based on gear type and area fished. Moreover, GARFO committed to developing EM performance standards and program requirements for the herring/mackerel and groundfish fishery by 2016 in its Electronic Technology Implementation Plan (2015)<sup>7</sup>.

Yet EM systems have yet to be formally approved as a monitoring tool for the groundfish fishery. Numerous pilot studies, including one recently completed by TNC, MCFA, GMRI, and Ecotrust Canada, have demonstrated that properly operated EM systems can capture high quality imagery that can be used to identify species and estimate lengths in the groundfish fishery. We are confident EM systems can provide a cost-effective monitoring tool for the groundfish fishery and urge the Council and GARFO to formally approve their use through the Amendment 23 process.

### **Changes in how landings information is provided**

There is an overlap between Amendment 23 and the NMFS ‘Data Visioning’ project, in that both are considering changes in landings reporting, with similar goals around timeliness and efficiency. The timing of the ‘Visioning’ is somewhat unclear, but it may well be aligned with the completion of this Amendment.

**Electronic VTR:** The amendment should explore incentives for broader use of EVTRs, including regulatory requirements for their use. Widespread use of eVTRs will generate more accurate, reliable, and timely data (due to self-populated fields and drop down menus), that take fishermen the same or less time to complete, and speed the movement of data through the management system.

**Timeliness:** All efforts should be made to improve the alignment of state and federal landings reporting timelines. We recognize that the Council does not have management authority over States, but an analysis of the impact of slow or misaligned reporting on the data lag in management and assessments could be compelling.

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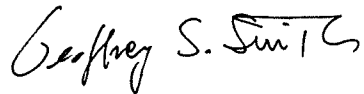
<sup>7</sup> Electronic Technology Implementation Plan. Greater Atlantic Regional Fisheries Office and Northeast Fisheries Science Center, January 30, 2015.

## **Conclusion**

The Conservancy appreciates the Council's commitment to developing a comprehensive monitoring program that provides accurate catch accounting and better data for stock assessments through Amendment 23. We are at a critical juncture the groundfish fishery and believe this Amendment provides the opportunity to put the fishery on a path toward better science, better management, and more successful fishing businesses.

We appreciate your consideration of our scoping comments and look forward to working together with the Council, NMFS, and the fishing industry to ensure meaningful and lasting outcomes in the Amendment 23 process.

Sincerely,

A handwritten signature in black ink that reads "Geoffrey S. Smith". The signature is written in a cursive, flowing style.

Geoffrey S. Smith  
Marine Program Director





April 3, 2017

Thomas A. Nies, Executive Director  
New England Fishery Management Council  
50 Water Street, Mill #2  
Newburyport, MA 01950

Re: Northeast Multispecies Amendment 23 Scoping Comments

Dear Mr. Nies:

I am writing on behalf of The Pew Charitable Trusts (Pew) to provide public comment on the New England Fishery Management Council's (Council) Scoping Document for Amendment 23 to the Northeast Multispecies FMP. Amendment 23 has the potential to improve catch monitoring in the groundfish fishery and increase this historic fishery's chances of recovery by implementing a strong, independently verifiable system that provides accurate and timely estimates of all catch. Pew supports the development of Amendment 23 to improve monitoring and accountability in the groundfish fishery, and requests that the Council analyze a broad range of alternatives, including approaches that allow for 100 percent monitoring of catches at sea and landings at the dock.

Specifically, we recommend consideration of the following measures for analysis in the amendment:

- A full range of at-sea monitoring (ASM) alternatives, including an alternative for 100 percent monitoring on all commercial groundfish fishing trips.
- A requirement for 100 percent monitoring for vessels fishing in more than one stock area.
- Video-based electronic monitoring (EM) alternatives, including methods to estimate total discards for each fishing trip:
  - Use of video data to directly estimate discards; and
  - Use of video data to audit discards reported in a logbook.
- The feasibility of using EM to monitor for maximized retention of catch, with catch sampling supported by a dockside monitoring program.
- A range of dockside monitoring alternatives to independently sample and verify landed weights and species. One alternative should be based on monitoring 100 percent of vessel landings.
- Expanded use of electronic reporting to improve reporting accuracy and provide more timely data for management.

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Robust catch monitoring is integral to the success of any fishery management system. This is particularly true for catch share-managed fisheries where individuals or groups of fishermen are directly accountable for staying within their allocated limits. Unfortunately, monitoring and accountability in New England's

groundfish fishery remains a significant challenge. Despite many of the region's stocks at historically low abundance, monitoring continues to be set at unacceptably low levels. For the fishing year 2016, at-sea monitoring coverage was reduced by nearly half, to just 14 percent of fishing trips. In 2017, the coverage level increased by just two (2) percent,<sup>1</sup> – still too low to provide reliable information for quota management and stock assessment science. Monitoring at these low levels can unintentionally create economic incentives for misreporting of catches, increased discarding and high-grading and other unsustainable practices that damage the long-term health of the fishery. For instance, a 2010 study estimated that 12 to 24 percent of New England's total catch of groundfish was taken illegally and thus was never accounted for in scientific assessments or management.<sup>2</sup> Low levels of monitoring in this fishery also undermine efforts to minimize bycatch, jeopardize the ability to prevent overfishing and rebuild overfished fish stocks, and likely contribute to chronic retrospective patterns and uncertainty in stock assessments.<sup>3</sup>

Higher levels of monitoring are needed in this fishery, and are essential to the success of the sector management system. Quota-based management demands high quality and timely information on catch so fishermen can stay within their allocated quota. Similarly, monitoring is needed to support scientifically robust stock assessments for establishing appropriate catch limits and to evaluate the progress of rebuilding overfished stocks. A strengthened monitoring and reporting system will provide greater accountability on the amount of fish caught, promote compliance with fishery regulations, and provide stronger assurance that the fishery is being sustainably managed.

The most effective way to provide accountability in the groundfish fishery is to require 100 percent monitoring at sea for all fishing trips. The advantages of 100 percent monitoring are many, including increased reliability of data for quota monitoring and assessments, elimination of potential bias due to observer effects, simplified program logistics, increased vessel incentives to avoid bycatch and accurately report catch, and improved confidence in data used for management decisions. There are many fisheries where both industry and management have recognized the importance of providing high quality catch data through full monitoring coverage, including groundfish fisheries in Alaska, the U.S. West Coast and British Columbia.<sup>4</sup> The benefits of learning from these examples in New England are clear.

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<sup>1</sup> NOAA Fisheries, NOAA Fisheries Announces At-Sea Monitoring 2017 Coverage Levels for Groundfish Sector Fishery, March 15, 2017.

[https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2017/03/15\\_asm2017levels.html](https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2017/03/15_asm2017levels.html)

<sup>2</sup> Dennis M. King & Jon G. Sutinen, 2010. Rational Noncompliance and the Liquidation of Northeast Groundfish Resources, *Marine Policy* 34, 7-21.

<sup>3</sup> Palmer MC. 2017. Vessel trip reports catch-area reporting errors: Potential impacts on the monitoring and management of the Northeast United States groundfish resource. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 17-02; 47 p.

<sup>4</sup> NOAA Alaska Regional Office, Monitoring and Reporting, available at: <https://alaskafisheries.noaa.gov/fisheries/observer-program>; Pacific Fishery Management Council, Groundfish:Trawl Catch Share Electronic Monitoring Program, available at: <http://www.pcouncil.org/groundfish/rawl-catch-share-program-em>; DFO, 2016. Pacific Region Integrated Fisheries Management Plan – Groundfish, available at: [http://publications.gc.ca/collections/collection\\_2016/mpo-dfo/Fs144-36-2016-eng.pdf](http://publications.gc.ca/collections/collection_2016/mpo-dfo/Fs144-36-2016-eng.pdf).

New and emerging monitoring tools, such as EM and electronic reporting, also hold promise for improving accountability and meeting data collection needs in a more cost-effective manner. The applicability of EM has been extensively tested in New England's groundfish fishery, and recent pilot testing presents opportunities to begin the transition to implementation.<sup>5</sup> NOAA's Greater Atlantic Regional Fisheries Office and the Northeast Fisheries Science Center also released an Electronic Technology Implementation Plan for the application of electronic technologies in Northeast fisheries, such as use of electronic vessel trip reports and other EM and reporting systems.<sup>6</sup> These and other 'real time' data tools should be evaluated to improve the speed and accuracy of data collection and reporting to facilitate more adaptive management.

Given the diversity in the groundfish fishery (e.g., vessel sizes, gear types, fishing practices, operational characteristics) a combination of monitoring approaches should be developed for analysis and tailored to the needs of sectors or individual vessels, as necessary, to provide monitoring solutions that are cost effective, efficient, and make best use modern technology. We recommend that Amendment 23 include the following for analysis:

- An enhanced monitoring system at-sea through the use of at-sea monitors and video-based EM to improve the accuracy and reliability of total catch (including bycatch and discards). This includes:
  - ASM coverage alternatives to collect information on all catch (retained and discarded). One alternative should provide 100 percent ASM on all commercial groundfish fishing trips.
  - A requirement for 100 percent monitoring for groundfish vessels fishing in more than one stock area.
  - Video-based EM alternatives,<sup>7</sup> including methods to estimate total discards for each fishing trip:
    - Use of EM video data to directly estimate total discards. Under this option, the video review rate (i.e., full census or random subsampling) necessary to accurately estimate total discards should be analyzed.
    - Use of EM video data to audit discards reported in a logbook. An appropriate level of video review (i.e., full census or random subsampling) should be analyzed. This audit approach is similar to the EM program implemented in British Columbia, which includes full video capture of all fishing events and partial review of imagery to verify the accuracy of discards reported in logbooks.<sup>8</sup>

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<sup>5</sup> NOAA Fisheries, Electronic Monitoring, available at: <http://www.nefsc.noaa.gov/fsb/ems>

<sup>6</sup> GARFO/NEFSC. Electronic Technology Implementation Plan (January 30, 2015), available at: <https://www.st.nmfs.noaa.gov/advanced-technology/electronic-monitoring/index>

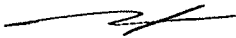
<sup>7</sup> EM would not replace the NEFOP sampling program that NOAA Fisheries deems necessary for its scientific needs. NEFOP observers would continue to be randomly deployed on vessels to collect biological samples and other scientific information.

<sup>8</sup> Stanley et al. 2015. Design and implementation of electronic monitoring in the British Columbia groundfish hook and line fishery: a retrospective view of the ingredients of success. *ICES Journal of Marine Science*, 72(4), 1230-1236.

- The feasibility of using EM to monitor for maximized retention of catch, with catch sampling supported by a dockside monitoring program.
- Dockside monitoring alternatives to independently sample and verify landed weights and species. One alternative should be based on monitoring 100 percent of vessel landings by dockside monitors. We emphasize that dockside monitoring should only be coupled with monitoring of the catch at sea (i.e., ASM or EM) to allow for independent estimates of at-sea discards.
- Expanded use of electronic reporting to improve reporting accuracy and provide more timely data for management.

Amendment 23 is an opportunity to establish a monitoring and reporting system for New England's groundfish fishery that delivers timely, reliable, independent accounting of all catch that is essential for both science and management. We appreciate the opportunity to provide these comments and look forward to the Council's further development of this important amendment.

Sincerely,



Peter Baker  
Director, U.S. Oceans, Northeast  
The Pew Charitable Trusts





**MAINE COAST  
FISHERMEN'S  
ASSOCIATION**



April 3, 2017

Thomas A. Nies, Executive Director  
New England Fishery Management Council  
50 Water Street, Mill 2  
Newburyport, MA 01950

Dear Mr. Nies,

Please accept these comments on behalf of the Maine Coast Fishermen's Association regarding Amendment 23 to the Fishery Management Plan (FMP) for the Northeast Multispecies groundfish complex.

The Maine Coast Fishermen's Association (MCFA) is an industry-based nonprofit which identifies and fosters ways to restore the fisheries of the Gulf of Maine and sustain Maine's historic fishing communities for future generations. Established and run by Maine fishermen, the objectives of the Association are: to provide a voice for our fishing communities; to rebuild the Gulf of Maine ecosystem; and to help build viable fishing businesses on our coast. With members living in communities from Kittery to Mount Desert Island, our members represent a diverse range of fisheries but have come together as one voice to weigh in on important management issues facing Maine fishermen. MCFA works closely with the Maine Coast Community Sector, a groundfish sector, so issues affecting the Northeast Multispecies complex are of special importance to us.

The stated purpose of Amendment 23 is "to improve reliability and accountability of the NE groundfish fishery monitoring program". We wholeheartedly support this goal, and we plan to continue working with the Council in order to achieve it. At present, our groundfish monitoring system involves huge costs to both taxpayers and the industry without much benefit in terms of effective monitoring or usable data. MCFA believes that an effective monitoring program for groundfish will include measures which accomplish the following goals, which we see as prerequisites for a healthy and well-managed fishery:

- Increase the accuracy and efficiency of monitoring programs:
  - Cut down on overly burdensome and outdated reporting requirements and methods, such as paper VTRs
  - Streamline the reporting process across technology platforms
  - Support new monitoring systems which increase accountability
  - Recognize that one-size-fits-all accountability requirements do not work
  - Take full advantage of a wide range of tools and technologies such as electronic monitoring, maximized retention fishing, dockside monitoring, and at-sea monitoring to achieve high quality and cost effective data collection
- Increase enforcement of existing regulations
  - Reduce the effect of observer bias and the observer effect on fishing vessel activity
- Verify fishermen's catch and discard data; improve reporting accuracy of fishery-dependent data



- Create a monitoring and scientific data collection system that is embedded on fishing vessels, is empowered to use verified fishery-dependent data, and can incorporate data into scientific process in real time (or as close as possible).
- Consider exemptions and special access programs for vessels which are 100% accountable
- Consider individual discard rates and lower uncertainty buffers for vessels which are 100% accountable

We hope to work with the Council throughout the process of creating Amendment 23. Thank you in advance for your consideration of our comments.

Sincerely,



Ben Martens  
Executive Director







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*The Pew Charitable Trusts presents this document on behalf of 7,618 members of the public.*

April 3, 2016

Thomas A. Nies, Executive Director  
New England Fishery Management Council  
50 Water St., Mill 2  
Newburyport, MA 01950

### **Northeast Multispecies Amendment 23 Scoping Comments**

Dear Executive Director Nies,

Thank you for the opportunity to comment on the New England Fishery Management Council's plan to improve monitoring and accountability in the groundfish fishery. Historically, this fishery was the backbone of New England's coastal economy. Unfortunately, the failure to expediently end overfishing of key groundfish species, such as Atlantic cod, has resulted in persistently overfished stocks, and fewer and fewer active fishermen. The sector system and annual catch limits implemented through Amendment 16 were steps in the right direction, but the lack of monitoring and accountability is preventing a broader recovery.

The fishery suffers from an inadequate catch reporting program that is also expensive and burdensome and results in unreliable data. I am pleased to see that Amendment 23 has been initiated to address these issues, and I request that you consider the following alternatives.

First, a monitoring program that records and verifies 100 percent of both landings and discards on all fishing trips is the best option for a truly accountable fishery. This not only would ensure that catch limits are adhered to, but it also would generate vital data to improve stock assessments and set appropriate catch limits. As fishermen contribute more data to the management system and the science improves, catch limits will be better understood and accepted, and trust between all parties will improve. One hundred percent monitoring would also reduce the "observer bias" that can occur when a fishing vessel carries an observer and, as a result, changes fishing behavior.

Second, 100 percent monitoring can be achieved through a variety of tools designed to be cost-effective and efficient and make best use of modern technology. A combination of electronic monitoring, at-sea and dockside monitors, improved enforcement measures, and new technology such as electronic trip reports and real-time location systems needs to be analyzed. The new and improved monitoring system must capture all fishing activity, accurately record all discards at sea, and verify landed catch both on board and at the dock.

New England's legendary groundfish fishery deserves a chance to recover the economic and cultural prominence it once held. The current monitoring systems are ineffective and are not working for our fish or fishermen. A program based on 100 percent monitoring would lead to a more accountable and sustainable era for this region's iconic fishery.

Sincerely,

7,618 members of the public





April 3, 2017

*Via Email to [comments@nefmc.org](mailto:comments@nefmc.org)*

Thomas A. Nies, Executive Director  
New England Fishery Management Council  
50 Water Street, Mill 2  
Newburyport, MA 01950  
Fax: (978) 465-3116  
Email: [comments@nefmc.org](mailto:comments@nefmc.org)

**Re: Northeast Multispecies (Groundfish) Amendment 23 Scoping Comments**

Dear Mr. Nies:

Oceana is the largest international ocean conservation organization solely focused on protecting the world's oceans, with thousands of members and supporters, including thousands of members in New England. Oceana appreciates the opportunity to provide comments on scoping for Amendment 23 to the Northeast Multispecies (Groundfish) Fishery Management Plan ("Groundfish FMP"). Amendment 23 offers the New England Fishery Management Council ("Council") an opportunity to fully evaluate the efficacy and outcomes of current groundfish catch monitoring and to develop alternatives that will make necessary changes to this important element of the Groundfish FMP. A robust catch and bycatch monitoring program under Amendment 23 will make the fishery more efficient and effective in achieving the goals of the fishery, the FMP and the Magnuson-Stevens Act ("MSA").

It is essential that any monitoring strategy adopted in Amendment 23 tie monitoring rates and requirement to the buffers required to account for scientific and management uncertainty. In essence, the fleet would be presented with a choice on a sliding scale: on one end, use more robust monitoring and be rewarded with the ability to catch more of its quota, or at the other, use less robust monitoring but agree to sacrifice some quota to account for the additional uncertainty that comes with this reduced monitoring. The marginal cost of additional monitoring should be compared to the marginal value of the additional fish that could be caught as the result of that monitoring.

To achieve this, Oceana recommends that the Council take the following actions with respect to Amendment 23:

- Amendment 23 must be developed in accordance with the National Environmental Policy Act ("NEPA") and the Magnuson-Stevens Act.

- Amendment 23 scoping should include a performance review of the Groundfish FMP catch and bycatch monitoring program
- Amendment 23 should explore a full range of alternatives to modify the Groundfish FMP catch and bycatch monitoring program, including consideration of a full range of alternatives for:
  - at-sea catch monitoring, including human observer coverage;
  - standards for Electronic Monitoring (EM);
  - improved spatial data collection;
  - improved and appropriate use of self-reported data;
  - consideration of funding alternatives to support the groundfish fishery and its catch monitoring needs; and
  - modifications to satisfy the SBRM guidelines of the National Marine Fisheries Service (“Fisheries Service” or “NMFS” or “agency”).

Oceana has been engaged as a stakeholder in the management of the groundfish fishery for more than 15 years with a particular interest in effective catch monitoring and minimizing bycatch. During this time, the fishery has failed to achieve its goals year in and year out. To correct these failures, Amendment 23 must include proven and effective changes to the management of the fishery that will finally end overfishing for all stocks and get the fishery as a whole on the path to recovery.

## **I. LEGAL BACKGROUND**

As it develops Amendment 23, the Council must comply with the requirements of NEPA, including the requirements to conduct a thorough scoping process that solicits broad input in order to identify a reasonable range of alternatives for addressing the purpose of the agency action. Once identified, those alternatives must be rigorously evaluated.

### **A. The Role of Scoping Under National Environmental Policy Act**

Congress enacted NEPA to ensure that federal agencies incorporated environmental concerns into their decision-making processes.<sup>1</sup> In furtherance of this goal, NEPA compels federal agencies and the councils to prospectively evaluate the environmental impacts of proposed actions that they carry out, fund, or authorize. Federal agencies must prepare an Environmental Impact Statement (“EIS”) whenever they propose “major Federal actions significantly affecting the quality of the human environment.”<sup>2</sup> Public involvement is essential to implementing NEPA; it “helps the agency understand the concerns of the public regarding the proposed action and its

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<sup>1</sup> 42 U.S.C. § 4331(a).

<sup>2</sup> *Id.* at § 4332(2)(C).



environmental impacts, identify controversies, and obtain the necessary information for conducting the environmental analysis.”<sup>3</sup>

Scoping is a critical early step in the EIS process, and provides an opportunity for parties with a variety of perspectives to help inform the process. It “sets the boundaries ... of the analysis,” “helps to identify information sources,” and “helps to focus alternatives and identif[y] issues to be addressed within the EIS.”<sup>4</sup> A comprehensive scoping process is essential for identifying the “reasonable range” of alternatives that must be evaluated in the EIS process to address the purpose and need of the agency action.<sup>5</sup> Those reasonable alternatives must be rigorously explored and objectively evaluated, and each alternative must be “considered in detail...so that reviewers may evaluate their comparative merits.”<sup>6</sup> “What constitutes a reasonable range of alternatives depends on the nature of the proposal and the facts in each case.”<sup>7</sup> As one court stated, the agency “must look at every reasonable alternative within the range dictated by the nature and scope of the proposal. The existence of reasonable but unexamined alternatives renders an EIS inadequate.”<sup>8</sup>

## **B. The Magnuson-Stevens Act and Associated Fisheries Service Guidance Require Effective Bycatch Monitoring and Quality Data Collection.**

Any monitoring program proposed through the Amendment 23 process must meet the MSA’s requirements of establishing a standardized reporting methodology that will result in the collection of accurate and precise data for management of the fishery. The monitoring program must be designed to meet the National Standard requirements of preventing overfishing while achieving optimum yield (National Standard 1), providing high quality and timely catch and bycatch data for proper management of the fishery (National Standard 2), and minimizing bycatch and bycatch mortality (National Standard 9).

### **1. Requisite Contents of Fishery Management Plans**

Bycatch monitoring is a significant component of fisheries management under the MSA. Congress wove monitoring requirements into every corner of the statute. The reduction of bycatch and bycatch mortality has been a focus of the MSA since at least the 1996 Sustainable Fisheries Act, which amended the MSA to include National Standards related bycatch. Under the MSA, an FMP “must establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures

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<sup>3</sup> NOAA Administrative Order Series 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act (May 20, 1999).

<sup>4</sup> 40 C.F.R. § 1501.7; National Marine Fisheries Service, *NEPA Informational Guide*, <http://www.nmfs.noaa.gov/pr/interactions/fkwtrt/orientation/other/nepa.pdf>; *Citizens’ Comm. to Save Our Canyons v. U.S. Forest Serv.*, 297 F.3d 1012, 1022 (10th Cir. 2002).

<sup>5</sup> 40 C.F.R. § 1502.14.

<sup>6</sup> *Id.* at § 1502.14(b).

<sup>7</sup> Council on Environmental Quality, 40 Most Asked Questions Concerning CEQ’s Nation Environmental Policy Act Regulations (Mar. 23, 1981), <https://energy.gov/sites/prod/files/G-CEQ-40Questions.pdf>.

<sup>8</sup> *Ilio’ulaokalani Coal. v. Rumsfeld*, 464 F.3d 1083, 1095 (9th Cir. 2006).

that...(A) minimize bycatch; and (B) minimize the mortality of bycatch which cannot be avoided.”<sup>9</sup> That methodology is referred to as a “standardized bycatch reporting methodology (“SBRM”). As recently published SBRM rules state, the “purpose of a standardized reporting methodology is to collect, record, and report bycatch data in a fishery ... to assess the amount and type of bycatch occurring in the fishery and inform the development of conservation and management measures that, to the extent practicable, minimize bycatch and bycatch mortality.”<sup>10</sup> When establishing an SBRM, a Council must address the following:

1. information about the characteristics of bycatch in the fishery;
2. the feasibility of the methodology from cost, technical and operational perspectives;
3. the uncertainty of the data resulting from the methodology; and
4. how the data resulting from the methodology are used to assess the amount and type of bycatch occurring in the fishery.<sup>11</sup>

The SBRM rules require that FMPs identify the procedures that constitute the SBRM for a fishery, and provide as examples of such procedures (i) observer programs, (ii) electronic monitoring and reporting technologies, and (iii) self-reporting mechanisms.<sup>12</sup> Guidance on the rules discusses how Councils should address variations in funding for these procedures, stating that if a Council “chooses to establish an SBRM that may be adjusted in response to changes in costs or funding, the Council should provide guidance to the Fisheries Service on how to adjust the implementation of the SBRM consistent with the FMP.”<sup>13</sup> Significantly, the guidance states: “NMFS reiterates that, regardless of resource constraints, all FMPs must establish an SBRM that meets the purpose described” in the new rules.<sup>14</sup>

In addition to establishing an SBRM, FMPs must establish “a mechanism for specifying *annual catch limits* [“ACLs”] in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, *including measures to ensure accountability* [“AMs”].”<sup>15</sup> The MSA also sets National Standards for how the Councils should prepare FMPs, all of which repeat the necessity for data-driven analysis to protect fisheries, ensure accountability and minimize bycatch. National Standard 1 states that “[c]onservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.”<sup>16</sup> Agency guidance on specifying ACLs and Accountability Measures AMs (issued through National Standard 1 guidance) describes the relationship between ACLs and AMs, stating that AMs are management controls designed to prevent ACLs from being exceeded, and to correct or mitigate overages of ACLs if they occur.<sup>17</sup> AMs can include closure of a fishery, closure of

<sup>9</sup> 16 U.S.C. § 1853(a)(11).

<sup>10</sup> 50 C.F.R. § 600.1600.

<sup>11</sup> 50 C.F.R. § 600.1610(2).

<sup>12</sup> 50 C.F.R. § 600.1610(a)(1).

<sup>13</sup> Standardized Bycatch Reporting Methodology, 82 Fed. Reg. 6317, 6320 (Jan. 19, 2017) (to be codified at 50 C.F.R. pt. 600).

<sup>14</sup> *Id.*

<sup>15</sup> 16 U.S.C. § 1853(a)(15) (emphasis added).

<sup>16</sup> 16 U.S.C. § 1851(a)(1).

<sup>17</sup> 50 C.F.R. § 600.310(g)(1).



specific areas, changes in gear, and changes in trip size or bag limits.<sup>18</sup> Fisheries managers must have accurate and timely monitoring data in order to set ACLs and determine whether and what types of AMs are necessary to prevent overfishing.

## **2. Court Rulings Underscore the Importance of Bycatch Monitoring and MSA Protocols**

Courts clearly view monitoring as a significant component of fisheries management. In *Oceana v. Locke*, the District of Columbia Court of Appeals invalidated the Fishery Service's New England SBRM methodology and remanded the issue to the agency because the agency termed the methodology as "optional" where "funding shortfalls" made it difficult to implement the monitoring protocols.<sup>19</sup> Finding that the exception for "funding shortfalls" was "so vague as to make the rule meaningless," the court concluded that the Fisheries Service improperly gave itself "complete discretion to determine when an external operational constraint prevents it from fully implementing the required" monitoring.<sup>20</sup> There, the court highlighted the significant role that monitoring plays in protecting a fishery, and would not permit the Fisheries Service to ignore monitoring rules even when the costs of implementation were high.

In *Conservation Law Foundation v. Evans*, the court invalidated a Fisheries Service Amendment and Framework Adjustment for the groundfish fishery because the new rules failed to comply with bycatch monitoring requirements.<sup>21</sup> In that case, the court admonished the Fisheries Service for acting arbitrarily and capriciously when it "refus[ed] to give effect to the clear will of Congress, which expressly directed [NMFS] to more accurately measure and reduce bycatch."<sup>22</sup>

## **3. The MSA's National Standards for Fisheries Management**

The prevention of overfishing, rebuilding of depleted stocks and minimization of bycatch and bycatch mortality are bedrock principles that must be followed with respect to all fisheries under the MSA. National Standard 1 states: "Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry."<sup>23</sup> The term "conservation and management measures" is defined to include "all of the rules, regulations, conditions, methods and other measures...which are required to rebuild, restore, or maintain, and which are useful for rebuilding, restoring, or maintaining, any fishery resource and the marine environment."<sup>24</sup> In order to be effective, those measures must be informed by accurate and precise catch and bycatch data, as part of a holistic approach to fishery management.

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<sup>18</sup> *Id.*

<sup>19</sup> *Oceana, Inc. v. Locke*, 670 F.3d 1238, 1241 (D.C. Cir. 2011).

<sup>20</sup> *Id.*

<sup>21</sup> *Conservation Law Found. v. Evans*, 209 F. Supp. 2d 1, 13 (D.D.C. 2001).

<sup>22</sup> *Id.* (The Fisheries Service violated an identical requirement under the Administrative Procedure Act that an agency not act arbitrarily or capriciously when promulgating new rules).

<sup>23</sup> 16 U.S.C. § 1851(a)(1).

<sup>24</sup> 16 U.S.C. § 1802(5)(A).

Holistic fishery management requires addressing the relationship of catch limit reference points—Overfishing Limits (“OFL”), Acceptable Biological Catch (“ABC”), Annual Catch Limit (“ACL”), and Accountability Measures (“AMs”)<sup>25</sup>—and catch and bycatch monitoring programs that incorporate SBRMs.<sup>26</sup> Fishery management measures to minimize bycatch and bycatch mortality, and bycatch monitoring through the SBRM, are crucial to the monitoring and assessment of U.S. fisheries. Moreover, these facets of management must be linked to an FMP’s ACLs and AMs, which are also required elements of FMPs.<sup>27</sup> Any ACL is, in turn, limited by and cannot exceed the ABC, which is a level of a fish stock’s annual catch that accounts for scientific uncertainty in the Overfishing Limit (“OFL”), *i.e.*, the estimate of the catch level above which overfishing is occurring.<sup>28</sup>

When specifying catch limits and AMs, Councils must take an approach that considers uncertainty in scientific information and management control of the fishery. The Fisheries Service’s guidelines for implementing National Standard 1 describe how the Councils could address uncertainty such that there is a low risk that limits are exceeded. For example, for stocks that are required to have an ABC, the Council must establish an “ABC control rule” setting forth an approach to setting the ABC for a stock as a function of the scientific uncertainty in the estimate of OFL and any other scientific uncertainty.<sup>29</sup> The guidelines state that the ABC control rule “should consider uncertainty in factors such as stock assessment results, time lags in updating assessments, the degree of retrospective revision of assessment results, and projections.”<sup>30</sup>

With regard to management uncertainty, the guidelines identify two sources of such uncertainty when establishing AMs for a fishery—uncertainty in the ability of managers to constrain catch so the ACL is not exceeded, and uncertainty in quantifying the true catch amounts—and state that analyses should be performed to determine the level of uncertainty, considering past management performance and factors such as time lags in reported catch.<sup>31</sup>

The guidelines also describe the sources of data that should be used to implement AMs. These include in-season monitoring data, annual catch data that can be compared to the ACL, and, where annual catch data is highly variable, multi-year average data.<sup>32</sup> The guidelines further state that “[w]henver possible, FMPs should include in-season monitoring and management measures to prevent catch from exceeding ACLs.”<sup>33</sup> It is clear from the guidelines that in-season monitoring is the preferred, primary method of protecting against exceeding catch limits, with other methods to be resorted to in the absence of accurate and precise in-season data. In other

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<sup>25</sup> 50 C.F.R. § 600.310 (National Standard 1 guidelines).

<sup>26</sup> 50 C.F.R. § 600.350 (National Standard 9 guidelines).

<sup>27</sup> 16 U.S.C. § 1851(a)(1); 50 C.F.R. § 600.310 (National Standard 1 guidelines).

<sup>28</sup> 50 C.F.R. § 600.310(f)(2)(ii), (4)(i).

<sup>29</sup> 50 C.F.R. § 600.310(f)(2)(i).

<sup>30</sup> 50 C.F.R. § 600.310(f)(1)(vi).

<sup>31</sup> 50 C.F.R. § 600.310(f)(1)(v).

<sup>32</sup> 50 C.F.R. § 600.310(g)(1).

<sup>33</sup> 50 C.F.R. § 600.310(g)(2).



words, without accurate and precise in-season monitoring data, it would be difficult to establish meaningful AMs to prevent overfishing.

National Standard 2 focuses on the scientific information required for effective fishery management, and states that “[c]onservation and management measures shall be based upon the best scientific information available.”<sup>34</sup> The guidelines further state that “[f]ishery conservation and management require high quality and timely biological, ecological, environmental, economic, and sociological and scientific information to effectively conserve and manage living marine resources.”<sup>35</sup> In order to meet this standard, then, it is essential that “high quality and timely” information regarding catch and bycatch be collected.

National Standard 9 focuses on bycatch, and states that “[c]onservation and management measures shall, to the extent practicable: (1) minimize bycatch; and (2) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.”<sup>36</sup> The guidelines notes that “bycatch can increase substantially the uncertainty concerning total fishing-related mortality, which makes it more difficult to assess the status of stocks, to set the appropriate OY and define overfishing levels and to ensure that OYs are attained and overfishing levels are not exceeded.”<sup>37</sup> Bycatch is a significant concern in the New England groundfish fishery. Without measures to effectively monitor bycatch, the fishery cannot be properly managed, bycatch cannot be minimized, and overfishing cannot be prevented.

## **II. FACTUAL BACKGROUND**

### **A. Chronology of Council Efforts to Implement Catch and Bycatch Monitoring in the Groundfish Sector Fishery**

The Groundfish FMP was implemented in 1986 to reduce fishing mortality of heavily fished groundfish stocks such as cod, haddock and flounder and to promote rebuilding to sustainable biomass levels. Thirteen species are managed through the Groundfish FMP.<sup>38</sup> From 1994 to 2010, the fishery used an input-based Days at Sea management strategy that attempted to control mortality through a combination of limits on fishing effort and daily or trip limits on some species. This approach led to widespread discarding of fish at sea and the fishery failing to meet its management goals.

The Groundfish FMP for cod, haddock and flounders first approved the use of sector management as part of Amendment 13 to the Groundfish FMP in May of 2004.<sup>39</sup> Developed by the Cape Cod Hook Fishermen’s Association, this first sector began in 2004 and received an

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<sup>34</sup> 16 U.S.C. § 1851(a)(2).

<sup>35</sup> 50 C.F.R. § 600.315(a)(1).

<sup>36</sup> 50 C.F.R. § 600.350(a).

<sup>37</sup> 50 C.F.R. § 600.350(b).

<sup>38</sup> New England Fishery Management Council, Northeast Multispecies (Groundfish), <http://www.nefmc.org/management-plans/northeast-multispecies> (last visited April 3, 2017).

<sup>39</sup> Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Amendment 13, 69 Fed. Reg. 22,905, 22,914 (May 1, 2004) (to be codified 50 C.F.R. pt. 648).

allocation for their group to fish differently than the Days at Sea fishery that was used to manage the fishery at the time. Instead of fishing with limits on the amount of time they could fish (an input control) the sector participants were granted a special allocation with an additional agreement between the group of vessels in the sector and the Fisheries Service to abide by special conditions to ensure that the sector respected its allocation with clear consequences for exceeding this allocation.<sup>40</sup> Enhanced monitoring of catch was a central pillar of this new program.

## 1. Amendment 16

Following the reauthorization of the Magnuson-Stevens Act in 2006, and the new requirement that all fisheries include ACLs and AMs,<sup>41</sup> the Council initiated Amendment 16, a management action that expanded the use of the sector approach to include the majority of the groundfish fleet. Amendment 16 created a larger sector program where vessels could self-select their sector membership and receive an allocation of any stocks for which the vessel had catch history during the qualification period. This sub-allocation to the sector, an Annual Catch Entitlement (“ACE”), included the quota contributions of each members of a sector, called Potential Sector Contributions (“PSC”). The sum of all member’s PSC of particular sector equals that sectors ACE, which is intended to be shared among sector members.

Central to the expanded sector program was a requirement to stop fishing if and when a sector’s allocation of a stock had been achieved, thus ensuring accountability as required by the reauthorized MSA.<sup>42</sup> This limit on catch (or “output control”) was a fundamental change in the management of the fishery. Where the fishery had a history of setting and then exceeding quotas through Days at Sea, sectors would stop fishing when a quota was achieved.

To mitigate the effect of these limits on fishing and provide flexibility for the fleet, Amendment 16 also allowed sectors to lease ACE allocations between sectors either as barter or for cash. Amendment 16 recognized that at-sea discards and data collected at sea were a pressing management issue for this fishery. Amendment 16 included advice that “because discards and area fished are critical elements in the monitoring of sector catch, sectors are required to develop an adequate independent third party at-sea/electronic monitoring program no later than FY 2012. This program will be used to verify area fished and catch (landings and discards), by species and gear type, for the purposes of monitoring sector ACE utilization.”<sup>43</sup> To implement the monitoring, the sectors relied heavily on the Fisheries Service to fulfill an important requirement of Amendment 16, at-sea observer coverage levels. Amendment 16 required that “(c)overage levels will be specified by the Fisheries Service on a yearly basis, based upon a list of participating vessels and gear types for each sector. At a minimum, such coverage will be

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<sup>40</sup> Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; 2005 Georges Bank Cod Hook Sector Operations Plan and Agreement and Allocation of Georges Bank Cod Total Allowable Catch, 70 Fed. Reg. 23,096 (May 4, 2005).

<sup>41</sup> 16 U.S.C. § 1853(a)(15).

<sup>42</sup> *Id.*

<sup>43</sup> Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Amendment 16, 75 Fed. Reg. 18,262, 18,278 (Apr. 9, 2010) (to be codified 15 C.F.R. pt. 902, 50 C.F.R. pt. 648).



sufficient to ensure that the resulting estimate of discards meets the coefficient of variation specified in the Standardized Bycatch Reporting Methodology (SBRM), but it is expected that coverage is likely to be higher than this minimum standard to monitor catch (both landings and discards) as closely as possible and to minimize coverage bias in each sector.”<sup>44</sup> Amendment 16 included provisions for the Fisheries Service to supplement the minimum observer coverage to support management but based coverage on the CV standard borrowed from the NE Region SBRM.<sup>45</sup>

Amendment 16 also relied heavily on self-reported information from the fishery to monitor catches. Amendment 16 required each vessel to continue using Vessel Trip Reports (“VTRs”) as logbooks to assign catches to the various stock areas in the region (e.g. Georges Bank, the Gulf of Maine, etc.). In fishing year 2010, the first year of sectors under Amendment 16, the Fisheries Service set at-sea coverage at 38 percent of sector trips, funded by the Fisheries Service with a clear plan that funding of at-sea monitoring would shift to the industry on May 1, 2012.<sup>46</sup>

## 2. Framework Adjustments

Since Amendment 16 implemented the sector management program in the groundfish fishery, the NEFMC has used a series of framework adjustments (“FW”) to adjust the at-sea monitoring requirements of the FMP. These adjustments have been piecemeal actions that were developed in a limited timeframe to meet other management needs of the fishery such as annual ACL setting.

In 2013, FW48 clarified the goals and objectives of the at-sea monitoring program and clarified that the CV Standard would be met for each stock at the overall stock level.<sup>47</sup> Then in 2016 FW55 adjusted the methodology by which the Fisheries Service calculates the necessary levels of observer coverage to meet the goals and objectives of the program.<sup>48</sup>

These actions each decreased coverage without a clear understanding of the effect of this additional factor on the efficacy of the catch monitoring program.<sup>49</sup> Each of these actions suffered from the short development window afforded framework adjustments. Experts on the Groundfish Plan Development Team (“PDT”) did not have adequate time to explore issues or solutions. As a result, modifications to the catch and bycatch monitoring program were incomplete and only served to weaken the value of the monitoring program in the name of cost-effectiveness.

Collectively, these actions have reduced the coverage rate on sector vessels from 38 percent under Amendment 16<sup>50</sup> to a current low of 14 percent in 2016 under FW55.<sup>51</sup> The fishery is

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<sup>44</sup> *Id.*

<sup>45</sup> *Id.*

<sup>46</sup> *Id.*; 75 Fed. Reg. at 18,299.

<sup>47</sup> New England Fishery Management Council, Framework Adjustment 48 to the Northeast Multispecies FMP 5 (2013).

<sup>48</sup> New England Fishery Management Council, Framework Adjustment 55 to the Northeast Multispecies FMP 55–56 (2016).

<sup>49</sup> *Id.* at 57.

<sup>50</sup> 75 Fed. Reg. at 18,272.

expected to require 16 percent coverage in 2017.<sup>52</sup> Put differently, the percentage of trips without an observer that rely on self-reporting of catch and discards has increase from 62% to 84% even as quotas have remained low and incentives to discard fish to stay under quotas has increased.

The end result is further erosion of the originally flawed catch and bycatch monitoring program. In a time of shrinking quotas due to the crisis in the fishery, which was declared a Federal disaster in 2012 and received \$32 million in disaster relief,<sup>53</sup> rather than develop an effective catch and bycatch monitoring program to end overfishing, the Council has instead chosen to rely upon the honesty and good will of the operators to accurately and precisely report catch and bycatch and to comply with the important prohibitions on discarding legal sized fish. This is akin to firing the bookkeeper when the bank balance is low and trusting that your bills will be paid on time.

During each of these processes, Oceana has expressed its concern about the effect of these changes on the ability of the Fisheries Service to administer the fishery, the ability to control catches under ACLs and ultimately the ability to ensure accountability, prevent overfishing and ultimately promote rebuilding of overfished stocks. In some cases, Oceana has challenged these actions as inconsistent with the MSA, leading to increased transparency in the monitoring rate calculation each year. Unfortunately, these changes to the monitoring program have come at a significant cost to the fishery that continues to suffer from failed management measures that are not achieving the goals of the FMP.

## **B. Biological Outcomes of the Groundfish Fishery Management Plan**

The groundfish fishery has suffered from decades of mismanagement and reached a collective low for its species in aggregate in 1994. Various management measures since then have attempted to recover these stocks but many still have not recovered, even after more than 20 years. Amendment 16 was heralded as the action that would finally help this fishery turn the corner. Quotas and bycatch limits are the fundamentals of sound management and should have been very effective in this task. However, during the sector era of the groundfish fishery, the performance of the fishery has diminished even further. Since Amendment 16 was implemented in 2010, the fishery has not achieved its goals and objectives. “Deep overfishing” continues and many stocks are near all-time lows.

Why has the sector management program failed to deliver its hoped-for results? One root cause is in effective monitoring. In each action to create and amend the catch share monitoring program, the Fisheries Service has been steadfast that the program would be up to the task of

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<sup>51</sup> Fisheries of the Northeastern United States; Northeast Groundfish Fishery, Framework Adjustment 55, 81 Fed. Reg. 26,411 26,419 (May 2, 2016) (to be codified 50 C.F.R. pt. 648).

<sup>52</sup> Press Release, NOAA Fisheries, NOAA Fisheries Announces At-Sea Monitoring 2017 Coverage Levels for Groundfish Sector Fishery (Mar. 15, 2017).

<sup>53</sup> NOAA Fisheries, Fishery Disaster Determinations, <http://www.nmfs.noaa.gov/sfa/management/disaster/determinations/index.html#acc56> (last visited April 3, 2017).



counting and accounting for catch.<sup>54</sup> Most recently in FW55, the Fisheries Service boldly stated that, “based on the available analyses of groundfish monitoring programs, we conclude that the sector monitoring requirements overall, including the adjustments to the method used to set the ASM coverage level in conjunction with other available data, are sufficient to monitor sector allocations and prevent overfishing.”<sup>55</sup>

The results of the fishery in recent years argues the opposite. Comparing the most recent fishery annual catch reports to the results of the 2014 operational stock assessment shows a broad disconnect between the reported catches of the sectors and the fishing mortality calculated by the assessment. In the fishery catch report for 2014, zero stocks exceeded their sector allocation and only two stocks exceeded their ACL (caused by catches outside the groundfish fishery).<sup>56</sup> However, the most recent Formal Operational Assessment indicates that six stocks were experiencing overfishing with fishing mortality rates above  $F_{msy}$ . Even more concerning some stocks exceeded  $F_{msy}$  by many multiples. Leading this group was Georges Bank cod (a stock at ~1% of its biomass target) that was fished at a rate more than nine times the sustainable level ( $F_{msy}$ ) and even higher than that relative to the levels needed to rebuild the stock ( $F_{rebuild}$ ).<sup>57</sup> The sector catch reporting system was saying “all is well” while the more rigorous assessment that considers a broad range of factor indicates a full-blown crisis.

Another indicator that monitoring is not supporting the management of the fishery is the growing trend of persistent “retrospective patterns” in the region’s stock assessments. These unexpected results of assessments show that the assessments are underestimating mortality and overestimating biomass. These retrospective patterns are consistent with inaccurate catch reporting that does not capture the true scope of the catch, much less bycatch.

This suggests that the current catch monitoring program is not working, is not collecting information that is representative of the performance of the fishery, and that a significant review and revision of this program is necessary to account for misreporting, underreporting and other inaccuracies in the catch monitoring program. Ineffective catch and bycatch monitoring under the Groundfish FMP is enabling overfishing, undermining the stock assessment process and hindering management processes that the Council uses to manage this fishery.

Considering the dire state of many stocks in the groundfish fishery,<sup>58</sup> there is no room for further ineffective measures. The groundfish fishery cannot withstand continued poor biological outcomes, and implementing effective catch and bycatch monitoring are critical.

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<sup>54</sup> FW48 Final Rule, 78 Fed. Reg. 26,142 (May 3, 2013). The level of observer coverage combined with the self-reporting requirements for sectors should provide confidence that the overall catch estimate is accurate enough to ensure that sector fishing activities are consistent with National Standard 1 requirements to prevent overfishing while achieving on a continuing basis optimum yield from each fishery.

<sup>55</sup> 81 Fed. Reg. at 26,420.

<sup>56</sup> NOAA Fisheries, Northeast Multispecies Fishery: Final Year-End Results for the Fishing Year 2014 (2015), [https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/Sector\\_Monitoring/FY14\\_Mults\\_Catch\\_Estimates.pdf](https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/Sector_Monitoring/FY14_Mults_Catch_Estimates.pdf).

<sup>57</sup> Northeast Fisheries Science Center, Operational Assessment of 20 Northeast Groundfish Stocks, Updated Through 2014 12 (2015).

<sup>58</sup> *Id.*

### C. Initiation of Amendment 23

Recognizing the persistent weaknesses in the groundfish monitoring program, in early 2016 the Council unanimously approved a “problem statement” to guide future review and modification of the groundfish monitoring program:

Problem statement: When Industry-Funded ASM requirements were established in Amendment 16, the expectation was that increased catch limits – as a result of rebuilding – would enable the industry to afford the cost of monitoring. Since 2010, ACLs for many stocks have declined sharply, along with groundfish revenues, and the size of the fleet. The affordability of the ASM program for groundfish sectors is in question. The current configuration of the ASM program may lead to significant economic impacts (i.e., economic losses) to the groundfish fishery and negative social impacts (i.e., those that reduce resiliency and increase vulnerabilities of fishing communities). Therefore, the Council requests analysis of the following by the PDT prior to the April Council meeting to assess whether:

- (1) the CV requirements and methodologies are the most appropriate to verify area fished, catch and discards by species and gear type for the sector system, and;
- (2) ASM provides the sector fishery, recognizing heterogeneity within the fleet (e.g., trip length, homeport, etc.), the maximum flexibility to meet ASM goals and objectives.<sup>59</sup>

The Council unanimously reiterated the importance of this issue with a statement that “the ASM action and completing the analyses in the ASM problem statement motion be of the highest priority for the 2016 groundfish priorities.”<sup>60</sup> The Council also noted its plan to develop Amendment 23 as a full amendment with an associated EIS beginning in 2017.

Amendment 23 was finally initiated in late 2016, a scoping document was prepared and approved by the Council and scoping began in early 2017 with the following purpose and need to guide the development of the amendment:<sup>61</sup>

The purpose of Amendment 23 is to adjust the groundfish monitoring program to improve reliability and accountability. In recent years, most Council discussions have focused on at-sea observer coverage because it provides the highest quality data, but it is expensive, and given the current low quotas in the fishery, the expense of at-sea monitoring is difficult for many fishermen to afford. There are also questions about the accurate representation of the information, since there is

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<sup>59</sup> New England Fishery Management Council Motions 4-5, [http://s3.amazonaws.com/nefmc.org/160126-29\\_Final\\_CouncilMtgMotions-to-Council.pdf](http://s3.amazonaws.com/nefmc.org/160126-29_Final_CouncilMtgMotions-to-Council.pdf) (last visited April 3, 2017).

<sup>60</sup> *Id.* at 5.

<sup>61</sup> New England Fishery Management Council, Scoping Document for Amendment 23 to the Northeast Multispecies Fishery Management Plan 3, [http://s3.amazonaws.com/nefmc.org/170217\\_GF\\_A23\\_Scoping-Documents.pdf](http://s3.amazonaws.com/nefmc.org/170217_GF_A23_Scoping-Documents.pdf) (last visited April 3, 2017).



evidence that fishing behavior may be different on observed and unobserved trips. For these reasons, the Council may explore alternatives to at-sea observers, and may consider changes to any part of the monitoring and reporting system for groundfish.

Addressing this purpose and need requires the development of an amendment to the Northeast Multispecies FMP to fully consider and analyze an appropriate range of management alternatives for changing the monitoring and reporting system. The Council is seeking comments and input from the public on this specific issue.

Oceana shares the Council's concerns with the state of the catch and bycatch monitoring program and its efficacy in achieving the goals and objectives of the Groundfish FMP and the requirements of Magnuson-Stevens Act. The scoping document is particularly strong in its emphasis on the need for accurate data and the possible difference between observed and unobserved trips. Oceana is also cognizant of the economics of the fishery and the need to balance data needs with the ability of the fishery to collect that data.

The catch and bycatch monitoring program is extremely important to the future of the groundfish fishery. Amendment 23, guided by the scoping document, will finally provide the Council with the time it needs to tackle these difficult issues and provide the fishery with long-overdue information to let the sector fishery operate as designed.

## DISCUSSION

It is essential that any monitoring strategy adopted in Amendment 23 tie monitoring rates and requirement to the buffers required to account for scientific and management uncertainty. In essence, the fleet would be presented with a choice on a sliding scale: on one end, use more robust monitoring and be rewarded with the ability to catch more of its quota, or at the other, use less robust monitoring but agree to sacrifice some quota to account for the additional uncertainty that comes with this reduced monitoring. The marginal cost of additional monitoring should be compared to the marginal value of the additional fish that could be caught as the result of that monitoring.

Amendment 23 must be developed in accordance with NEPA and the MSA. In addition, the Amendment 23 scoping process should include a review the performance of the Groundfish FMP catch and bycatch monitoring program to fully understand its failings. A number of questions should be asked in this context. Amendment 23 should explore a full range of alternatives to modify the Groundfish FMP catch and bycatch monitoring program. Oceana's recommendations for alternatives are discussed below.

**I. AMENDMENT 23 MUST BE DEVELOPED IN ACCORDANCE WITH NEPA AND THE MSA.**

As it develops Amendment 23, the Council should consider a broad range of monitoring alternatives, as required by NEPA, particularly in light of the funding constraints that have drastically reduced the amount of at-sea monitoring that has been conducted since Amendment 16 was promulgated. In doing so, it must consider alternatives suggested in this scoping process, and it must “rigorously explore and objectively evaluate” a “reasonable range” of such alternatives.<sup>62</sup> Given the monitoring challenges that the fishery has experienced so far, it would seem that the type of well-informed, broad-based analysis required under NEPA is the only path to finding a workable monitoring solution for this fishery.

The NEPA process is just that, however, and is meaningless if Amendment 23 does not ultimately meet the requirements of the MSA by establishing an SBRM that will provide the accurate, precise and timely monitoring data that is necessary to establish ACLs and AMs that will actually prevent overfishing. As noted in recent SBRM guidance, cost and other feasibility concerns “do not exempt an FMP from the requirement to establish as standardized reporting methodology.”<sup>63</sup> This is particularly apt in light of the inadequate agency funding for monitoring of the fishery. Furthermore, while the MSA requires that ACLs and AMs be established to prevent overfishing, as discussed above in Section II, there has been a disconnect in the fishery in recent years, with stocks declining even while ACLs appear to have been respected. This suggests a failure to collect accurate catch and bycatch data, resulting in ineffective ACLs and AMs.

Amendment 23 must also meet the requirements of the National Standards, by helping to prevent overfishing while achieving optimum yield (National Standard 1), by being based on the best scientific information available (National Standard 2), and by minimizing bycatch, and to the extent it cannot be avoided, minimizing the mortality of bycatch (National Standard 9). Under National Standard 1, Councils must take an approach that considers uncertainty in scientific information and management control of the fishery. Given the misreporting and underreporting that has occurred in the fishery and the overall failure to prevent overfishing, it is clear that there is a great deal of uncertainty in the data currently being collected. It is therefore essential that the Council explore the full range of scientific and management uncertainty that have hindered effective management of the fishery, and design a monitoring program that adequately compensates for that uncertainty.

Under National Standard 2, it is essential that “high quality and timely” scientific information be collected.<sup>64</sup> Amendment 23 and the Groundfish FMP cannot succeed if the monitoring methods it establishes do not ensure the collection of high quality data. As discussed above, the quality of catch and bycatch data varies widely, with at-sea monitoring generally being the highest quality, and self-reporting generally being much less accurate and precise. Amendment 23 must

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<sup>62</sup> 40 C.F.R. § 1502.14.

<sup>63</sup> 50 C.F.R. § 600.1610(a)(2)(ii).

<sup>64</sup> 50 C.F.R. § 600.315(a).



recognize these differences and account for them. It must also ensure that data is provided in a timely way, so that fishery managers have the tools to make prompt decisions if necessary to protect fish stocks. Amendment 23 must also support the National Standard 9 requirement of minimizing bycatch and bycatch mortality. Accurate and precise bycatch monitoring is a necessary predicate to bycatch reduction. One example of how Amendment 23 can support this goal is by encouraging the use of gear types that reduce bycatch by allowing reduced monitoring for vessels that use the innovative gear.

NEPA and the MSA provide the rules and the roadmap for developing an FMP Amendment that will ensure the collection of accurate and precise data for preventing overfishing and reducing bycatch. Amendment 23 must meet these requirements, both in process and substance.

## **II. AMENDMENT 23 SCOPING SHOULD INCLUDE A PERFORMANCE REVIEW OF THE GROUNDFISH FMP CATCH AND BYCATCH MONITORING PROGRAM.**

To address the goals and objective of Amendment 23 provided in the scoping document, Amendment 23 should contain, first and foremost, a thorough evaluation of the current catch monitoring program for the groundfish fishery. This should include both at-sea and shoreside components, the analytics that support catch monitoring and documentation and the in-season and inter-season analysis that is used to evaluate and administer the fishery. This analysis should be completed to answer five fundamental questions about the monitoring program:

- 1) Is the current monitoring program effective in supporting the sector management program, controlling fishing mortality, ending overfishing and rebuilding overfished stocks?

The sector system is designed, first and foremost, to control fishing mortality at levels that will support sustainable management of the groundfish fishery resource and ensure the accountability required by the MSA. Catch monitoring is an integral part of this program to prevent overfishing. Amendment 23 should take a hard look at the monitoring program and the results that this approach has delivered. Is the FMP successfully meeting its goals? Is the science supporting the fishery strong? What effect does the current monitoring program have on these important elements of the FMP?

- 2) Does this monitoring program ensure accountability for catches in the fishery at the appropriate level?

Accountability is a fundamental requirement of the MSA.<sup>65</sup> Amendment 23 should explore the workings of each sector and the sector fishery as a whole to determine where accountability is applied for each sector and whether the current monitoring system supports this approach. The ACL → PSC → ACE construct blurs the issue of accountability in the fishery. Although an overall ACL is developed, it is then conveyed to the sector member as PSC associated with each

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<sup>65</sup> 16 U.S.C. §1853(a)(15).

permit and then re-aggregated at the sector level as ACE where it can be used. It is important to know, for the purposes of monitoring and managing the fishery, whether accountability remains at the sector level (measured through ACE allocation) or are the sectors, through their operations plans and contracts, requiring each vessel or sector member to be accountable for their own catches relative to the PSC that they contributed to the sector.

Additionally, when ACE is leased between sectors, are the proceeds held by the sector generally? Or, are these transactions done on behalf of a member with proceeds going to the member? These questions are fundamental to the operation, administration, and finding of the sector fishery now that the fishery has matured past its infancy.

Further, issues such as bias may not be apparent at an aggregated sector level. But, if accountability is truly at the PSC level, bias may be present but not examined under the assumption that accountability is occurring at the sector level.

Each of these scenarios for accountability requires different approaches to monitoring to be effective. Amendment 23 should prepare for this with an understanding of the current fishery dynamics and operation. These issues must be fully explored in the analysis of the current monitoring program to inform the development of effective future monitoring strategies as individual accountability requires different monitoring than cooperative monitoring.

3) Is the information being collected accurate and precise?

It is critical that the catch information collected in the fishery is representative of the true fishing behavior of the fishery and its participants. Accuracy and precision have been persistent issues in the sector monitoring program since the sector monitoring was first developed and approved in Amendment 16 in 2009. Amendment 23 should take considerable time assessing the accuracy and precision that the fishery is currently achieving. Further, Amendment 23 should explore bias at the vessel, sector and fishery levels since bias may not be apparent at the aggregated sector or fishery level but may be present at the vessel level. It is important that Amendment 23 analyze bias in the context of sector operations.

4) How is data collected, managed, analyzed and used in the fishery?

The sector fishery is data-dependent and uses a series of sophisticated processes to collect, manage and analyze this data to support management of the fishery. These processes are supported by a range of Fisheries Service policies and procedures that complement the Groundfish FMP regulations. These include bycatch estimation methodologies, dealer reporting requirements and the Fisheries Service catch reconciliation process. All of these are integral to support catch monitoring. Amendment 23 should shine a bright light on these processes to look for redundancies, efficiencies and means to improve the flow of information in the fishery. An ancillary benefit of this assessment will be transparency for the range of the fishery's stakeholders who may or may not understand how the Fisheries Service and the Council use this information to administer the fishery.



5) Does the Groundfish FMP meet the requirements for SBRM included in the Fisheries Service's January 2017 guidance?

On January 19, 2017, the Fisheries Service issued guidance to all Councils to guide the development and establishment of SBRMs for each FMP.<sup>66</sup> These guidelines include a requirement to review each FMP in the near future to assess compliance with these new guidelines. The guidelines have an emphasis on the connection between SBRMs and conservation and management of fisheries as well as bycatch reduction.<sup>67</sup>

These are issues that are front and center in Amendment 23, and the Council should use the Amendment 23 EIS to complete this important assessment. Fortunately, the Council has initiated a full amendment for this action supported by an EIS. This will give the Council, Council staff and the Groundfish PDT latitude to explore these important issues that are critical to the success of the catch monitoring program. These issues can then inform the development of a full range of alternatives to amend the FMP.

**III. AMENDMENT 23 SHOULD EXPLORE A FULL RANGE OF ALTERNATIVES TO MODIFY THE GROUNDFISH FMP CATCH AND BYCATCH MONITORING PROGRAM.**

Following a complete assessment of the current sector catch monitoring program, Amendment 23 should consider a full range of alternatives to address identified weaknesses in the current program. To achieve the overarching goals of statistically sound monitoring and economic sustainability and recognizing the connection between monitoring and management, Oceana urges the Council to include the following in the range of issues and alternatives that are developed in Amendment 23. These alternatives will support the realized management of the sector fishery instead of the idealized view that was approved by Amendment 16.

**A. At-Sea Observers**

Human observers, whether deployed on the water through the National Marine Fisheries Service Northeast Fishery Observer Program (NEFOP) or the Groundfish At-Sea Monitoring Program (ASM) or virtually through Electronic Monitoring (EM) technology, are the most effective objective tool to monitor fisheries.

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<sup>66</sup> Standardized Bycatch Reporting Methodology, 82 Fed. Reg. 6320 (January 19, 2017)

<sup>67</sup> 50 C.F.R. § 600.1600. "purpose of a standardized reporting methodology is to collect, record, and report bycatch data in a fishery ... to assess the amount and type of bycatch occurring in the fishery and inform the development of conservation and management measures that, to the extent practicable, minimize bycatch and bycatch mortality."

All of the methods may contribute to useful bycatch estimation programs, but at-sea observation (observers or electronic monitoring) provides the best mechanism to obtain reliable and accurate bycatch estimates for many fisheries.<sup>68</sup>

Amendment 23 must include a range of alternatives to set rates of human observers that will produce data that is accurate, precise and timely. These three characteristics are all important to support management while combinations of the three each fail to meet the needs of the fishery.

## 1. Accuracy

Accuracy, or the “degree of conformity of a measure to a standard or a true value”<sup>69</sup> is perhaps the most important measure of catch monitoring program as this assesses how close observed values are to the true catch of the vessel, fleet or fishery. As the Groundfish PDT advised in 2012: “A biased discard estimate will have more influence on the accuracy of sector catches than the CV standard. It is therefore critical to have enough coverage that the presence of bias can be detected; ideally coverage should provide a way to estimate the amount of bias.”<sup>70</sup>

If information is not representative of the true behavior or performance of the fishery or if fishing is different when an observer is present, the data is inaccurate. Bias in at-sea monitoring can come in different forms. Observer effect, whereby fishing vessels behave differently when they know they are being observed, is another form of bias that must also be controlled and considered when designing an effective catch and bycatch monitoring program. Additionally, while observer data may be accurate for the portion of the fishery that is observed, if the observed vessels, sectors, trips or areas are not representative of the fishery as a whole, bias may be introduced when the bycatch estimated from observer samples are expanded over the rest of a vessel’s trips, its catch sector or the fishery to estimate total bycatch.

It is critically important that the catch data used to support the management of the fishery is demonstrably accurate and free of bias. The Council should include measures that describe and account for bias in the monitoring program to ensure that all catch is accounted for and overfishing is prevented.

## 2. Precision

Precision, on the other hand, refers to how close estimates from different samples are to each other but not the true value. This measure has some value but does not refer to the true performance or behavior of the vessel, fleet or fishery. As the Groundfish PDT advised in 2012,

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<sup>68</sup> National Marine Fisheries Service, *Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs v (2004)*, <http://spo.nmfs.noaa.gov/tm/tm66.pdf> [hereinafter *Evaluating Bycatch*].

<sup>69</sup> Merriam-Webster, *Definition of accuracy*, <https://www.merriam-webster.com/dictionary/accuracy> (last visited April 3, 2017).

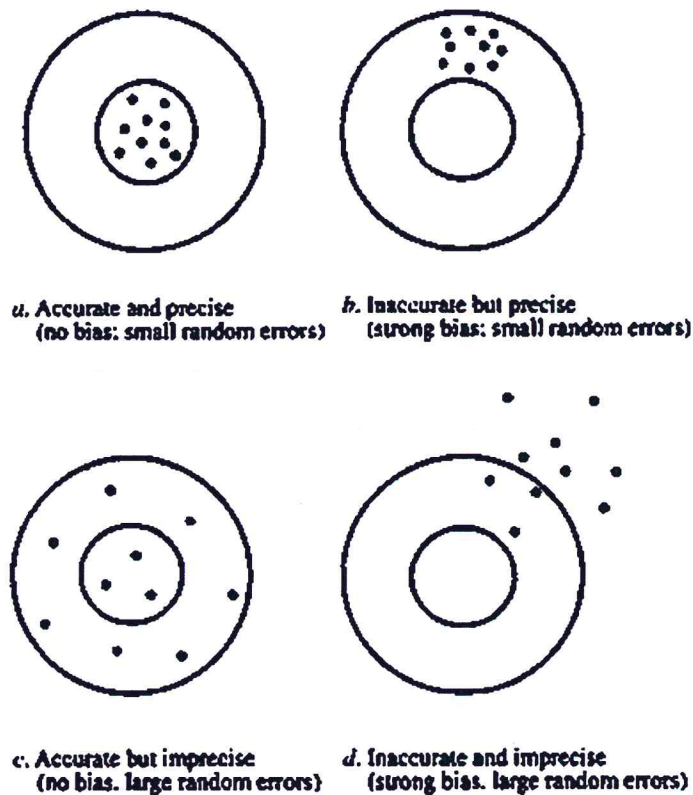
<sup>70</sup> Northeast Fisheries Science Center, *Summary of Analyses Conducted to Determine At-Sea Monitoring Requirements for Multispecies Sectors FY 2015*, Appendix B - New England Fishery Management Council Multispecies Plan Development Team Memo 36 (July 27, 2012), [http://www.nefsc.noaa.gov/fsb/asm/FY2015\\_Multispecies\\_Sector\\_ASM\\_Requirements\\_Summary.pdf](http://www.nefsc.noaa.gov/fsb/asm/FY2015_Multispecies_Sector_ASM_Requirements_Summary.pdf) (last visited April 3, 2017).



“[Coefficient of variation (“CV”)], by itself, may not be the appropriate standard for determining observer coverage levels needed to monitor sector catch quotas.”<sup>71</sup>

However, a CV standard of precision has been driving the calculation of observer coverage in the sector fishery since its first season. The 30 percent CV standard measuring precision was inappropriately borrowed from the Northeast (“NE”) Region SBRM for use in Amendment 16. Amendment 23 should explore a range of alternatives to appropriately consider the value of a precision standard in the catch monitoring program and the effects of these precision choices on uncertainty and management outcomes.

These concepts of precision and accuracy are best illustrated in the following diagrams from the UN Food and Agricultural Organization (FAO):<sup>72</sup>



Amendment 23 should develop alternatives that deliver catch information that is demonstrably accurate and precise (figure a. above). Any of the other combinations have weaknesses and uncertainties that must be explained, and explicitly accounted for in management decisions.

<sup>71</sup> *Id.*

<sup>72</sup> L.P. van Reeuwijk & V.J.G. Houba, *Basic Statistical Tools in Guidelines for Quality Management in Soil and Plant Laboratories* (1998), <http://www.fao.org/docrep/W7295E/w7295e08.htm>.

### **3. Timeliness**

The groundfish fishery relies on a consistent flow of data to support in-season management. It is critically important that this information be provided to the Fisheries Service, the Council and the fishery in a timely fashion to support the management goals of the FMP and ensure accountability of the sector fishery. Amendment 23 and the discussion of the treatment of data should consider options to improve the speed that data is processed.

#### **B. Electronic Monitoring**

In recent years Electronic Monitoring has been developed for a number of gears and fisheries around the world including some pilot programs in the NE Region and required programs in the U.S. Atlantic Highly Migratory Species fishery.<sup>73</sup>

While Amendment 23 is not likely to approve EM for use to replace or supplement the monitoring of the groundfish fishery, the Council should consider options and alternatives related to future use of EM to avoid *ad hoc* consideration of these programs in segments of the fishery. Specifically, Amendment 23 should establish objective performance criteria and standards for EM programs to ensure that EM systems are standardized, interoperable and effective to support management and assessment of the fishery. These standards should include the following aspects.

##### **1. Electronic Monitoring Sampling Design**

EM systems are unique tools to monitor fisheries that cannot and should not be substituted for observers on a one-for-one basis. EM systems carry unique requirements and considerations for their use. EM must be strategically deployed within a larger sampling design. The Council, in consultation with the Fisheries Service should develop standards for acceptable EM sampling design and include these standards for consideration and approval of EM in the fishery.

##### **2. Data Quality (accuracy, precision, timeliness and interoperability)**

Data collected by EM technology is subject to the same measures of data quality as human observer programs: accuracy, precision and timeliness. Amendment 23 should include standards for accuracy, precision and timeliness that will be used to assess future EM applications. Additionally, the Council should consult with the Fisheries Service to develop standards for EM programs to ensure that they are compatible and interoperable with existing technologies used to administer the fishery.

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<sup>73</sup> Atlantic Highly Migratory Species; 2006 Consolidated Atlantic Highly Migratory Species (HMS) Fishery Management Plan; Amendment 7, 79 Fed. Reg. 71,510, 71,515 (Dec. 2, 2014) (to be codified 19 C.F.R. pt. 902, 50 C.F.R. pt. 635).



### 3. New Electronic Technologies

Amendment 23 should include options to expand the use of satellite technology to enhance catch monitoring and reporting. Specifically, Amendment 23 should consider enhanced use of Vessel Monitoring Systems (VMS) to improve catch documentations as well as consideration of emerging technologies like Automatic Identification System (AIS) paired with Global Fishing Watch<sup>74</sup> and Pelagic Data Systems,<sup>75</sup> a new solar powered, low-cost technology to collect high resolution spatial data at sea at a far lower cost than VMS.

### C. Flexibility in Monitoring

Oceana appreciates that the groundfish fishery is heterogeneous and the factors that drive sectors, ports or individuals may vary widely along with the incentives to change. To this fact, Oceana recommends that the Council include alternatives in Amendment 23 that provide the fishery with flexibility and choice in how to achieve the essential monitoring that the sector fishery requires. These options are discussed below.

#### 1. Coverage rates specific to Each Sector and/or Gear

Since the implementation of Amendment 16 in 2010, the Fisheries Service has established monitoring requirements for the fishery as a whole and specified essential information such as observer coverage rates regardless of the specifics of a particular vessel. This has required monitoring to be the same for an 80-foot trawler as a 40-foot gillnetter, even when those gears and their catch characteristics are likely vastly different. Similarly each sector has been required to use the same monitoring requirements regardless of the sector's composition.

This one-size-fits-all approach is contrary to the vision for monitoring described in Amendment 16, which required each sector to develop its own monitoring program.<sup>76</sup> It is also likely that this requirement has stifled innovation in the sector fishery as sectors are resigned to the Fisheries Service's requirements rather than thinking of a new approach that could drive down its monitoring requirements. For example, if Amendment 23 provides additional flexibility, a sector could limit its roster to certain gears, certain stock areas, or an individual could change from one gear to another to experience lower monitoring requirements.

Finally, the Fisheries Service and its industry research partners have spent a considerable amount of time and money to develop selective fishing gears like the Ruhle trawl. Flexibility in monitoring will encourage more vessels to adopt this gear if it comes with a corresponding reduction in monitoring requirements.

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<sup>74</sup> See Global Fishing Watch, *About the Project*, <http://globalfishingwatch.org/the-project> (last visited April 3, 2017).

<sup>75</sup> See Pelagic Data Systems, *How It Works*, <http://www.pelagicdata.com> (last visited Apr. 3, 2017).

<sup>76</sup> 50 C.F.R. § 648.87(b)(2)(xi) ("Detailed plans for the monitoring and reporting of landings and discards by sector participants, including, but not limited to, detailed information describing the sector's dockside/roving and at-sea/electronic monitoring program for monitoring utilization of ACE allocated to that sector").

Amendment 23 should include a range of alternatives that provide flexibility set monitoring according to sector, gear area fished and other factors with a clear requirement that the monitoring program provide statistically robust information to support management, end overfishing and achieve the goals of the FMP.

## **2. Monitoring/Buffer Tradeoff Approach**

During the development of FW48, the Groundfish PDT began exploring a monitoring strategy that ties monitoring rates and requirement to the buffers required to account for scientific and management uncertainty. In essence, the fleet would be presented with a choice on a sliding scale: on one end, use more robust monitoring and be rewarded with the ability to catch more of its quota, or at the other, use less robust monitoring but agree to sacrifice some quota to account for the additional uncertainty that comes with this reduced monitoring. This approach presents monitoring as a business decision for the fishery with the backstop that the uncertainty buffers will ensure that overfishing does not occur and stocks are rebuilt.

### **D. Self-Reported Data**

The Council should take great care when considering the continued use of self-reported information as part of the groundfish catch reporting program. These reporting tools have inherent biases that are compounded by the incentives to under-report or misreport catch to either stay under a quota allocation or be forced to acquire additional quota to cover extra catches in the fishery.

This position is supported by the findings of the Fisheries Service in its 2004 report *Evaluating Bycatch*: “Inaccuracies of logbooks primarily result from misreporting of species that are of little economic interest (particularly of bycatch species) and low compliance rates with reporting requirements. If fishermen perceive that accurate reporting of bycatch will result in restricted fishing effort or access, they have an incentive to underreport.”<sup>77</sup> Further this report summarized the use of self-reporting in comparison with at-sea observers: “Data collected from at-sea observation programs (which usually are observer programs) provide better estimates of bycatch rates than do data from either fishery-independent surveys or self-reporting.”<sup>78</sup>

More specific to the groundfish fishery, the FMP requires vessels to use VTRs to self-report catches on multi-day trips to attribute catches to multiple stock areas. This requirement allows vessels tremendous flexibility to misreport catches and manipulate their catch allocations and undermine management. This is especially relevant where a vessel reports catch of a depleted stock (e.g. Gulf of Maine haddock) as catch of a more abundant stock of the same species (e.g. Georges Bank Haddock). A recent agency report investigating the errors in VTR data confirms

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<sup>77</sup> Evaluating Bycatch at 28-29.

<sup>78</sup> *Id.* at 45.



that this is currently happening in the fishery where “for some stocks the estimated errors are large in one or more years.”<sup>79</sup>

Most importantly for Amendment 23, this report also advises that “(m)uch of the error could be mitigated through improvements in catch monitoring and/or management measures designed to improve catch accounting,”<sup>80</sup> and further advises, “(t)he problem of catch-area reporting errors could also be solved through changes in fisheries management measures; these measures could include restricting vessels to fishing in only [one] statistical area unless carrying an observer or requiring 100% observer coverage.”<sup>81</sup>

Amendment 23 should include clear reforms to the use of self-reported catch information in the fishery. VTR data cannot and should not be used for catch reporting without significant improvements and a proven means to document and verify all catches.

#### **E. Funding**

Effective catch monitoring is integral to the success of the Groundfish FMP. Without accurate and precise information, the FMP cannot fulfill its various legal obligations under the MSA. Oceana understands that funding catch monitoring may be a burden for the fishery and the Fisheries Service. But, participating in a sophisticated fishery also provides participants with benefits in exchange for this monitoring in the form of set quotas that will not close prematurely and the ability to buy, sell and lease quota which provides real value to the quota. Considering the uncertainty in government funding, the Fisheries Service’s other monitoring obligations in the region and the ongoing responsibility of the industry to fund the monitoring program, Oceana encourages the Council to explore a full range of funding alternatives in Amendment 23.

Most importantly, any monitoring strategy adopted in Amendment 23 should tie monitoring rates and requirement to the buffers required to account for scientific and management uncertainty. In essence, the fleet would be presented with a choice on a sliding scale: on one end, use more robust monitoring and be rewarded with the ability to catch more of its quota, or at the other, use less robust monitoring but agree to sacrifice some quota to account for the additional uncertainty that comes with this reduced monitoring. The marginal cost of additional monitoring should be compared to the marginal value of the additional fish that could be caught as the result of that monitoring. Other recommended alternatives include but should not be limited to the following.

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<sup>79</sup> Michael Palmer, Northeast Fisheries Science Center, Vessel Trip Reports Catch-area Reporting Errors: Potential Impacts on the Monitoring and Management of the Northeast United States Groundfish Resource 1(2017), <http://www.nefsc.noaa.gov/nefsc/publications/crd/crd1702/>.

<sup>80</sup> *Id.* at 12.

<sup>81</sup> *Id.*

**1. Reduced costs from monitoring flexibility alternatives**

Many of the monitoring strategies discussed above may reduce the monitoring needs for particular sectors, vessels and gears that adapt and innovate to meet the data needs of the fishery compared to the overall fishery. These reduced costs should be discussed in Amendment 23, which may provide additional incentive for innovation.

**2. Quota set-asides/auctions to fund monitoring**

In some FMPs a portion of the quota is reserved as a set-aside and auctioned off annually to provide additional catch opportunity and a source of funding for management priorities like research. Amendment 23 should explore opportunities to set aside a portion of the ACL for key stocks to fund monitoring. This is particularly true for those stocks that constrain fishing for more abundant stocks where a small amount of quota obtained through the auction would open additional fishing opportunity.

**3. Using revenue from quota leasing/sales to offset monitoring costs**

As discussed above, each sector receives a portfolio of ACE each year that is commensurate with the PSC of the sector's members. This ACE has real value in the ACE trading market and Amendment 23 should, as part of the discussion of ACE trading suggested above, explore the potential value of these trades as a source of funding for monitoring where a sector would lease some of its quota to offset monitoring costs.

**4. Increasing value of well-documented catches to offset monitoring costs**

In recent years new technologies have emerged that allow catch to be documented, verified and traced through the supply chain from boat to plate. These technologies have resulted in measurable increases in the value of these catches when compared to typical catches of the same stocks. Many Councils, and the Fisheries Service itself, work to promote U.S. seafood and the U.S. fishing industry.<sup>82</sup> The Council should consider developing a program to enhance catch documentation, verification and traceability to increase funding for monitoring.

**F. Modifications to Satisfy the Fisheries Service's SBRM Guidelines**

Based on the analysis of the monitoring program and the requirements of the Fisheries Service's SBRM guidelines, Amendment 23 should include necessary amendments to the Groundfish FMP to bring it into compliance with agency guidance. These needs should be identified in the analytical process but if a robust catch monitoring program is developed to support the sector fishery, these modifications will likely be clerical and procedural since accurate and precise

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<sup>82</sup> NOAA, *FishWatch: U.S. Seafood Facts*, <http://www.fishwatch.gov/> (last visited April 3, 2017).



monitoring that inform management will already be in place. The Council should reconcile this FMP in Amendment 23 rather than using a future action.

## CONCLUSION

Oceana appreciates the opportunity to provide comments on scoping for Amendment 23 to the Groundfish FMP. The groundfish fishery is suffering due to a lack of proper monitoring. The percentage of trips without an observer that rely on self-reporting of catch and discards has increase from 62% to 84% even as quotas have remained low and incentives to discard fish to stay under quotas has increased. The end result is further erosion of the originally flawed catch and bycatch monitoring program.

Oceana is pleased that the Council has initiated a full amendment for this action supported by an EIS. By doing so, the Council will be able to explore the important monitoring issues and alternatives critical to the success of the groundfish fishery catch monitoring program. To achieve this, Oceana recommends that the Council take the following actions with respect to Amendment 23.

First and foremost, it is essential that any monitoring strategy adopted in Amendment 23 tie monitoring rates and requirement to the buffers required to account for scientific and management uncertainty. In essence, the fleet would be presented with a choice on a sliding scale: on one end, use more robust monitoring and be rewarded with the ability to catch more of its quota, or at the other, use less robust monitoring but agree to sacrifice some quota to account for the additional uncertainty that comes with this reduced monitoring. The marginal cost of additional monitoring should be compared to the marginal value of the additional fish that could be caught as the result of that monitoring.

In addition, Oceana recommends the following:

- Amendment 23 must be developed in accordance with the National Environmental Policy Act (“NEPA”) and the Magnuson-Stevens Act.
- Amendment 23 scoping should include a performance review of the Groundfish FMP catch and bycatch monitoring program
- Amendment 23 should explore a full range of alternatives to modify the Groundfish FMP catch and bycatch monitoring program, including consideration of a full range of alternatives for:
  - at-sea catch monitoring, including human observer coverage;
  - standards for Electronic Monitoring (EM);
  - improved spatial data collection;
  - improved and appropriate use of self-reported data;
  - consideration of funding alternatives to support the groundfish fishery and its

- catch monitoring needs; and
- modifications to satisfy the Fishery Service's SBRM guidelines.

Oceana remains committed to the success of the New England groundfish fishery and the recovery of this fishery. Oceana encourages the Council to use Amendment 23 to make the sector program and the overall fishery more successful and efficient. Oceana appreciates the opportunity to provide input and thanks you for your time. We will continue to be engaged in this process moving forward.

Sincerely,



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Gib Brogan  
Fisheries Campaign Manager  
Oceana, Inc.

\_\_\_\_\_/s/\_\_\_\_\_  
John Rousakis  
Janine Panchok-Berry  
Counsel for Oceana  
O'Melveny & Myers LLP

**Sherie Goutier**

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**From:** Bonnie Brady <greenfluke@optonline.net>  
**Sent:** Monday, April 03, 2017 5:01 PM  
**To:** comments  
**Subject:** Comments amend 26  
**Attachments:** 170217\_GF\_A23\_Scoping-hearing-notice-REVISED.pdf



We do not support additional electronic monitoring for groundfish sector or in the possible future, common pool boats, other than EM through the EVTR system already in use by NOAA through its study fleet. The EVTR system should be expanded.

Nefop should be the only observing that takes place, and paid for by NMFS/NOAA

Groundfish boats cannot afford cameras or paying for additional at sea monitoring.

Thank you

Bonnie Brady

Long Island Commercial Fishing Association.

Sent from my iPhone





**For a thriving New England**

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Thomas A. Nies, Executive Director  
New England Fishery Management Council  
50 Water Street, Mill #2  
Newburyport, MA 01950

April 3, 2017

**Re: Northeast Multispecies Amendment 23 Scoping Comments**

Dear Mr. Nies:

Conservation Law Foundation (CLF) thanks you for the opportunity to provide scoping comments on the development of Amendment 23 to the Northeast Multispecies Fishery Management Plan (Groundfish Monitoring Amendment).

It would be difficult for CLF to overstate the importance of this amendment for the future of New England's groundfish fishery. We have been following this fishery since 1989, when the management plan only covered cod, haddock, and yellowtail flounder and Amendment 4 was under development. At that time, all three stocks were declared to be overfished and the New England Fishery Management Council (Council) did not take the action necessary to stop the overfishing, leading to CLF's first litigation under what is now called the Magnuson-Stevens Act.

Now, 19 amendments and nearly thirty years later, both cod stocks and the yellowtail flounder stocks are still overfished and subject to overfishing. CLF knows of no other fishery management council in the federal system that has performed as poorly with respect to preventing persistent overfishing on commercial species under its management. Another aspect of this history hasn't changed: the assessment scientists have been repeatedly advising the Council with every cod and flounder assessment that there were persistent problems with the data, consistently resulting in the underestimating of the actual amount of fishing mortality on the water and overestimating the biomass.

To CLF and many others we have talked with, the conclusion is inescapable that there is far more at-sea fishing mortality of these stocks than has been estimated from existing fisheries-dependent observed data streams, vessel trip reports, and landings data.

The Council now knows that Carlos Rafael, head of one of the largest groundfish operations, was blatantly and rampantly cheating with respect to his at-sea catch. His recent admissions of guilt to mislabeling, though, simply concerned the mislabeled cod and other fish that his boats caught and *landed*. There is no way of knowing what his boats were doing all these years with respect to pitching legal cod, yellowtail flounder, or other stocks overboard *at-sea without recording*. Similarly, there is no way of knowing exactly how many cod and yellowtails are being discarded at-sea unreported by the

fleet as a whole. Dr. Mike Palmer's recent report,<sup>1</sup> discussed below, makes clear that the potential scope of the data problem is even more widespread based on his analysis of intentional or unintentional misreporting of data on VTRs and its impact on the accuracy of the assessments that are based on that data.

The Council cannot carry out its responsibilities under the Magnuson-Stevens Act without good assessment science on not only cod and yellowtail but all groundfish stocks; and good science is 100% dependent on access to accurate and reliable data with respect to at-sea catch. Given that the Massachusetts state cod survey is now confirming the federal assessment numbers of low and truncated cod population size, the longstanding challenges of rebuilding cod will likely be with the region for some time.<sup>2</sup> Members of the fishing industry have called for abandoning the models, saying they are no longer reliable as predictive tools. This is not acceptable when there are actions that the Council and NOAA Fisheries can take to improve the quality and reliability of the catch data.

Amendment 23 is likely the last meaningful opportunity the Council has to get on top of the management challenge presented by the stalled recovery of these important stocks. Rebuilding cod and yellowtail stocks starts with good science, and as stated above, that good science starts with accurate and reliable at-sea data in addition to landings data and independent fisheries data. The need for this data is two-fold: (1) to be used for modelling (science) and (2) to be used in the regulatory process (compliance).

The stated purpose of Amendment 23 is "to adjust the groundfish monitoring program to improve reliability and accountability [of the NE groundfish monitoring program]."<sup>3</sup> CLF fully supports the development of Amendment 23 and the strong need to revise the groundfish monitoring program. CLF defines accountability as:

*The ability to ensure that all landings and discards occurring within a fishery are accurately and reliably accounted for in order to ensure that annual catch limits are adhered to and that the best available information is included in stock assessments.*

You have specifically requested comments on the range of alternatives that the Council should consider in Amendment 23, the specific issues that are most important when evaluating tradeoffs associated with

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<sup>1</sup> Palmer MC. 2017. Vessel trip reports catch-area reporting errors: Potential impacts on the monitoring and management of the Northeast United States groundfish resource. US Dept Commerce, Northeast Fishery Science Center Ref Doc 17-021 47p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 20543-1026, or online as <http://www.nefsc.noaa.gov/publications/>

<sup>2</sup> Abel, David. A milestone in the war over the true state of cod. The Boston Globe. [Boston] April 3, 2017 available at: <https://www.bostonglobe.com/metro/2017/04/02/milestone-war-over-true-state-cod/OdTWfI2sw9z3VoZTwKaWjP/story.html>

<sup>3</sup> New England Fishery Management Council, Scoping Document for Amendment 23 to the Northeast Multispecies Fishery Management Plan (Groundfish Monitoring Amendment), February 17, 2017 available at: [http://s3.amazonaws.com/nefmc.org/170217\\_GF\\_A23\\_Scoping-Documents.pdf](http://s3.amazonaws.com/nefmc.org/170217_GF_A23_Scoping-Documents.pdf)



monitoring discards at-sea using at-sea monitors, and whether the Council should consider changes in how landings information is provided.<sup>4</sup> Our specific comments follow.

## **1. Monitoring Coverage Is Not, and Has Never Been Sufficient**

There are currently three sources of data collected for the New England's groundfish fishery: vessel trip reports from fishermen and dealers, vessel position data, and third party data (NEFOP observers and at-sea monitors). In 2010, management of the New England groundfish fishery underwent a major overhaul with the implementation of Amendment 16 and the transition to a collective quota-based system. Since the transition, the need to understand how many groundfish are taken from the ocean, and counted against the sector quotas, has become ever more imperative, hence the creation of the at-sea monitoring program. Although generally consistent with the law, there were concerns with Amendment 16 and the monitoring program from the start regarding the ability to effectively and accurately monitor landings and bycatch under the quota system.<sup>5</sup> Those concerns clearly remain today, and, if anything, have intensified as some groundfish stocks have reached historic lows and strict catch limits have been implemented.

Under a quota-based system, accurate reporting of catch and discard is essential in order to prevent overfishing. The fishery has been plagued, however, by too low coverage levels of at-sea observer/monitor coverage. When quotas are as low as they currently are for stocks such as Gulf of Maine and Georges Bank cod, it's expected that discards, not landings, would compose most of the catch. However, monitoring levels have also reached alarmingly low levels (86 percent of groundfish trips went unmonitored in fishing year 2016; 84 percent of trips will be unmonitored in fishing year 2017) that odds of obtaining accurate catch data are greatly reduced, even though monitoring coverage levels meet the 30CV standard requirement.<sup>6</sup> The CV standard requirement is flawed, however, because it is a precision estimate and does not consider the accuracy of the data.

## **2. Failures of the Existing Groundfish Monitoring Program**

The existing groundfish monitoring program is an overly burdensome, outdated, non-technology-based reporting system – for both fishermen and observers. Furthermore, it is a poor use of taxpayer and fishermen's dollars as it is extremely expensive yet provides biased and unreliable data. The New England groundfish fishery lacks accountability because of inadequate and low levels of monitoring due to fundamental flaws in the existing monitoring program.

As a consequence, particularly when the persistent overfished (or now unknown) status of several of the groundfish stocks is constricting the opportunities to catch and land more abundant co-located stocks,

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<sup>4</sup> New England Fishery Management Council, Scoping Document for Amendment 23 to the Northeast Multispecies Fishery Management Plan (Groundfish Monitoring Amendment), February 17, 2017 *available at*: [http://s3.amazonaws.com/nefmc.org/170217\\_GF\\_A23\\_Scoping-Documents.pdf](http://s3.amazonaws.com/nefmc.org/170217_GF_A23_Scoping-Documents.pdf)

<sup>5</sup> Complaint for Declaratory and Injunctive Relief, *Oceana, Inc. v. Locke*, No. 10-cv-774 (D.D.C. May 7, 2010).

<sup>6</sup> It is also not clear how many of the 20-30 boats that Dr. Palmer identified in his paper as being the crux of the multi-stock area misreporting are covered by these programs.

the system practically breeds incentives for non-compliance. While there are individuals in the fishery like Carlos Rafael who bragged about his non-compliance and misreporting and said it was the responsibility of government to catch him, it is basic human nature that misreporting will increase under such circumstances.

The Magnuson-Stevens Act requires the Council to prevent overfishing and rebuild overfished stocks. In developing the groundfish monitoring amendment, the Council should pay particular attention to how the amendment is serving the purposes of National Standards 1, 2, and 9:

*National Standard 1: Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.*

*National Standard 2: Conservation and management measures shall be based upon the best scientific information available.*

*National Standard 9: Conservation and management measures shall, to the extent practicable, (a) minimize bycatch and (b) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.*

The importance of each of these national standards is completely predicated on accurate data. Since accurate data cannot be obtained without efficient monitoring and accountability in the fishery, it would not be possible prevent overfishing to comply with National Standard 1 of the Magnuson-Stevens Act in the absence of such data. Without accurate catch data, it is impossible to comply with National Standard 2 because the best available science requires accurate data as inputs. And without accurate data, it is impossible to comply with National Standard 9. If managers don't know what the actual bycatch on the water looks like, then it cannot be minimized or avoided. At the end of the day, Amendment 23 is about bringing the multispecies groundfish fishery finally into compliance with the Magnuson-Stevens Act.

In addition to the axiomatic truth that managers cannot prevent overfishing if they don't know about it, National Standard 2 requires that fishery management decisions are based on the best available science. It is evident, however, that catch and discard data in New England's groundfish fishery is highly uncertain and has likely gotten worse after the catch share program was implemented.<sup>7</sup> This is due to a multitude of reasons including "the observer effect," misreporting catch, and illegal catch.

Observer data is the only third party data managers have about catch at sea, but it is unreliable as a predictor of unobserved fishing behavior and is significantly biased. All humans behave differently when they are being observed. It is something every adult experiences directly when driving or when paying

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<sup>7</sup> Palmer MC. 2017. Vessel trip reports catch-area reporting errors: Potential impacts on the monitoring and management of the Northeast United States groundfish resource. US Dept Commerce, Northeast Fishery Science Center Ref Doc 17-021 47p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 20543-1026, or online as <http://www.nefsc.noaa.gov/publications/>



taxes. The fisheries observer effect changes how and even likely where fishermen fish when there is an observer on board.<sup>8</sup> This becomes structurally problematic when observer data collected on the miniscule 14 percent of trips (16 percent in fishing year 2017) is used to estimate discard rates for the unobserved trips. If fishermen are discarding tons of fish on unobserved trips without reporting, then the observed trip estimates are significantly low and biased.

There is also evidence of catch accounting errors by fishermen, particularly those on multiple stock area trips, on their Vessel Trip Reports (VTRs), which is explained in detail by the recently released NEFSC paper by Michael Palmer.<sup>9</sup> Palmer identified catch accounting errors as misreporting catch, false identification of species, or reporting catch from the wrong stock area, all of which often lead to underreporting of particular species. The errors were particularly problematic on multi-area trips, which have become more common among larger vessels. Palmer estimates that, for multi-area trips, VTR-reported area and observer-reported area matched less than 50 percent of the time. The errors were larger for “choke species” or when quotas for particular stocks – Gulf of Maine cod in 2013 and Gulf of Maine haddock in 2012 – were reduced in the fishery.

In the event that quotas are low enough that there is a risk of the fishery being shut down, or when leasing prices are high, or when an individual’s operation will exceed his potential sector contribution, there are overpowering incentives to misreport catch: accountability in the fishery greatly diminishes, especially when there’s the thought that other fishermen are misreporting as well. There is currently not a high enough cost for misreporting catch or illegal catch and discard. In fact, analysis from 2010 showed that economic gains from illegal fishing could be five times higher than the cost of possible penalties.<sup>10</sup> Even an operation as corrupt as Carlos Raphael’s seems likely to be allowed to continue in the New England fishery despite numerous, major, and repeated confessions of misreporting and non-reporting. What signal does that send?

In addition to the unreported or misreported catch taking place, another source of uncertain data in the groundfish fishery, as noted above, is simply the fact that there is a certain amount of illegal catch taking place. Rafael’s multicount criminal indictment is a prime example of the lack of checks and balances in the groundfish fishery and shows just how far illegal activity can go within the fishery without detection. Were it not for the IRS sting, Mr. Rafael would no doubt continue to have eluded the limits of management and the law with impunity.

All of these activities lead to low accountability in the groundfish fishery and create an uneven playing field for fishermen, particularly those who are inclined to fully comply with the rules. Highly uncertain

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<sup>8</sup> Benoit HP and Allard J. 2009. Can the data from at-sea observer surveys be used to make general inferences about catch composition and discards? Canadian Journal of Fisheries and Aquatic Sciences 66: 2025-2039.

<sup>9</sup> Palmer MC. 2017. Vessel trip reports catch-area reporting errors: Potential impacts on the monitoring and management of the Northeast United States groundfish resource. US Dept Commerce, Northeast Fishery Science Center Ref Doc 17-021 47p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online as <http://www.nefsc.noaa.gov/publications/>

<sup>10</sup> Sutinen DM and King JG. 2010. Rational noncompliance and the liquidation of Northeast groundfish resources. Marine Policy 34: 7-21.



data, as a result of the reasons listed above, also impedes the ability of fishery managers to effectively manage the resource and set accurate annual catch limits (ACLs) and, consequently, accountability measures fail. This can lead to highly variable and unpredictable ACLs, as well as lost business opportunity for fishermen.

The presence of retrospective patterns in the groundfish fishery stock assessments—widely believed to be caused by the use of inaccurate data-- has resulted in a great distrust between fishermen and scientists. This lack of trust can result in fewer fishermen directly participating in the science and management process or even accepting and fishing within the quota. Some may say that the science is wrong and cannot be trusted, but the science will never be fixed without improved better data and catch accountability.

Distrust between fishermen, scientists, managers, and other stakeholders is further exacerbated by the high cost and unequitable nature of the monitoring program. The cost of the monitoring program is very expensive relative to the amount of monitoring hours logged and the quality of the data collected, and the burden of the monitoring program often becomes much greater for the small vessels.

### **3. Alternatives to Consider**

The Council has a legal obligation to prevent overfishing, use the best available science, and minimize bycatch. Any alternatives that the Council considers should work towards maximizing accurate data in the fishery to meet this legal obligation. Given what the Council and the agency now knows about the state of this fishery, CLF believes that the current monitoring system can no longer be deemed to meet minimum legal standards and that the *status quo* alternative is not legally approvable. A Council failure to categorically reject the *status quo* system will signal that it not serious about solving this fundamental data and accountability problem.

The Council should focus its analysis on alternatives where the monitoring systems achieve 100 percent accountability in the fishery in order to eliminate the risk of observer bias, prevent or help account for misreporting, and greatly reduce the risk of illegal catch. Such an alternative is the only approach that would significantly reduce uncertainty in stock assessment models, potentially stabilize ACLs, and increase the investment potential of the fishery through stock rebuilding. Any less than 100 percent, there is the high and demonstrated risk of unreliable and inaccurate data. CLF would emphasize that the focus should be on 100 percent accountability *at-sea*, through either at-sea observers or electronic monitoring (EM).

It is also worth mentioning that in 2014 the Council's Groundfish Plan Development team supporting 100 percent observer coverage for the commercial fleet in the Gulf of Maine after Gulf of Maine cod populations reached historic lows.<sup>11</sup>

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<sup>11</sup> Development of Framework Adjustment 53 to the Multispecies Fishery Management plan. New England Fisheries Management Council Groundfish Plan Development Team. November 5, 2014.

Due to the variability of vessel size in the fishery, there will not be a one-size-fits-all monitoring system, but CLF supports the approval of new EM options, such the maximum retention model for larger vessels. As more options become available, CLF would like to see an eventual transition to 100 percent electronic monitoring and eliminate the use of at-sea observers. This would level the playing field across the fishery and fishermen would have incentive to accurately report and handle catch to reduce video review costs.<sup>12</sup>

CLF would also like to see the Council consider ways to streamline reporting requirements of data. We support the Council considering a requirement that all data should be recorded electronically on a haul-by-haul basis. Requiring electronic reporting would additionally give fishermen access to the benefit of Wi-Fi, which would not only allow for “real-time” eVTRs, but fishermen would also be able to more easily communicate back to land. Improved catch data and electronic data sharing would also allow and justify new approaches stock assessment models. But there is no rationale for moving toward real-time assessment and management approaches until the data is reliable.

Until a full transition to EM can be made, the Council should also consider new alternatives for assigning at-sea monitors in order to increase accuracy and fairness in the fishery. For example, monitors could be assigned on a discard proportional basis. Simply put, this means that the vessels who catch most of the fish would be monitored more often. In addition, CLF supports an alternative option that would require 100 percent monitoring for vessels fishing in more than once stock area, the need for which was made clear by the Palmer paper cited above. Such a fix of the broken system, could be and should be implemented immediately.

The Council should consider and analyze management benefits that could be offered to those vessels that achieve 100 percent accountability early, including the possibility of gear/mesh size exemptions, special access programs, lower uncertainty buffers, and exemptions from certain reporting requirements. The Council would need to be complete an assessment of any ecological or economic impacts of these potential benefits.

CLF also believes that the Council should use Amendment 23 to analyze and explore the development of a US version of the Norwegian reference fleet concept:

<http://www.nefsc.noaa.gov/read/popdy/studyfleet/Documents/NedreaasVartdalReferenceFleet.pdf>.

This approach appears to have many benefits from improved dynamic fishery management, improved real-time data streams, and better cooperation between fishermen and scientist, all without compromising the profitability of fleet participants.

#### **4. Tradeoffs to Evaluate**

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<sup>12</sup> Ecotrust Canada, Gulf of Maine Research Institute, Maine Coast Fishermen’s Association, and The Nature Conservancy. Electronic Monitoring in the New England Groundfish Fishery: Lessons Learned from a Collaborative Research Project (FY2013-2015). 2017.



conservation law foundation

The cost of achieving 100 percent accountability will obviously be a hurdle moving forward. CLF encourages the Council to analyze the disproportionate impact of monitoring costs per unit of catch within the fleet to ensure that smaller day boats that seem to land a small fraction of the total groundfish catch are not bearing the lion's share of the monitoring program costs relative to trip boats. CLF also supports the Council evaluating the use of public-private partnerships to help fund increased monitoring coverage. We would also support exploring the development of "accountability quota banks" or set-aside quotas in consideration of increased monitoring coverage. The Council has broad discretion in how available catch is allocated to such programs in order to mitigate industry costs.

More to the point for this amendment, however, is that the Council always bear in mind the economic, social and biological costs of *not* achieving 100 percent accountability. The problems with cod and some of the flounder species are persistent and result in both lost harvest opportunities for more abundant stocks but also delayed rebuilding and achievement of optimum yield for cod and yellowtail themselves.

Thank you for considering our comments. We look forward to working with you further in the amendment development process.

Sincerely,

A handwritten signature in blue ink that reads 'Peter Shelley'.

Peter Shelley  
Senior Counsel

A handwritten signature in blue ink that reads 'Allison Lorenc'.

Allison Lorenc  
Policy Analyst





April 2, 2017  
Mr. Thomas A. Nies  
New England Fisheries Management Council  
50 Water Street, Mill #2  
Newburyport, MA 01950  
Re: Amendment 23 to the Northeast Multispecies Fishery Management Plan – Scoping Comments

Dear Tom:

Thank you for the opportunity to submit comments to assist the New England Fishery Management Council's (Council) development of Amendment 23 (A23) to the groundfish fishery management plan (FMP). A23 aims to modify the existing at-sea monitoring (ASM) program to improve the accuracy and reliability of the data collection program and to improve the overall level of accountability to the rules, regulations, and reporting requirements.

Reliable fishery-dependent data is a key element of a successful science and management regime. It is essential in sustaining a fishery that is healthy and economically successful over the long term; and it is critical in meeting the mandates of the Magnuson-Stevens Act (MSA), including preventing overfishing while achieving optimum yield and ensuring accountability with annual catch limits (ACLs).<sup>1</sup> 16 U.S.C. §§ 1851(a)(1), 1853(a)(15). Numerous analyses developed by agency scientists and other experts (described in detail below) collectively highlight the critical need to think comprehensively about improving monitoring in order to meet the needs for successful management of the Northeast multispecies groundfish fishery. In this context, A23 represents a crucial opportunity to ensure management of the fishery complies with the law while putting it on the path to long-term sustainability and success.

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<sup>1</sup> The NS1 Guidelines contemplate a catch limit framework that reduces target catch limits (the ACL) from the overfishing level based on risk and uncertainty. 50 C.F.R. § 600.310(f)(1)(ii), (iii). Low levels of confidence, and high error in the accuracy and reliability of reported catch is a key factor associated with management uncertainty. It also contributes to the significant increase in retrospective error for many stock assessments in recent years (the 2015 Operational Assessment noted that the number of stocks experiencing retrospective pattern has increased from two to seven in just a few years—Paul Rago, et al. 2015).

## Vision Statement

Effective monitoring that collects reliable data and fosters a culture of accountability would address the most serious flaws in existing management. If framed and advanced effectively, A23 will improve stock assessments and lead to higher biomass over time; stabilize ACLs, leading to better business planning for industry and greater investment potential; and reduce management and scientific uncertainty, leading to higher annual catch entitlements (ACE) for fishermen.

New monitoring models like EM will inspire fishermen to become active participants and integral partners in the scientific data-gathering process. This cooperation will increase the amount and the utility of fishery-dependent data in management and science and build trust, improve working relationships and foster creative business arrangements across all stakeholders—including fisherman-to-fisherman.

In short, an improved monitoring system will not only level the playing field, but also play a significant role in providing better information, ensuring greater stability, and delivering predictability for the fishery. These three elements are fundamental for any industry to function effectively, and they are imperative if we are to secure a more prosperous fishing future in the Northeast groundfish fishery.

## Background

A16 established industry-funded at-sea monitoring (ASM) requirements within the groundfish sector management system to facilitate accurate monitoring of multispecies catch, and to ensure that sector catch entitlements would not be exceeded. In 2012, the Council further articulated the goals and objectives of the sector monitoring program in Framework 48 (FW48) in order to assist the National Marine Fisheries Service (NMFS) and the sectors in designing and evaluating proposals to satisfy monitoring requirements. Since the implementation of A16, the ASM program has been the subject of much debate and review..

Over the past several years, the Council has dedicated significant time and effort to evaluating the efficiency, effectiveness, and utility of the ASM program in meeting the FW48 monitoring goals and objectives. For example, at the direction of the Council, the Plan Development Team (PDT) has produced multiple memos and analyses to suggest ways to modify the existing ASM program to address issues ranging from increasing cost effectiveness to verifying area fished to improving the accuracy and reliability of the data collected.<sup>2</sup> With regard to the high cost of ASM, Framework 55 modified the methodology for establishing observer coverage rates based on the CV standard to reduce costs and lower coverage rate variability from year to year.

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<sup>2</sup> The PDT is currently working on a comprehensive white paper that examines the existing ASM program in terms of its costs and benefits, ability to meet the goals of FW48, accuracy and bias of the resulting data, utility of the ASM program for stock assessments, and potential for alternative monitoring programs and models, such as electronic monitoring and dock side monitoring. Also at the direction of the council, the PDT met on at least four separate occasions since 2012 (March 30, 2016; May 12, 2015; May 28, 2015; March 13, 2012) to discuss specific questions posed by the council regarding ways to improve/and or modify the existing ASM program.



A23 is intended to move beyond the issue of direct costs of ASM and instead address broader concerns relating to cost-effectiveness, accuracy, and reliability. Effectively resolving these issues require wholesale changes to the monitoring program and moving away from the CV methodology altogether.

### Problem Statement

Recent and ongoing analyses by the PDT, the Northeast Fishery Science Center (NEFSC), and external experts have identified a number of issues with existing fishery-dependent information, which include: observer effects where vessels fish differently on unobserved trips<sup>3</sup>; serial underreporting and misreporting on Vessel Trip Reports (VTRs) in multiple stock areas<sup>4</sup>; undocumented catch and illegal discards<sup>5</sup>; and problems associated with the administration, operation, and the human dimensions of the ASM program<sup>6</sup>. Still other reports point to challenges in meeting some of the goals and objectives of A16 as clarified through FW55 specifically related to cost effectiveness. These include: the potential for inequitable distribution of ASM costs to industry (to the extent that ASM costs are transferred to industry)<sup>7</sup>; and expensive per sea day costs relative to electronic monitoring (EM).<sup>8</sup>

As noted above, while there may not be universal agreement on all of these analyses and their conclusions, taken together they highlight the critical need to think about monitoring in a better way in order to meet the needs for successful management of the Northeast multi-species groundfish fishery.

Through this amendment process, the Council and NMFS are requesting public comment to “identify important issues and develop a complete range of alternatives that meet the purpose and need for this amendment,” as part of the scoping process required under the National Environmental Policy Act (NEPA). The scoping document identifies the needs for this action as first, addressing the challenge of balancing the cost of adequate at-sea observer coverage with the industry’s ability to cover this cost in the current low quota environment; and second, improving the accuracy of extrapolating observer data to unobserved trips.<sup>9</sup>

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<sup>3</sup>Demarest, Chad (2016) ‘Observer Effects’, presented at the Groundfish PDT May 11, 2016

[https://prezi.com/ehawe5t7z5ep/160511\\_groundfish\\_pdt/](https://prezi.com/ehawe5t7z5ep/160511_groundfish_pdt/)

<sup>4</sup> Palmer, Michael (2017) ‘Vessel Trip Reports Catch-area Reporting Errors: Potential Impacts on the Monitoring and Management of the Northeast United States Groundfish Resource’

<http://nefsc.noaa.gov/publications/crd/crd1702/>

<sup>5</sup> Discussion at PDT meeting, March 30, 2016

<sup>6</sup> Kennelly, S., Ives, M. (2015) Report for the Program Review of the Northeast Fisheries Science Center Fisheries Sampling Branch’ [http://www.nefsc.noaa.gov/fsb/misc/fsb-review-final-report/cic.pdf?utm\\_source=NEFSC+Fisheries+Sampling+Branch+Review&utm\\_campaign=NEFSC+FSB+Report&utm\\_](http://www.nefsc.noaa.gov/fsb/misc/fsb-review-final-report/cic.pdf?utm_source=NEFSC+Fisheries+Sampling+Branch+Review&utm_campaign=NEFSC+FSB+Report&utm_)

<sup>7</sup> Sun, C-H.J. and Fine, L. A cost-effective discards-proportional at-sea monitoring allocation scheme for the groundfish fishery in New England. 66 Marine Policy 75-82

<sup>8</sup> Sylvia, G., Harte, M. and C. Cusak (2016) Challenges, Opportunities, and Costs of Electronic Fisheries Monitoring [https://www.edf.org/sites/default/files/electronic\\_monitoring\\_for\\_fisheries\\_report\\_-\\_september\\_2016.pdf](https://www.edf.org/sites/default/files/electronic_monitoring_for_fisheries_report_-_september_2016.pdf)

<sup>9</sup> See Purpose and need section of Council Scoping document, page 3

However, as currently articulated, A23's purpose and need omits any reference to ensuring compliance with ACLs. In light of the centrality of ACL adherence to preventing overfishing and achieving rebuilding (as well as its status as an independent statutory requirement) and the evidence before the agency that mis-reporting and observer bias likely has resulted in ACL overages, the purpose and need of A23 includes ensuring accountability to ACLs, not simply generally improving accountability.<sup>10</sup> See *Nat'l Parks & Conservation Ass'n v. BLM*, 606 F.3d 1058, 1070 (9th Cir. 2010) ("agencies must look hard at the factors relevant to the definition of purpose. . . an agency should always consider the views of Congress, expressed, to the extent that the agency can determine them, in the agency's statutory authorization to act"); see also *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991).

Compliance with ACLs is not only a legal requirement under the MSA but also a critical need if we are to address the biological challenge of rebuilding overfished groundfish stocks. Stated another way, the persistent lack of reliable and accurate fishery-dependent data is a significant factor in the failure of rebuilding overfished stocks and therefore a major contributor to the low quotas in the fishery.

This Amendment is well timed; groundfish monitoring reforms are long overdue. As of 2015, 13 of the 20 groundfish stocks were either overfished or their overfished status was unknown.<sup>11</sup> Of the stocks where overfishing status is known, five stocks are still experiencing overfishing. The Council should develop a reasonable range of alternatives to address the purpose and need of the action in a manner that will assure accurate accounting of ACLs necessary to prevent overfishing and rebuild overfished stocks. We expect the Council will develop and rigorously explore all reasonable alternatives in an environmental impact statement as required by NEPA. See 40 C.F.R. §§ 1502.14(a) and 1502.13.

#### Reliability of Fishery-Dependent Data in the New England Groundfish Fishery

One of the key terms in the Council's motion that created this amendment is "reliability" of fisheries information. The existing method of setting observer coverage at a level where discards can be estimated with a 30% coefficient of variance is merely a precision standard. Such an approach does not provide an accurate or reliable determination of catch and bycatch necessary for setting measures to ensure accountability with annual catch limits as required by 16 U.S.C. § 1853(a)(15). In addition, the courts have recognized the CV standard does not reliably estimate catch on its own, but must rely on the existence of "multiple safeguards – such as self-reporting, reporting by vendors, and sanctions for misreporting – that help to ensure the reliability of data on sector catch." *Oceana v. Pritzker*, 26 F. Supp. 3d 33, 51 (D.D.C. 2014). Coverage must be sufficient to "monitor sector operations, to the extent practicable, in order to reliably estimate overall catch by sector vessels." 50 C.F.R. § 648.87(b)(1)(v)(B)(1)(i)

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<sup>10</sup> For example, an accurate statement of purpose and need could read: "The purpose of Amendment 23 is to adjust the groundfish monitoring program to improve reliability and ensure accountability with ACLs." The paragraph would also be more complete if it included a reference to Palmer's work on misreporting.

<sup>11</sup> See 2015 Groundfish Stock Status, <http://www.nefsc.noaa.gov/groundfish/operational-assessments-2015/stock-status.html>.

If these “multiple safeguards” are in place, and if the assumption that fishing behavior remains unbiased on unobserved trips holds, then achieving this CV standard can result in very low coverage rates on many stocks<sup>12</sup>, whose discards are highly predictable from observed trips. But the agency’s own analyses show that fishing behavior does in fact change significantly on unobserved trips (Demarest 2012; 2016)<sup>13</sup>. Therefore, these analyses show that the CV method is biased and the discards predicted by this method are not accurate, making the CV method an inappropriate tool to continue to rely upon to predict discards for the fishery.

In addition, information about stock area fished is currently derived from self-reported vessel trip reports (VTRs). As long as the captains report ‘area fished’ accurately, then area fished information from VTRs can be used to apportion total catch per trip for stock assessments. But the sector management system relies on separate quotas defined by stock boundaries for different stocks of the same species. Prices for quota share, which fishermen must hold to go fishing, vary depending on which stock area they catch fish in. As a result the separate quotas defined by stock boundaries produce an economic incentive to misreport and under-report landings area information on VTRs by vessels fishing in more than one broad stock area on the same trip, especially for low quota species, in order to avoid catch limits and high quota share prices (Palmer 2017)<sup>14</sup>.

Palmer 2017 showed that misreporting/under-reporting since the advent of sector management may have resulted in multiple ACLs being exceeded—including GOM cod, GOM Haddock, EGB Cod, and SNE Winter Flounder. Given the low levels of monitoring and continued incentives to misreport, it is reasonable to conclude that ACLs are being exceeded today as they likely were in the past.

Taken together, the current monitoring and reporting system falls far short of providing the reliable information that fishery managers and the Council seek for effectively managing the fishery.

#### Accountability in the New England Groundfish Fishery

In addition to modifying the existing ASM program to increase the reliability of fishery-dependent information, the Council also initiated A23 to improve the overall level of accountability in the fishery. Accountability means confidence that all landings and discards occurring within a fishery are accurately and reliably accounted for, increasing certainty that

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<sup>12</sup> In May 2016, NMFS approved Framework Amendment 55 to the Groundfish FMP, modifying the calculation of observer coverage to reduce monitoring to only 14% of trips - without demonstrating whether the measure would result in a 50% or greater chance of preventing overfishing, as required by *NRDC v. Daley*, 209 F.3d 717, 753-54 (D.C. Cir. 2000).

<sup>13</sup> Demarest 2016 showed significant differences (95% confidence level) between observed and unobserved trips for ‘total trip duration’, ‘total kept ground fish’, ‘total kept all fish’, and significant differences (90% confidence level) for ‘total low quota species kept’.

annual catch limits are adhered to and that the best available information is included in stock assessments.

The current low levels of monitoring in the fishery contribute significantly to a culture of low accountability. Low accountability leads to perverse incentives for non-compliance—and it is human nature to react to these incentives. For example, the lower the monitoring levels, the easier it is to ‘waste a trip’ by fishing differently when observed; or to develop habits of misreporting or under-reporting area fished if one knows that no one is usually watching. In addition, this behavior is exacerbated by an individual’s lack of confidence that others are playing by the rules. Ariely et al (2009)<sup>15</sup> found that when we see cheating around us, particularly when it’s part of our ‘in-group’, individuals are much more likely to cheat themselves.

Put a little differently, if fishermen think other fishermen don’t report their catch of low quota stocks accurately, or change their behavior on observed trips to avoid them, then that belief likely influences the accuracy of their own reporting or the incentive to change their own behavior on observed trips.<sup>16</sup> Similarly, it is likely that self-reported VTR area information would be more accurate if each fisherman knew that everyone else was also making additional efforts to report accurately.

#### ASM Administrative Issues

Multiple reviews of the ASM program in recent years have shown that it lacks cost-effectiveness, is administered in a way that disproportionately affects some segments of the fleet over others, and is ineffective at deterring cheating. Above all, for the purposes of this comment letter, the reviews have shown that the ASM program has failed to provide accountability in the fishery or to produce accurate, reliable information

In 2015, Independent Consulting closely examined the administration of the ASM program through an in-depth analysis of the programs administered by NOAA’s Fisheries Sampling Branch (FSB). The report found striking evidence that over 50% of trips get cancelled by fishermen after they have been chosen by the Pre-Trip Notification System (PTNS) to carry an observer<sup>17</sup> as fishermen try to avoid coverage (leading to inaccurate internal trip counts). Anecdotally, many fishermen also complain they are disproportionately selected for at-sea monitors because observers “like their boats better.”<sup>18</sup> If this practice is true, it is inconsistent with the ASM program’s purported approach of using random selection. Whatever the reason,

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<sup>15</sup> Ariely, D., Ayal, S., and F. Gino (2009) ‘Contagion and Differentiation in unethical behavior: the effect of one bad apple on the bushell’, *Psychological Science*, 20: 393-398.

<sup>16</sup> Ariely, D. 2009 ‘Our Buggy Moral Code’ TED Talks, New York, NY.  
[https://www.ted.com/talks/dan\\_ariely\\_on\\_our\\_buggy\\_moral\\_code](https://www.ted.com/talks/dan_ariely_on_our_buggy_moral_code)

<sup>17</sup> The PTNS system is referred to as the ‘Pre-trip Cancellation System’ within the FSB.

<sup>18</sup> Personal Communication, Ben Martens, Maine Coast Fishermen’s Sector

there are stark differences in the coverage rates for individual vessels each year,<sup>19</sup> even for vessels in the same sector, which creates equity and fairness issues.

This analysis also documented a stunning 95% turnover rate for observers over the past three years. For example, between NEFOP and ASM, the FSB successfully trained 40 people, and only 2 active observers remain. Reasons cited for such high turnovers included dissatisfaction with pay, frustrations with not getting on trips, and variable working conditions under the different providers (in terms of health plans, holidays, scheduling, bonus structures, etc.)<sup>20</sup> Such high turnovers mean more inexperienced observers on boats, reduced data quality, increased time (and money) needed for data checking and quality assurance, and more time and money for training new observers.

But perhaps the most troubling evidence found was that 10-15% of the active fleet remains permanently on the 'do not deploy' list (because of safety or harassment concerns for the observer), thereby rewarding bad behavior by vessel captains and crew. For the rest of the fleet, the actual coverage rate has been below the target coverage rate each year since the advent of the ASM program.<sup>21</sup>

When these administrative issues are combined with the inherent bias and reporting errors associated with ASM implementation within the fishery, the problems of collecting accurate and reliable fishery-dependent information are exacerbated.

### Evolution of Electronic Monitoring (EM) in New England

Cost effective monitoring of the groundfish fishery is going to require the use of new tools to meet the goals of improved accuracy and reliability. Over the last seven years, NOAA, industry, and environmental groups have devoted significant effort towards expanding the use of EM as a cost-effective alternative to current monitoring systems. There are two EM program designs currently being considered in the New England groundfish fishery. These include the "audit model" and the "maximized retention model." Both models are designed to increase accuracy and accountability of fishery-dependent information and are intended to be flexible enough to fit a variety of different types of fishing operations at different scales.

The audit model uses EM to verify discards reported by a captain on a vessel trip report. It has generally been designed for smaller vessels with low total discards. Under the audit approach, cameras would operate 100%, with a smaller portion of the film randomly reviewed. There is also another version of this type of model that might be considered for some vessels under

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<sup>19</sup> Groundfish PDT Memo, April 5, 2016 [http://s3.amazonaws.com/nefmc.org/3a\\_160405-DRAFT-PDT-memo-to-the-GF-Committee-re-groundfish-monitoring-program-v1\\_1.pdf](http://s3.amazonaws.com/nefmc.org/3a_160405-DRAFT-PDT-memo-to-the-GF-Committee-re-groundfish-monitoring-program-v1_1.pdf)

<sup>20</sup> Kennelly, S., Ives, M. (2015) Report for the Program Review of the Northeast Fisheries Science Center Fisheries Sampling Branch' [http://www.nefsc.noaa.gov/fsb/misc/fsb-review-final-report/cic.pdf?utm\\_source=NEFSC+Fisheries+Sampling+Branch+Review&utm\\_campaign=NEFSC+FSB+Report&utm](http://www.nefsc.noaa.gov/fsb/misc/fsb-review-final-report/cic.pdf?utm_source=NEFSC+Fisheries+Sampling+Branch+Review&utm_campaign=NEFSC+FSB+Report&utm)

<sup>21</sup> Groundfish PDT Memo, April 5, 2016 [http://s3.amazonaws.com/nefmc.org/3a\\_160405-DRAFT-PDT-memo-to-the-GF-Committee-re-groundfish-monitoring-program-v1\\_1.pdf](http://s3.amazonaws.com/nefmc.org/3a_160405-DRAFT-PDT-memo-to-the-GF-Committee-re-groundfish-monitoring-program-v1_1.pdf)



different scenarios, and that is where the cameras are operated to match the current level of observer coverage and 100% of the film is reviewed.

The maximized retention model is being designed for larger, higher volume vessels which would be exempted from minimum size requirements for allocated species under a combination of EM and dockside monitoring. EM would be used to ensure that regulated groundfish species are not discarded, regardless of size. Under the max retention model, the cameras record 100% of fishing activity, and a random sample of the film is reviewed. Because the vessel does not know what part of the film is reviewed, the incentive to change behavior in the face of observation is negated. Additionally, reporting is done at the haul by haul level, which by itself has been shown to increase the accuracy of self-reported area fished (Palmer 2017). When coupled with GPS positioning data via VMS satellite technology, area fished can be known with certainty and automatically reported electronically.

#### Key Questions to Consider for Scoping

We appreciate this opportunity to provide comments on how Amendment 23 can establish new or modified monitoring alternatives that result in collecting more accurate, accountable, timely, streamlined, cost-effective, and reliable data. Specifically, the following sections will address three key questions posed by the Council:

- 1) What alternatives should the Council consider in A23 to change the groundfish monitoring program?
- 2) What specific issues are most important when evaluating the tradeoffs associated with monitoring discards at sea using ASM?
- 3) Should the Council consider changes to the way landings information for groundfish is provided?<sup>22</sup>

The Scoping Document also notes that currently, cost effectiveness is the primary goal of the ASM<sup>23</sup> program, with all other goals (improved data for stock assessments, reducing discards, etc) being secondary. Reliability, accountability, and data accuracy are crucial to accomplishing the legal requirements of the MSA and the goals of fishery management in New England, and therefore should constitute the primary goals of a monitoring system and A23. Further, we request that there be careful consideration of the definition of “cost effectiveness” in the context of effective monitoring. Defining what an effective monitoring system is first, and then

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<sup>22</sup> SCOPING DOCUMENT for Amendment 23 to the Northeast Multispecies Fishery Management Plan  
[http://s3.amazonaws.com/nefmc.org/170217\\_GF\\_A23\\_Scoping-Document.pdf](http://s3.amazonaws.com/nefmc.org/170217_GF_A23_Scoping-Document.pdf)

<sup>23</sup> SCOPING DOCUMENT for Amendment 23 to the Northeast Multispecies Fishery Management Plan  
[http://s3.amazonaws.com/nefmc.org/170217\\_GF\\_A23\\_Scoping-Document.pdf](http://s3.amazonaws.com/nefmc.org/170217_GF_A23_Scoping-Document.pdf)

identifying appropriate tools and strategies to minimize the cost necessary to implement that system, will be important for achieving the aims of this amendment.

Scoping Question 1) What alternatives should the Council consider in A23 to change the groundfish monitoring program?

New monitoring alternatives for the groundfish fishery are not likely to be a ‘one size fits all’ solution, but more practicably will include a combination of different approaches, which together constitute a wholesale change to the existing system. This wholesale change or overhaul is badly needed to fix the current monitoring program’s significant shortcomings—which include inaccurate data, inefficiency, lack of cost effectiveness, and its role in the documented low levels of reporting compliance.

Specifically, wholesale changes to the existing monitoring program should be a combination of different approaches that include 100% monitoring (mandated via human observer and/or EM) for a portion of the fleet; a new mandated dockside monitoring (DSM) program for a portion of the fleet; and new incentives or exemptions for fishermen to adopt 100% monitoring (via EM or human observers). Specific examples are discussed in detail below:

**Alternative 1: 100% monitoring with DSM for high volume/high discard fisheries for vessels that fish in more than one broad stock area on the same trip.**

According to Palmer (2017), the problem of catch area misreporting could be solved by restricting vessels to fishing in one statistical area per trip unless carrying an observer or requiring 100% monitoring on all trips.

Under this alternative, vessels should be allowed to choose which monitoring alternative they prefer—the 100% human observer model, or 100% monitoring via “Maximum Retention EM” (see detailed explanation below at Alternative 2). For the Maximum Retention EM option, participating vessels would be exempted from minimum size requirements for allocated species. Both models would require 100% DSM that only applies to vessels fishing in more than one broad stock area on the same trip.

This alternative would have the single largest impact on the fishery by improving both the accuracy of fishery-dependent information and fleet-wide accountability. Prior to sectors, only 17% of all trips fished in more than one broad stock area; but by 2015, more than 50% of all trips fished in more than one broad stock area. Multi-stock area trips are taken by the largest, highest volume fishing vessels, which collectively represent more than 80% of the total catch of the fishery (Palmer 2017).

Misreporting and mis-apportionment of catch has plagued the fishery since the advent of the sector management system, and multiple attempts to solve this problem have failed. For example, in 2012, the sectors developed a type of “gentlemen’s agreement” in their operations

plans<sup>24</sup> that any vessel fishing west of the 70-15 degree line (Gulf of Maine) and another broad stock area on the same trip must carry an observer due to major concerns by the small boat fleet of significant misreporting/mis-apportionment of catch.

However, the problem continued to escalate, and in 2015 NOAA Office of Law Enforcement (OLE) declared that misreporting and mis-apportionment of catch was a ‘high priority.’ OLE subsequently implemented a new rule that requires vessels to submit a daily VMS catch report if they fish in the Gulf of Maine and another stock area on the same trip. It is unclear what impact this has had, but widespread misreporting continues—especially since VMS catch reports are not official catch reports and therefore not binding. Palmer’s (2017) report highlights just how serious the problem of misreporting has become. For example, he showed the possibility that due to misreporting the EGB Cod ACL might have been exceeded by a magnitude of 2.5 times its catch limit.

### **Alternative 2: Approval of Maximum Retention EM model**

The maximum retention EM model has great potential to improve the accuracy of fishery-dependent information and to increase efficiency and accountability in the fishery. This alternative would exempt vessels from current prohibitions on the possession of undersize fish and minimum size requirements for allocated groundfish as well as the ASM program requirements as the EM and dockside components in tandem would provide sufficient catch data.

The Gulf of Maine Research Institute (GMRI) and Environmental Defense Fund (EDF) are currently developing a maximum retention EM model with DSM, working with NOAA, the NEFSC, and key industry members. This model is being developed primarily for large trawlers as an alternative to ASM and is more suited to the large-vessel fleet than the audit-based EM model. The audit model has been shown to work well for vessels with limited discards, but this model quickly becomes infeasible for high volume vessels due to the complex handling protocols. The maximum retention EM model holds promise for overcoming these obstacles. Field testing of the maximum retention EM model will begin this summer, which means preliminary results could be available for consideration by the Council later this year to help inform this alternative.

In addition to including this model as an alternative, specific standards that our field test will explore should be considered by the Council through this amendment, such as: appropriate EM review rate, the level (and duties) of DSM, the frequency and type of reporting (e.g. haul by haul, electronic reported from the fishing grounds), and a list of acceptable discards (e.g. non-ground fish species).

### **Alternative 3: Approval of Audit model EM for appropriate vessels**

The Council and NMFS should use this Amendment process to formally approve Electronic Monitoring Systems for use in the groundfish fishery. Amendment 16 provided a framework for

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<sup>24</sup> NEFS XX 2015 Sector Operations Plans [www.noaa.gov/sectoroperationsplans](http://www.noaa.gov/sectoroperationsplans)

EM systems to be used in place of observers or at-sea monitors when the technology is deemed sufficient for a specific trip based on gear type and area fished.

But EM systems have yet to be formally approved as a monitoring tool for the groundfish fishery. Numerous pilot studies, including one recently completed by TNC, MCFA, GMRI, and Ecotrust Canada, have demonstrated that properly operated EM systems can capture high quality imagery that can be used to identify species and estimate lengths in the groundfish fishery. We are confident EM systems can provide a cost-effective monitoring tool for the groundfish fishery and urge the Council and GARFO to formally approve their use through the Amendment 23 process.

**Alternative 4: Combine incentives and fishing exemptions to maximize the effectiveness of EM, and develop EM standards that are cost-effective and allow for wide-scale adoption.**

The collective use of EM (either the audit model or the maximum retention model) by a majority of the fleet would change the culture from one of low accountability to one where data from fishermen would be trusted by scientists and used for management purposes because it is accurate and reliable, thus encouraging vessels to provide more and more accurate data.

For a discrete category of vessels, like smaller inshore vessels that rarely target groundfish, or those that use extra-large mesh, it will be important to consider how to ensure full accountability in a manner that is not cost-prohibitive for these boats. Specifically, EM might not be appropriate for all vessels, and it will be valuable to explore alternative approaches to determine if there are ways to combine EM with additional incentives for those categories of smaller vessels with very low volumes of groundfish.

Providing additional incentives or fishing exemptions for fishermen who agree to use EM and fish under a model of 100% accountability would encourage better monitoring and data collection and could address longstanding problems in the fishery. EM standards that are cost-effective and flexible encourage maximum participation. For example, fishermen who adopt improved practices resulting in improved accountability could receive:

- Additional quota set aside, giving back management uncertainty for key stocks
- Access to an additional quota bank designed to reward accountability
- Additional carryover allowances
- Exempted use of certain gear/mesh size (e.g. allowance to use 5.1 inch square mesh cod end to target healthy haddock stocks).
- Exemptions to fish multiple gear types on the same trip (e.g. groundfish and tuna gear)
- Exemption from Pre-Trip Notification system
- Subsidized upfront equipment costs for EM

**Scoping Question 2) What specific issues are most important when evaluating the tradeoffs associated with monitoring discards at sea using ASM?**

When evaluating tradeoffs for improving the existing monitoring program, it is important to consider the economic and biological tradeoffs. The PDT evaluated some of these tradeoffs through a series of meetings in 2015 and 2016 and determined that part of the cost of lowering ASM coverage rates, or re-stratification of how observers are deployed, may result in losing the ability to use ASM data for stock assessments. Demarest (2016) showed that even under the existing coverage rates and stratification levels, significant observer bias exists in the CV method, which likely disqualifies it for use in stock assessments regardless. Therefore, consideration of entirely new monitoring systems like EM is vital, and it is important to evaluate the tradeoffs relative to those systems and compare to the biological and economic costs/benefits of the existing ASM program.

*Bio-economic Tradeoffs of the Current ASM program*

It is unlikely that any alternative monitoring program could be cheaper than the existing ASM program due to extremely low existing coverage rates. Based on sectors' negotiated sea day rates of about \$600 per day and the ability to request half day rates<sup>25</sup>, the average cost per day for a full day rate is between \$60-\$70 (assuming the cost of one full day trip is spread out over ten trips (10% coverage rate)), and the average cost per day for a half day is between \$30-\$40 per day. With the existing government subsidies of 85% of total cost, the actual out of pocket cost to industry is between \$10-\$20 per day.

However, there are significant bio-economic costs associated with low observer coverage, including increased risk of overfishing both in-season and retrospectively; increased risk of abandoning analytical models completely due to excessive retrospective error; reduced fleet-wide investment potential via highly variable ACLs; inefficient quota markets; inefficiencies and transcribing errors associated with pen and paper reporting; and significant time spent on data reconciliation.

There are also severe equity issues and tradeoffs associated with deployment of human observers for the existing ASM program. Given the way observers are assigned (based on gear type, and not total catch/total revenue), there is potential for highly inequitable distribution of ASM costs to industry. For example, when the PTNS system assigns observer coverage, a small dayboat trawl vessel that lands 1,000 lbs of fish in a single trip is just as likely to be covered as a large trawl vessel that lands 100,000 lbs of fish in a single trip—and both boats are subject to the same per day cost (Sun and Fine 2016).

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<sup>25</sup> personal communication with sector managers from NH sector, Maine Coast Sector, Cape Cod Sector



*Bio-economic Tradeoffs Associated with Fully Accountable Monitoring Models (e.g. EM/DSM)*

Conversely, there are long term bio-economic benefits of an accurate and accountable monitoring program, including one that uses EM technology: improved stock assessments that lead to higher yields over time; more stable ACLs via lower scientific and management uncertainty; higher private investment potential as a result of higher certainty and more stable ACLs; the potential for higher annual catch entitlements (ACE) for fishermen as stocks rebound and continue to grow.

The total cost of any EM program depends on program design, standards applied, and type of technology employed. And unlike human observers, EM is based on technology that is always evolving and becoming cheaper, more streamlined and integrated. The most recent analysis of EM costs relative to human observer programs in other fisheries throughout United States showed marginally lower per day rates for EM.<sup>26</sup>

For example, a preliminary cost estimate for the use of EM in the Alaska Pacific Cod Pot fishery is \$287 to \$433 per day compared to \$1,067 for an observer. The British Columbia groundfish hook and line fishery has estimated EM costs of \$350/day for EM compared to \$708/day for ASO in the fishery<sup>27</sup>. Recent estimates for EM costs in the West coast limited entry groundfish trawl fishery calculate that shoreside whiting vessels can save \$183 per day using EM rather than an observer (depending on auditing and storage costs which will decrease the savings). A mothership catcher vessel may save roughly \$2,400 per trip using EM rather than an observer (Pacific Fisheries Management Council 2016).

As noted above, fishermen who use EM become integral partners in the scientific data gathering process and the utility of fishery-dependent data dramatically increases and is used directly in management and science. This builds trust and increases cooperation across all stakeholders, especially between fishermen as they now have confidence that everyone is playing by the same set of rules, working towards the same science and management goals.

This understanding will increase opportunities for coordination and information sharing by fishermen for business purposes (e.g. bycatch hotspot tools, quota sharing, and revenue/cost sharing arrangements). Increased trust and social capital between fishermen in the same sector, and between sectors, will also streamline transactions (including ACE trades) and reduce transactions costs.

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<sup>26</sup> Sylvia, G., Harte, M. and C. Cusak (2016) Challenges, Opportunities, and Costs of Electronic Fisheries Monitoring [https://www.edf.org/sites/default/files/electronic\\_monitoring\\_for\\_fisheries\\_report\\_-\\_september\\_2016.pdf](https://www.edf.org/sites/default/files/electronic_monitoring_for_fisheries_report_-_september_2016.pdf)

<sup>27</sup> Sylvia, G., Harte, M. and C. Cusak (2016) Challenges, Opportunities, and Costs of Electronic Fisheries Monitoring [https://www.edf.org/sites/default/files/electronic\\_monitoring\\_for\\_fisheries\\_report\\_-\\_september\\_2016.pdf](https://www.edf.org/sites/default/files/electronic_monitoring_for_fisheries_report_-_september_2016.pdf)

### *Bio-economic costs of low monitoring in multi-species catch share fisheries*

Bio-economic tradeoffs of low monitoring and low accountability in multispecies catch share fisheries has also been described extensively in the literature. For example, Squires et al (1998)<sup>28</sup> found that “costs savings may be realized in the short term by insufficient observer coverage, but the longer term costs may be even greater as the effects of higher levels of discards eventually accumulate even if they are not immediately apparent.”

When examining compliance and enforcement in the New England groundfish fishery, Sutinen and King (2009)<sup>29</sup> found that “a proper system of monitoring and enforcement is crucial to the success of multispecies catch share fisheries. If regulators have little idea about what is being caught, discarded and landed, then the resource may be compromised and the full expected benefits of catch shares will fail to emerge.”

The need for monitoring is also probably higher with catch shares than with a more complete property rights system according to Tisdell (1991)<sup>30</sup>, because with catch shares the rights are specified on the resource flow (the catch) rather than the resource stock itself. Thus, catch share fishermen may not face the full incentives to invest in the future stock by deferring harvests through full compliance, since individual quota holders do not bear the full costs of their over-harvest, which is instead borne collectively by all catch share fishermen and the resource stock itself (Squires 1991)<sup>31</sup>.

In multispecies catch share fisheries specifically, Squires and Kirkley (1991) found that the problem of illegal discarding, misreporting, observer bias, and generally inaccurate information might have the greatest impact on the ability of the quota trading market to function efficiently. Hatcher (2015)<sup>32</sup> showed that if low monitoring and enforcement exists in the fishery, the price of the quota will never rise above the opportunity cost of discarding—so prices can’t act as a built-in constraint to prevent over-harvesting and to efficiently redirect effort (Hatcher 2015).

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<sup>28</sup> Squires, D., H. Campbell, S. Cunningham, C. Dewees, R. Quentin Grafton, S. Herrick, J. Kirkley, S. Pascoe, K. Salvanes, B. Shallard, B. Turris, and N. Vestergard. Individual Transferable Quotas in a Multi-species Fishery, Marine Policy, 1998, 22.

<sup>29</sup> Sutinen, J. G. and King, P. The economics of fisheries law enforcement. Land Economics, 2009, 61, 387-397.

<sup>30</sup> Tisdell, C. A., Economics of Environmental Conservation. Elsevier Science, Amsterdam, 1991, 116.

<sup>31</sup> Squires, D. and Kirkley, J. Individual transferable quotas in a multiproduct common property industry. Journal of Environmental Economics and Management, 1991, 21

<sup>32</sup> Hatcher, A., “What determines Quota Prices in Multi-species ITQ Fisheries?” European Association of Environmental and Resource Economists 21st Annual Conference 24 - 27 June 2015, Helsinki, Finland <http://www.webmeets.com/eaere/2015/prog/viewpaper.asp?pid=466>.

**Scoping Question 3) Should the Council consider changes to the way landings information for the groundfish fishery is provided?**

We recommend the Council consider significantly modifying the existing reporting requirements to be more streamlined, less redundant, and to provide higher utility of fishery-dependent data to sectors and fishermen. This should start at the vessel level, where all fishing effort should be required to be recorded electronically on a haul by haul basis. For EM models, NOAA has already mandated that all reporting be done at the haul by haul level; this requirement should be expanded to the rest of the fleet<sup>33</sup>.

NOAA's Fishery-Dependent Data Modernization work aims to have all fishermen report electronically in the next two years. This goal should account for the availability of new cost-effective Wi-Fi options, where NOAA prioritizes reporting in real time from the fishing ground via internet options at sea. This type of wireless broadband VMS option would provide substantial additional benefits for crewmembers, who would then have access to social media, email and voice services while at-sea.

Electronic reporting starting at the vessel level should flow to NMFS, dealers, and Sector managers simultaneously—integrated and interoperable in real time—ready to be immediately disseminated back to sectors for weekly reports and real time updates of ACE accounts for members. Reconciliation should be automatic and not require sector managers to drive to NOAA's office and go through individual paper reports one by one.

The switch to sector management dramatically increased the amount, the frequency and the redundancy of reporting requirements. This redundancy can easily lead to inaccurate fishery-dependent reports. For example, it is reasonable to assume that redundant and extensive reporting requirements frustrate and fatigue many fishermen, especially when they must be complied with via outdated reporting technology. This is especially true if fishermen are unaware of how the reported information will be used for science and management, and the process for integrating and reconciling information amongst dealers, sector managers, state agencies, and NMFS.

New electronic reporting systems based on open source software that allow multiple entities to receive the same information in real time would dramatically improve the accuracy of fishery-dependent information, especially if this data could also be retrieved in real time by fishermen for business and marketing purposes. Current data confidentiality restrictions on regulatory data should be modified to allow for third party verification for full system traceability via the supply chain. The existing pen and paper reporting system limits transparency, traceability, and interoperability and reduces chances for fishermen to directly participate in the science and

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<sup>33</sup> Palmer (2017) provides evidence of more accurate reporting at the haul level.

management process. Finally, if DSM is used as an option for a portion of the fleet, landings data should also be available electronically in real time and acceptable for management and science reporting.

Conclusion:

A23 has the potential for fundamentally transforming the way the multi-species ground fish fishery is monitored, how the data is collected, and how it is reported and integrated into science and management. Different alternatives will be discussed through this amendment process that provide an opportunity for monitoring to become unbiased and fully accountable, for data collection to be based on new and advancing technology, and for reporting to become more granular and near real time. These transformations would completely change for the better how scientific models are determined, how fisheries dependent data can be utilized and monetized, and how fishermen can become research partners and active participants in the science and management of their fishery.

Many fishermen argue that they are seeing something very different than the scientific surveys. We now know that even when at-sea monitors are onboard the vessels 10% of the time, that they are also seeing something very different than what fishermen when they're not onboard. The best way to close these gaps is to finally see what fishermen are seeing 100% of the time. This can happen through this amendment. Information about what fishermen are catching through effective monitoring, on vessels and at the dock would give fishermen more confidence in the science, would ensure that everyone is playing by the same rules, and let the rest of the world see what fishermen see when they are fishing.

Sincerely,

Joshua Wiersma, PhD

Manager Northeast Fisheries



Joan O'Leary

**From:** rmnbcush@myfairpoint.net  
**Sent:** Friday, March 31, 2017 3:36 PM  
**To:** comments  
**Subject:** groundfish monitoring



<footer class="signatureContainer"></footer>Dear Mr. Nies, My name is Randy Cushman. I am the Captain of the F/V Ella Christine. I have been otter trawl fishing for groundfish in the gulf of Maine for 35 years. This fishery has been my primary source of income for that duration. I support the use of electronic monitoring or "EM". I have been using the EM for the past 3 years. With this one system you can do the job of three systems, which are research, accountability and enforcement. These are the main issues we have in the fishery. Improving the stock assessment: The results of the stock assessment are hardly ever what I expect to hear as a fisherman, based on what I see on the water getting data from fishermen into the system will help make sure that the stock assessment is based on what is happening on the water. Fishermen are already collecting data through their VTR's, and finding ways to verify and use that information will help encourage more collaboration and trust between industry and management. Encouraging fair play: All fishing vessels should be following the law. When some individuals are able to skirt the rules, it makes other fishermen wonder why they should bother fishing honestly. Honest fishermen should be rewarded and dishonest fishermen should be punished. We need more accountability in order to make this happen. Increased accountability will help level the playing field and allow us to rebuild our fish stocks. A monitoring policy that works for a large off shore vessel probably won't work for my boat. Dock side monitoring is unworkable for remote ports like mine is Port Clyde, Maine, but not for bigger cities. A good monitoring system would recognize the differences between ports and vessels and work with those differences, not treat them like they are all the same. We should also encourage the use of new technology when it will relieve burdens on fishermen. Finally, with EM's this may be a way to help reach a balance between cost and benefits in this fishery. The groundfish monitoring system should work for all fishing businesses and ports, regardless of size and location. It should enforce fair fishing practices and create ways for data that fishermen collect to get into the scientific process. The groundfish industry has been struggling for many years and a good monitoring system should help revive and restore it, instead of making even harder to fish.....

Thank

you for your attention to this issue. Sincerely, Cap't Randy Cushman

F/V Ella Christine

jc, rf 4/4/17

Thomas Nies  
Executive Director  
New England Fishery Management Council  
50 Water Street, Mill 2  
Newburyport, MA 01950



Dear Mr. Nies,

My Name is Glen Libby, I am part owner of two groundfish fishing boats based in Port Clyde Maine, I spent approximately 40 years of my life on the water fishing for groundfish, shrimp, and scallops.

I served one term on the New England Fisheries Management Council, and served several years on the Maine Marine Resources Advisory Council. I have participated in numerous meetings over several decades as a council member and member of the public representing myself and other fishermen.

I am a founding member of the Maine Coast Fishermen's Association, Maine Coast Community Groundfish Sector, Mid Coast Fishermen's Cooperative and currently manage Port Clyde Fresh Catch, a community based seafood processing and marketing cooperative based in Port Clyde Maine.

In regards to fisheries monitoring, the main problem is affordability. Most if not all fishermen want to have a sustainable and thriving resource and recognize the fact that in order to make informed management decisions multiple data streams are necessary to "get it right". The affordability problem in this case, pertaining amendment 23, stems from the high cost of monitoring as a percentage of catch and gross profit from varying sizes of fishing operations.

The flat rate charge of x number of dollars per day for each fishing trip uses the wrong metric and places all the risk on fishing operations. I presume that monitoring companies are in the business of monitoring fisheries to make a profit. It appears that they basically get paid a set fee regardless of the profit or loss on a given fishing trip. This results in monitoring companies being able to operate with very little risk, meaning, there is no shared risk if the trip is a broker and the catch or prices are low. Virtually anyone in business would love to operate with very low risk but that is not reality in the rest of the world. The risk of a broken or very low profit trip must be shared by the monitoring company.

Low risk is great for monitoring companies that either operate cameras or have live bodies on board but a set fee makes the cost of monitoring as a percentage of gross profit per fishing trip impossible to quantify for fishermen. This results in changes in fishing behavior to try to minimize cost and ultimately loss of potential valuable data. Fishing at a loss due to an arbitrary fee imposed by government is seen as punitive and not well accepted by fishermen. When you consider that we now have very high leasing costs for some species added to overhead the monitoring costs are not affordable as currently structured.

There are literally trips where the gross is so low due to either pricing or low catch or high lease price, where the fishermen would owe money after paying for the monitoring. Given this situation which has not really been encountered yet due to government funding, what do we do when the money is not there to pay the monitors, or crew, or suppliers etc. ? This will happen with the total cost of monitoring in its current form being placed on the fishermen.

As a side note, in my opinion, most programs that are funded by government do not have a cost structure analysis that reflect actual public sector business operations. Government funding will allow for less than optimum efficiency when it comes to the structuring of said programs. When taking 100% of funding from public sector operations ( fishing) a much higher degree of efficiency will be required. Communication between fishing businesses, monitoring companies and government analysts are essential or the fishing operations will face failure due to overhead that is too high to maintain operations.

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Regardless of the methods that are employed until the cost structure and assumed risk are shared by fishermen and monitoring companies, monitoring the fishery will continue to be a problem.

Fishermen are often characterized as “just wanting to fish” and “not wanting to deal with management” and while this may be true to a degree they can easily figure out what will or will not work for them financially.

I would propose that the cost of monitoring is shifted from a set fee or one size fits all approach to one where a percentage of gross profit from a given fishing trip is used. What that percentage is and how it is structured throughout the fleet should be determined through discussion with members of the fishing industry, regulators and monitoring companies. This would require that the monitoring company be willing to assume some of the risk if the percentage of gross did not meet their cost projections on a given trip.

In my opinion this is standard operating procedure for any successful business. If income does not meet projections or need, then you adjust your methods to become more efficient and remain in business by reducing cost. If the current monitoring operations do not want to do this then open up the bidding to others who will. Any monitoring business that cannot do this analysis and find ways to become more efficient has no business being in business especially when it is 100% financed by fishermen. The same ability to refine and develop efficient methods that lower costs must also be part of government management of the data. If doing something, in this case analysis of collected monitoring data, results in a process that is unaffordable then the process must be refined until it is affordable.

To summarize we need three things to make monitoring work.

1: Efficient and affordable data collection.

2: Efficient and affordable data analysis.

3: Affordable cost structuring for the fishing fleet arrived at through thorough discussion and vetting with fishermen.

As a business manager if I were hypothetically in control of this anyone who said “it can’t be done” would be fired and those that are willing to “get to work” would be retained, and promoted. “What ever it takes” should be the mantra, not “we can’t do it because.....” (Which to me was the most frustrating statement to have to listen to during my brief time on the council)

Public sector funds are now going to be used to fund monitoring, we owe it to the people who are providing the funding to deliver the best product in the most efficient and affordable form possible.

Respectfully submitted,

Glen Libby

Port Clyde, Maine

**Joan O'Leary**

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**From:** Gary Libby <portclydecowboy@gmail.com>  
**Sent:** Sunday, April 02, 2017 3:57 PM  
**To:** comments  
**Subject:** Amendment 23



My name is Gary Libby and my fishing boat is the Leslie & Jessica

I would like to express my views on this amendment 23. The first thing I want to say is I've fished for ground fish for 37 years and that's excluding last year, I had to make the dissension to sell my ground fish permit last year, the reasons was industry funded monitoring and high lease prices, and I didn't want to be a arm chair fisherman. It was sold so the fishermen in the sector I belonged to could use the allocation in the future.

I guessing you would like to have a diverse fleet of boats fishing in the future. Well I used a EM system a few years ago and it worked fine and though it would be in place now. But I guess not or I wouldn't committing on this amendment. I would share a few things about those young kids you send out on fishing boats, anytime that I got a kid as a observer it was like baby sitting if they weren't sea sick they stumbled aorund on deck did things like losing the shovel overboard and asking what type of fish we were catching. I would also like to say that if the observer had done it for a while there was no problems and at times they were a asset and helped a lot. So before anyone gets sent offshore they should have sea time and not just a summer day lobstering or on a recreational fishing

.From my point of view the EM systems will save money for NMFS and the fishing industry.

Now it says you want a reporting system. Well I also used a E logbook it also worked fine, the way we worked that out was not thought the VMS, we used a thumb drive I would up load the report on it and send it though my land computer to the dealers and VERS. If you are looking for tow by tow reporting we need better VMS signal. I think it would be better for all [nmfs and fishermen] to have real time reporting so quota monitoring would be better but don't try to reinvent the wheel if the reports come in within 24 hours of the end of the trip that would work. When I used the E logbook my fish were reported before they were sold every time.

I hope the gold of NMFS is to have a fishery that has a lot of fish and as many fishermen as possible and fishermen that respect their fellow fishermen and the resource thanks for allowing me to give my input on this amendment

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Captain Gary Libby  
Never stop fighting till the fight is done.  
Live long, live strong, eat seafood.

Scrf 4/4/17

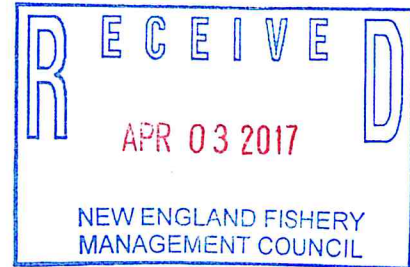
Joan O'Leary

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**From:** Chris Lish <lishchris@yahoo.com>  
**Sent:** Sunday, April 02, 2017 9:53 PM  
**To:** comments  
**Subject:** Restore the New England Cod Fishery -- Fisheries of the Northeastern United States; Northeast Multispecies Fishery; Notice of Intent To Prepare an Environmental Impact Statement; Scoping Process; Request for Comments (Document Number: 2017-03236)

Sunday, April 2, 2017

Thomas A. Nies  
Executive Director  
New England Fishery Management Council  
50 Water Street, Mill 2  
Newburyport, MA 01950



Subject: Restore the New England Cod Fishery -- Fisheries of the Northeastern United States; Northeast Multispecies Fishery; Notice of Intent To Prepare an Environmental Impact Statement; Scoping Process; Request for Comments (Document Number: 2017-03236)

Dear Executive Director Nies,

Thank you for the opportunity to comment on the New England Fishery Management Council's plan to improve monitoring and accountability in the groundfish fishery. Historically, this fishery was the backbone of New England's coastal economy. Unfortunately, the failure to expediently end overfishing of key groundfish species, such as Atlantic cod, has resulted in persistently overfished stocks, and fewer and fewer active fishermen. The sector system and annual catch limits implemented through Amendment 16 were steps in the right direction, but the lack of monitoring and accountability is preventing a broader recovery.

*"Our duty to the whole, including to the unborn generations, bids us to restrain an unprincipled present-day minority from wasting the heritage of these unborn generations. The movement for the conservation of wildlife and the larger movement for the conservation of all our natural resources are essentially democratic in spirit, purpose and method."*  
-- Theodore Roosevelt

The fishery suffers from an inadequate catch reporting program that is also expensive and burdensome and results in unreliable data. I am pleased to see that Amendment 23 has been initiated to address these issues, and I request that you consider the following alternatives.

*"Then I say the Earth belongs to each generation during its course, fully and in its own right, no generation can contract debts greater than may be paid during the course of its own existence."*  
-- Thomas Jefferson

First, a monitoring program that records and verifies 100 percent of both landings and discards on all fishing trips is the best option for a truly accountable fishery. This not only would ensure that catch limits are adhered to, but it also would generate vital data to improve stock assessments and set appropriate catch limits. As fishermen contribute more data to the management system and the

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science improves, catch limits will be better understood and accepted, and trust between all parties will improve. One hundred percent monitoring would also reduce the “observer bias” that can occur when a fishing vessel carries an observer and, as a result, changes fishing behavior.

*“As we peer into society’s future, we—you and I, and our government—must avoid the impulse to live only for today, plundering for our own ease and convenience the precious resources of tomorrow. We cannot mortgage the material assets of our grandchildren without risking the loss also of their political and spiritual heritage. We want democracy to survive for all generations to come, not to become the insolvent phantom of tomorrow.”*

*-- Dwight D. Eisenhower*

Second, 100 percent monitoring can be achieved through a variety of tools designed to be cost-effective and efficient and make best use of modern technology. A combination of electronic monitoring, at-sea and dockside monitors, improved enforcement measures, and new technology such as electronic trip reports and real-time location systems needs to be analyzed. The new and improved monitoring system must capture all fishing activity, accurately record all discards at sea, and verify landed catch both on board and at the dock.

*“Every man who appreciates the majesty and beauty of the wilderness and of wild life, should strike hands with the farsighted men who wish to preserve our material resources, in the effort to keep our forests and our game beasts, game-birds, and game-fish—indeed, all the living creatures of prairie and woodland and seashore—from wanton destruction. Above all, we should realize that the effort toward this end is essentially a democratic movement.”*

*-- Theodore Roosevelt*

New England's legendary groundfish fishery deserves a chance to recover the economic and cultural prominence it once held. The current monitoring systems are ineffective and are not working for our fish or fishermen. A program based on 100 monitoring would lead to a more accountable and sustainable era for this region's iconic fishery.

*“A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.”*

*-- Aldo Leopold*

Thank you for your consideration of my comments. Please do NOT add my name to your mailing list. I will learn about future developments on this issue from other sources.

Sincerely,  
Christopher Lish  
San Rafael, CA

**Sherie Goutier**

---

**From:** Brian Claspell <Brian642@outlook.com>  
**Sent:** Friday, March 24, 2017 10:27 PM  
**To:** comments  
**Subject:** Amendment 23- public scoping comments



I am a small commercial fishing boat owner based in New London, Ct. In regards to the public scoping meeting on March 21 in Groton, CT, on Amendment 23 , I would like to voice my opposition to any and all proposals currently put forth by the council. Having industry funded observer coverage/ costly electronic camera systems would be devastating to our already struggling fleet of a few boats that are left. I urge the council put this on hold and find alternative solutions.

Thank you

- Brian Claspell

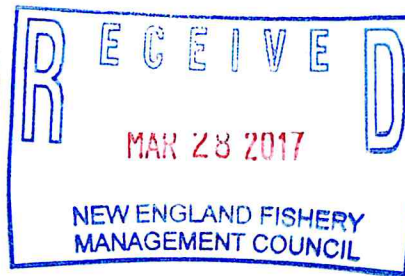
F/v Emily & Caitlyn Ilc

jc, rf 3/27/17

**Seafreeze Ltd.**



100 Davisville Pier  
North Kingstown, RI 02852



March 27, 2017

**Scoping Comments Re: Amendment 23 to the Northeast Multispecies Fishery Management Plan**

As this action is closely related with the Council's ongoing Industry Funded Monitoring Amendment, we believe it is important to comment.

The paramount consideration in any industry funded monitoring program is affordability and maintaining profitability for the vessels. If any industry funded monitoring program is unaffordable to the point of net loss, or if profitability is eroded to the point that it is no longer worth the labor, risk and effort of conducting business for a small profit margin, industry effort disappears and businesses collapse. By requiring such industry funded programs that cause economic loss or collapse, optimum yield as required by the MSA cannot and will not be achieved.

In June of 2015, the NEFSC Social Sciences Branch conducted an economic analysis that showed in all years since 2010, roughly 30% of groundfish vessels have operated with negative returns to owner, i.e. at a net loss, and that if groundfish vessels were required to pay for ASM coverage, 60% of the vessels would operate at a net loss. This analysis did not account for the cost of leasing quota, which indicates that the actual percentage of business collapse is much higher.<sup>1</sup>

In response, the Groundfish Committee discussed the ASM cost at length at their June 4, 2015 meeting. The Committee acknowledged that the ASM program was financially top-heavy, that the cost did seem to outweigh the benefits of the program, and moved to request that the Council suspend the ASM program due to its tremendous cost.<sup>2</sup> At its June 16-18 2015 meeting, the Council voted both to suspend the ASM program and to conduct a cost benefit evaluation of the ASM program.<sup>3</sup> NMFS denied the Council's emergency suspension request due to the fact that the industry funding was required by Amendment 16, and the cost benefit analysis was never conducted.

The foremost accomplishment of Amendment 23 must be to remove all industry funded monitoring costs from this fishery. If any regulatory or industry funded program is causing financial debilitation and resulting in vessels no longer being able to engage in a fishery, it must be immediately removed. There is no sense collecting fishery information if there is no fishery left.

The Amendment 23 scoping document indicates the Council wishes to look at electronic monitoring as an alternative to ASM. This is an even more expensive and unproven monitoring option and should be removed from the document as an alternative. In June 2015, NMFS produced a document comparing estimated costs of ASM and EM for a hypothetical groundfish sector. According to this analysis, EM was twice as expensive as ASM. Estimated annual monitoring costs per vessel were \$31,620 for ASM, and \$60,058 for EM. This did not include the estimated \$87,475 EM startup costs per vessel, shared between the sector (\$59,575) and NMFS (\$27,900). Furthermore, this study was based only on "dayboat" cost estimates for EM, with a trip consisting of an average 3-5 hauls per trip and trip

<sup>1</sup> [http://s3.amazonaws.com/nefmc.org/150626\\_NEFSC\\_updated\\_asm\\_report\\_Demarest.pdf](http://s3.amazonaws.com/nefmc.org/150626_NEFSC_updated_asm_report_Demarest.pdf)

<sup>2</sup> [http://s3.amazonaws.com/nefmc.org/11\\_150604\\_GF\\_CTE\\_Draft\\_Summary-2.pdf](http://s3.amazonaws.com/nefmc.org/11_150604_GF_CTE_Draft_Summary-2.pdf)

<sup>3</sup> [http://s3.amazonaws.com/nefmc.org/150615-18\\_final\\_motions2.pdf](http://s3.amazonaws.com/nefmc.org/150615-18_final_motions2.pdf)

jc, rf 3/31/17

duration of only 0.6-2.5 days.<sup>4</sup> On “trip” vessels with extended trips and many more hauls, the cost per trip would be substantially higher.

In 2015, the groundfish fleet harvested only 29% of the overall groundfish quota due to various regulatory issues. Placing further industry funded costs on vessels, whether in the form of ASM, EM or observers, all of which have already been documented to be unaffordable, will further prohibit this fishery from achieving OY or MSY. The most important element of this amendment is the future financial sustainability and profitability of the groundfish fleet. Should the Council pursue any further industry funded options for this fishery, there will be no future.

We do not support eroding the profitability of the fishing industry to fund regulations enacted by the Council and NMFS that they themselves do not have the funds to enforce or monitor. The work of this Amendment should focus on removing this financial burden on fishing vessels while improving utilization of the information already available to the Council and Agency.

Thank you for the opportunity to comment.

## Sherie Goutier

---

**From:** Jim Kendall <nbsc@comcast.net>  
**Sent:** Thursday, March 23, 2017 6:13 PM  
**To:** John Bullard  
**Cc:** comments; Jonathan F. Mitchell; Trombly, Ian; John Quinn; Tom Nies; Sarah Heil; Jennifer Goebel  
**Subject:** RE: "Northeast Multispecies Amendment 23 Scoping Comments."

Hello John;

Thank you for the kind salutation.

With regard to the meeting process & the role of the NEFMC, you might note that I did in fact address them regarding this matter. However, since this is a major & very contentious issue, I felt that I needed to address this to you & your office, as I did previously. While the deep sea coral Amendment may be an important part of fishery habitat management, I would think that it is one of the lesser concerns (for the moment at least) to a majority of the NB "groundfish" fishermen.

You, perhaps better than anyone in your organization know the limitations of many of the fishermen in & around the port of New Bedford, where perhaps due to their ethnic background, many are reluctant to attend meetings, particularly those outside of their home port of New Bedford. I am not saying that this is right, however it is fact. While it is true that the committees generally have a major say in where these meetings are held, the makeup of those committees likely will influence those choices.

My appeal to you is the same as it was previously; please convey & express to the appropriate entities the importance of at least trying to accommodate the concerns, needs & convenience of an apparent majority of fishermen who reside in a general area, which in this case is the port of New Bedford, MA. Matters of this sort are & will become increasingly relevant as New Bedford continues to stand out as the hub of what once was a diverse & vibrant fishing industry.

*Thank you:  
Jim Kendall.*

~~~~~  
Jim Kendall  
New Bedford Seafood Consulting  
[nbsc@comcast.net](mailto:nbsc@comcast.net)  
(508) 997-0013 office  
(508) 287-2010 cell

**From:** John Bullard - NOAA Federal [mailto:[john.bullard@noaa.gov](mailto:john.bullard@noaa.gov)]  
**Sent:** Thursday, March 23, 2017 11:20 AM  
**To:** Jim Kendall



**Cc:** comments@nefmc.org; Jon Mitchell; ian.trombley@mail.house.gov; Dr. John F. Quinn; Thomas Nies; Sarah Heil; Jennifer Goebel

**Subject:** Re: "Northeast Multispecies Amendment 23 Scoping Comments."

Dear Capt. Kendall,

I received your email and your comments about the lack of a hearing in New Bedford on Amendment 23 to the Multispecies Plan. You imply this is GARFO's decision and that we don't recognize the importance of the Port of New Bedford. First of all as you must know by now, it is the Council who determines where meetings are held. They just held a meeting in New Bedford last week on the Deep Sea Coral Amendment. Secondly, we recognize the importance of the Port of New Bedford and do our best to support all the fisheries who operate there.

John

On Tue, Mar 21, 2017 at 8:07 PM, Jim Kendall <[nbsc@comcast.net](mailto:nbsc@comcast.net)> wrote:

I have attached my comment with regard to A23 to the Multispecies Fishery Management Plan. It does not address any of the issues within the Amendment, but rather what is missing when addressing those issues! I'm referring to the apparent avoidance to hold hearings within the ports of New Bedford/Fairhaven & Rhode Island!

*Jim Kendall.*

~~~~~

Jim Kendall

New Bedford Seafood Consulting

19 Weaver Street

New Bedford, MA 02740-1240

[nbsc@comcast.net](mailto:nbsc@comcast.net)

[\(508\) 997-0013](tel:(508)997-0013) office

[\(508\) 287-2010](tel:(508)287-2010) cell

--

**John K. Bullard**

**Regional Administrator**

National Marine Fisheries Service

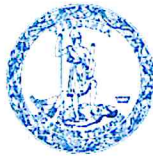
Greater Atlantic Regional Fisheries Office

55 Great Republic Drive, Gloucester, Massachusetts 01930

Phone: (978) 281-9250

[john.bullard@noaa.gov](mailto:john.bullard@noaa.gov)





## COMMONWEALTH of VIRGINIA

### DEPARTMENT OF ENVIRONMENTAL QUALITY

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[www.deq.virginia.gov](http://www.deq.virginia.gov)

Molly Joseph Ward  
Secretary of Natural Resources

David K. Paylor  
Director

(804) 698-4000  
1-800-592-5482

February 24, 2017

Thomas A. Nies  
Executive Director  
New England Fishery Management Council  
50 Water Street, Mill 2  
Newburyport, MA 01950

RE: NOAA Fisheries of the Northeastern United States; Northeast Multispecies Fishery; Scoping Request

Dear Mr. Nies:

This letter is in response to the scoping request for the above-referenced project.

As you may know, the Department of Environmental Quality, through its Office of Environmental Impact Review (DEQ-OEIR), is responsible for coordinating Virginia's review of federal environmental documents prepared pursuant to the National Environmental Policy Act (NEPA) and responding to appropriate federal officials on behalf of the Commonwealth. Similarly, DEQ-OEIR coordinates Virginia's review of federal consistency documents prepared pursuant to the Coastal Zone Management Act which applies to all federal activities which are reasonably likely to affect any land or water use or natural resources of Virginia's designated coastal resources management area must be consistent with the enforceable policies Virginia Coastal Zone Management (CZM) Program.

### DOCUMENT SUBMISSIONS

In order to ensure an effective coordinated review of the NEPA document and federal consistency documentation, notification of the NEPA document and federal consistency documentation should be sent directly to OEIR. We request that you submit one electronic to [eir@deq.virginia.gov](mailto:eir@deq.virginia.gov) (10 MB maximum) or make the documents available for download at a website, file transfer protocol (ftp) site or the VITAShare file transfer system (<https://vitashare.vita.virginia.gov>). We request that the review of these two documents be done concurrently, if possible.

The NEPA document and the federal consistency documentation (if applicable) should include U.S. Geological Survey topographic maps as part of their information. We strongly encourage you to issue shape files with the NEPA document. In addition, project details should be adequately described for the benefit of the reviewers.

ck 2/26/17  
jc 2/28/17

## **ENVIRONMENTAL REVIEW UNDER THE NATIONAL ENVIRONMENTAL POLICY ACT: PROJECT SCOPING AND AGENCY INVOLVEMENT**

As you may know, NEPA (PL 91-190, 1969) and its implementing regulations (Title 40, *Code of Federal Regulations*, Parts 1500-1508) requires a draft and final Environmental Impact Statement (EIS) for federal activities or undertakings that are federally licensed or federally funded which will or may give rise to significant impacts upon the human environment. An EIS carries more stringent public participation requirements than an Environmental Assessment (EA) and provides more time and detail for comments and public decision-making. The possibility that an EIS may be required for the proposed project should not be overlooked in your planning for this project. Accordingly, we refer to "NEPA document" in the remainder of this letter.

While this Office does not participate in scoping efforts beyond the advice given herein, other agencies are free to provide scoping comments concerning the preparation of the NEPA document. Accordingly, we are providing notice of your scoping request to several state agencies and those localities and Planning District Commissions, including but not limited to:

Department of Environmental Quality:

- DEQ Regional Office\*
- Air Division\*
- Office of Wetlands and Stream Protection\*
- Office of Local Government Programs\*
- Division of Land Protection and Revitalization
- Office of Stormwater Management\*

Department of Conservation and Recreation

Department of Health\*

Department of Agriculture and Consumer Services

Department of Game and Inland Fisheries\*

Virginia Marine Resources Commission\*

Department of Historic Resources

Department of Mines, Minerals, and Energy

Department of Forestry

Department of Transportation

Note: The agencies noted with a star (\*) administer one or more of the enforceable policies of the Virginia CZM Program.

## **FEDERAL CONSISTENCY UNDER THE COASTAL ZONE MANAGEMENT ACT**

Pursuant to the federal Coastal Zone Management Act of 1972, as amended, and its implementing regulations in Title 15, *Code of Federal Regulations*, Part 930, federal activities, including permits, licenses, and federally funded projects, located in Virginia's Coastal Management Zone or those that can have reasonably foreseeable effects on Virginia's coastal uses or coastal resources must be conducted in a manner which is consistent, to the maximum extent practicable, with the Virginia CZM Program.

Additional information on the Virginia's review for federal consistency documents can be found online at  
<http://www.deq.virginia.gov/Programs/EnvironmentalImpactReview/FederalConsistencyReviews.aspx>

## DATA BASE ASSISTANCE

Below is a list of databases that may assist you in the preparation of a NEPA document:

- DEQ Online Database: Virginia Environmental Geographic Information Systems

Information on Permitted Solid Waste Management Facilities, Impaired Waters, Petroleum Releases, Registered Petroleum Facilities, Permitted Discharge (Virginia Pollution Discharge Elimination System Permits) Facilities, Resource Conservation and Recovery Act (RCRA) Sites, Water Monitoring Stations, National Wetlands Inventory:

- [www.deq.virginia.gov/ConnectWithDEQ/VEGIS.aspx](http://www.deq.virginia.gov/ConnectWithDEQ/VEGIS.aspx)

- DEQ Virginia Coastal Geospatial and Educational Mapping System (GEMS)

Virginia's coastal resource data and maps; coastal laws and policies; facts on coastal resource values; and direct links to collaborating agencies responsible for current data:

- <http://128.172.160.131/gems2/>

- DHR Data Sharing System

Survey records in the DHR inventory:

- [www.dhr.virginia.gov/archives/data\\_sharing\\_sys.htm](http://www.dhr.virginia.gov/archives/data_sharing_sys.htm)

- DCR Natural Heritage Search

Produces lists of resources that occur in specific counties, watersheds or physiographic regions:

- [www.dcr.virginia.gov/natural\\_heritage/dbsearchtool.shtml](http://www.dcr.virginia.gov/natural_heritage/dbsearchtool.shtml)

- DGIF Fish and Wildlife Information Service

Information about Virginia's Wildlife resources:

- <http://vafwis.org/fwis/>

- Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Database: Superfund Information Systems

Information on hazardous waste sites, potentially hazardous waste sites and remedial activities across the nation, including sites that are on the National Priorities List (NPL) or being considered for the NPL:

- [www.epa.gov/superfund/sites/cursites/index.htm](http://www.epa.gov/superfund/sites/cursites/index.htm)

- EPA RCRAInfo Search

Information on hazardous waste facilities:

- [www.epa.gov/enviro/facts/rcrainfo/search.html](http://www.epa.gov/enviro/facts/rcrainfo/search.html)

- EPA Envirofacts Database



EPA Environmental Information, including EPA-Regulated Facilities and Toxics Release Inventory Reports:

- [www.epa.gov/enviro/index.html](http://www.epa.gov/enviro/index.html)

- EPA NEPAassist Database

Facilitates the environmental review process and project planning:

<http://nepaassisttool.epa.gov/nepaassist/entry.aspx>

If you have questions about the environmental review process and/or the federal consistency review process, please feel free to contact me (telephone (804) 698-4204 or e-mail [bettina.sullivan@deq.virginia.gov](mailto:bettina.sullivan@deq.virginia.gov)).

I hope this information is helpful to you.

Sincerely,

A handwritten signature in black ink that reads "Bettina Sullivan". The script is cursive and fluid, with the first name and last name clearly distinguishable.

Bettina Sullivan, Program Manager  
Environmental Impact Review and  
Long-Range Priorities

**Sherie Goutier**

**From:** Jim Kendall <nbsc@comcast.net>  
**Sent:** Tuesday, March 21, 2017 8:07 PM  
**To:** comments; John Bullard  
**Cc:** Jonathan F. Mitchell; ian.trombley@mail.house.gov  
**Subject:** "Northeast Multispecies Amendment 23 Scoping Comments"  
**Attachments:** Comment on Amendment 23 re.docx



I have attached my comment with regard to A23 to the Multispecies Fishery Management Plan. It does not address any of the issues within the Amendment, but rather what is missing when addressing those issues! I'm referring to the apparent avoidance to hold hearings within the ports of New Bedford/Fairhaven & Rhode Island!

*Jim Kendall.*

~~~~~

Jim Kendall  
New Bedford Seafood Consulting  
19 Weaver Street  
New Bedford, MA 02740-1240  
[nbsc@comcast.net](mailto:nbsc@comcast.net)  
(508) 997-0013 office  
(508) 287-2010 cell

# Comment on Amendment 23 re: Slighted Ports

March 21, 2017

I wasn't going to offer a comment on this Amendment simply because GARFO & company has once again chosen to ignore the value & the importance of holding a public hearing with the New Bedford/Fairhaven, & Rhode Island groundfish fishermen!

My comment with regard to Amendment 23 to the NE GroundFish Multispecies' FMP remains the same as I last tried to convey to the NEFMC & RA John Bullard!

When the hell does New Bedford/Fairhaven, the largest groundfish port on the East Coast, rate a Scoping Hearing? This same question is being raised in RI as it pertains to them as well.

At some point, the Service is going to have to recognize the fact that the majority of GF activity is within those two (2) areas that you have taken considerable effort to avoid. It is not your comfort or convenience that you should be considering when designating the ports or areas that are worthy of hosting these meetings!

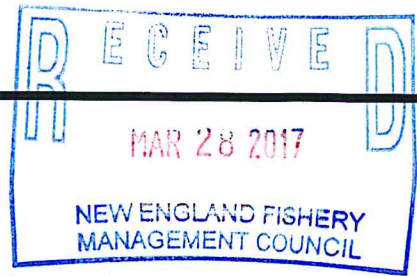
I'm not saying that these other venues don't deserve to be considered, but neither do we deserve to be denied &/or ignored! The RA's previous comment to me regarding this same issue (see my previous comment regarding when we were last summarily dismissed), "that we could attend via an online hearing" is not only condescending, but it is impertinent when viewed as his response to our fishermen!

I never would have expected to have to remind the RA (as a former mayor of New Bedford), not only of the importance of this fishery to New Bedford, but of the New Bedford fishing industry to that same groundfish fishery!

I am sure that my shipmates from Rhode Island harbor similar thoughts & feelings regarding this apparently intended slight to both our areas.

Jim Kendall  
New Bedford Seafood Consulting  
March 21, 2017

**Joan O'Leary**



**From:** Caleb Laieski <caleb\_m\_laieski@yahoo.com>  
**Sent:** Tuesday, March 28, 2017 11:09 PM  
**To:** Tom Nies  
**Cc:** John Quinn; Terry Stockwell; Joan O'Leary  
**Subject:** Northeast Multispecies Amendment 23 Scoping Comments

Dear Executive Director Nies,

Thank you for the opportunity to comment on the New England Fishery Management Council's plan to improve monitoring and accountability in the groundfish fishery. Historically, this fishery was the backbone of New England's coastal economy. Unfortunately, the failure to expediently end overfishing of key groundfish species, such as Atlantic cod, has resulted in persistently overfished stocks, and fewer and fewer active fishermen. The sector system and annual catch limits implemented through Amendment 16 were steps in the right direction, but the lack of monitoring and accountability is preventing a broader recovery.

The fishery suffers from an inadequate catch reporting program that is also expensive and burdensome and results in unreliable data. I am pleased to see that Amendment 23 has been initiated to address these issues, and I request that you consider the following alternatives.

First, a monitoring program that records and verifies 100 percent of both landings and discards on all fishing trips is the best option for a truly accountable fishery. This not only would ensure that catch limits are adhered to, but it also would generate vital data to improve stock assessments and set appropriate catch limits. As fishermen contribute more data to the management system and the science improves, catch limits will be better understood and accepted, and trust between all parties will improve. One hundred percent monitoring would also reduce the "observer bias" that can occur when a fishing vessel carries an observer and, as a result, changes fishing behavior.

Second, 100 percent monitoring can be achieved through a variety of tools designed to be cost-effective and efficient and make best use of modern technology. A combination of electronic monitoring, at-sea and dockside monitors, improved enforcement measures, and new technology such as electronic trip reports and real-time location systems needs to be analyzed. The new and improved monitoring system must capture all fishing activity, accurately record all discards at sea, and verify landed catch both on board and at the dock.

New England's legendary groundfish fishery deserves a chance to recover the economic and cultural prominence it once held. The current monitoring systems are ineffective and are not working for our fish or fishermen. A program based on 100 percent monitoring would lead to a more accountable and sustainable era for this region's iconic fishery.

Thank you for your time and consideration,

Caleb Laieski

cc, cf 3/31/17

**Amendment 23**

**To the**

**Northeast Multispecies Fishery Management Plan**

**Appendix II**

**Draft Fishery Data for Stock Assessment Working Group Report and**

**SSC Sub-Panel Peer Review Report**



**SSC REVIEW DRAFT**

# ***Fishery Data for Stock Assessment Working Group Report***

**November 19, 2018**

Working Group: Steve Cadrin (Chair, SMAST), Robin Frede (NEFMC), Emily Keiley (GARFO), Brian Linton (NEFSC), Jean-Jacques Maguire (SSC), Paul Rago (NEFSC retired), Rich Bell (TNC), Vito Giacalone (NESC), Chad Demarest (NEFSC), Chris Brown (FV Proud Mary) and Mark Gibson (RIDEM retired)

Other Contributors: Cate O'Keefe (MADMF), Greg DeCelles (MADMF), Brooke Wright (SMAST), Alex Hansell (SMAST), Chris McGuire (TNC), Dan Hennen (NEFSC)

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## **Executive Summary**

The New England Fishery Management Council formed a working group to discuss the topic of how fishery-dependent data can be used to inform stock abundance to address four main deliverables:

- 1) explain how fishery-dependent and fishery-independent data are used in stock assessments,
- 2) summarize the utility and limitations of using fishery catch rates (CPUE, catch per unit effort) as an index of abundance for Northeast Multispecies stocks,
- 3) identify the fishery factors and fishery-dependent data needed to create a CPUE that would be a reliable index of abundance for Northeast Multispecies stocks, and
- 4) compare the desired factors identified with existing conditions and data for the fishery.

### **How fishery-dependent and fishery-independent data are used in stock assessments**

Stock assessments rely on fishery monitoring information to estimate total fishery removals and age composition as well as fishery-independent data to provide indices of relative stock abundance and age distribution. Stock assessments assume that estimates of fishery removals are accurate. Information from the various fishery monitoring programs are combined to determine landings and discards (by species, stock area, month, and fishing), fishing effort (by statistical area, month and gear), as well as size and age composition (by species, statistical area, month and gear).

Age-based stock assessments estimate abundance of each yearclass in a population based on information from fishery monitoring programs and fishery-independent surveys. Fishery monitoring data is used to derive a time series of fisheries removals (commercial landings, commercial discards, recreational landings, and recreational discards) as well as the age composition of those removals. fishery-independent surveys or fishery catch rates are used to determine whether the fishery removals came from a relatively abundant or a relatively depleted stock. Population models are fit to the available fishery and fishery-independent data to estimate a time series of stock abundance, age structure and fishing mortality. Some groundfish stocks are based on data-limited approaches, which also rely on estimates of fishery removals and indices of abundance.

Abundance indices are assumed to be proportional to stock size, so factors that might interfere with the relationship between index and stock (e.g., changes in vessel or gear characteristics) must be accounted for. Fishery-independent data is obtained primarily through research surveys, which are used to estimate relative or absolute stock abundance and sample for size and age through a planned sampling design. Fishery-independent surveys are designed to standardize for vessel, fishing gear, fishing protocol, as well as time and area. Fishery catch rates (CPUE) are more difficult to standardize because fishing effort is based on individual fishing decisions within the constraints of regulations.

### **The utility and limitations of using CPUE as an index of abundance for Northeast Multispecies stocks**

Fishery catch rates (CPUE) are used in many stock assessment models as an index of stock abundance. These applications assume that CPUE is proportional to stock abundance, but this assumption is only valid in some situations. Fisheries are not designed to representatively sample a fish population, so trends in catch rates may not reflect trends in the stock. Fishery catch rates can be standardized to account for factors like changing patterns in fishing area, fishing season, or vessel characteristics, but some factors cannot be effectively standardized.

Stock assessments of New England groundfish currently do not use CPUE as an index of abundance in the stock assessment model. However, CPUE is used in other northeast U.S. stock assessments and was previously used in most groundfish assessments before 2008. Several more recent groundfish assessments considered CPUE as an index of abundance but did not include it as an index of abundance.

Despite the limitations of using CPUE as an index of abundance in some situations, including CPUE in a stock assessment can be informative. Including CPUE as an index of abundance has the potential to improve performance of groundfish assessments if the index is sufficiently standardized. Even if it is not used as an index of abundance in the stock assessment model, including CPUE in a stock assessment can also be valuable for providing fishery data with greater spatial and temporal resolution than fishery-independent surveys and understanding fishery dynamics. The inclusion of fishery perceptions of trends in catch rates may also improve the acceptance of stock assessment results by the fishing industry.



### **Fishery factors and fishery-dependent data needed for a reliable CPUE index**

Several aspects of fisheries and data are needed to create a CPUE to be a reliable index of abundance for Northeast Multispecies stocks. Differences in fishing power need to be standardized so that a unit of effort and CPUE are comparable over time. Information on target species is helpful for developing a CPUE, particularly to select fishing effort targeted at the species of interest and to exclude effort that is deliberately avoiding ‘choke stocks’. Catch estimates need to be accurate for an informative CPUE index, either an entire fleet CPUE or a smaller standard fleet. An understanding of fishing effort is needed to develop a CPUE, including information on fishing gear, fishing power, and an appropriate unit of fishing effort for each type of fishery. Fine-scale temporal and spatial information is helpful for measuring and standardizing fishing effort, even if catch, effort and CPUE are derived in more aggregated units (e.g., statistical reporting area, quarter-year). Ideally, the inclusion probabilities of fishery observations (i.e., the chance of each time/location observation being sampled) should be known for a CPUE series to be a representative index of abundance.

### **Desired factors and existing conditions**

A large amount of fishery-dependent data is currently collected from fishermen in the Northeast multispecies fishery, but CPUE is not currently being used in groundfish stock assessments because of limitations in the monitoring programs (e.g., data resolution, mis-reporting, observer bias), constraints of the stock assessment process (e.g., increasing scope of assessments with limited time and resources), as well as challenges posed by current conditions in the groundfish fishery (e.g., avoidance behavior). At-sea observer coverage is based on achieving a standard of precision for discard estimates. However, the precision estimate does not account for ‘observer bias’ (i.e., observed trips do not represent unobserved trips because of difference in fishing behavior). Observer coverage should provide confidence that the overall catch estimate is accurate. Vessel Trip Reports (VTRs) do not record fine-scale effort data. Many VTRs report aggregate effort and by statistical fishing areas. Most of the data in VTRs is self-reported but is not verified (e.g., location, discarded catch). Vessel Monitoring System (VMS) information could be used to verify VTR location information, but such evaluations are rare.

Federally permitted seafood dealers submit weekly electronic purchase reports. Although total landings derived from dealer reports are assumed to be a census of fishery landings, recent violations document substantial mis-reporting. The magnitude of misreporting and

resulting bias in estimates of landings are unknown.

Study fleets and Electronic Monitoring (EM) projects have the potential to provide greater spatial and temporal resolution of catch and effort. Both systems integrate logbooks with vessel positioning systems, and both have options for verifiable self-reported data.

Electronic VTRs (eVTRs) and EM are used to monitor a portion of the groundfish fleet, but the data are not routinely used to derive CPUE.

### **Recommendations:**

1. As a routine term of reference, a time series of CPUE should be evaluated and considered as an index of abundance in all benchmark stock assessments, not necessarily accepted as an index of abundance in the final stock assessment model.
2. For CPUE to be considered as an index of abundance in stock assessment models, CPUE must be standardized sufficiently to account for changes in vessel efficiency, gear selectivity, targeting/avoidance behavior, inclusion probabilities, spatial aggregation of fish, and hyperstability. For example, the Southeast Data and Assessment Review (SEDAR) process developed a checklist for evaluating fishery-dependent and fishery-independent indices.
3. Identifying best practices for developing a standardized CPUE index using northeast fishery monitoring data would be an appropriate topic for a research track assessment for all groundfish stocks.
4. Simulation analysis should be used to evaluate the performance of alternative approaches to developing standardized CPUE as an index of abundance.
5. Processes for soliciting fishermen's expertise for understanding factors of CPUE, fishing patterns, and targeting or avoidance behavior should be included in the stock assessment process such as workshops and questionnaires.
6. Study fleets that have similar gear, vessel size, vessel power and target species should be considered for the development of CPUE indices.
7. At-sea observer data should be used in the development of CPUE indices with fine-scale standardization, but 'observer bias' should be considered.
8. Advanced technologies (e.g., electronic monitoring systems) should be considered in the development of CPUE indices with fine-scale standardization.
9. Criteria should be developed to identify targeted fishing effort by species, including historical, fishery "footprints."
10. Appropriate units of fishing effort should be developed for each type of fishery (e.g., trawl, gillnet, and hook gears).

## Background

At the September 2017 meeting, the New England Fishery Management Council passed a motion from the Groundfish Committee: *“to request that the Executive Committee discuss convening a Working Group to identify and/or improve methods for using monitoring data in stock assessments to estimate stock biomass.”* The Council discussed the Working Group at the December 2017 meeting to clarify that the Working Group was formed to explore the use of catch-per-unit-effort (CPUE) in stock assessments as an index of abundance. During the discussion of 2018 priorities, the following motion was adopted (emphasis added): *“to amend the priorities for Groundfish for 2018 to include all regulatory requirements and Amendment 23 and by clarifying that work on Amendment 23 includes utilization of workshops/expanded PDT meetings for development of technical elements i.e. EM, DSM etc. and a working group to discuss the topic of how fishery-dependent data can be used to inform stock abundance.”*

In January 2018, the Council’s Executive Director recommended that *“The Council and the NEFSC should convene a working group with four main deliverables:*

- (1) Explain how fishery-dependent and fishery-independent data are used in stock assessments. This should include an explanation of how different data elements are used and interact in an age-based analytic assessment.*
- (2) Summarize the theoretical utility and limitations of using CPUE/LPUE as an index of abundance for Northeast Multispecies stocks. List recent (GARM III or later) efforts to create a CPUE for any of these stocks and the results of those efforts (i.e. successful/unsuccessful, used in analytic assessment, etc.).*
- (3) Without regard to existing fishing practices, regulations, or monitoring systems, identify the fishery factors and fishery-dependent data needed to create a CPUE that would be a reliable index of abundance for Northeast Multispecies stocks.*
- (4) Compare the desired factors identified with existing conditions and data for the fishery. This should be a gap analysis of factors and data needed, as well as the analytical approaches necessary, to create a CPUE that would be a reliable index of abundance for Northeast Multispecies stocks.”*

A Working Group was formed with membership from New England Fishery Management Council staff, Science and Statistical Committee (SSC), Northeast Fisheries Science Center (NEFSC), NOAA's Greater Atlantic Regional Office (GARFO), university, state agency and NGO scientists as well as the fishing industry. Four meetings were held (April 26 2018, June 25 2018, August 6 2018, September 7, 2018; New Bedford MA) to review the expected deliverables, develop a work plan, review information relevant to deliverables and form recommendations. Meetings were open and contributions were welcome from all participants. Final recommendations were developed at the September 7th meeting and were reviewed on a conference call (November 2, 2018), and the consensus report was developed by correspondence.

## ***Deliverable 1:***

***Explain how fishery-dependent and fishery-independent data are used in stock assessments. This should include an explanation of how different data elements are used and interact in an age-based analytic assessment.***

### **1.1 Types of Stock Assessments**

*What are the types of stock assessments, and what data are used in them?*

Several general approaches are used for assessments of New England groundfish stocks (NEFSC 2017, Table 1). The most informative stock assessments are age-based analytical assessments. However, assessments of some groundfish stocks are based on data-limited approaches, either because information is not sufficient to support age-based assessments or age-based assessments are not reliable.

Age-based analytic stock assessments rely on fishery monitoring information to estimate total fishery removals and age composition as well as fishery-independent data to provide indices of relative stock abundance and age distribution. Data-limited stock assessments rely on fishery monitoring information to estimate total fishery removals (and size distribution for some stocks) and fishery-independent data to provide indices of relative stock abundance or estimates of absolute stock abundance (and size distribution for some stocks). All stock assessments assume that estimates of fishery removals are accurate. Even data-limited stock assessments that are based on survey trends require some information on fishery removals to derive catch advice.

### **1.2 Data Used in Stock Assessments**

*What fishery-dependent and independent data are used in stock assessments?*

Fishery-dependent data is collected through fishery monitoring, with the primary purpose of estimating removals. There are also many secondary objectives of fishery monitoring such as sampling size and age composition, estimating fishing effort, and estimating fishery catch rates. These objectives are achieved through collection of different fishery data elements:

- Dealer reports provide a census of landings, and Vessel Trip Reports (VTRs) provide a census of fishing effort by stock area, and the two are linked to derive landings by stock area.
  - Data for trip reports are either from paper logbooks or electronic vessel trip reports (eVTRs).
- At sea monitoring (at-sea monitoring program, ASM, and Northeast Fisheries Observer Program, NEFOP) is primarily used to estimate discarded catch.
  - Discards are quantified on observed trips and expanded to an estimate of discards on trips that do not carry an observer or at-sea monitor.



- NEFOP observers collect biological information (size structure and age samples) from discarded fish in order to characterize the age structure of discards.
- Port samplers collect biological information (size structure and age samples) from landed fish in order to characterize the age structure of the kept catch.
- The Marine Recreational Information Program (MRIP) monitors catch and effort of recreational fisheries.
- Electronic Monitoring (EM) can be used in place of at-sea monitors to collect spatially specific information on fishing activity and discards. Several EM alternatives are currently under consideration through exempted fishing permits, but the programs are small (~10% of the active groundfish fleet) and relatively recent. EM is used to quantify discards for those vessels participating in experimental fishing permit programs, but is not currently used in assessments for purposes beyond catch accounting. EM data has the potential to be included in assessments for additional purposes in the future as these programs are ongoing.
  - In some cases, EM is used to estimate discards (audit or census approach). Cameras collect information on the number and size distribution of discarded fish, which is used to derive discard weight. The age structure of the discarded catch would need to be estimated based on the length frequency information. Haul level information on kept catch would be provided by the captain through an electronic vessel trip report.
  - In other cases, EM is used to verify that groundfish are not discarded at sea (maximum retention approach). In this instance, dockside monitors are used to quantify the magnitude of groundfish catch, and the catch is sampled dockside in order to collect biological information.
- Study fleet combines spatially explicit eVTRs with focused biological sampling.

Information from the various fishery monitoring programs are combined to determine landings and discards by species, statistical area, month, gear (and market category for landings); fishing effort by statistical area, month and gear; and length, weight and age by species, statistical area, month and gear.

Fishery-independent data is obtained primarily through research surveys, which are used to estimate relative or absolute stock abundance and sample for size and age through a planned sampling design. Surveys are usually conducted on research vessels using standardized, commercial fishing gear. Industry-based surveys involve commercial fishing vessels that are commissioned to conduct surveys, but industry-based surveys have had limited application in New England groundfish stock assessments.

### **1.3 How are Data Used in Stock Assessments**

*How are fishery-dependent and independent data used in stock assessments*

#### *1.3.1 Age-based Assessments*

Age-based stock assessments estimate abundance of each yearclass in a population based on information from fishery monitoring programs and fishery-independent surveys. Fishery monitoring data is used to derive a time series of fisheries removals (commercial landings, commercial discards, recreational landings, and recreational discards) as well as the age composition of those removals. Fishery-independent surveys or fishery catch rates are used to determine whether fishery removals came from a relatively abundant or a relatively depleted stock. Population models are fit to the available fishery and fishery-independent data to estimate a time series of stock abundance, age structure and fishing mortality. Some age-based models can fit to size composition data rather than age composition.

Data from several fishery monitoring programs are used to derive fishery removals for New England groundfish stocks. Commercial landings for each groundfish stock are derived from a merger of vessel trip reports and dealer reports. Age composition of commercial landings is derived from port samples of size and age distribution. Discard rates from observed trips are expanded to all trips to estimate commercial discards. Age composition of commercial discards is derived from observer samples of size and age distribution. Recreational catch and size composition is derived from the Marine Recreational Information Program. All of these estimates of removals and age composition are combined to derive total removals and age composition.

Estimates of fishery removals provide valuable information on productivity of the fish population. In the simplest sense, the scale of fishery removals is the minimum population estimate for each year, because there has to be enough fish in the population to support the estimated removals. So, the greater the removals, the greater the minimum population estimate. However, fish also die from natural causes, and many survive each year, so that the true population size is considerably greater than the estimate of fishery removals. The time series of removals offers information on sustained productivity, but more information is needed to determine if the estimated removals were produced by a relatively large stock or a relatively small stock.

Samples of size and age distribution of fishery catch are informative for estimating mortality rates and recruitment of young fish. More old fish in fishery samples can indicate relatively high survival and low mortality rates, whereas fewer old fish in fishery samples can indicate relatively low survival and high mortality rates. More young fish in fishery samples can indicate relatively strong recruitment. Tracking yearclasses through time helps to estimate recruitment and mortality from age composition. Fishery samples of age structure are also influenced by size and age selectivity (i.e., smaller-younger fish can escape fishing gear, and larger-older fish are more vulnerable to fishing). So, fishery-independent surveys of size and age distributions are also valuable for estimating recruitment and mortality rates.

An estimate of fishery removals provides a minimum stock estimate, but relative indices of stock abundance are needed to estimate the abundance associated with fishery removals. When abundance indices are relatively high, the estimated fishery removals are interpreted to have come from a relatively abundant stock, with relatively low fishing mortality. When abundance indices are relatively low, the estimated fishery removals are interpreted to have come from a relatively depleted stock, with relatively high fishing mortality.

Abundance indices are assumed to be proportional to stock size. If an index is to track stock abundance, then factors that might interfere with the relationship between index and stock (e.g., changes in vessel or gear characteristics) must be accounted for. Fishery-independent surveys are designed to standardize for vessel, fishing gear, fishing protocol, as well as time and area, and there are no attempts to increase fishing efficiency. When changes to survey protocols are introduced, they often involve experiments to evaluate the effect of the changes.

Fishery catch rates (catch per unit of effort, CPUE) are more difficult to standardize because fishing effort is based on individual fishing decisions within the constraints of regulations (e.g., choice of vessel, fishing gear, fishing protocol, time and area). Fishery regulations and individual choice complicate the use of fishery catch rates as abundance indices in stock assessments. As a result, fishery-dependent indices must be standardized after the data are collected using statistical methods.

Fishery-independent surveys and fishery-dependent CPUE are related to stock size, assuming that they are proportional to stock abundance, and that ‘catchability’ of the survey or the fishery is constant by age throughout the time series. ‘Catchability’ is a combination of fishing gear efficiency (i.e., the proportion of encountered fish that are captured) and availability of fish to the gear (i.e., the overlap of the fish population and the fishery or survey in space and time).

All age-based assessments of New England groundfish stocks use fishery-dependent data for catch estimates (landings and discards) and age composition, and fishery CPUE was traditionally used in many groundfish stock assessments, but fishery CPUE is not currently used in any of the New England groundfish stock assessments because of difficulties standardizing fishery CPUE.

Problems with using fishery CPUE were first identified in herring fisheries when purse seine indices of stock sizes were used in the assessment. The stock size indices remained stable as large herring fisheries off Norway, in the North Sea and on Georges Bank collapsed in the late 1960s and early 1970s. Catch per set proved to be a poor index of stock size, because catch per set is an index of school size, not an index of the size of the stock and did not take searching time into account. Catch per night or per day could have been better indices of abundance, but there was a strong movement to conclude that purse seine catch and effort data was useless as an index of stock size. There were also problems with technological changes (fish detection, power block etc.). Notwithstanding this, for one of the small herring

stocks in Newfoundland, biomass estimates from an assessment using aerial surveys as an index of stock size matched the purse seine CPUE.

As an alternative to fishery CPUE, the Northeast Fisheries Science Center was a pioneer in using fishery-independent surveys for abundance indices, with the autumn survey starting in 1963, and the spring survey starting in 1968. The Canada Department of Fisheries and Oceans (DFO) started its summer surveys on the Scotian Shelf and in the Gulf of St. Lawrence in 1970 and off Newfoundland in 1978. The UK started its groundfish survey in the North Sea in 1975, and the European Union has been funding demersal surveys in the Mediterranean since about 1995.

fishery-dependent indices of stock size continue to be used in many stock assessments in the U.S. and worldwide. For example, tuna fisheries are distributed too widely to be surveyed. fishery-dependent indices of abundance are used regularly in Mid-Atlantic, South Atlantic, and Gulf of Mexico stock assessments. These fishery-dependent indices are constructed using gear or fleet-specific catch per unit effort (CPUE) data (e.g., commercial longline, recreational charter boat). Appendix 1 includes an explanation of the use of fishery-dependent indices of abundance in the Southeast Data and Assessment Review (SEDAR) process, as well as a worksheet developed in 2010 by Southeast Fisheries Science Center (SEFSC) staff to help evaluate both fishery-dependent and fishery-independent indices of abundance for inclusion in SEDAR stock assessments.

### *1.3.2 Empirical Approaches*

Data-limited stock assessments in New England monitor relative or absolute stock abundance or biomass, and catch advice is based on information from fishery monitoring and fishery-independent surveys. Fishery monitoring data is used to derive a time series of fisheries removals (commercial landings, commercial discards, recreational landings, and recreational discards). fishery-independent surveys or fishery catch rates are used to determine whether the fishery removals came from a relatively abundant or a relatively depleted stock.

There are three general types of empirical approaches used to assess New England groundfish stocks: the survey expansion approach, the smoothed survey approach, and AIM (An Index Method). The survey expansion approach estimates a swept area biomass estimate from an average of spring and fall fishery-independent biomass indices. An exploitation rate, which is a function of recent catch estimates, is applied to the swept area biomass estimate to generate catch advice. The smoothed survey approach creates a smoothed biomass index from an average of spring and fall fishery-independent biomass indices. The proportional rate of change over the most recent three years of the smoothed index is estimated, and that rate of change is applied to average catch from the most recent three years to generate catch advice. In both approaches, fishery-dependent data are used to estimate total removals. The AIM approach differs from the other empirical approaches, because it directly incorporates fishery-dependent data. The AIM approach uses fishery-dependent annual catches and

fishery-independent biomass indices to estimate relative fishing mortality rates and stock replacement ratios.

## 1.4 Northeast Multispecies Assessments

*What types of assessments are used for Northeast groundfish stocks?*

The 20 stocks of Northeast groundfish use both age-based analytical assessments and empirical approaches. As of the latest operational assessments conducted in 2017, eleven stocks had analytical assessments, and nine had other, including empirical, assessments (NEFSC 2017, Table 1). Table 2 provides a summary of data used from catch and survey information in each groundfish assessment for the 2017 Operational Assessments.

**Table 1:** Summary of 2017 Operational Assessments, including model type, estimates of biomasses and fishing mortality rates in 2016, and biological reference points for groundfish stocks. Note: Atlantic halibut is not included as the assessment for this stock was conducted in a separate process; Atlantic halibut has an empirical assessment (from NEFSC 2017).

Table 6: Summary of Operational Assessment estimates of biomasses and fishing mortality rates in 2016 and biological reference points for groundfish stocks. Reference points are not estimable for some stocks. Terminal biomass estimates for CODGB and YELGB are for 2017 rather than 2016.

| Stock    | Model type         | $B_{2016}$<br>(mt) | $B_{MSY}$<br>(mt) | $\frac{B_{2016}}{B_{MSY}}$ | $F_{2016}$ | $F_{MSY}$ | $\frac{F_{2016}}{F_{MSY}}$ | MSY<br>(mt) | $\rho$ adj? | Comments                                                    |
|----------|--------------------|--------------------|-------------------|----------------------------|------------|-----------|----------------------------|-------------|-------------|-------------------------------------------------------------|
| CODGM    | ASAP (M=0.2)       | 3,046              | 40,604            | 0.08                       | 0.228      | 0.17      | 1.31                       | 7,049       | No          |                                                             |
| CODGM    | ASAP<br>(M-ramp)   | 3,262              | 59,714            | 0.05                       | 0.237      | 0.18      | 1.34                       | 10,502      | No          |                                                             |
| CODGB    | Empirical          | 7,237              |                   |                            | 0.174      |           |                            |             | No          | Smoothed survey indices used to estimate biomass            |
| HADGB    | VPA                | 290,324            | 104,312           | 2.78                       | 0.309      | 0.35      | 0.88                       | 24,372      | Yes         |                                                             |
| HADGM    | ASAP               | 47,821             | 6,769             | 7.06                       | 0.137      | 0.46      | 0.30                       | 1,547       | No          |                                                             |
| YELCCGM  | VPA                | 1,191              | 4,640             | 0.26                       | 0.314      | 0.27      | 1.15                       | 1,154       | Yes         |                                                             |
| YELSNEMA | ASAP               | 152                | 1,860             | 0.08                       | 1.09       | 0.34      | 3.20                       | 511         | Yes         |                                                             |
| FLWGB    | VPA                | 3,946              | 7,600             | 0.52                       | 0.117      | 0.52      | 0.22                       | 3,500       | Yes         |                                                             |
| FLWSNEMA | ASAP               | 4,360              | 24,687            | 0.18                       | 0.21       | 0.34      | 0.62                       | 7,532       | No          |                                                             |
| PLAUNIT  | VPA                | 13,351             | 13,503            | 0.99                       | 0.111      | 0.22      | 0.51                       | 2,924       | Yes         |                                                             |
| WITUNIT  | Empirical          | 14,563             |                   |                            | 0.035      |           |                            |             | No          | Average survey biomass, exploitation ratio used             |
| REDUNIT  | ASAP               | 359,970            | 247,918           | 1.45                       | 0.011      | 0.04      | 0.29                       | 9,318       | Yes         |                                                             |
| HKWUNIT  | ASAP               | 21,276             | 30,948            | 0.69                       | 0.066      | 0.18      | 0.36                       | 4,867       | Yes         |                                                             |
| POLUNIT  | ASAP (base)        | 183,907            | 105,510           | 1.74                       | 0.036      | 0.26      | 0.14                       | 19,427      | Yes         | Flat top selectivity model was used for sensitivity testing |
| POLUNIT  | ASAP (flat<br>top) | 72,889             | 60,738            | 1.20                       | 0.079      | 0.25      | 0.32                       | 11,692      | Yes         | see above                                                   |
| CATUNIT  | SCALE              | 652                | 1,612             | 0.40                       | 0.002      | 0.22      | 0.01                       | 232         | No          |                                                             |
| FLDGMGB  | AIM                | 0.36               | 2.06              | 0.17                       | 0.222      | 0.34      | 0.65                       | 700         | No          | Biomass in kg/tow. F values reflect exploitation rate       |
| FLDSNEMA | AIM                | 0.329              | 0.253             | 1.30                       | 1.733      | 1.92      | 0.90                       | 500         | No          | Biomass in kg/tow. F values reflect exploitation rate       |
| OPTUNIT  | Index-based        | 0.223              | 4.94              | 0.05                       | 0.221      | 0.76      | 0.29                       | 3,754       | No          | Biomass in kg/tow. F values reflect exploitation rate       |
| FLWGM    | Empirical          | 2,585              |                   |                            | 0.086      | 0.23      | 0.37                       |             | No          | 30+ cm biomass, exploitation ratio used                     |
| YELGB    | Empirical          | 3,118              |                   |                            | 0.009      |           |                            |             | No          | Average survey biomass, exploitation ratio used             |



**Table 2:** Summary of data used in each groundfish assessment for the 2017 Operational Assessments. Note: Atlantic halibut is not included as the assessment for this stock was conducted in a separate process (from NEFSC 2017).

Table 3: Data used in each assessment. The column heads are US commercial landings (US c-lnd), US commercial discards (US c-dis), US recreational landings (US r-lnd), US recreational discards (US r-dis), Canadian catch (CA cat), Northeast Fisheries Science Center spring, fall and winter surveys (NE S, NE F and NE W), Massachusetts spring and fall surveys (MA S and MA F), Maine/New Hampshire spring and fall surveys (ME/NH S and ME/NH F) and Canadian Department of Fisheries and Oceans February survey (DFO S).

| Stock    | Catch    |          |          |          |        | Surveys |      |      |      |      |         |         |       |
|----------|----------|----------|----------|----------|--------|---------|------|------|------|------|---------|---------|-------|
|          | US c-lnd | US c-dis | US r-lnd | US r-dis | CA Cat | NE S    | NE F | NE W | MA S | MA F | ME/NH S | ME/NH F | DFO S |
| CODGM    | Yes      | Yes      | Yes      | Yes      | No     | Yes     | Yes  | No   | Yes  | No   | No      | No      | No    |
| CODGB    | Yes      | Yes      | Yes      | Yes      | Yes    | Yes     | Yes  | No   | No   | No   | No      | No      | No    |
| HADGM    | Yes      | Yes      | Yes      | Yes      | No     | Yes     | Yes  | No   | No   | No   | No      | No      | No    |
| HADGB    | Yes      | Yes      | No       | No       | Yes    | Yes     | Yes  | No   | No   | No   | No      | No      | Yes   |
| YELCOGM  | Yes      | Yes      | No       | No       | No     | Yes     | Yes  | No   | Yes  | Yes  | Yes     | Yes     | No    |
| YELSNEMA | Yes      | Yes      | No       | No       | No     | Yes     | Yes  | Yes  | No   | No   | No      | No      | No    |
| FLWGB    | Yes      | Yes      | No       | No       | Yes    | Yes     | Yes  | No   | No   | No   | No      | No      | Yes   |
| FLWSNEMA | Yes      | Yes      | Yes      | Yes      | No     | Yes     | Yes  | Yes  | Yes  | No   | No      | No      | No    |
| REDUNIT  | Yes      | Yes      | No       | No       | No     | Yes     | Yes  | No   | No   | No   | No      | No      | No    |
| PLAUNIT  | Yes      | Yes      | No       | No       | Yes    | Yes     | Yes  | No   | Yes  | Yes  | No      | No      | No    |
| WITUNIT  | Yes      | Yes      | No       | No       | No     | Yes     | Yes  | No   | No   | No   | No      | No      | No    |
| HKWUNIT  | Yes      | Yes      | No       | No       | Yes    | Yes     | Yes  | No   | No   | No   | No      | No      | No    |
| POLUNIT  | Yes      | Yes      | Yes      | Yes      | No     | Yes     | Yes  | No   | No   | No   | No      | No      | No    |
| CATUNIT  | Yes      | Yes      | Yes      | No       | No     | Yes     | Yes  | No   | Yes  | No   | No      | No      | No    |
| FLDGMGB  | Yes      | Yes      | No       | No       | No     | No      | Yes  | No   | No   | No   | No      | No      | No    |
| FLDSNEMA | Yes      | Yes      | No       | No       | No     | No      | Yes  | No   | No   | No   | No      | No      | No    |
| OPTUNIT  | Yes      | Yes      | No       | No       | No     | Yes     | No   | No   | No   | No   | No      | No      | No    |
| FLDWGM   | Yes      | Yes      | Yes      | Yes      | No     | Yes     | Yes  | No   | Yes  | Yes  | Yes     | Yes     | No    |
| YELGB    | Yes      | Yes      | No       | No       | Yes    | Yes     | Yes  | No   | No   | No   | No      | No      | Yes   |

Table 3 provides a more detailed summary of the data components used in groundfish assessments, including the fishery-dependent and fishery-independent data sources that contribute to each of those components, and a description of the information provided by these data sources.

**Table 3:** A general description of data components used in SAW/SARC assessments, the data sources that contribute to each of those components, and a description of the information provided by those data sources. Age data typically are not available for commercial discards and recreational landings and discards. Therefore, age-length keys are borrowed from other sources for those components. Canadian catch and survey indices are provided by the Canadian DFO.

| <b>Data Component</b>        | <b>Source</b>            | <b>Description</b>       |
|------------------------------|--------------------------|--------------------------|
| <b>Fishery-Dependent</b>     |                          |                          |
| Commercial landings at age   | Dealer reports           | Landings                 |
|                              | VTR                      | Area allocation          |
|                              | Port biological samples  | Lengths and ages         |
| Commercial discards at age   | ASM                      | Discards                 |
|                              | NEFOP                    | Discards                 |
|                              | NEFSC surveys            | Borrowed age-length keys |
|                              | Port biological samples  | Borrowed age-length keys |
| Recreational landings at age | Angler intercept survey  | Landings                 |
|                              | Coastal household survey | Angler effort            |
|                              | NEFSC surveys            | Borrowed age-length keys |
|                              | Port biological samples  | Borrowed age-length keys |
|                              | Angler intercept survey  | Discards                 |

|                              |                          |                            |
|------------------------------|--------------------------|----------------------------|
| Recreational discards at age | Coastal household survey | Angler effort              |
|                              | NEFSC surveys            | Borrowed age-length keys   |
|                              | Port biological samples  | Borrowed age-length keys   |
| Catch weights at age         | Port biological samples  | Lengths and ages           |
|                              | NEFSC surveys            | Length-weight relationship |
| <b>Fishery-Independent</b>   |                          |                            |
| Indices at age               | NEFSC surveys            | Survey catch               |
|                              |                          | Survey effort              |
|                              |                          | Lengths and ages           |
|                              | State surveys            | Survey catch               |
|                              |                          | Survey effort              |
|                              |                          | Lengths and ages           |
| Maturity                     | NEFSC surveys            | Maturity                   |
| Natural mortality            | Varies by stock          | Natural mortality          |

## ***Deliverable 2:***

***Summarize the theoretical utility and limitations of using CPUE/LPUE as an index of abundance for Northeast Multispecies stocks. List recent (GARM III or later) efforts to create a CPUE for any of these stocks and the results of those efforts (i.e. successful/unsuccessful, used in analytic assessment, etc.).***

### **2.1 Theoretical Utility and Limitations of CPUE and LPUE**

Fishery catch per unit effort (CPUE), or landings per unit effort (LPUE), is often considered to be proportional to stock abundance. However, this assumption is only valid in some situations. In a fishery-independent survey, information is collected using a rigid sampling design, with a focus on standardization of collection methods, representativeness of stations, stratification, and known or estimated ‘inclusion probabilities’ (i.e., the chance of each population unit being sampled). The resulting index is assumed to be a function of the sampling design alone, and does not consider variation in capture efficiency or availability. In general, high capture probabilities will result in more precise estimates of abundance since measurement error will be reduced, and this principle is often used to justify the use of commercial fishing vessels for surveys. However, it is equally important to consider the other factors of a scientific survey that allow the sampled population to represent the unsampled population.

One of the most important features of a scientific design is that inclusion probabilities are known. Typically, the probability of a particular station is known and every location within a stratum has an approximately equal probability of being sampled. All surveys have some minor violations of perfect random sampling (e.g., untowable bottom, increasing conflicts with fixed gear), but such violations are assumed to be negligible. In a commercial fishery, the inclusion probabilities are far from equal, because fishing effort is usually where the fish are, and one or more vessels repeatedly fish at the same location. Such samples provide useful information on the local abundance of the resource, but they may not represent areas outside of the fishing grounds. For more information on this topic, Sarndal et al. (1992) provide a general explanation of inclusion probabilities and the role they play in survey sampling. For real world examples, Smith et al. (2009) and Smith et al. (2017) discuss inclusion probabilities as they relate to the sampling of sea scallops. The Marine Recreational Information Program (MRIP) website explains how they use inclusion probabilities, which they refer to as selection probabilities, to generate recreational catch estimates (<https://www.st.nmfs.noaa.gov/recreational-fisheries/Understanding-Estimation/estimation-methods>).

A fishing fleet includes a mixture of vessels with variations in the abilities to capture fish. Therefore, catchability of the fleet varies over time of year, area fished, weather conditions and many other factors (Maunder et al. 2006). These factors increase the variability of fishery CPUE and can make it difficult to extract an index of stock abundance from the variability. This difficulty was recognized as early as the mid 1950's. Beverton and Holt (1957) identified some of the factors influencing CPUE, particularly the importance of spatial fishing patterns. Statistical models are commonly used to derive an index of abundance by standardizing other factors of variability in CPUE (e.g., Maunder and Punt 2004). Similar to fishery-independent survey designs, standardized CPUE indices can be biased or difficult to estimate. Model development can be complicated and models often do not explain much of the variability in CPUE.

Fishery CPUE and fishery-independent survey indices may not be correlated, because of the disparity between the objective of maximizing profits under continually changing resource abundance, regulatory constraints, prices and costs and the objective of conducting a fishery-independent survey with known inclusion probabilities. The entire purpose of standardization methods is to account for the underlying factors in CPUE and isolate an abundance index.

## **2.2 Use of CPUE in Stock Assessments in the Greater Atlantic Region**

Summaries of fishery CPUE as an index of abundance have recently been prepared by Hennen (2018, Appendix 2) and O'Keefe et al. (2015, Appendix 3). Both reports address the overall use of CPUE in regional stock assessments. O'Keefe et al. (2015) provide more details on the rationale for inclusion or exclusion of CPUE as documented in the stock assessment reports and also makes recommendations for future work. Below we provide a summary of CPUE/LPUE usage in some key groundfish stock assessments.

*Cod* (Gulf of Maine) - CPUE was used as an index in the stock assessment model before 2012. After the 2011 Gulf of Maine cod assessment, the Scientific and Statistical Committee (SSC) identified CPUE as one of four topics that warranted further investigation. SSC members did not agree on whether CPUE should be used as an index of abundance to tune the stock assessment, with some supporting the idea and others considering it inappropriate. The cod benchmark assessment included a CPUE working group that was convened in August 2012 in Gloucester, MA. As a result of that meeting, several analyses were prepared, including an LPUE index for the commercial fleet and another for the recreational fleet. A [report](#) from the workshop concluded that neither commercial, nor recreational CPUE was a useful index of abundance, because cod became aggregated in the Gulf of Maine in the late 2000's and catch rates increased while abundance declined.



*Cod* (Georges Bank) - LPUE was not used as an index of abundance in the stock assessment model, but was estimated prior to 1998. The 2012 Working Group (see above) re-examined CPUE as an index and concluded neither commercial, nor recreational LPUE was a useful index of abundance. Management changes beginning in 1994 changed the spatial pattern of the fishery, effectively breaking the time series. In addition, the LPUE index included only US landings while the stock straddles the Hague line. The recreational LPUE index was not considered representative due to small sample size as well as the cross boundary issues concerning fish landed in Canada.

*Witch flounder* - LPUE was included in stock assessments until 1999, but LPUE was excluded from the stock assessment model in 1999 because of uncertainty associated with the 1994 change in effort reporting. In 2015 the NEFSC partnered with GMRI to hold a series of meetings throughout New England designed to improve the stock assessment process and data streams feeding into the assessments. The series culminated with a workshop in November 2015. One of the outcomes of that workshop was the funding (by the NEFMC, NEFSC, and EDF) of a research project to develop a groundfish CPUE index for the 2016 witch flounder benchmark assessment. Alternative series of CPUE were developed for consideration in the SAW62 witch flounder stock assessment. Based on reports of recent avoidance behavior, catch rates of targeted fishing effort were derived from dealer records of LPUE from trips that caught  $\geq 40\%$  witch flounder and observer records of a target fleet in the western Gulf of Maine. The standardized catch rate series have similar trends, but the dealer data had some statistical challenges and the observer data did not have adequate sample size in some years. A series of standardized dealer LPUE for trips with  $\geq 40\%$  witch flounder was the preferred CPUE index (Cadrian and Wright 2016). The dealer-logbook series was included in a sensitivity run for the analytic SCAA model that was ultimately not accepted by the peer review panel.

*White Hake* - LPUE was used in stock assessments before 2012. Multiple LPUE series from gillnets and trawls were examined for the 2012 [benchmark](#). The LPUE series were not expected to perform well due to area closures and other management changes affecting effort. The index showed different trends when only directed trips (as opposed to all trips, or all trips where some threshold proportion of the total landings were white hake) were used to determine effort. Some, but not all, of the variants of the LPUE index correlated well with the survey trends, but there was little interest in using it in the model and it was dropped. Although the LPUE series were not included in the stock assessment model, they were more strongly correlated to the stock estimates than fishery-independent survey indices (O'Keefe et al. 2015) suggesting that they were accurate indicators of relative stock size despite the concerns about closed areas and other management changes.

*Haddock* (Gulf of Maine) - LPUE was not used as an index of abundance in the stock assessment model, but was examined by the 2012 Working Group. LPUE was not considered a reliable index of stock abundance by the Working Group. It was not possible to clearly define effort for this stock since it was difficult to tell which trips were targeting haddock. LPUE trend was not correlated with the other indices of abundance used in the assessment model.

*Haddock* (Georges Bank) - CPUE was included in early stock assessments, but has not been included in stock assessment models since 1998.

*Pollock* - CPUE was examined in [2010](#), but not used in assessment. CPUE was not used in the assessment because of limitations in the calculation of effort due to regulatory changes over time (Days at Sea limits, closed areas, etc...).

*Yellowtail flounder* - CPUE was included in early stock assessments, but has not been included in stock assessment models since 1991. CPUE was examined in [2012](#), but an index of abundance could not be created, due to complications resulting from the changing management regime (closed areas, DAS regulations, etc...) and the shift from a directed fishery to a bycatch fishery which made calculation of effort intractable.

*Redfish* - CPUE was used as an index of abundance until the 2008 [assessment](#). The CPUE index was abandoned in the 2008 assessment because of a sharp reduction in directed redfish trips.

*Halibut* - Halibut is a data-poor stock, and the 2017 assessment was unable to determine stock status. Funding by the NEFMC, NEFSC, and EDF supported a research project to develop a groundfish CPUE index for halibut. Halibut fishermen from Maine were interviewed and surveyed to determine the factors that influence halibut catch rates, and the identified factors were incorporated as predictor variables in the CPUE standardization process. Results suggested stable or increasing catch rates from 2002–2017, and the influence of location, soak time, depth and month on halibut CPUE (Hansell et al. 2018). The CPUE series could serve as an input for future analytical assessment models.

In general, commercial CPUE was included in many stock assessments up to the mid 1990's. Usage increased in the late 1980's particularly following the development of CPUE standardization methods (Gavaris 1980). The standardization method allowed investigators to identify and standardize the effects of area, vessel class, and season on CPUE. The absence of interactive effects with year and selection of cases based on percent of total catch can produce biased results (Appendix 4). Subsequent improvements in statistical methods eliminated many of the problems with earlier methods but do not address issues of excluding observations of low CPUE.

The implementation of mandatory Vessel Trip Reports in 1994 resulted in a sharp break in the use of CPUE in stock assessments. Attempts to reconcile earlier CPUE metrics from Port Agent interviews met with limited success, and the absence of any formal overlap in methodologies precluded estimation of calibration factors. If stock conditions and regulations had remained constant, the new VTR could have constituted a new time series of relative abundance metrics. Unfortunately, increasingly stringent management measures, particularly for groundfish, further compromised the use of commercial CPUE. For example, the closures of large areas on Georges Bank and in Southern New England resulted in the displacement of vessels to other areas. Such management changes created a year-area interaction effect.

Fisheries management measures from the mid-1990s to mid-2000's included trip limits, a series of fine-scale effort controls, and vessel buy-back programs. Fishermen, often in collaboration with science partners, introduced various gear modifications to alter the selectivity of species, particularly in trawls. Interactions with protected species led to modifications of mesh sizes, especially in gillnet fleets. Not all of these changes were adequately captured in the VTRs, especially when conservation-oriented gears were employed. Assuming that the catchability effects of the modified gears observed in experiments were realized in actual fishing conditions, the consequence of not recording the changes would be to increase the variability of CPUE observations.

Perhaps the biggest change occurred when groundfish sectors were introduced, for the majority of the groundfish fleet, in 2010. Annual catch limits were imposed, and fisherman could choose to participate in sectors to trade quotas and adjust effort to meet economic objectives. Based on historical catches of individual vessels, a portfolio of total catch was assigned to each sector. The uneven biological production of various species created huge disparities in relative abundance and subsequent catch limits. As many species co-occur the inability to selectively harvest abundant species without exceeding catch limits on depleted stocks led to the concept of "choke species". These conditions led to further distortions of CPUE as fishermen tried to avoid "choke species". Selecting targeted fishing effort (e.g., by identifying a spatial and seasonal 'footprint' of targeted fishing effort) can be used to derive a CPUE index of abundance by filtering out avoidance behavior.

Collectively, these factors led to the exclusion of CPUE in groundfish stock assessments. Examination of fishery-dependent CPUE and comparison with fishery-independent measures has been informative, especially for Gulf of Maine cod, where concentration of the fishery on a shrinking footprint was evident in both types of surveys. The exclusion of CPUE when multiple changes occur is not exclusively an East Coast phenomenon. On the west coast, CPUE usage in models decreased around 2000 as summarized in Fields et al. (2006): *"In practice however, fishery CPUE data are often considered suspect as an index*

*of stock abundance for a variety of reasons. For example, catch rates may be stable in the face of stock declines as a result of increasing fishing power or changing spatial patterns in effort (Hilborn and Walters 1992; Walters 2003). Furthermore, management measures can substantially alter the integrity of fishery-dependent data, particularly for resources that are considered overfished or depleted and consequently become subject to efforts by managers to reduce or control catches. For example, in response to declines in rockfish abundance, trip limits off the USA West Coast have become increasingly restricted over time (e.g. Fig. 2), culminating in complete non-retention of some species and massive closures of habitat in recent years. As a result, for all but one of the nine assessments in Table 1 that included commercial CPUE indices, the index was truncated by 2000 because of difficulties interpreting catch rates given the impact (perceived or otherwise) of regulatory changes. CPUE indices based on data from recreational fishers have largely continued to be used for several West Coast groundfish assessments where fishery-independent surveys are lacking or particularly imprecise. Standardization of these CPUE data typically involves analysis of the spatial (depth) and temporal (seasonal) restrictions that primarily affected catch rates in these fisheries (Maunder and Punt 2004; Stephens and MacCall 2004) so there is some confidence that the standardized annual index represents the trend in stock abundance.” However, contrary to the summary in this excerpt from Field et al. (2006), CPUE is still used in many U.S. west coast stock assessments (e.g., gopher rockfish, vermilion rockfish, yellowtail rockfish, yelloweye rockfish, Bering Sea pollock, ...).*

### **2.3 Potential Utility of CPUE and LPUE**

Although limitations have been identified, there is potential utility of CPUE in the assessment process, perhaps outside of formal models. CPUE provides greater spatial and temporal resolution than fishery-independent surveys (e.g., year-round versus snapshots) and a large increase in the number of observations feeding into the model. Groundfish assessments have been performing poorly, and some surveys have been delayed or curtailed due to vessel problems. The use of a CPUE series may help to stabilize model trends and outputs, resolve conflicting trends in the models, and could improve model performance during a time when there were major changes to survey operations, and to the groundfish management structure. There is also recognition that use of CPUE in assessments may improve industry buy-in to model results, and greater value added from monitoring. For CPUE to be considered as an index of abundance in stock assessment models, CPUE must be standardized sufficiently to account for changes in vessel efficiency, gear selectivity, targeting/avoidance behavior, inclusion probabilities, spatial aggregation of fish, and hyperstability.

Fishery-dependent CPUE data can have uses in an assessment beyond serving as an index of stock abundance. For example, a CPUE index can provide a perspective of what the fishery sees regarding a particular stock, which can be compared to what a scientific survey index reveals about that stock. Such a comparison could serve as a springboard for exploring factors (e.g., changes in the distribution of fishing and survey effort over time) that might explain perceived differences between the two indices.



### ***Deliverable 3:***

***Without regard to existing fishing practices, regulations, or monitoring systems, identify the fishery factors and fishery-dependent data needed to create CPUE that would be a reliable index of abundance for Northeast Multispecies stocks.***

The Fishery Data for Stock Assessment Working Group identified the following fishery factors and fishery-dependent data that are needed to create a CPUE to be a reliable index of abundance for Northeast Multispecies stocks. The answer to the Council's question was approached by initially identifying ideal conditions for developing CPUE series that can accurately index stock abundance so that these ideals can be considered in the monitoring plan.

#### **3.1 Homogeneous fleet**

For an ideal CPUE for Northeast multispecies stocks, each vessel and each unit of fishing effort would have the same fishing power (i.e., the fishery fleet would be homogeneous across the entire stock area of a particular species or suite of species, and would be homogeneous with respect to vessel size, fishing power, gear used, captain skill level, and seasonality). The fleet would have been operating in the same manner throughout the desired time period for the CPUE. However, some of these factors may be beyond what is needed to create an informative CPUE series. For example, vessel size, area and season effects can be standardized, and the factor of similar captain skill level does not necessitate that this be the same captain fishing throughout the time period, as even captains' experience levels change over time. Past information could be used to develop homogeneous fleets from preexisting data to calculate historical CPUE or to work with current vessel operators to develop homogeneous fleets for CPUE moving forward.

#### **3.2 Target species and avoidance species information**

Critical fishery-dependent data needed for developing a CPUE is accurate target species information, because the targeted trips are used to estimate the effort component (i.e., the denominator) of the CPUE equation. Equally important is accurate avoidance species information, because including trips that avoid the target species in your CPUE analysis might negatively bias the resulting indices. Target species should be single species, unless the fleet is truly targeting multispecies stocks, and is not avoiding certain stocks. Target and avoidance species should be known before fishing begins to avoid specifying targeting based on what was caught after the fact.

### **3.3 Accurate Catch Information**

Accurate, well-reported catch (landings and discards) information is needed for developing a CPUE for groundfish stocks. Catch data that is misreported or poorly reported will not produce a useful CPUE index. Although a census of catch can be informative, it is not required, because CPUE is a relative index. For example, observer data can be used for information on catch and catch rates. It is most useful for discard estimates, as kept/landed catch information is not the primary target of observer data collection (NEFSC FSB 2016). Observer data is the only method currently available for quantifying the magnitude of discards. However, electronic monitoring is currently being evaluated as an alternative or supplement to observer data through Exempted Fishing Permits, and in the future if adopted for wider use by the fleet, could be used for discard estimates as well. In practice, VTRs are useful only for landings and LPUE.

### **3.4 Understanding of Effort**

An understanding of fishing effort is needed to develop a CPUE for groundfish stocks. This includes information on the fishing gear used and fishing power of the vessel. Gear information should be as specific as possible, and should note gear modifications with conservation objectives (e.g. haddock separator trawl, Rhule trawl). It is necessary to know both historical fishing effort and current fishing effort. Like catch data, accurate effort data is essential for creating a useful CPUE index. Vessel efficiency ideally would be stationary across time and space, or changes in vessel efficiency would need to be standardized. An appropriate unit of fishing effort is needed for each type of fishery. For example mobile gear effort can be measured in time (e.g., hours towing) or area swept, but fixed gear requires alternative units of effort (e.g., soak time, number of hooks, length of gillnets, ...).

### **3.5 Fine Scale (tow-by-tow) Effort and Location Information**

To create a CPUE for groundfish stocks, it is ideal to have tow-by-tow information. Catch and effort data can always be aggregated at the trip or higher level, but cannot be disaggregated if data at the tow level is not collected. Tow-level data is particularly important if a vessel targets different species on different tows within the same trip. In this

case, the trip level information will simply be an average of the vessel's effort across the range of target species, and not be useful for creating a CPUE.

### **3.6 Inclusion Probability**

The inclusion probabilities for observations from a fishery (i.e., the probability that fish at a given location will be sampled) should be known to construct a CPUE index. These inclusion probabilities are used to weight the observations so that observations from areas of high fish density, which are repeatedly sampled by the fishery, are not given undue weight in the CPUE calculations compared to areas of lower fish density, which may be sampled rarely or not at all by the fishery. Ignoring the inclusion probabilities (i.e., assuming they are equal across the entire distribution of the stock) could lead to positively biased estimates of CPUE, because the CPUE estimates would be based primarily on repeated observations from high fish density areas, where fishing effort is concentrated. It would be like repeatedly sampling the population of New York City, and assuming those observations could be used to estimate the population density of the entire United States.

#### ***Deliverable 4:***

***Compare the desired factors identified with existing conditions and data for the fishery.***

***This should be a gap analysis of factors and data needed, as well as the analytical approaches necessary, to create a CPUE that would be a reliable index of abundance for Northeast Multispecies stocks.***

#### **4.1 Introduction**

The mismatch between fishermen's perceptions of what fish stocks are available on their fishing grounds and results from recent assessments for several New England groundfish stocks has caused a renewed interest in examining the use and utility of CPUE in assessments. Fishermen generally have a greater trust in the information they collect and a greater understanding of catch and effort statistics than fishery-independent data and model results. Additionally, fishermen may be able to accurately identify trends in catch rates based on historical knowledge of spatial and temporal species distributions, marketability, and business planning. A large amount of fishery-dependent data is currently collected from fishermen participating in the Northeast multispecies fishery (see Table 4), but indices such as LPUE and CPUE have not been used in recent groundfish stock assessments. This results from limitations of the current data streams (data resolution, potential bias) and limitations of the assessment process (limited time, and resources), and challenges posed by current conditions in the groundfish fishery compared to the ideal factors needed for a CPUE (e.g., avoidance behavior). We provide an overview of the existing data, identify gaps, and challenges, and provide recommendations for the enhanced use of fishery-dependent data to inform stock assessments.

**Table 4:** Types of fishery-dependent data collected from required reports for the Northeast Multispecies complex (O’Keefe et al., 2017).

| Data Type                      | Vessel Trip Report (VTR) | Vessel Monitoring System (VMS) | Dealer Report | Observer Reports (NEFOP) | At-Sea Monitoring (ASM) | Dockside Monitoring |
|--------------------------------|--------------------------|--------------------------------|---------------|--------------------------|-------------------------|---------------------|
| Vessel Permit                  | X                        | X                              | X             |                          |                         | X                   |
| Operator Permit                | X                        | X                              |               |                          |                         |                     |
| Area Fished (statistical area) | X                        |                                |               |                          |                         | X                   |
| Area Fished (Lat/Lon)          |                          | X                              |               | X                        | X                       |                     |
| Time Fished                    | X                        | X                              |               | X                        | X                       |                     |
| Landed Species (for sale)      | X                        |                                | X             | X                        | X                       | X                   |
| Landed Species (not sold)      |                          |                                |               | X                        | X                       |                     |
| Discarded Species              | X                        |                                |               | X                        | X                       |                     |
| Species Disposition            |                          |                                |               | X                        | X                       |                     |
| Landing Date                   |                          |                                | X             | X                        | X                       | X                   |
| Landing Port                   |                          |                                | X             | X                        | X                       | X                   |
| Dealer Demographics            |                          |                                | X             |                          |                         |                     |
| Market Category                |                          |                                | X             |                          |                         |                     |
| Landed Species Price           |                          |                                | X             |                          |                         |                     |
| Tow Duration                   |                          | X                              |               | X                        | X                       |                     |
| Steaming Time                  |                          | X                              |               |                          |                         |                     |
| Vessel Characteristics         |                          |                                |               | X                        | X                       |                     |
| Gear Characteristics           |                          |                                |               | X                        | X                       |                     |
| Target Species                 |                          |                                |               | X                        | X                       |                     |
| Biological Information         |                          |                                |               | X                        |                         |                     |

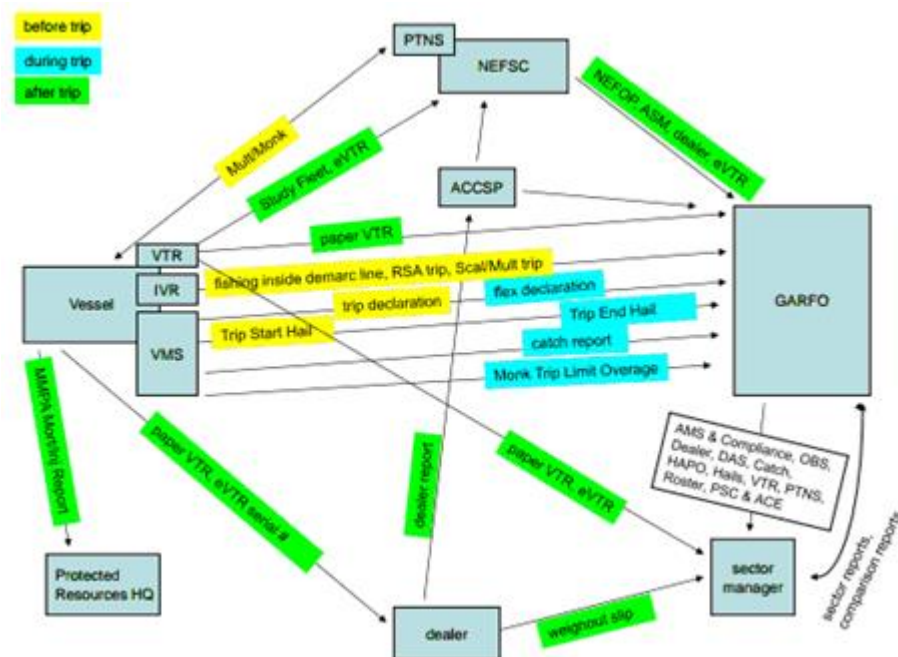
The fishery monitoring system includes the process for deciding the sampling rates (e.g., the portion of trips sampled by observers, the number of port samples), the selection processes for samples, fishery definitions, data collection, data analysis, communication and data access. The current fishery monitoring system was designed to meet many evolving objectives (e.g., enforcement, monitoring, stock assessments, and facilitation of other management requirements). The current fishery-dependent data collection programs were developed based on a sequence of changing needs, so the result is a complex system, with many redundant data streams, that may not be optimal to meet current needs.

## 4.2 Overview of Current Fishery-Dependent Data Collection Systems and Identification of Gaps

Fishery-dependent data involves the standardized collection of information from fishing operations. Landings from commercial fisheries are monitored through a census of dealer records and mandatory vessel trip reports (VTR/eVTR) from fishermen. State landings also contribute to the total observed removals. The biological attributes of landings are monitored by port agents who collect length and age samples. Federal and industry-funded observers collect data on species composition, and the amount, size, and age composition of catch (landings and discards) at sea on commercial fishing vessels. In the recreational fishery, both landings and discards must be estimated from samples. In addition, social and economic data are collected through a variety of surveys that target specific segments of the fishing industry (crew, owners). These socio-economic surveys provide insights into the



costs, wages and wellbeing. In the following sections the various fishery-dependent data collection programs, their strengths, and limitations relative to CPUE, are described in relation to the Northeast multispecies fishery.



**Figure 1:** Fishery-dependent data flow chart for northeast multispecies Sector vessels, developed for the Northeast fishery-dependent Data Visioning Workshop (Figure credit: Daniel Salerno, fishery-dependent Data Mapping Exercise).

#### 4.2.1 Observer Program

The Fisheries Sampling Branch (FSB) at NEFSC collects, maintains, and distributes data from fishing trips that carry at-sea monitors. FSB manages two separate but related monitoring programs: the Northeast Fisheries Observer Program (NEFOP) and the At-Sea Monitoring (ASM) Program. Although each program is tailored to meet specific monitoring objectives, the programs function similarly.

**Table 5:** Comparison of the duties and requirements for ASM Monitors and NEFOP observers.

| <b>Tasks and Requirements</b>  | <b>ASM Monitor</b>                                                    | <b>NEFOP Observer</b>                                                                                                                                    |
|--------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Program Objective              | Groundfish Sector Catch Accounting                                    | SBRM Discard Estimation                                                                                                                                  |
| Bachelor's Degree              | No<br>(high school diploma or equivalency)                            | Yes                                                                                                                                                      |
| NMFS Training Duration         | 11 days                                                               | 15 days                                                                                                                                                  |
| Data Collection                | Basic & Focused                                                       | Advanced & Diverse<br>(more logs/sheets, higher complexity, greater variety)                                                                             |
| Biological Sampling            | Length frequencies of certain key fish only<br>(few physical samples) | High degree and diversity of catch sampling, including collection of biological samples and necropsies of mammals, turtles, birds, fish, and crustaceans |
| Amount of Gear Issued          | 45 items                                                              | 85 items                                                                                                                                                 |
| Supplemental Research Projects | No                                                                    | Yes                                                                                                                                                      |

**Observer Responsibilities**

- Conduct a pre-trip safety inspection;
- Communicate observer duties and data collection needs with vessel crew;
- Collect economic information, such as trip costs (i.e. price of fuel, ice, etc...);
- Collect fishing gear information (i.e. size of nets and dredges, mesh sizes, and gear configurations);

- Collect tow-by-tow information (i.e. depth, water temperature, wave height, and location and time when fishing begins and ends);
- Record all kept and discarded catch (fish, sharks, crustaceans, invertebrates, and debris) on observed hauls (species, weight, and disposition)
- Record kept catch on unobserved hauls (species, weight, and disposition);
- Collect actual catch weights whenever possible, or alternatively, weight estimates derived by sub-sampling;
- Collect whole specimens, photos, and biological samples (i.e. scales, ear bones, and/or spines from fish, invertebrates, and incidental takes); and
- Assemble information on interactions with protected species, such as sea turtles, porpoise, dolphins, whales, and birds.

The observer's goal is to collect actual weights whenever possible, and alternatively, weight estimates using a variety of subsampling methods when collection of actual weights is not possible. The Northeast Fisheries Science Center Fisheries Sampling Branch Observer Operations Manual provides detailed sampling priorities for each fishery. In general, observers' first priority is to collect actual weights on priority discards (for ASM, these are groundfish species, and for NEFOP, these are groundfish, commercially important species, and target species). Next, observers should collect actual weights on non-priority discards, followed by actual weights or estimates of kept catch.

The NEFOP program's resources are finite, and FSB relies on national priorities (endangered or protected species), fishery management priorities determined by the New England and Mid-Atlantic Fishery Management Councils, and scientific priorities related to stock assessments to determine priorities for the NEFOP observer program. These program priorities, and the Standardized Bycatch Reporting Methodology (SBRM) that identifies relative fleet contribution to discards, guide the allocation of NEFOP coverage resources to fishing trips. Federally-funded observer coverage provided by NEFOP to meet SBRM requirements partially satisfies the total monitoring coverage for groundfish sectors. Sectors are required to design, implement, and pay for any portion of trips not covered by NEFOP. The Council has modified the monitoring requirements for Northeast multispecies sectors several times since they were established in Amendment 16 to the Northeast Multispecies Fishery Management Plan, most recently in Framework 55, which became effective on May 1, 2016. The updated regulatory requirements related to the monitoring coverage rate standard are found at 50 CFR 648.87(b)(1)(v)(B) and require that:

1. Sampling coverage must be sufficient to at least meet the precision standard specified in the Standardized Bycatch Reporting methodology, a 30% coefficient of

variation, at the overall stock level for each stock of regulated species and ocean pout and to monitor sector operations, to the extent practicable, in order to reliably estimate overall catch by sector vessels;

2. Sampling coverage shall reflect the primary goal of the program, to verify area fished, as well as catch and discards by species and gear type, in the most cost-effective means practicable, as well as the other goals and objectives;
3. Sampling coverage will be based on the most recent 3-year average of the total required coverage level necessary to reach the required coefficient of variation for each stock;
4. Sampling coverage that will apply is the maximum stock-specific level after filtering out healthy stocks;
5. Healthy stocks are defined as those in a given fishing year that are not overfished, with overfishing not occurring according to the most recent available stock assessment, and that in the previous fishing year have less than 75 percent of the sector sub-ACL harvested and less than 10 percent of catch comprised of discards.

The total monitoring coverage, ultimately, should provide confidence that the overall catch estimate is accurate enough to ensure that sector fishing activities are consistent with National Standard 1 requirements to prevent overfishing while achieving on a continuing basis optimum yield from each fishery. However, the precision target of the Standardized Bycatch Reporting Method does not account for ‘observer bias’ (i.e., observed trips do not represent unobserved trips because of difference in fishing behavior).

**Table 6:** Target and realized coverage rates for groundfish sectors, fishing years 2010-2017.

| Fishing Year | NEFOP target coverage level | ASM target coverage level | Total target coverage level | Realized coverage level |
|--------------|-----------------------------|---------------------------|-----------------------------|-------------------------|
| FY 2010      | 8 %                         | 30 %                      | 38 %                        | 32 %                    |
| FY 2011      | 8 %                         | 30 %                      | 38 %                        | 27 %                    |
| FY 2012      | 8 %                         | 17 %                      | 25 %                        | 22 %                    |
| FY 2013      | 8 %                         | 14 %                      | 22 %                        | 20 %                    |
| FY 2014      | 8 %                         | 18 %                      | 26 %                        | 25.7%                   |
| FY 2015      | 4 %                         | 20 %                      | 24 %                        | 19.8%                   |
| FY 2016      | 4 %                         | 10 %                      | 14 %                        | 11.1%                   |
| FY 2017      | 8 %                         | 8 %                       | 16 %                        | n/a*                    |

***For more information on these programs:***

[https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/Sectors/ASM/FY2018\\_Multispecies\\_Sector\\_ASM\\_Requirements\\_Summary.pdf](https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/Sectors/ASM/FY2018_Multispecies_Sector_ASM_Requirements_Summary.pdf)

#### 4.2.2 Fishing Vessel Trip Reports (Logbooks)

The vessel owner or operator of any vessel issued a valid Federal fishing permit (or one who is eligible to renew a limited access permit) must maintain on board the vessel an accurate fishing log. The owner/operator is also required to submit to NMFS, for each fishing trip, a report regardless of the species taken. If no fishing trip is made during a week or month a report stating that must be submitted to NMFS. With the exception of vessels fishing under a surf clam or ocean quahog permit, at least the following information and any other information required by the Regional Administrator must be provided: Vessel name; USCG documentation number (or state registration number, if undocumented); permit number; date/time sailed; date/time landed; trip type; number of crew; number of anglers (if a charter or party boat); gear fished; quantity and size of gear; mesh/ring size; chart area fished; average depth; latitude/longitude (or loran station and bearings); total hauls per area fished; average tow time duration; hail weight, in pounds (or count of individual fish, if a party or charter vessel), by species, of all species, or parts of species, such as monkfish livers, landed or discarded; dealer permit number; dealer name; date sold, port and state landed; and vessel operator's name, signature, and if applicable the operator's permit number (50 CFR 648.7).

A new VTR is required to be completed each time a vessel changes gear type, mesh size, or statistical area during a fishing trip. All species caught, including all protected species, are required to be reported on the FVTR.

**Table 7:** Data collected in each FVTR (Credit: SBRM Omnibus Amendment)

|                                                                                                                                                                                                                                                            |                                                                                                                                                                                                               |                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><u>Vessel, crew, operator</u></b><br>Vessel name<br>USCG documentation number<br>or State registration number<br>Federal permit number<br>Number of crew<br>Number of anglers (charter/party)<br>Vessel operator's name<br>Signature of vessel operator | <b><u>Gear</u></b><br>Gear type<br>Quantity and size<br>Mesh/ring size<br><br><b><u>Location</u></b><br>Chart area (statistical area)<br>Average depth<br>Latitude/longitude or<br>Loran station and bearings | <b><u>Commercial Catch</u></b><br>Pounds kept (by species)<br>Pounds discarded (by species)<br>Sea turtle incidental take<br>Skates by size category                                                          |
| <b><u>Trip Information</u></b><br>Date/time sailed<br>Date/time landed<br>Commercial or charter/party trip                                                                                                                                                 | <b><u>Effort</u></b><br>Number of hauls<br>Tow/soak time duration                                                                                                                                             | <b><u>Charter/Party Catch</u></b><br>Number kept (by species)<br>Number discarded (by species)<br><br><b><u>Sale/Landing</u></b><br>Dealer permit number<br>Dealer name<br>Date sold<br>Port and state landed |

Limitations of the initial VTR data sets were described by the SARC in 1996 (NMFS 1996). Since then, many of these limitations have been addressed. In particular, subsequent



peer reviews through numerous SARC's and a review by the National Research Council (1998) have identified the strengths, weaknesses, and appropriate uses of the VTR data from the Northeast. VMS data can be used as a tool to monitor the accuracy and completeness of VTRs, and guide efforts to improve VTR compliance, but such evaluations of VTRs are rare. The number of vessels which are potentially underreporting statistical areas on a frequent basis is small relative to the total number of vessels submitting VTRs. Improvements are needed in the compliance of VTR reporting regulations, particularly among those vessels likely to be fishing on multiple fish stocks. Given the manageable size of the problem and availability of tools to monitor these data, the quality of self-reported data should be monitored and improved through targeted outreach and education activities.

#### ***4.2.3 Dealer Reports***

Since May 1, 2004, all federally permitted seafood dealers, or any individual acting as a dealer, have been required to submit weekly electronic purchase reports to NMFS. The reports are required to provide a detailed report of all fish purchased or received for a commercial purpose, other than solely for transport on land (50 CFR 648.7). Specifically dealer purchase reports are required to include the; dealer name; dealer permit number; name and permit number or name and hull number (USCG documentation number or state registration number, whichever is applicable) of vessel(s) from which fish are purchased or received; trip identifier for each trip from which fish are purchased or received from a commercial fishing vessel; date(s) of purchases and receipts; units of measure and amount by species (by market category, if applicable); price per unit by species (by market category, if applicable) or total value by species (by market category, if applicable); port landed; cage tag numbers for surf clams and ocean quahogs, if applicable; disposition of the seafood product; and any other information deemed necessary by the Regional Administrator. If no fish are purchased or received during a reporting week, a report so stating must be submitted. Dealer purchase reports are compiled and submitted to NMFS through one of two approved software packages specifically developed for this purpose or through a file upload process. Although total landings derived from dealer reports are assumed to be a census of fishery landings, recent violations document substantial misreporting. The magnitude of misreporting and resulting bias in estimates of landings are unknown.

Dealer reports are assumed to be the best source for comprehensive estimates of total landings and the resulting revenue generated. They can be used by the dealers for tax preparation purposes and as legal documentation of the purchase and sale of the landed catch.

Starting in 2012, in addition to dealer purchase reports, dealers, or any person acting in the capacity of a dealer, that purchases fish from a vessel enrolled in a sector, or the common pool must provide “a copy of any weigh-out documents or dealer receipts for that particular offloading event to the dockside monitor and vessel and allow the dockside monitor to sign a copy of the official weigh-out document or dealer receipt retained by the dealer, or sign a dockside monitoring report provided by a dockside/roving monitor that verifies the amount of each species offloaded, as instructed by the Regional Administrator”. Dockside monitoring is no longer required.

#### ***4.2.4 Study Fleet Program***

The Cooperative Research Study Fleet program at the Northeast Fisheries Science Center collects self-reported catch (landed and discarded) from commercial vessels with electronic logbooks. The Study Fleet program was initiated in 2002 with the dual objectives of: (1) assembling a study fleet of commercial New England groundfish vessels capable of providing high resolution (temporal and spatial) self-reported data on catch, effort and environmental conditions while conducting normal fishing operations; and (2) developing and implementing electronic reporting hardware and software for the collection, recording, and transferring of more accurate and timely fishery-based data (GMA 2001, Palmer et al. 2007). The program also provides an opportunity for fishermen and scientists to work in partnership on various research projects, fosters a collaborative relationship and gives industry members a stake in the science being conducted by the Northeast Fisheries Science Center.

The Study Fleet program has evolved through three phases. Phase I focused on development of the electronic logbook software and concurrent hardware testing. Phase II began in September 2004 and expanded the size of the fleet while continuing testing, evaluation, and refinement of the software. Phase III began in 2006 and continues to the present, with further improvements and emphasis on data transmission methods including wireless, gathering additional oceanographic data, and data feedback loops for fishermen. The current Study Fleet (Phase III) is a fully functioning program of over forty paid participant vessels electronically reporting tow level fishery-dependent data during normal fishing operations for all trips. The Cooperative Research Branch periodically publishes a solicitation for new study fleet participants and vessel captains self-select to apply. If qualified, they become paid participants. Participation is continuous based on mutual agreement between the Captain and NEFSC. The Captains are required to report catch and discards on every tow. Vessel involvement is capped based on the budget of the program. Digital collection of environmental data and enhanced bio-sampling of target and bycatch

species are also part of the program. Electronic reporting helps reduce data entry, transcription, and recall errors, reduces NMFS staff- hours needed to enter data, and makes catch and discard data available faster than paper reports.

Study Fleet and Northeast Fishery Observer Program (NEFOP) data on the Northeast shelf were compared at the end of phase II (Palmer et al. 2007) and again during phase III in 2014 (Bell et al. 2017) (summarized below). Direct comparison of the two data sources indicated that they were very similar, though not identical. The two programs were created with different goals; however, both have the potential to contribute to assessments and management.

Due to the relatively small size, geographic focus, and design of the Study Fleet program, it has limitations in its ability to represent the dynamics and habits of all fishing fleets on the Northeast US Shelf. Unlike the NEFOP/At-Sea-Monitor programs, Study Fleet was not designed as a statistical sampling program and has a large number of recorded trips from a self-selected group of vessels that may or may not represent the dynamics of the entire fleet. The program itself currently contains about forty vessels that generally fish southern New England and Mid Atlantic compared to the 269 vessels that landed groundfish in 2016 (Murphy et al. 2018). There are thousands of Study Fleet records from individual tows providing excellent information, but the tows are largely with trawl gear and provide reasonable coverage for a select number of species. Due to funding-capped participation, the Study Fleet data do not provide information for the broad suite of stocks and gears needed to account for discards across all taxa and fleets managed on the US Northeast Shelf (Wigley et al. 2006). In addition, the geographic base for many of the current Study Fleet vessels may not be well suited to represent vessels fishing in other areas, such as the Gulf of Maine. In some cases, however, Study Fleet may provide better coverage for fleets such as the small mesh fishery in New England.

Despite the non-random sampling design of Study Fleet, the discard estimates across the entire fishing fleet for some species show general agreement between the two programs (Bell et al. 2017). In select cases, the Study Fleet data had similar discard estimates as NEFOP/ASM, but lower levels of uncertainty. This suggests that in limited circumstances, Study Fleet may potentially act as sub-samples of the larger groundfishing fleets. If this is true, an expanded use of Study Fleet, or study fleet like information could be appropriate after accounting for the limitations, including taking into account the need for area specific estimates, and instituting appropriate audit checks. The majority of the data do show general agreement between the two programs.

To compliment observer information, self-reported data may be of use where the Study Fleet coverage in a particular fleet is quite high and therefore a proportion of the data could be vetted with NEFOP/ASM data. Self-reported catch data could be of use where observer coverage is limited or lacking, or if there are specific questions surrounding geographic locations that are well sampled by Study Fleet vessels (Starr 2010). Self-reporting by industry has often been used in Europe and elsewhere for data limited cases (Starr and Vignaux 1997, Dobby et al. 2008, Hoare et al. 2011, Miona et al. 2015). It may be possible to statistically sample the Study Fleet data and combine it with the NEFOP/ASM data in particular situations. Statistically combining data from the two programs would increase the pool of available information and potentially reduce the estimates of uncertainty. Cross checking data records between the two programs could have value for quality control across both programs, however, the utility may be limited given the small size of the Study Fleet program.

Two of Study Fleet's largest contributions have been in the development of electronic reporting in the Northeast (including the software, data transfer, work flow and regulatory hurdles) as well as the relationship building between the fishing industry and the Science Center. Historically, Study Fleet data has been used for single projects or for researching specific questions. The enhanced bio-sampling portion of the program has consistently provided samples for maturity studies and other work around life history parameters. Study Fleet data has been brought into planning processes for offshore wind and management areas because of the high spatial resolution of the information including temperature and depth sensors on the nets specifying exactly where the tows occurred. Study Fleet information was one of the key data sources used in a recent NEFSC/GARFO study evaluating appropriate initial business rules for the groundfish Electronic Monitoring program. Gear studies have occurred and the habitat suitability work for the Butterfish and Mackerel stock assessments were done with Cooperative Research staff and some Study Fleet vessels. The partnerships developed through the program have also created a framework from which cooperative research can be conducted such as some of the catchability and gear comparison work.

#### ***4.2.5 Port Sampling***

For some species, size distributions can be used to develop a CPUE index for a size category (e.g., to exclude small sizes that have greater uncertainty in species identification). Biological samples have been collected from New England's fishing ports since the 1930's. The stated purpose of the port sampling program is "to estimate length, age and species composition that assist in the characterization of the commercial catch" (Biological Sampling Work Instructions 1.0 and 3.0). Biological samples are collected from federally

permitted fishing vessels that have been fishing for federally managed species within the US Exclusive Economic Zone (EEZ).

On a daily basis, samples are collected based on quarterly listings of desired samples provided by NEFSC. Samples are collected throughout the year; the specific sampling design depends on the anticipated landings. The Biological Sampling Coordinator (BSC) audits and compares the gathered biological data with the list of data requested by NEFSC, from this comparison the BSC produces a “Concerns Document” that is distributed to the field staff. The Concerns Document provides field staff with an overview of the needed samples. It is the responsibility of the field staff (samplers) to identify and target landings that may have the species needed to fulfill the required sampling needs. The sampler may utilize VMS email, hail lines, or other industry contacts / local knowledge to locate desired landings. A basic sample consists of 100 fish measured, and 25 selected on a stratified basis for aging (with the exception of shellfish) and the aggregate weight of the measured fished (BSWI 2.0). The biological data gathered is based on species and market category specific guidelines provided by NEFSC.

The port-sampling program provides crucial data on the composition of landings. Program strengths include the flexible and cost effective nature. However, the program also faces a number of significant challenges. One of the issues is the difficulty locating some needed samples (particular strata, species, and gear types may be under sampled due to the difficult nature in locating and sampling landings from these categories). Increased communication (in real-time) between vessels and samplers may aid in the collection of better data (Cadrin and Keiley, 2014).

An additional challenge faced by a dock-side sampling program stems from the regulatory process. The introduction of ‘no possession’ limits for many species eliminates these stocks from the sampling pool. This may have unintended consequences in the stock assessments and also puts more weight on the need for accurate discard and catch data from observed and unobserved trips.

The utility of port samples may also be compromised if there is misreporting of area-fished. If the stock area is miss-assigned to sampled fish due to misreporting this error results a mischaracterization of landings in the stock assessment. Multiple area trips also provide a number of challenges throughout the data collection and assessment processes. Port samples are not collected from trips that fished in multiple areas because samples cannot be attributed to stocks. The lack of samples from multiple-area trips may introduce bias (by



excluding these types of trips from the data collection process) and could result in some species or market categories being undersampled.

*For more information on this program:*

[https://www.nefsc.noaa.gov/fsb/manuals/2013/NEFSC\\_Biological\\_Sampling\\_Manual.pdf](https://www.nefsc.noaa.gov/fsb/manuals/2013/NEFSC_Biological_Sampling_Manual.pdf)

#### **4.3 Bridging the Gap – Recommendations for Improved Collection and Use of fishery-dependent Data in Stock Assessments**

Improving the potential utility of fishery-dependent data for stock assessments and management may require changes to the data collection programs, data analysis and assessment processes. CPUE series are more likely to be representative of stock trends when the fleet covers the entire stock area and is relatively homogeneous with respect to fishing power, seasonality, captain skill, etc. For example, fishery-dependent longline catch rates are the primary index of abundance for the Canadian Atlantic halibut assessment. Indices developed from inshore-only vessels have properties similar to scientific surveys that cover only part of the resource area. Inter-annual but unknown variations in availability will be confounded with abundance. Because the groundfish fleet is not homogeneous, approaches such as the use of index fleets, or footprints may be necessary. In addition, the available data streams that provide fishery-dependent data are not perfect; while improvement of these data streams should be a priority, equally important is the need to understand the uncertainties, biases and implications of the utility of these data streams.

##### ***4.3.1 Use of Index Fleets to Develop CPUE Indices***

Although CPUE series are more likely to be representative of stock trends when there is a homogeneous fleet of vessels that covers the entire stock area of a particular species throughout the period, this does not preclude the ability to develop a CPUE for groundfish stocks. Instead, a CPUE index could be developed by identifying groups of fishermen that display more consistent behavior (in terms of fishing practices) over a time series in a particular area within a species footprint, or expected area of species distribution. This would involve compiling a group of vessels that have similar gear, vessel size, vessel power and target species. Although such a CPUE index may not be representative of the entire stock, it could provide additional information for fine-scale spatial areas and may provide some information on general trends, or could be used in conjunction with other indices. CPUE indices developed from vessels operating in one area within the stock boundary (for example, inshore area only) have properties similar to scientific surveys that

cover only part of the resource area.

In order to determine an appropriate time period for developing a CPUE, a timeline of changes in fishing gear, vessel characteristics, personnel, and other factors affecting catchability, ideally on a vessel-by-vessel basis, is desired. Such information could be used to identify periods of time where catchability appears to be relatively stable for a fleet or for a subset of a fleet, where it might be feasible to construct a CPUE index. CPUE must be standardized sufficiently to account for any changes in vessel efficiency, gear selectivity, targeting/avoidance behavior, inclusion probabilities, spatial aggregation of fish, and hyperstability.

The multispecies fishery encompasses a diversity of fleets, target species, and fishing practices, which complicates the development of CPUE/LPUE indices. The fishery is also managed under two different regimes, sectors (a quota based catch share system), and the common pool (effort control based on days-at-sea and trip limits). However, the majority of the groundfish fleet are currently enrolled in sectors. To enable the use of CPUE/LPUE indices in this fishery “index fleets” may be needed. An index fleet can be a subset of the fishery that is identified as having similar effort over a period of time (for post processing and analysis), or a fleet could be “designed” moving forward (a study fleet type concept). This would involve standardization of the fleet across vessels characteristics and fishing behavior.

Collaborating with fishermen to identify index fleets and trends in catch rates could enhance efforts to develop standardized CPUE indices. The Sector management system, which has been in place in New England since 2010, includes mechanisms to collect data on target species, influences of management intervention on catch and effort, operating costs, and species marketability. Efforts should be made to work collaboratively with members of the Sector system to extract fishery-dependent information that can be used to identify index fleets, such as information on target species (and avoidance behavior), spatial and temporal patterns in fishing, and changes in catch and effort as a result of management intervention and economic considerations. The Sector system could be utilized to collect this information from fishermen, for example, through regular meetings with Sector members to collect such information to identify index fleets, or perhaps through surveys distributed to Sector members designed to collect information on fishing operations.

The “Review of Northeast Fishery Stock Assessments” report suggested establishment and use of a subset of fishing vessels to provide more detailed logbook data than are recorded

in the mandatory VTRs. The Northeast Fisheries Science Center developed the Study Fleet in 2002 with the objective of assembling a subset of commercial New England vessels capable of providing high resolution (spatial and temporal) self-reported data on catch, effort and environmental conditions while conducting “normal” fishing operations. The program was intended to provide stock assessment scientists with more precise and accurate fishery-dependent data (e.g., more precise estimates of fishing effort, spatially explicit catch, and discard locations) and to improve the understanding of catch rates and species assemblages (NEFSC, 2007). Additionally, it was noted that the collaborative nature of the Study Fleet pilot program could create a channel through which stock assessment scientists and industry members could directly communicate and share information that would serve as the basis for future collaborative research projects (Murawski 2002).

The domain of influence of study fleet data should be investigated further. These data have fine-scale information that might ultimately be important for an overall estimate of fishery-dependent abundance measure. These data might also be useful for determining the effective sample size of such information. For example, repeated towing at the same site will confirm local abundance and if indicative of high catch rates, will enhance the profitability of the trip. However, they are not independent measures of abundance and should be downweighted when combined with data from other trips. Similar considerations apply when evaluating multiple vessels from the same port fishing in the same area at the same time.

CPUE indices from Study Fleet have been submitted as working papers to stock assessments, but this is not a consistent data stream such as the federal and state trawl surveys and the landings data. A consistent workflow including a quality control process similar to NEFOP and a standard method to calculate CPUE or process additional data could result in greater use of Study Fleet catch data. Because of the large amount of tow level data and direct interaction with the vessels themselves, knowledge of what is being targeted at the haul level could be incorporated to potentially produce catch rate estimates for specific species in specific areas. Study Fleet could also provide a useful means to tackle many of the research recommendations that are produced during each stock assessment.

Currently, the Study Fleet program has greater representation in Southern New England and the Mid Atlantic. This likely has more to do with existing conditions and opportunity than a strategic plan. The Program may benefit from a steering committee to identify additional areas where the fisheries information could benefit assessments and

management, potentially aid in shaping its focus, and identify future challenges where additional data by fleet, species, or sector could inform management decisions.

#### ***4.3.2 Identification of Historical, Stock Specific, Fishery “Footprints”***

An important factor to account for when creating a CPUE is that fishing vessels concentrate their efforts where the fish are found, and so observations from fishing vessels tend to be clustered in particular areas. These observations cannot be extended beyond the fishing area since areas outside of the fishing zone are not sampled and have unknown inclusion probabilities. Observations need to have a known or approximate probability of inclusion to allow for appropriate weighting. This can be addressed by developing a set of stock specific inclusion probabilities across the shelf that could be used as weighting factors for fishery-dependent data. A comprehensive summary of expected seasonal footprints for abundance, drawn from expert judgment would be valuable, in terms of informing this probability in a design-based approach. Due to the collective potential to extract relatively reliable tow-level granularity from VMS, NEFOP and ASM data, these datasets should be examined as a way of evaluating the current stock-specific footprints of the fishery with respect to historical footprints in an approach that would weight observations post-hoc.

One question is whether it is possible to determine the inclusion probability of observations from fishing vessels given the use of closed areas as a part of the management regime, as these closed areas have changed the availability of access to fish throughout the fishery time period. It should be noted that equal probability cannot be achieved, even with surveys, and so care should be taken to ensure that fishery-dependent data like a CPUE is not held to a higher standard than fishery-independent data.

Development of a footprint would require the incorporation of historical knowledge of the stock and fishery distribution. Development of a footprint based only on status quo conditions would likely lead to a biased outcome. Simulation studies could be used to explore the sensitivity to these conditions.

#### ***4.3.3 Defining Effort***

Discussions on the utility of fishery-dependent data and the use of CPUE and LPUE indices often focus on the estimates of catch (or landings). However, the appropriate definition of effort is critical to the development of these indices and use of fishery-dependent data. For some gears, it is easy to define a unit of effort for the purpose of

calculating CPUE. For example, a single haul would represent a unit of effort for trawl gear. For other gears, it is not so easy to define a unit of effort. For example, with hook and line gear, the jig drift could be hours long, and for gillnets all placed in the same area, it can be difficult to determine whether these are all one unit of effort or multiple units of efforts. The relationship between catch and effort would need to be explored when determining the appropriate unit of effort.

Several Stock Assessment Workshops have noted the lack of fine scale information as a challenge to incorporating fishery-dependent data, specifically CPUE in assessment models. Additionally, changes in technology, efficiency and behavior have been cited as reasons why CPUE information is not informative as an index of stock abundance. Collection of more detailed information about target species, fishing location, and vessel, operator and gear characteristics could enhance our understanding of fishing behavior under changing management scenarios, and provide the necessary level of detail to construct CPUE indices. These enhancements could be obtained through modification to the data collection systems. In addition to refining the data collected, collaboration between fishing captains, gear manufacturers, and scientists on the gear definitions, fishing practices, and factors that impact effort is recommended. A workshop focused on developing agreed upon definitions of effort units for different gear types with Center scientists, and members of the fishing industry is a recommended first step in refining how we collect, interpret and utilize effort information.

There are challenges with collecting the information on effort needed to construct a CPUE. Accurate characterization of target species may prove difficult to obtain. Target and avoidance species should be known before fishing begins, which in theory is straightforward information to obtain, but in practice is less defined, as fishermen typically make decisions about where to fish for a particular species, however, once in that location, they are somewhat bound by the species available to them in that area. The post hoc determination of “target” species is likely to induce biases of unknown magnitude that vary over time. Appendix 4 provides some details on how this bias arises when post hoc criterion are applied to define target species. Steps could be taken to improve the collection of target species information in the Observer program, perhaps through outreach with fishermen to explain the importance of this data piece in understanding fishing effort and considering the development of CPUE. Additionally, while stationary vessel efficiency across time and space is desired for CPUE, information on effort for developing a CPUE could be obtained by accounting for changes in vessel efficiency across time (in particular) and space and providing model-based estimates of these changes. These vessel efficiency changes may include changes in gear, such as doors, mesh, sweeps, etc., and changes in



technology such as sensors, fishfinders, etc. Workshops with members of the fishing industry, or fishermen's surveys, where fishermen could share information on such vessel efficiency changes would be useful for obtaining information needed to account for changes that impact fishing effort when considering a CPUE.

#### ***4.3.4 Collecting the Data: Leveraging the At-Sea Monitoring and Northeast Observer Programs***

Observer estimates of catch rates fulfill many of the desirable features of a CPUE time series. First, it is the only method currently approved for quantifying the magnitude of discards. In practice, VTR are useful only for landings because discards cannot be validated from VTRs. Second, random selection and independent observation are advantages, however, the “observer effect” may compromise the utility of such data. Bias is important with respect to magnitude and trend. If the magnitude of the observer effect is a few percent, it will be small relative to natural variations. Small, consistent biases may be acceptable.

Recent analyses (Demarest 2018; Appendix 5) demonstrates that fishing vessels in the Northeast groundfish fishery alter their behavior in response to observers. Generally, the most pronounced effects are seen across trip duration, kept catch, kept groundfish and trip revenue. Observer presence has the smallest effect on the number of groundfish market categories and non-groundfish average prices, but even here differences are observed. Incentives to alter fishing behavior have varied across time. Prior to sector implementation, discards had no direct cost to fishermen and trip limits required discarding certain species. These factors may have reduced the incentive to alter fishing practices in response to an observer, noting that gillnet vessels did demonstrate a significant behavioral response prior to sectors. After full sector implementation, the accountability of discards and the application of sector/gear specific discard rates to unobserved trips, together with the potential catch of constraining stocks, increased the incentive to change behavior in response to an observer. The data show a trend for three key metrics—in almost all circumstances vessels appear to retain fewer fish, fish for less time and obtain lower revenues when an observer is on board. Persistent differences such as higher average groundfish prices with an observer on board (trawl vessels) and emerging differences like a greater number of market categories retained with an observer (gillnet vessels) indicate that the composition of catch on observed trips is different. This suggests that data collected by observers are not merely a compressed representation of unobserved fishing practices but,

rather, they may be non-representative along critical dimensions such as proportions and quantities of fish discarded and retained.

A well-designed observer program would have representative coverage. Although greater observer coverage is expensive, it has potential to provide better data of the spatial scale that is desired by management. In addition, higher coverage may reduce the bias currently observed, increasing the utility of the data for constructing CPUE indices. Increased observer coverage would improve data quality, and accurate catch data are a necessary component to creating a CPUE for groundfish stocks. Complete observer coverage would provide a whole fleet index and avoid the issue of observer bias. Although increased observer coverage would reduce, or eliminate some of the current problems, it is not a complete fix.

#### ***4.3.5 Collecting the Data: Use of Technology to Improve Data Quality***

Self-reporting tools are valuable in that they generally have lower initial costs, are not overly complex or difficult to integrate into fishing operations, and are generally more acceptable to industry as they give the fishing vessel and crew increased responsibility for reported data. Integration of self-reporting tools with independent monitoring tools allows for cross-checking and audit of self-reported data and also increases incentives within the industry to provide accurate self-reported data. The limitations of self-reported catch data are well known (e.g., Walsh et al. 2002, NMFS 2004). Electronic reporting and electronic monitoring represent additional ways to collect and record catch and discard data for compliance and monitoring.

Electronic reporting (e.g. electronic logbook, eVTR, FLDRS) generally refers to the recording and transferring of data electronically instead of with a paper-based system. In general, electronic reporting has the potential to reduce transcription errors and time needed to enter data from paper-based system by auto-populating fields and using simple quality control measures, while at the same time improving the timeliness by which the data is available for use. Depending on the configurations, an electronic reporting system can integrate with GPS or VMS data already being collected.

There are a number of electronic reporting software packages in use on fishing boats in New England, some developed by NMFS and some by private providers. GARFO's current policy establishes the technical standards for reporting, therefore enabling public and private entities to develop effective software tools that deliver required data and meet the needs of the fishing industry.

Electronic monitoring uses on-board systems that can include cameras, gear sensors, data storage, and GPS units that capture video or photo recordings of fishing activity with associated sensor and positional information. Electronic logbooks can also be integrated to record catch and discard information. Electronic monitoring system configurations vary, but typically consist of cameras focused on specific areas of the vessel where gear is deployed/recovered, fish are sorted and processed as well as along the rails where discarding occurs. Electronic monitoring can be implemented at a variety of scales, from basic requirements such as tracking slippage events (catch discarded before being brought on board) and takes of protected species to documenting discards to full species-specific accounting of catch and discards. Electronic monitoring is often considered an alternative to human at-sea monitors, but it can also be used to complement human monitors. There are a number of electronic monitoring projects currently underway in the Greater Atlantic region as well as many projects throughout the United States (<https://www.fisheries.noaa.gov/national/fisheries-observers/electronic-monitoring>) and the world.

Depending on the desired goals, electronic monitoring is a means for collecting fisheries dependent data that can be less biased, more transparent and verifiable. Video collected at sea is reviewed on shore by trained reviewers to collect required information, produce reports, and verify compliance. Video review protocols can vary; in some programs 100% of the video is reviewed, while in other programs a portion of the video is reviewed. Video data can be stored and re-reviewed in the future if necessary.

In general, two different models have been used to implement electronic monitoring programs: partial coverage and full coverage (including audit approaches). In the partial coverage model, vessels equipped with electronic monitoring systems are required to run the system only on trips for which they are selected. This mimics partial observer coverage, but does not eliminate the opportunity for bias as vessels know when the system is in use.

In the full coverage model, the video is recording during 100% of a fishing trip. For review purposes, the audit option requires only a portion of the video to be reviewed randomly to validate the vessel's eVTR. Each discarded fish is handled to enable species ID and a length measurement. If the comparison of VTR-reported discarded weights and video review estimates is within predetermined ranges, the VTR is used for catch accounting. When the comparison with the eVTR is outside acceptable ranges, the EM report or a fixed/assumed discard rate can be used for catch accounting. Vessels with repeated trips outside accepted ranges will be evaluated for continued participation in the program. This

model is typically suited for vessels with lower discard volumes. A different full coverage option exists for vessels that are required to use maximized retention for catch handling. In this option, there are minimal discards at sea, and most catch is accounted for by human dockside monitors. The video is reviewed to confirm compliance with applicable discard rules. Video review costs for Maximized Retention are typically lower than in the audit option, but dockside monitoring is required. The audit option is typically easier for vessels with higher discard volumes since there are fewer changes to typical catch handling procedures. Under the audit and Maximized Retention models, the cameras are always recording so the potential for any bias is basically eliminated and without a human observer on board, questions about safety at sea or other concerns around human observers are removed. Reducing the number of human observers, however, could reduce biological sampling unless augmented by port side sampling.

Several studies have shown that electronic monitoring can produce data of similar or greater quality to human observer data. There generally is a learning curve as captains modify catch handling techniques to meet review requirements and minimize processing time.

While electronic monitoring can monitor and verify vessel compliance, like any system there are still challenges in implementation. Video quality can be reduced under certain conditions (e.g. fogged over lenses, vessel turned into the sun). The cost of electronic monitoring can be variable based on the program's goals, objectives, and requirements. Technical specifications and performance standards are critical to establish early in program design because they can affect both costs and program effectiveness in meeting regulatory requirements. Video review and data storage costs currently make up a significant portion of overall program costs, through technology advancements and systems design will likely dramatically reduce both the cost and time of review in coming years. As electronic monitoring continues to expand, it has the potential to produce high quality, unbiased fisheries dependent data that could be used to improve fisheries management measures.

#### ***4.3.6 Best Practices for Soliciting and Using Fishermen's Knowledge***

Analyses that miss important attributes of fishing behavior will be misleading. Similarly, perceptions of abundance that are unsubstantiated by data or apply to a limited spatial domain will be equally misleading. For some species, there is a large gap between fishermen's perceptions and stock assessment results. To bridge this gap there may be some value in a formal liaison/training program that goes beyond the necessarily cursory training that occurs in Marine Resource Education Program (MREP)-like programs.

One possible approach is the expansion of the MREP program to include a longer-term pairwise training/collaboration of experienced fishermen with analysts. The fishermen would gain a greater appreciation of the limitations of existing data and the analyst could test novel hypotheses with existing data. Both parties would need to be held in high regard by their respective disciplines. Such a collaboration will not be useful if its benefits accrue only to the two parties. So it would be equally important that the results of such collaborations are widely disseminated, probably via the Council process. This would require some sort of grant to support industry participation and a memorandum of understanding with NMFS.

The utility of fishery-dependent data is not limited to the development of CPUE indices. Fishermen's observations of stock trends, such as spatial distribution, abundance, size and age structure could be of great utility to stock assessment scientists and managers alike if these data were collected in a rigorous, scientific format. These data could be used to inform trends, validate (or call into question) survey or assessment results, and inform potential research and data needs.

ICES disseminates a survey that solicits information from fishermen on fish stocks and fishery trends that is formally included in the assessment and management process (see Appendix 6). A survey of North Sea fishermen in five countries - Belgium, Denmark, England, the Netherlands, and Scotland - has been carried out annually since 2003 (following a pilot in 2002) with the aim of making their knowledge of the state of fish stocks available to fisheries scientists and fisheries managers. Results of the survey are provided to the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). The questionnaire-based survey collects information on vessel size and fishing gear type, on the status of key fish species, and on the fishermen's economic circumstances (further information on the survey is provided in Appendix 6) across 10 areas of the North Sea. These areas are based on the standard roundfish sampling areas defined by ICES. The purpose of this questionnaire is to ensure that fishermen's knowledge of the state of fish stocks is considered during the development of TACs. Questionnaires are translated and circulated to North Sea fishermen by national coordinators representing coordinating organizations in the five participating countries. These coordinating organizations consist of industry associations.

This model could be adapted to US fisheries. In the groundfish fishery, we have the advantage of having a network of sectors, and reporting mechanisms that could be adapted to include this type of survey or data collection.



An alternative strategy would be to modify the current format of the pre-assessment meetings. The industry outreach meetings are generally perceived as lip service, and have limited utility with regard to the development or refinement of the stock assessment. The timing of these meetings is one aspect that should be modified. Industry input should be solicited before the assessment is run, to enable the assessment scientist enough time to digest and utilize the information/feedback provided. Surveys could also be used to collect information prior to assessments to get broader input, followed up by a working meeting to discuss trends and implications, and provide an opportunity for a discussion between the groups.

Regardless of the specific platform for dissemination, a survey must be well designed to enable interpretation and use of the information.

#### ***4.3.7 Use of Simulation Studies to Examine the Utility of CPUE***

Observations that are based on a scientific survey have well known asymptotic properties and are in part, justified by the expectation that these studies will yield meaningful results. However, much depends on satisfying the underlying assumptions about measurement, selection of sampling units, appropriateness of stratification, etc. And of course, any given design can occasionally yield results that are very far from the true value.

Correspondence between a CPUE measure and the derived abundance in an assessment is somewhat circular. Correspondence in such situations is valuable only if the assessment itself is correct. Almost any model will work well when the fishing mortality is high. All models have problems when fishing mortality is low because the ratio of observed to unobserved mortality decreases and reliance on the assumptions that generate the unobserved mortality increases.

Coherence between the CPUE measure and fishery-independent indices can beg the question of the value of redundant indices in a model fitting context. Of course in the real world, affirmation of trends from independent sources is valuable for acceptance of results. However, the possibility that the CPUE measure is more representative of the true state of nature cannot be excluded when the basis of comparison is based only on the coherence with model results.

Simulation studies conditioned on the known (or perceived) properties of the multispecies groundfish fishery would be instructive. Simulations would also clarify the importance of several prevailing practices:

1. Selection of trips based on target species;
2. Selection of trips based on percent composition of the target species. Such measures will be biased, but the bias may not be important in all cases; and,
3. Interpretation of signals derived from CPUE estimates where abundance in unobserved areas must be imputed. (eg. What would catch rates in closed areas have been?)
4. Examine the impacts of regulations and/or misreporting on an index of CPUE
5. Test the development and biases of different CPUE analytical methods

It is understood that the output from such analyses would only be as good as the operating model.

#### ***4.3.8 Improving the Stock Assessment Process***

The utilization of CPUE indices within the assessment framework, has been limited by time, and resources to assess the uncertainties, limitations, and potential biases associated with the various data streams. The utility of fishery-dependent data for informing stock assessments will likely vary between stocks, and fisheries, but is a valuable source of information that should not be overlooked.

Based on our review of the use and utility of CPUE/LPUE information in stock assessments of New England groundfish prior to 1994, as well as in assessments of stocks in the Mid-Atlantic region, Southeast region, and ICES and ICCAT assessed stocks, we propose recommendations to reconsider CPUE data in future assessments of the groundfish stocks. These recommendations build upon previous suggestions with an objective of integrating existing information and supplementing current data collection systems.

Despite some limitations, a significant amount of fishery-dependent data are currently available for analysis. These data could be examined by assessment, academic or non-government scientists outside of the stock assessment process to determine the utility of including CPUE and LPUE information. Lack of time and resources during stock assessment workshops have been cited as reasons why extensive analyses of CPUE information have not been conducted (O’Keefe 2017). Efforts to standardize fishery-independent survey data have been conducted outside of assessments, resulting in availability of reviewed information for use in assessment models. Similar efforts could be

applied to fishery-dependent data prior to benchmark assessment for New England groundfish stocks. Additionally, the SAW55 review recommended that NEFSC should allocate more resources into developing new methods that have potential to substantially improve assessment precision and accuracy. This could include further exploration into CPUE.

Meaningful utility of CPUE / LPUE indices can be external to analytical assessment models. Recognizing the standard for inclusion as an input to an analytical model is high, it should not preclude its use external to the model as a comparative signal to the model outputs. Coherence, or a lack thereof, between fishery-dependent signals of relative abundance and independent indices used in the model should be seen as optimum.

The terms of reference for benchmark stock assessments set the scope of topics, analyses and issues to be covered by the assessment Working Group. Formal inclusion of evaluation of standardized CPUE and LPUE as an explicit component of the generic term of reference on fishery data could help to ensure that the topic is addressed (i.e., “investigate the utility of commercial or recreational LPUE as a measure of relative abundance”). There is opportunity for public comment and input, there is an explanation of the rationale for inclusion or exclusion of the data, all possible uses of the information have been considered, and the use and utility of CPUE and LPUE can be reviewed externally by assessment review committees. This recommendation complements the previous recommendation to examine fishery-dependent data utility outside of the assessment process. Compiling the appropriate data and determining suitable methods for standardizing CPUE should be completed prior to the assessment, so that results can be used to address a specific term of reference for evaluation of the utility of the information for assessment purposes. Identifying best practices for developing a standardized CPUE index using northeast fishery monitoring data would also be an appropriate topic for a research track assessment for all groundfish stocks.

When considering CPUE as an index of abundance for a particular groundfish stock, it is recommended that the assessment scientist follow SEDAR/Southeast best practices for using CPUE as indices of abundance by filling out a similar worksheet used to evaluate use of fishery-dependent and fishery-independent indices of abundance in assessments (Appendix 1). SEDAR assessments routinely use fishery-dependent indices of abundance, and the evaluation worksheet serves to provide those constructing the indices with a checklist of the information that should be provided to the SEDAR Data Workshop for proper evaluation, and provide the Data Workshop’s Indices of Abundance Working Group with guidance on what points to consider when evaluating an index of abundance. Such a

practice would be useful for evaluating CPUE as an index of abundance for groundfish stocks.

#### ***4.3.9 Considerations and Best Practices when Using CPUE***

Consider using shorter time series for inference rather than trying to build a model for the entire history. For example, calibrating fishing practices before and after introduction of sectors may not be possible. The “super model” that explains every intervention over the last 50 years may be impossible. Focus on shorter time intervals where the cumulative effects of interventions and fluctuations in abundance are smaller.

Some important considerations for developing a standardized CPUE index:

1. Changes over time that have implications for estimating catchability
  - a. Changes in reporting methodology: Port agents to mandatory VTR
  - b. Changes in gear efficiency
  - c. Improvements in vessel technology, especially GPS and other electronics
  - d. Changes in regulatory or economic incentives, e.g., Sectors management of groundfish
  - e. Changes in area access, e.g., Georges Bank fishery closures, scallop harvest areas, Gear Restriction Areas (GRA) in Mid Atlantic.
  - f. Changes in other regulations (especially trip limits, individual quotas)
2. Statistical issues
  - a. Model complexity
  - b. Interactive factors
  - c. Extracting an annual effect can be difficult, especially when interactive effects are present
3. Unequal probability sampling—basic idea is to downweight observations from sites with high probabilities of inclusion.
  - a. Basic stratified survey
  - b. Cluster sampling considerations
  - c. Horvitz-Thompson, Hansen-Hurwitz estimators
4. Other approaches
  - a. Observer program estimates of CPUE
  - b. VTR + VMS
  - c. Observer Data + SASI
  - d. Homogenous fleet

Specific recommendations:

1. Use Observer program data to generate CPUE (i.e., landings plus discards per trip or other unit of effort)
  - a. Advantages
    - i. Vessel selection is randomized
    - ii. Observations are standardized and documented
    - iii. Observations are available on a tow by tow basis
    - iv. Fishing areas are known
    - v. Multiple years of data are available
    - vi. SBRM methods can be used to estimate average CPUE
  - b. Disadvantages
    - i. “Observer effect” may alter area fished, trip duration, targeting.
    - ii. Avoidance of random vessel selection
    - iii. Shifting selection criteria prior to SBRM, e.g., protected, monitoring of US-Canada trips, etc.
2. Use synoptic methods such as VMS, Swept-Area-Sensitivity-Impact model, expert knowledge to estimate inclusion probabilities
  - a. Advantages
    - i. Fishing areas by species have been estimated
    - ii. Inclusion probabilities should be functions of habitat and as such should be considered relatively stable quantities.
    - iii. Multiple years of survey data could also be used to estimate potential fishing areas
  - b. Disadvantages
    - i. Resolution of information may be too coarse, e.g., Stat Area only on VTR, single point for entire trip, absence of multiple trip information, gear codes may not be sufficient for specialized gear.
3. Use estimated inclusion probabilities to appropriately weight samples from
  - a. VTR
  - b. Study Fleet
  - c. Observed trips
  - d. Survey data
4. Test proposed methods using simulated data.
  - a. There appear to be relatively few tests in the literature with realistic conditions

- b. Proposed methods should be able to handle time x area interactions
- c. Develop imputation or extrapolation methods for cases where primary fishing areas change over time (See Walters 2003).



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# Appendices

## ***Appendix 1: Use of fishery-dependent indices of abundance in SEDAR assessments***

Fishery-dependent indices of abundance are used regularly in Southeast Data, Assessment, and Review (SEDAR) stock assessments, due to a lack of long term, high quality fishery-independent survey data. These fishery-dependent indices are constructed by Southeast Fisheries Science Center (SEFSC) staff using gear or fleet-specific catch per unit effort (CPUE) data (e.g., commercial longline, recreational charter boat).

Trips targeting the species of interest are identified using a data subsetting techniques developed by Stephens and MacCall (2004). The Stephens and MacCall method is an objective approach in which a logistic regression is used to estimate the probability that the target species could have been encountered given the presence or absence of other species reported from the trip.

Various standardization methods are used to construct the fishery-dependent indices of abundance. The most commonly used approach in SEDAR assessments is the delta lognormal model approach (Lo et al. 1992). This method combines two separate general linear model (GLM) analyses. The first GLM analysis models the proportion of positive trips, assuming a binomial error distribution. The second GLM analysis models the catch rates on successful trips, assuming a lognormal error distribution. A set of factors is identified as possible influences on the proportion of trips that landed the target species and on the catch rate of that species. For example, a commercial longline index for Gulf of Mexico tilefish (*Lopholatilus chamaeleonticeps*) considered as factors: year, season, subregion, longline length, number of days at sea, size of crew, distance between hooks, and number of hooks fished (McCarthy 2010). All 2-way interactions among significant main effects are examined. A forward stepwise regression procedure is used to determine the set of fixed factors and interaction terms that explain a significant portion of the observed variability.

In 2010, a worksheet was developed by SEFSC staff to help evaluate indices of abundance for inclusion in SEDAR stock assessments. The worksheet served two functions. First, it provided those constructing the indices with a checklist of the information that should be provided to the SEDAR Data Workshop for proper evaluation. Second, it provided the Data Workshop's Indices of Abundance Working Group with guidance on what points to consider when evaluating an index of abundance. This worksheet was used first in the assessments of Gulf of Mexico tilefish (SEDAR 2011a) and yellowedge grouper (*Epinephelus flavolimbatus*; SEDAR 2011b). The worksheet has been used in most SEDAR benchmark assessments since then.

The worksheet is used to evaluate fishery-dependent and fishery-independent indices of abundance constructed using a variety of statistical methods. Therefore, not every section of the worksheet is applicable to each index evaluated. The worksheet includes sections describing data

sources, methods, model diagnostics, model results, and a special section for when multiple model structures are considered. Each section includes multiple evaluation criteria, with space to score information availability and make general comments on each criterion. The Working Group's recommendation for accepting or rejecting the index is reported, along with the justification for that recommendation. The justification can include instructions for revising the index, to have it reconsidered by the Working Group.

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Evaluation of Abundance Indices of [Species Name]:  
[Index Name]

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

- A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.
- B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)
- C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)
- D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).
- E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).
- F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.

| Not Applicable | Absent | Incomplete | Complete |
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2. Fishery Dependent Indices

- A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).
- B. Describe any changes to reporting requirements, variables reported, etc.
- C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).
- D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.

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METHODS

1. Data Reduction and Exclusions

- A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.
- B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).
- C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?

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Working Group  
Comments:

## 2. Management Regulations (for FD Indices)

- A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).
- B. Describe the effects (if any) of management regulations on CPUE
- C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.

| Not<br>Applicable | Absent | Incomplete | Complete |
|-------------------|--------|------------|----------|
|                   |        |            |          |
|                   |        |            |          |
|                   |        |            |          |

## 3. Describe Analysis Dataset (after exclusions and other treatments)

- A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.
- B. Include tables and/or figures of number of positive observations by factors and interaction terms.
- C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.
- D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.
- E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates **OR** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).
- F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.
- G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).

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## 4. Model Standardization

- A. Describe model structure (e.g. delta-lognormal)
- B. Describe construction of GLM components (e.g. forward selection from null etc.)
- C. Describe inclusion criteria for factors and interactions terms.
- D. Were YEAR\*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?
- E. Provide a table summarizing the construction of the GLM components.
- F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)
- G. Report convergence statistics.

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## Working Group Comments:

## MODEL DIAGNOSTICS

*Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.*

### 1. Binomial Component

- A. Include plots of the chi-square residuals by factor.
- B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year\*area)
- C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).

| Not Applicable | Absent | Incomplete | Complete |
|----------------|--------|------------|----------|
|                |        |            |          |
|                |        |            |          |
|                |        |            |          |

### 2. Lognormal/Gamma Component

- A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.
- B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).
- C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.
- D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.
- E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.
- F. Include plots of the residuals by factor

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### 3. Poisson Component

- A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).
- B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).
- C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.
- D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.
- E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.

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### 4. Zero-inflated model

- A. Include ROC curve to quantify goodness of fit.
- B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).
- C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.

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**Working Group Comments:**

*The feasibility of this diagnostic is still under review.*

## MODEL DIAGNOSTICS (CONT.)

| Not Applicable | Absent | Incomplete | Complete |
|----------------|--------|------------|----------|
|                |        |            |          |

**Working Group Comments:**

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.

E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.

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MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report

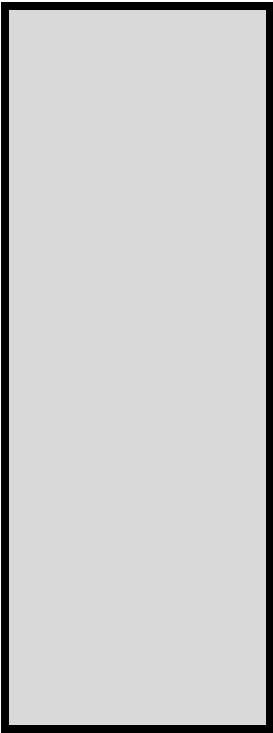
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).

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IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:  
*(Note: this is always recommended but required when model diagnostics are poor.)*

- 1. Plot of resulting indices and estimates of variance
- 2. Table of model statistics (e.g. AIC criteria)

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|                             | <i><b>Date Received</b></i> | <i><b>Workshop<br/>Recommendation</b></i> | <i><b>Revision Deadline<br/>***</b></i> | <i><b>Author and<br/>Rapporteur<br/>Signatures</b></i> |
|-----------------------------|-----------------------------|-------------------------------------------|-----------------------------------------|--------------------------------------------------------|
| <b>First<br/>Submission</b> |                             |                                           |                                         |                                                        |
| <b>Revision</b>             |                             |                                           |                                         |                                                        |

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author **DOES NOT** commit to any **LEGAL OBLIGATION** by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

***Justification of Working Group Recommendation***

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## ***Appendix 2: Hennen 2018***

***The following summary was prepared by Dan Hennen at the Northeast Fisheries Science Center and reviewed by Mike Simpkins. It has been reproduced in its entirety for inclusion in the working group report of the FDSA.***

### **CPUE as an Index of Abundance in Stock Assessments**

Catch per Unit Effort (CPUE) is used in some regions to index the abundance of stocks. It is most commonly employed where there are limitations to fishery-independent data sources (e.g. many stocks in the SE US).

When there are more robust alternatives available, using CPUE as an abundance index is problematic. Fisheries are subject to regulations that affect catch rate, such as limits on the days at sea (DAS, an effort control) or changes to the fishing season, and areas open to fishing. Regulations are not constant over time. Therefore comparing catch rates through time requires adjustments to account for changes in the behavior of fishers resulting from the changes to regulations. These can be difficult to model and often leave the analyst in a situation where it is unclear whether a change in CPUE is due to a change in regulations or a change in stock abundance. The challenge posed by changing regulations is further complicated by the fact that fisheries are non-random relative to space. If fishing is concentrated on areas of high density, or areas near ports, CPUE will not follow total abundance. Generalization of CPUE to the entire stock area can be particularly challenging if the fishery does not occur in a substantial portion of the stock area. In this case, assumptions about the abundance in unfished areas are required. Gear efficiency changes over time in commercial (or recreational) operations. Reductions in handling time, increases in vessel speed or efficiency, better fish detection, or catching power, all can cause changes in catch rate. These are unlikely to accrue in the fishery systematically, as they are adopted unevenly throughout the fleet, and are difficult to track or isolate with modelling. Finally, fisheries that garner the most interest tend to be the most depleted. These fisheries are likely to have an important bycatch component. Bycatch can be challenging to track, in terms of magnitude, but particularly in terms of effort. The question of which trips, or how much of any given trip, to include as “effort” for calculating bycatch is particularly thorny. In the northeast, bycatch is generally less reliably estimated before 2005 because of low coverage rates in the observer program.

When fishing practices and regulations are dynamic, it is hard to be sure that CPUE is tracking abundance. The only option for checking the performance of CPUE as an index (in most situations) is to compare it to an independent measure of abundance. When CPUE and the independent measure agree, that can result in more confidence in both measures, though there may be limited value in inputting both into an assessment model because of redundancy and



covariance/colinearity in the measures. When the two measures diverge, CPUE is typically considered unreliable because of the reasons listed above.

## **Background Literature**

There is a fairly extensive literature on the use of CPUE as an index of abundance. It is given several pages in “Quantitative Fisheries Stock Assessment” by Hilborn and Walters.

Notable peer reviewed articles include several by Maunder (e.g. [Maunder and Punt, 2004](#), [Maunder et al 2006](#)), Walters ([Walters, 2003](#)), and Harley ([Harley et al, 2001](#)). These and several others are briefly summarized [here](#).

## **Non NEFSC Reports**

There was a dedicated CPUE workshop at GMRI in November of 2015 (see [Narrative](#)), which included contributions from several non-NEFSC folks. A report from SMAST ([O’Keefe et al. 2015](#)) considered how Fisheries Dependent Data (FDD) and particularly CPUE was used in groundfish assessments, (see summary).

## **NEFSC Reports**

*Cod* (GOM) - CPUE used as index before 2012.

A workshop was convened in 2012 to address the apparent disconnect between CPUE and Fisheries Independent Data (FID) based trends. A [report](#) from the workshop concluded that neither commercial, nor recreational CPUE was a useful index of abundance. Cod became aggregated in the Gulf of Maine in the late 2000’s and catch rates increased while abundance declined. This is the most extensive examination of CPUE as an index that NEFSC has conducted.

*Cod* (GB) - LPUE not used as an index of abundance, but was estimated prior to 1998.

The 2012 WG (see above) re-examined CPUE as an index and concluded neither commercial, nor recreational LPUE was a useful index of abundance. Management changes beginning in 1994 changed the spatial pattern of the fishery, effectively breaking the time series. In addition, the LPUE index included only US landings while the stock straddles the Hague line. The recreational LPUE index was not considered representative due to small sample size as well as the cross boundary issues concerning fish landed in Canada.

*Haddock* (GOM) - LPUE not used as an index, but examined in 2012 WG.

LPUE was not considered a reliable index of stock abundance by the WG. It was not possible to clearly define effort for this stock since it was difficult to tell which trips were

targeting haddock. LPUE trend was not correlated with the other indices of abundance used in the assessment model.

*White Hake* - LPUE used before 2012.

LPUE was examined for the 2012 [benchmark](#). A priori it was not expected to perform well due to area closures and other management changes affecting effort. The index showed different trends when only directed trips (as opposed to all trips, or all trips where some threshold proportion of the total landings were white hake) were used to determine effort. Some, but not all, of the variants of the LPUE index correlated well with the FID trends, but there was little interest in using it in the model and it was dropped.

*Pollock* - CPUE examined in [2010](#), but not used in assessment.

CPUE was not used in the assessment because of limitations in the calculation of effort due to regulatory changes over time (Days at Sea limits, closed areas, etc...).

*Yellowtail flounder* - Examined CPUE in [2012](#).

No index could be created for this stock, due to complications resulting from the changing management regime (closed areas, DAS regulations, etc...) and the shift from a directed fishery to a bycatch fishery which made calculation of effort intractable.

*Tilefish* - Uses CPUE as an index.

Tilefish do not have a FID survey trend. CPUE is the only index of abundance in the [assessment](#).

*Bluefish* - Uses recreational CPUE as an index of abundance.

The recreational CPUE index is possibly the most important index in the [assessment](#) model.

*Scup* - thorough examination of CPUE as an index in 2015, but it is not used in the [assessment](#).

The scup assessment WG thoroughly explored using CPUE as an index of abundance. They used several data sources for catch, including: [dealer reports](#), [VTR data](#), [observer data](#), [recreational vessel VTR](#), [MRFSS and MRIP data](#), and commercial [study fleet data](#). Data limitations included: some data sources included only landings, effort was difficult to determine because it was not clear which trips were scup targeted, and because changes to management and data reporting have made it hard to build a [consistent time series](#).

*Witch flounder* - Thorough examination of CPUE as an index in 2015, but it is not used in the [assessment](#).

The witch flounder WG evaluated CPUE indices from several data sources for their utility as indices of abundance. These included: [dealer reports](#) (at several different proportions of total trips base on threshold witch flounder catch [levels](#)) , [VTR](#), and [Observer program data](#). Each of the CPUE indices from data sources presented various limitations to their utility as an index of abundance. The dealer data included only landings and was no definitive reason to prefer one set of total trips over another to use for effort determination. The VTR and observer data probably underestimated discard rate. There was also concern over how changes in management regulations have affected effort over time. A cooperative study fleet longline survey was also considered as a source for an abundance index, but the survey time series was short and no witch flounder had been caught.

*Striped bass* - used MA commercial CPUE and CT recreational CPUE indices until [2009](#).

Both CPUE indices were removed in 2009 due to possible errors in the index (CT) and the determination that anglers were targeting aggregations (MA).

*Northern shrimp* - CPUE calculated but not used as an index of abundance in the [assessment](#).

Not considered a reliable index of abundance because of increasing fisher efficiency over time, seasonal changes in efficiency, attrition of successful harvesters, and seasonal shifts in shrimp distribution.

*Redfish* - CPUE used as an index of abundance until 2008 [assessment](#).

The CPUE index was abandoned in the 2008 assessment because of a sharp reduction in directed redfish trips.

*Monkfish* - CPUE is calculated but not used as an index of abundance in the [assessment](#).

Monkfish CPUE is not considered a reliable index of abundance because much of the catch is taken in a multispecies fishery and effort is difficult to define. Data collection methods have also changed over time. Regulatory changes have also complicated the estimation of effort.

*Squid* - LPUE was calculated for the 1996 [assessment](#) and provided an initial estimate of biomass.

The LPUE index was abandoned in the 2002 assessment because of changes in data collection procedures and problems determining catch location.

*Fluke* - (In progress) CPUE is being evaluated as an index of abundance in the assessment.

Data sources being considered include: dealer data from trawl fisheries, VTR data from trawl fisheries, observer data, MRFSS and MRIP data, and recreational VTR data. Reports are in draft form and not linked here.

*Clams* - CPUE is calculated for each assessment, but is not used as an index of abundance.

Surfclam and ocean quahog CPUE are not considered reliable indices of abundance because the fishery is highly aggregated in space. Fishers work in small areas until density is depleted below a threshold level of economic return and then shift to a new location. CPUE is not well correlated to total abundance.

*Black sea bass* - Recreational CPUE was developed and used in the 2016 [assessment](#).

CPA (catch per angler) was used as an index of abundance in the model and was fit well in the southern region of the spatial model. The fit was not as good in the northern region.

#### *Multispecies Stock Assessments*

[Maunder et al \(2006\)](#) point out that CPUE is a particularly poor index of abundance for multispecies frameworks. The reason for this is that the catchability coefficients for different species are different, even if those species are caught by the same gear. The species that is caught most effectively will deplete at a faster rate than the other species. The other caveats mentioned above, catchability changing over time, target shifting in the fishery and changes in regulations, etc., all apply to multispecies fisheries as well.

## **FISHERY DEPENDENT DATA IN NEW ENGLAND GROUND FISH STOCK ASSESSMENTS**

Catherine E. O’Keefe and Steven X. Cadrin  
School for Marine Science and Technology (SMAST)  
University of Massachusetts Dartmouth  
Joshua Wiersma  
Environmental Defense Fund

### **BACKGROUND**

Several groundfish stocks in New England are currently overfished and have shown inadequate recovery despite historic low fishing effort and increasingly strict fishing regulations. Fishery-independent data sources, specifically federal surveys, have shown declines in biomass and abundance for certain species (NEFSC, 2015c). While surveys provide information on trends in population status, fishery-dependent data sources provide the magnitude of fishery removals and may be useful to examine spatially- and temporally-specific fishing patterns and enhance our understanding of management and environmental influences on fish populations (Hilborn and Walters, 1992). Fishery management interventions, however, pose challenges to incorporating fishery-dependent data in stock assessments. Fishermen, scientists and managers are calling for a renewed examination of data systems, specifically catch-per-unit-effort (CPUE) indices that might overcome scientific challenges and provide finer scale insights into complex population dynamics.

CPUE is commonly used as an index of abundance for stock assessment. Similar to the way fishery-independent surveys are related to stock size, CPUE is assumed to be proportional to stock abundance:

$$CPUE_t = q N_t$$

where  $q$  is a catchability coefficient and  $N_t$  is stock size at time  $t$ . The relationship assumes that catchability is constant throughout the time series. CPUE is typically standardized to account for factors of catch rate that are not related to stock size (e.g., Maunder & Punt, 2004).

The Environmental Defense Fund (EDF) worked with the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST) to examine expanded use and utility of fishery-dependent data in fish stock assessments. Although the majority of stock assessments incorporate catch data (landings and discards), CPUE information is not currently used in any of the New England groundfish stock assessments. Based on a review of historical use of CPUE in groundfish assessments, we propose possible opportunities to reconsider this information for the groundfish assessments, which could help to reconcile what fishermen see on the water with the results of analytical analyses.

### **OBJECTIVE**

The objective of this study was to determine how fishery-dependent data, specifically CPUE, has been used to inform the stock assessments of New England groundfish. The report includes a summary of the types of fishery-dependent data that are available and used in the assessment process, an evaluation of the rationale for the inclusion or exclusion of CPUE information in assessments, and recommendations for possible reconsideration of CPUE information in the assessments of New England groundfish stocks.

## **DATA TYPES**

Several types of fishery-dependent data are collected to support the assessments and management of stocks included in the Northeast Multispecies Fishery Management Plan. Regulated data collection for harvesters and seafood dealers include information on catch (landings and discards), fishing location and time, and biological characteristics (length and weight). Table 1 summarizes some of the types of fishery-dependent data collected through regulated reports for the Northeast Multispecies complex. Information from the various reporting requirements are combined to determine landings and discards by species, area, season and gear; effort by area, season and gear; length, weight and age by species by area, season and gear; and catch per unit effort (CPUE). Fishery-dependent information from voluntary data collection programs has also been used to support bycatch avoidance (O’Keefe and DeCelles, 2013; Bethoney et al., 2013; Gauvin et al., 1995), risk pooling of quota (TNC, 2012; Holland and Jannot, 2012), and optimized harvest strategies (Dunn et al., 2013). There are also several types of data that are collected by fishermen through collaborative research that can support stock assessments and management advice. Table 2 summarizes some of the types of data collected by fishermen in the New England region to address specific research questions and improve uncertainties in stock assessments and catch-setting advice.

## **FISHERY-DEPENDENT DATA IN STOCK ASSESSMENTS**

There are currently 13 species managed as 21 stocks in the Northeast Multispecies Fishery Management Plan (NEFMC, 2015; Table 3). The assessments for all 21 stocks include landings and discard data derived from fishery-dependent data reporting. For some stocks, information from both the commercial and recreational sectors of the fishery is utilized in the assessments. Recreational catch is included in assessments of all stocks that have (or had) a substantial recreational catch (e.g., Gulf of Maine cod, haddock, and winter flounder, Georges Bank cod, and pollock).

Indices of abundance derived from fishery data were included in several of the Northeast groundfish stock assessments until 1994. The Fishery Conservation and Management Act of 1976 established regional fishery management councils and mechanisms to control fishing activities (USDOC, 1976). The New England Fishery Management Council approved the first fishery management plan for the New England groundfish fishery in 1977, which included cod, haddock and yellowtail flounder, and was focused on individual species quotas with individual trip limits (OSB, 1998). In 1982, the Council abandoned the trip limit system under the Interim Groundfish Fishery Management Plan due to inadequate monitoring and enforcement of the trip limit system. The new management system replaced trip limits with minimum fish size and



codend mesh size regulations for Georges Bank and the Gulf of Maine (NEFMC, 1993). The Hague Line on Georges Bank was established in 1984, which created a boundary between the US and Canadian Exclusive Economic Zones, and placed the most productive haddock grounds, traditionally fished by US vessels, on the Canadian side of the boundary. The Northeast Multispecies Fishery Management Plan was implemented in 1986 and was the first plan in the world to set biological targets in terms of maximum spawning potential; this plan greatly expanded the number of species included in the management unit (NEFSC, 1993). Between 1986 and 1993 the plan was amended several times to change the minimum landing size and mesh size regulations, establish new spawning closure areas, reduce small mesh fishing in the Gulf of Maine, increase enforcement ability, and include additional species. Although there were several management interventions throughout this period, stock assessments for cod and haddock included standardized commercial CPUE information.

The major management interventions introduced in 1994, including three large areas closed to mobile gear on Georges Bank and restrictions on fishing effort, impacted fishery behavior both spatially and temporally (OSB, 1998). The regulations were designed to reduce fishing effort and fishing mortality, and therefore fundamentally disrupted time series of CPUE indices. The fishery-dependent data collection system also changed in 1994, transitioning from fishermen interviews in a landings intercept program to self-reported logbooks/vessel trip reports (VTRs) to obtain information on fishing effort and location (NEFSC, 1996). Since 1994, there have been a series of significant management changes in the Northeast Multispecies Fishery Management Plan, including effort reductions, gear selectivity modifications, introduction of output controls, and inclusion of leasing options for quota (NEFMC, 2015). The frequent changes in management, switch in the fisheries-dependent data collection system, and the multispecies nature of the fishery have hindered the ability to develop useful indices of abundance from fishery data. These problems have resulted in decisions to exclude CPUE as indices of stock abundance for assessments. Several potential problems associated with the use of commercial catch rate indices have been documented for fisheries globally (e.g. Harley et al., 2001; Maunder et al., 2006). However, it is informative to evaluate CPUE indices to gain a better understanding of commercial catch patterns, even if these indices are not included in the assessment model. Currently none of the groundfish stock assessments include CPUE or landings-per-unit-effort (LPUE) indices in the assessment models. However, several recent analyses of the utility of abundance indices have indicated that further research should be applied to standardize the complexity of factors influencing fishery catch rates, and that such analysis would be best pursued outside the terms of reference for any single stock assessment (NEFSC, 2012c; 2014b; 2015a).

We reviewed recent benchmark stock assessment documents to determine if and how CPUE/LPUE information was considered. The topic has been specifically addressed in some assessments, such as Gulf of Maine haddock, white hake, and pollock, and a dedicated workshop was conducted on the use of CPUE and LPUE for the Gulf of Maine and Georges Bank cod stocks (NEFSC, 2012c). For other species, CPUE and LPUE have not been investigated for utility since 1994. The following sections summarize the use and utility of CPUE and LPUE, as described in recent Stock Assessment Workshop and Review Committee reports for several stocks managed under the Northeast Multispecies Fishery Management Plan.

## **Cod – Gulf of Maine (*Summarized from SAW 55; NEFSC, 2013a*)**

Trends in commercial landings per unit effort (LPUE) were used in Gulf of Maine cod stock assessments prior to SAW 53 (2012b). LPUE-at-age indices from 1982 to 1993 were calculated based on an otter trawl sub-fleet. The index was not extended beyond 1994 because of major changes occurring in the Gulf of Maine groundfish fishery, including regulatory measures to reduce fishing effort, closed areas, changes in mesh size and trip limits, as well as a change in the fisheries-dependent data collection system. All of these issues affect the comparability of LPUEs estimated from 1994 onward with the earlier time series. These same issues would make standardization of a contemporary catch per unit effort (CPUE) index difficult. The SAW 53 Working Group examined model sensitivity runs to assess the utility of including the LPUE index. Model results were insensitive to the index, and the Working Group decided to remove the index from the SAW 53 assessment.

The disconnect between the increasing CPUE reported by groundfish fishermen and the comparatively limited rebuilding suggested in the SAW 53 assessment led to an NEFSC-sponsored CPUE/LPUE Working Group to review and evaluate the information available on both commercial and recreational CPUE (NEFSC, 2012c). The CPUE/LPUE Working Group concluded that ideally, LPUE indices should be formally considered and vetted as inputs into the assessment model. They made a recommendation that if an LPUE index is determined to be a poor index of fish abundance, the index should be described in the assessment report and explanations put forward describing why the information in the LPUE index may be inconsistent with other assessment tuning indices, even though it may not be formally included as a model input. This recommendation has not been implemented in updated stock assessments for Gulf of Maine cod (Palmer, 2014; NEFSC, 2015b).

The SAW 55 Working Group considered several analyses in an attempt to develop representative indices of Gulf of Maine cod exploitable biomass based on commercial and recreational LPUE. One analysis updated the LPUE index used prior to SAW 53 through 2011 (Palmer, 2012). This index standardized the effects of year, depth, tonnage class, quarter and statistical unit area as factors in a Generalized Linear Model and showed trends that tracked spawning biomass (SSB), as estimated during SAW 53, relatively well up until 2006, after which time LPUE increased much faster than SSB. A hypothesis for the divergence in trends considered by the SAW 55 Working Group was that sand lance abundance, which is a forage species of cod, became abundant in a small region of the western Gulf of Maine (near Stellwagen Bank) between 2006 and 2010 (Richardson et al., 2012), resulting in the aggregation of cod in the area and thus elevated commercial catch rates. Increased observations of sand lance in cod stomachs from the fall Northeast Fisheries Science Center Bottom Trawl Survey in Stellwagen Bank combined with VTR, Vessel Monitoring System (VMS) and observer data indicated that Stellwagen Bank may have become a forage ‘hot spot’ for cod with highly concentrated fishing effort since the mid-2000s. The Working Group concluded that a large abundance of cod in a region easily exploitable by the day boat fleet was likely responsible for the increase in CPUE reported by the fishing industry between 2006 and 2010 (NEFSC, 2013a).

The Working Group noted that cod appeared to be aggregated in a small area of the Gulf of Maine, which suggests that the catchability (relationship between LPUE and biomass) has

changed over the LPUE time series. They mentioned that over the longer term, there have been a number of regulatory changes (e.g. seasonal closures, trip limits, etc.) which challenge the utility of commercial LPUE as an index of Gulf of Maine cod biomass. Based on these concerns, the Working Group recommended that the commercial LPUE index should not be used in the SAW 55 assessment model. An LPUE index was also developed for the recreational fishery (Wood, 2012). However, based on concerns comparable to those of the commercial fishery, the Working Group recommended that the recreational LPUE index also should not be included in the Gulf of Maine cod assessment model.

#### **Cod – Georges Bank (*Summarized from SAW 55; NEFSC, 2013a*)**

The LPUE index for Georges Bank cod was last estimated in 1998 (SAW 27; NEFSC, 1998), but was not used as an index of abundance in the assessment or in any subsequent assessments. Effort data after 1994 was no longer considered to be equivalent to the historic 1978-1993 effort series for Georges Bank cod due to increased management restrictions and the change in effort monitoring. The SAW 55 Working Group repeated an analysis first conducted in 1993 (SAW 15; NEFSC, 1993), which used a Generalized Linear Model to estimate standardized US fishing effort and commercial LPUE for Georges Bank cod during 1978-2011. The resulting LPUE index indicated a declining trend from 1980 through 1995, a gradual increase to 2002 with another decline through 2006, then an increasing trend to 2011. The SAW 55 Working Group reviewed the updated analysis and recommended that the standardized LPUE not be used in the SAW 55 assessment model for several reasons. The Working Group noted that LPUE did not represent the entire stock for the entire time series because the index incorporates only the US landings and effort data in the western part of the stock area since 1985, whereas the Canadian fishery contributes about 25% to the overall landings. Additionally, they noted the significant regulatory changes since 1994 and implementation of sector management, which have resulted in spatial shifts in the fishery. The Working Group concluded that the recommendation to not utilize the index was consistent with the findings of the NEFSC-sponsored CPUE/LPUE Working Group (NEFSC, 2012c).

The Working Group also applied a Generalized Linear Model to recreational data to estimate an LPUE index (cod landed/angler hour) for Georges Bank cod during 1994-2011. The Working Group had several concerns with respect to the applicability of the LPUE index, including uncertainty about whether the data reported was in pounds or in numbers, the limited number of party/charter boats involved in the fishery that consistently fished over the time series, and that the fishery was conducted primarily in the westernmost part of the stock area. The Working Group concluded that the recreational LPUE index was not representative of the stock and should not be included in the assessment model.

#### **Haddock – Gulf of Maine (*Summarized from SAW 59; NEFSC, 2014b*)**

The SAW 59 Working Group for Gulf of Maine haddock analyzed LPUE by generating an analytical dealer data set and applying a Generalized Linear Model (NEFSC, 2014b). The Working Group considered only the trawl fleet data, given that Gulf of Maine haddock landings are dominated by this fleet. They noted that there was no way to accurately identify which trips in the dealer data constitute ‘groundfish’ trips with some probability of encountering haddock

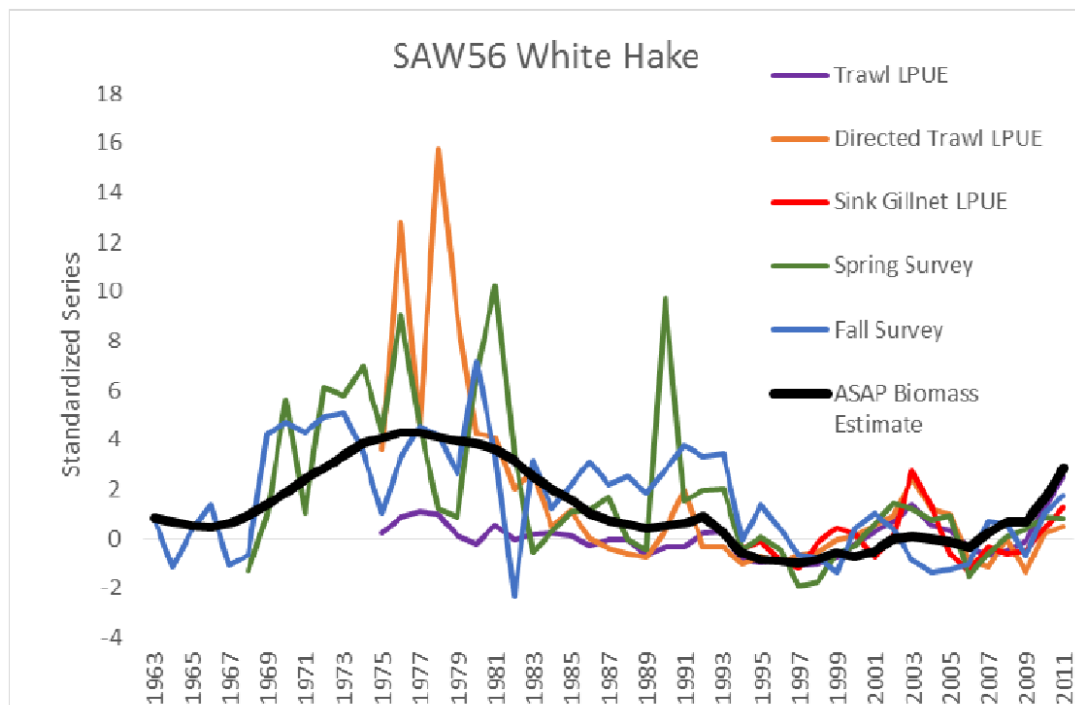
and which trips were engaged in other fisheries (e.g., fluke) with virtually no probability of encountering haddock. For that reason, only trips that landed  $\geq 1$  lb haddock were included in the model. Results for nominal Gulf of Maine haddock commercial trawl LPUE (landings per days fished) showed very little trend since the mid-1980s after declining from a peak in 1980. A comparison of the standardized LPUE index to the spawning stock biomass (SSB) estimates showed close agreement of the two series until 1994. There were several moderate-to-strong recruitment events between 1993 and 1998 leading to a large increase in spawning biomass between 1994 and 2002 (NEFSC, 2012a). The LPUE index, while it increased slightly between 1994 and 2009, did not increase consistent with the rate of increase in estimated stock size. According to the Working Group, there was an apparent shift in relationship between LPUE and stock size in the mid-1990s, such that after the mid-1990s, LPUE is not informative as an index of stock abundance. Based on these results, the Working Group concluded that the commercial LPUE index would not be used in the Gulf of Maine haddock assessment model, and that the recommendation was consistent with the recommendations of other recent assessments (SAW 55; NEFSC, 2013a).

The Working Group conducted sensitivity analyses that included the commercial and recreational LPUE indices separately within the base model assessment. Model fits to both the commercial and recreation LPUE indices exhibited a poor fit with strong residual patterning. The Working Group concluded that the results from these sensitivity analyses suggested that the LPUE indices are not reflective of stock abundance and should not be used for model tuning.

#### **White Hake – Gulf of Maine/ Georges Bank (*Summarized from SAW 56; NEFSC, 2013b*)**

The Working Group for Stock Assessment Workshop 56 on Gulf of Maine/Georges Bank white hake analyzed LPUE indices to address one of the assessment terms of reference (TOR), “TOR 2. ...Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data”. The Working Group calculated commercial LPUE for otter trawl gear (landings per unit effort in metric tons landed per day fished) indices for white hake using 40% of the landed trip comprised of white hake as the cutoff for standardization for directed trips. Total otter trawl nominal LPUE indices were stable or increased through 1985, generally declined through 1997, and increased to a peak in 2003 depending on the total percentage of landings. The Working Group also analyzed standardized LPUE for all otter trawl trips and for the 40% directed trips. Trends in the standardized LPUE series were similar to the trends in the nominal LPUE indices. They concluded that the standardized effort suggested that overall effort declined since 1992, while the directed effort was higher in the 1980s than in the 1990s and recently increased. Similarly, the Working Group calculated nominal and standardized commercial LPUE for sink gillnet gear. The Working Group noted that the effort data for sink gillnets appeared to be different between 1975-1993 and 1994-2011. The data collection system changed at that time and the way effort was calculated was likely not the same. Therefore, only data from 1994 onwards were used in the standardization. Results showed that all of the sink gillnet LPUE indices generally decreased from 1975 through 1993, increased from 1994-2003, generally declined through 2008, and increased through 2010.

Although not incorporated in the stock assessment (ASAP) model, the results of the LPUE analysis were described and considered in SAW 56 (NEFSC, 2013b). The Working Group noted that the distribution pattern of weighted LPUE (sum of pounds landed in a ten-minute square/sum of days fished in that ten-minute square) in otter trawls had the highest LPUE values occurring in the northeast portion of the Gulf of Maine with lower values of LPUE to the west, and that sink gill net LPUE was higher in the southeast Gulf of Maine with a slight increase from 2008-2011 (NEFSC, 2013b). The trawl and gillnet LPUE series were moderately correlated with the ASAP estimate of stock biomass, and the model estimates of stock biomass were more positively correlated with the standardized directed trawl LPUE series than either survey series, even though the survey series were included in the model.



### **Pollock (*Summarized from SAW 50; NEFSC, 2010*)**

The 50th Stock Assessment Working Group for pollock in US waters concluded that trends in CPUE have limitations due to regulatory and management changes over time (days-at-sea, area closures, etc.). They also stated that trends in nominal effort (number of trips and/or number of days absent) might be useful for interpretation purposes, but not for direct use in assessment models. Despite these statements, no CPUE/LPUE data were examined in the last assessment for pollock.

### **Winter Flounder – Gulf of Maine, Georges Bank, Southern New England/Mid-Atlantic (*Summarized from SAW 52; NEFSC, 2011*)**

The winter flounder assessments for all three managed stocks, which were last benchmarked in 2011, do not include any analysis of CPUE or LPUE as indices of stock abundance for commercial or recreational fishing patterns. The Working Group for SAW 52 examined a

constant CPUE model to assign trip landings from 2004-2008 for eight species managed under the Northeast Multispecies Fishery Management Plan that are managed as separate stocks, including winter flounder (Palmer and Wigley, 2011). This analysis used VMS data as a proxy for fishing activity in the Northeast Region based on previous studies (e.g., Murawski et al., 2005) to assess the magnitude of misreporting on VTRs, and subsequently the magnitude of misreporting of landings by stock areas. While the analysis noted the caveat that a constant CPUE assumption violates known groundfish distribution patterns, the results of the analysis were used to examine landings of winter flounder by stock area. The analysis showed that since 2005, VMS has provided >80% coverage of winter flounder landings (Palmer and Wigley, 2011). The analysis was not specifically designed to examine trends in abundance for winter flounder stocks, but it provides an example of combining VTR and VMS data to examine CPUE/LPUE trends.

### **Yellowtail Flounder – Southern New England/Mid-Atlantic (*Summarized from SAW 54; NEFSC, 2012d*)**

The Working Group for SAW 52 Southern New England/Mid-Atlantic yellowtail flounder reported an attempt to examine a CPUE index. They noted that there are currently no estimates of CPUE or effort for this species. The Working Group concluded that given the major changes in management, specifically the reduction in allowable days at sea and the regulated 2-for-1 counting of days at sea, as well as the changes in the reporting methodology, CPUE was not likely to be a good indicator of stock status. The Working Group also noted that the fishery has changed from one dominated by a directed fleet that took substantial amounts of yellowtail to a bycatch fishery. They concluded that CPUE/LPUE could not be included in the assessment of the stock.

### **Other Northeast Multispecies Stocks**

Several assessments for stocks managed under the Northeast Multispecies Fishery Management Plan do not incorporate CPUE/LPUE information, and have not considered such information since the major management interventions and monitoring changes of the mid-1990s. The assessment for Georges Bank yellowtail flounder is currently based on an empirical data approach using only survey indices due to previous poor assessment model performance, which precludes use of CPUE/LPUE information. Other stocks have not been subject to benchmark updates in several years (Georges Bank haddock, Cape Cod/Gulf of Maine yellowtail flounder, American plaice, witch flounder, Acadian redfish, Gulf of Maine/Georges Bank and Southern New England/Mid-Atlantic windowpane flounder, Atlantic halibut, ocean pout and Atlantic wolffish).

All of the groundfish stock assessments were updated in 2015 through the Northeast Fisheries Science Center Groundfish Operational Assessments. The operational assessments incorporated updated data (both fishery-independent and dependent), but did not include changes to the reviewed benchmark assessment approaches (NEFSC, 2015d).



## **EVALUATION OF RATIONALE FOR INCLUSION OR EXCLUSION OF FISHERY-DEPENDENT DATA STREAMS**

Through our review of the use of fishery-dependent data streams used in the assessments of the New England groundfish stocks, we examined whether or not the assessment included a rationale for including or excluding various data types, and if there was consistency in the rationale among assessments. Specific data obtained from VTRs, VMS, Dealer reports and the observer program have been used consistently and are well-documented in the assessment reports for the groundfish species. However, there are several data gaps associated with these required data collection systems, which preclude use of certain types of information and confounds assessment analyses. For example, VTR data on discards is notoriously problematic and is not used for assessment purposes. Information on discards is obtained from observer or At-Sea Monitor data, which had a relatively low coverage rate prior to 2005. Total catch is therefore difficult to determine, resulting in confounding trends in CPUE. Another major gap associated with the current fishery-dependent data collection systems is the lack of vessel, operator and gear-specific characteristics. Several assessment reports noted the challenges in using CPUE as an indicator of stock size because of changes in fishery efficiency. While some general knowledge about the effects of increased efficiency resulting from advances in navigational and technological equipment exists, specific information at the individual vessel level is lacking, making it difficult to compare relative catch rates between years.

Recent assessments that have reported CPUE/LPUE information have provided rationale for excluding these data from assessment models. As summarized above, the cod, haddock, white hake, pollock, winter flounder and yellowtail flounder assessments examined the use and utility of CPUE/LPUE information and concluded that the information was not representative of trends in stock size and should not be included in the assessment model. Recent assessments for several stocks in the Northeast Multispecies complex do not include any analysis of CPUE/LPUE, and it is unclear whether or not such information could be used. While there was a long period between 1994 and 2010 when CPUE/LPUE information was not included in the assessments of groundfish stocks, recent benchmark assessments have included an analysis of CPUE/LPUE as a measure of stock abundance in the terms of reference.

Despite the challenges associated with constructing CPUE/LPUE indices for use in the assessments of New England groundfish species, these types of fishery-dependent data can provide useful insights about fleet behavior, population dynamics and environmental conditions. The Gulf of Maine cod assessment report noted that CPUE remained high during a period where cod biomass was declining, possibly due to targeting a foraging ‘hot spot’ on Stellwagen Bank related to an increase in sand lance abundance. While this may be confounding information for producing a stock wide abundance index, it sheds light on a shift in trophic dynamics that has important ramifications for understanding environmental influences on fish stocks. The Gulf of Maine haddock assessment report showed a mismatch of CPUE associated with increasing biomass due to large recruitment events in the late 1990s. Although there may be limited utility of CPUE information as an index of haddock stock size, information about fleet behavior and impacts of management interventions could be examined. Another example of using CPUE information was included in the winter flounder assessment report as a way to assign trip

landings by stock area. Despite noted caveats, the information was useful to address misreporting of landings by stock area on VTRs.

Catch per unit of effort is a metric that the fishing fleet understands and relies on to make decisions about where, when and what to target. The uncertainty associated with recent stock assessments, coupled with historic low fishing allocations has triggered a renewed interest by the fishing industry to examine CPUE/LPUE data as a way to reconcile the perceived mismatch of assessment results with on the water observations. Incorporating CPUE/LPUE into assessment models may not be appropriate for many stocks based on the provided rationale in the assessment reports; however examination of the available data to address questions from the fishing industry could reveal novel results related to fine scale spatial and temporal patterns. An immense amount of time and resources have been expended to standardize survey catch data to produce a single time series. Much of this work has been conducted outside of the stock assessment process with results applied to assessments. Similarly, effort could be dedicated to examine methods to standardize CPUE/LPUE indices. The rationale for excluding these data in assessments is largely focused on the challenges associated with standardizing the data due to a variety of influences. While the rationale is sound, it does not preclude additional exploration of possible ways to make CPUE/LPUE information more useful for assessments.

## **RECOMMENDATIONS FOR FUTURE USE OF FISHERY-DEPENDENT DATA IN STOCK ASSESSMENTS**

Use of fishery-dependent data for assessment and management purposes has been reviewed both generally (e.g., Maunder et al., 2006; Maunder and Punt, 2004; Harley et al., 2001) and specific to the Northeast region (e.g., OSB, 1998; NEFSC, 2012c; GMRI, 2014). Several recommendations about the use of CPUE/LPUE have been generated over the last two decades. We summarized the use and utility of CPUE/LPUE information for a small sample of stocks outside of the New England region and the major findings and recommendations specific to New England groundfish CPUE/LPUE data, and included additional recommendations based on our review of assessments of Northeast Multispecies stock assessments, past and current efforts on this topic, and feedback from the fishing industry.

### **Review of the Use of CPUE/LPUE Information in Assessments of Species in Other Fisheries**

#### ***Tilefish (Summarized from SAW 58; NEFSC 2014a)***

A fishery-independent index of abundance does not exist for tilefish. The NEFSC bottom trawl surveys only catch a few tilefish per survey, so the time series is not a useful index of abundance. The assessment relies on fishery-dependent commercial CPUE as an index of abundance. Analyses of catch (landings) and effort data from three different series of longline fishery data were analyzed. CPUE trends were very similar for most vessels that targeted tilefish. Since 1979, the tilefish industry has changed gear configurations. Due to possible changes in catchability associated with the changes in fishing gear, the Working Group considered that it would be best to use the three available CPUE indices separately rather than combined into one or two series. The Working Group suggested that changes in the CPUE were generally explained with

evidence of strong incoming year classes that track through the landings size composition over time. Since the 2009 tilefish assessment (SAW 48; NEFSC, 2009) there appeared to be increases in CPUE due to one or two new strong year classes. In general, strong year classes appear to persist longer in the fishery after the implementation of the Fishery Management Plan and after the constant quota management came into effect.

There was some uncertainty associated with the assessment results for tilefish. The Working Group noted that there were unknown effects on CPUE from fishery conflicts with lobster and trawl gear, unfished areas on the south flank of Georges Bank, effects of targeting incoming year classes and avoiding extra-large fish due to marketability, and unknown effects due to competition from increased dogfish abundance. However, the assessment model (ASAP) was able to match the year class dynamics seen in the commercial size distributions and CPUE patterns. The Review Committee recommended developing an industry-based survey to collect more intensive size and catch information on a haul by haul basis to supplement the current CPUE indices (NEFSC, 2014a).

### **Bluefish (*Summarized from SAW 60; NEFSC, 2015a*)**

A standardized bluefish CPUE index from the recreational fishery was evaluated and its utility as an index of abundance was considered by the Stock Assessment Working Group for SAW 60 (NEFSC, 2015a). The Marine Recreational Information Program (MRIP) index covers the entire range of the Atlantic coast stock of bluefish and includes information on older age classes that are poorly sampled by standard fishery-independent surveys, so the Working Group chose to include it as an index of abundance in the assessment model. The MRIP intercept data was used to develop a set of directed bluefish trips, defined as any trip that caught bluefish (regardless of disposition) or where the angler reported targeting bluefish. The MRIP CPUE showed a decline in catch per trip during the 1980s and mid-1990s, before rebounding in the late 1990s to fairly stable levels since 2000 (Figure 1). Sensitivity of the assessment model to individual survey indices was tested by removing each index and re-running the model. The model was fairly insensitive to the removal of all the indices except for the MRIP recreational CPUE index. The MRIP CPUE index was so important because it provides most of the information for model estimates at older ages. When the Working Group removed the MRIP index from the model there was a significant decrease in fishing mortality estimates and an increase in abundance and biomass estimates, which were not considered to be representative of the stock trends.

Figure 1. Bluefish model (solid line) fit to the MRIP CPUE index (open circles; from NEFSC, 2015a).

### **Scup (*Summarized from SAW 60; NEFSC, 2015a*)**

The Stock Assessment Working Group for scup compiled CPUE data and conducted analyses on constructing an index of abundance in 2015 based on fishing industry (both commercial and recreational) comments about the utility of fishery-dependent CPUE. Data sources included: 1) the commercial Dealer reported data for trawl gear; 2) the commercial fishing VTR data for trawl gear; 3) observer program data for trawl gear; 4) the recreational for-hire fishing vessel VTRs for rod-and-reel gear; 5) the Marine Recreational Fishery Statistics Survey / Marine Recreational Information Program (MRFSS/MRIP) data for rod-and-reel gear; and 6) commercial Study Fleet detailed catch per tow information. The Working Group evaluated the

utility of CPUE as indices of abundance in the scup stock assessment, and noted generally that: 1) the utility of the fishery-dependent data as the basis for indices of abundance is limited because some reports include only landings, so the resulting LPUE could be biased low relative to the true abundance of fish; 2) the use of only positive trips that catch scup may bias the LPUE or CPUE, and may be influenced by management regulations; and 3) the ratio of catch to effort has generally changed over time due to fish abundance, management regulations, or changes in data reporting systems. The Working Group reported that over the long term, there have been a number of regulatory changes, primarily seasonal trip limits and mesh regulations, which are different in timing and magnitude for each year.

The Working Group continued the analysis by investigating the utility of ‘directed scup trips’ from the Dealer landings reports as the basis for an index of abundance. They used data from “75% scup trips” LPUE (trips for which scup account for 75% or more of the reported landings), which removed ~200,000 “bycatch” trips for scup. The resulting LPUE series was different than all other survey and CPUE stock indicators (e.g., slight peak in LPUE in mid 1990s). They concluded that further analysis beyond the scope of the assessment was needed to standardize the complexity of factors influencing fishery catch rates, and recommended that a standardized fishery-dependent CPUE of scup targeted tows, from either observer samples or the commercial study fleet, might be considered as an additional index of abundance to complement survey indices in future benchmark assessments.

### **Atlantic Bluefin Tuna – Western and Eastern Stocks (*Summarized from ICCAT, 2014*)**

The International Commission on the Conservation of Atlantic Tunas (ICCAT) conducted a stock assessment for Atlantic Bluefin tuna in 2014. The assessment for the western stock, which used a Virtual Population Analysis (VPA), included relative abundance indices from twelve fleets, including two areas of Canadian rod and reel, tended line and harpoon fisheries, three US rod and reel fisheries, the US Gulf of Mexico pelagic longline fishery, and Japanese longline fishery in the western north Atlantic. The assessment for the eastern stock, also a VPA, included CPUE indices from the Japanese longline fishery in the East Atlantic and Mediterranean (1975-2009, for ages 6+), the Norwegian purse seine fishery (1955-1979, for ages 10+), the Japanese longline fleet in the North East Atlantic (1990-2013, for ages 4+), and the Spanish baitboat fishery. The assessment group noted that there were various problems associated with the eastern stock model results due to the quality of the data. For example, they highlighted the difficulty of the CPUE indices in tracking recent changes in tuna abundance due to management that has directly affected catch, effort and selectivity-at-age in the fisheries. The poor quality of data translates into high sensitivity of the VPA model to minor changes in the CPUE indices. The assessment group concluded that the outputs of the eastern stock VPA remained highly unstable and need to be confirmed by further analyses that would use other modeling approaches than the current VPA. While the CPUE indices were problematic for reasons similar to those in the assessments of Northeast Multispecies stocks (e.g., management interventions and changes in fishery efficiency), the indices are a necessary component of the assessment due to lack of other types of fishery-independent data (ICCAT, 2014).

### **ICES Stock Assessments**

Many assessments for eastern Atlantic stocks that are conducted by the International Council for Exploration of the Sea (ICES) include CPUE/LPUE indices. For example, the North Sea saithe (*Pollachius virens*) assessment includes CPUE information from three commercial fleets as tuning indices, the French demersal trawl fishery and German and Norwegian bottom trawl fisheries, and the North Sea turbot (*Scophthalmus maximus*) assessment includes CPUE information from the Dutch beam trawl fleet (ICES, 2015). No assessment model has been applied to anglerfish (*Lophius piscatorius* and *budegassa*) in the Iberian region, however LPUE from Spanish fleets was used in combination with limited survey information to set catch advice for the 2015 fishing year (ICES, 2014). The assessment for sole (*Solea solea*) in the Bay of Biscay includes CPUE indices from two French trawl fleets, a Belgian beam trawl fleet and inshore and offshore Bay of Biscay trawl fleets (ICES, 2014). All of the ICES example stocks are included in fishery management plans that have changed over time to include effort restrictions, closed areas, and gear modifications.

### **Prior Recommendations for the Use of CPUE in Northeast Multispecies Stock Assessments**

In 1998, a review of Northeast fishery stock assessments was conducted by the Committee on Northeast Fishery Stock Assessments, the Ocean Studies Board, the Commission on Geosciences, Environment and Resources and the National Research Council (OSB, 1998). The review concluded that the skepticism expressed by National Marine Fisheries Service assessment scientists and the Stock Assessment Review Committees about the usefulness of aggregated catch and effort data to construct CPUE series was appropriate due to the quality of logbook data and various management measures that were imposed after 1994. They noted, however, that “fishers have a greater trust in the data that they themselves provide, and therefore an effort should be made to validate and use CPUE data”.

The resulting report from the review, “Review of Northeast Fishery Stock Assessments”, included several recommendations related to use and utility of fishery-dependent data, specifically CPUE information. The report suggested that in order to obtain valid CPUE series, changes in fishing technology, fishing competence and restrictions on effort must be accounted for in the analysis. The report outlined a possible approach of disaggregating the data not only by vessel, but also by captain and management events. The objective of the approach was to focus on periods with constant technology (e.g., same gear, same engine), constant fishing competence (same captain and key crew), and same external conditions (e.g., management regime with respect to closed areas and periods, days at sea limitations, rules for discards and bycatch). The report noted that the resulting catch series from this suggested approach would be highly variable within each period, but could be analyzed together to produce a CPUE series related to relative abundance. As a mechanism to obtain data of sufficient quality for disaggregated CPUE analysis, the report suggested establishment and use of a subset of fishing vessels to provide more detailed logbook data than are recorded in the mandatory VTRs.

The report included several additional recommendations related to the use of fishery-dependent data and fishermen’s knowledge in the stock assessment process. The list below is excerpted from the Recommendations section of the 1998 report, with specific focus on fishery-dependent data use and utility.

- *Improve the collection, analysis, and modeling of stock assessment data. Such improvements could include evaluations of sample size, design, and data collection in the fishery and the surveys; the use of alternative methods for data analysis; consideration of a wider variety of assessment models; and better treatment of uncertainty in forecasting.*
- *Improve relationships and collaborations between NMFS and fishers by providing, for example, an opportunity to involve fishers in the stock assessment process and using fishers to collect and assess disaggregated Catch-Per-Unit-Effort data.*
- *Work toward a comprehensive management model that links stock assessments with ecological, social and economic responses and adaptation for long-term management strategies. This involves input from the social sciences (economics, social and political science, operational research) and from a wider range of natural sciences (ecology, genetics, oceanography) than traditionally is the case in fisheries management.*

In 2012, the Northeast Fisheries Science Center sponsored a Workshop titled, “Utility of Catch and Landings Per Unit of Fishing Effort (CPUE and LPUE) in Gulf of Maine and Georges Bank Cod Stock Assessments”, which included fishermen, fisheries scientists and managers (NEFSC, 2012c). The stated objectives of the workshop were to determine the factors of fishery-dependent information that confound the use of CPUE and LPUE, and recommend new ways to mitigate those factors and potentially incorporate their use in the assessments of the Gulf of Maine and Georges Bank cod stocks.

Presentations and discussions during the Workshop noted several challenges to the use of CPUE/LPUE indices in stock assessments, including the previously mentioned management interventions in the New England groundfish fishery, changes in fishery efficiency, market influences on targeted species, lack of reliable catch data, and shifts in trophic dynamics. However, participants generally agreed that there is low public access to and understanding of CPUE/LPUE data or modeling outcomes. The end result from assessments (i.e. stock status and catch level advice for managers) is mostly what is seen by the fishing community. Workshop participants discussed whether or not improving fishery-dependent data to support use of CPUE/LPUE information in stock assessments was worthwhile. Recommendations from the Workshop included:

- *Determine if dealer records are representative of CPUE/LPUE.*
- *Assemble relevant databases using VTRs, observer data and VMS information from specific fishing vessels that may have a more consistent fishing history over a large number of years.*
- *Examine alternative specifications for defining directed cod fishing trips, look at creating more concise categories of fishing gear and modes of deployment that are similar, and analyze these trips for CPUE/LPUE trends.*
- *Examine the use of temporal factors, such as seasonal or monthly time periods as fixed effects in the model using LPUE information.*

### **New Recommendations for the Use of CPUE in Northeast Multispecies Stock Assessments**

Based on our review of the use and utility of CPUE/LPUE information in stock assessments of New England groundfish prior to 1994, as well as in assessments of stocks in the Mid-Atlantic



region and ICES and ICCAT assessed stocks, we propose recommendations to reconsider CPUE data in future assessments of the groundfish stocks. These recommendations build upon previous suggestions with an objective of integrating existing information and supplementing current data collection systems.

- Collect the fishery-dependent information needed to identify target species as well as other important factors for standardizing catch rates, such as vessel, operator and gear characteristics, fine scale spatial and temporal fishing behavior and regulatory framework.

NOAA leadership in the Greater Atlantic Region prioritized modernizing fishery-dependent data systems as an opportunity to create efficiencies and improve catch accounting, stock assessments and fine-scale management approaches through timely and accurate data collection and processing. The National Marine Fisheries Service conducted a review of fishery-dependent data collection systems in the Northeast region in 2014, and proposed to implement an improved fishery-dependent data collection system by 2017 (GMRI, 2014). Several Stock Assessment Workshops have noted the lack of fine scale information as a challenge to incorporating fishery-dependent data, specifically CPUE in assessment models. Additionally, changes in technology, efficiency and behavior have been cited as reasons why CPUE information is not informative as an index of stock abundance. Collection of more detailed information about target species, fishing location, and vessel, operator and gear characteristics could enhance our understanding of fishing behavior under changing management scenarios, and provide the necessary level of detail to construct CPUE indices. The opportunity to introduce changes or additions to the current data collection systems is available under NOAA's fishery-dependent data visioning project, and inclusion of target species, vessel, operator and gear characteristics, fine scale spatial and temporal fishing behavior and regulatory framework should be included in the improved data collections system.

- Prioritize the evaluation of standardized CPUE and LPUE for New England groundfish species as a research agenda to be conducted outside of the stock assessment workshop process.

Fishery-dependent data are currently available for analysis. These data could be examined by assessment, academic or non-government scientists outside of the stock assessment process to determine the utility of including CPUE and LPUE information. Lack of time and resources during stock assessment workshops have been cited as reasons why extensive analyses of CPUE information have not been conducted. Efforts to standardize fishery-independent survey data have been conducted outside of assessments, resulting in availability of reviewed information for use in assessment models. Similar efforts should be applied to fishery-dependent data prior to benchmark assessment for New England groundfish stocks.

- Include the evaluation of standardized CPUE and LPUE as a term of reference in each benchmark stock assessment in Northeast stock assessment workshops for consideration in the stock assessment model.

The terms of reference for benchmark stock assessments set the scope of topics, analyses and issues to be covered by the assessment Working Group. Formal inclusion of

evaluation of standardized CPUE and LPUE as a term of reference could help to ensure that the topic is addressed, there is opportunity for public comment and input, there is an explanation of the rationale for inclusion or exclusion of the data, all possible uses of the information have been considered, and the use and utility of CPUE and LPUE can be reviewed externally by assessment review committees. This recommendation complements the previous recommendation to examine fishery-dependent data utility outside of the assessment process. Compiling the appropriate data and determining suitable methods for standardizing CPUE should be completed prior to the assessment, so that results can be used to address a specific term of reference for evaluation of the utility of the information for assessment purposes.

- Explore Study Fleet data for the derivation of standardized CPUE and LPUE series.

As noted above, the “Review of Northeast Fishery Stock Assessments” report suggested establishment and use of a subset of fishing vessels to provide more detailed logbook data than are recorded in the mandatory VTRs. The Northeast Fisheries Science Center developed the Study Fleet in 2007 with the objective of assembling a subset of commercial New England vessels capable of providing high resolution (spatial and temporal) self-reported data on catch, effort and environmental conditions while conducting “normal” fishing operations. The program was intended to provide stock assessment scientists with more precise and accurate fishery-dependent data (e.g., more precise estimates of fishing effort, spatially explicit catch, and discard locations) and to improve the understanding of catch rates and species assemblages (NEFSC, 2007). Additionally, it was noted that the collaborative nature of the Study Fleet pilot program could create a channel through which stock assessment scientists and industry members could directly communicate and share information that would serve as the basis for future collaborative research projects (Murawski 2002). The Study Fleet has been active for over 8 years, and has collected a large dataset of fishery-dependent information. A formal review of the utility of the data for the derivation of standardized CPUE and LPUE series should be conducted. The study fleet offers a small sample of the fleet with electronic logbooks. Fleet-wide implementation of electronic logbooks could offer a census of more precise catch location and effort statistics.

- Collaborate with fishermen to identify appropriate index fleets, factors influencing catch rates, and perceptions of trends in catch rates.

The mismatch between fishermen’s perceptions of what is occurring on the water and results from recent assessments for several New England groundfish stocks has caused a renewed interest in examining the use and utility of CPUE information in assessments. As previously noted, fishermen generally have a greater trust in the information they collect and a greater understanding of catch and effort statistics than fishery-independent data and model results. Additionally, fishermen may be able to accurately identify trends in catch rates based on historical knowledge of spatial and temporal species distributions, marketability, and business planning. Collaborating with fishermen to identify index fleets and trends in catch rates could enhance efforts to develop standardized CPUE indices. The Sector management system, which has been in place in New England since

2010, includes mechanisms to collect data on target species, influences of management intervention on catch and effort, operating costs, and species marketability. Efforts should be made to work collaboratively with members of the Sector system to extract useful fishery-dependent information and inform the stock assessment process.

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Table 1. Types of fishery-dependent data collected from required reports for the Northeast Multispecies complex.

| Data Type                      | Vessel Trip Report (VTR) | Vessel Monitoring System (VMS) | Dealer Report | Observer Reports (NEFOP) | At-Sea Monitoring (ASM) | Dockside Monitoring |
|--------------------------------|--------------------------|--------------------------------|---------------|--------------------------|-------------------------|---------------------|
| Vessel Permit                  | X                        | X                              | X             |                          |                         | X                   |
| Operator Permit                | X                        | X                              |               |                          |                         |                     |
| Area Fished (statistical area) | X                        |                                |               |                          |                         | X                   |
| Area Fished (Lat/Lon)          |                          | X                              |               | X                        | X                       |                     |
| Time Fished                    | X                        | X                              |               | X                        | X                       |                     |
| Landed Species (for sale)      | X                        |                                | X             | X                        | X                       | X                   |
| Landed Species (not sold)      |                          |                                |               | X                        | X                       |                     |
| Discarded Species              | X                        |                                |               | X                        | X                       |                     |
| Species Disposition            |                          |                                |               | X                        | X                       |                     |
| Landing Date                   |                          |                                | X             | X                        | X                       | X                   |
| Landing Port                   |                          |                                | X             | X                        | X                       | X                   |
| Dealer Demographics            |                          |                                | X             |                          |                         |                     |
| Market Category                |                          |                                | X             |                          |                         |                     |
| Landed Species Price           |                          |                                | X             |                          |                         |                     |
| Tow Duration                   |                          | X                              |               | X                        | X                       |                     |
| Steaming Time                  |                          | X                              |               |                          |                         |                     |
| Vessel Characteristics         |                          |                                |               | X                        | X                       |                     |
| Gear Characteristics           |                          |                                |               | X                        | X                       |                     |
| Target Species                 |                          |                                |               | X                        | X                       |                     |
| Biological Information         |                          |                                |               | X                        |                         |                     |

Table 2. Types of collaborative research data collected by fishermen to support stock assessment and management advice.

| Data Type                                                 | Industry-Based Surveys | Tagging Studies | Mortality Studies |
|-----------------------------------------------------------|------------------------|-----------------|-------------------|
| Area Swept Biomass by Species                             | X                      |                 |                   |
| Biological Samples                                        | X                      |                 |                   |
| Gear Selectivity                                          | X                      |                 |                   |
| Gear Efficiency                                           | X                      |                 |                   |
| Seasonal Distribution by Species                          | X                      | X               |                   |
| Movement Patterns                                         |                        | X               |                   |
| Stock Identification                                      |                        | X               |                   |
| Abundance Estimates                                       |                        | X               |                   |
| Spawning Locations                                        |                        | X               |                   |
| Discard Mortality Estimates (commercial and recreational) |                        | X               | X                 |
| Post-Release Survival Estimates                           |                        |                 | X                 |

Table 3. The species and stocks of groundfish managed under the Northeast Multispecies Fishery Management Plan.

| Species             | Stocks                                                                      |
|---------------------|-----------------------------------------------------------------------------|
| Cod                 | Gulf of Maine<br>Georges Bank                                               |
| Haddock             | Gulf of Maine<br>Georges Bank                                               |
| Yellowtail Flounder | Cape Cod/Gulf of Maine<br>Georges Bank<br>Southern New England/Mid-Atlantic |
| Winter Flounder     | Gulf of Maine<br>Georges Bank<br>Southern New England/Mid-Atlantic          |
| Windowpane Flounder | Gulf of Maine/Georges Bank<br>Southern New England/Mid-Atlantic             |
| American Plaice     | Gulf of Maine/Georges Bank                                                  |
| Witch Flounder      | Single Stock                                                                |
| Acadian Redfish     | Gulf of Maine/Georges Bank                                                  |
| Pollock             | Single Stock                                                                |
| White Hake          | Gulf of Maine/Georges Bank                                                  |
| Atlantic Halibut    | Gulf of Maine/Georges Bank                                                  |
| Ocean Pout          | Single Stock                                                                |
| Atlantic Wolffish   | Single Stock                                                                |

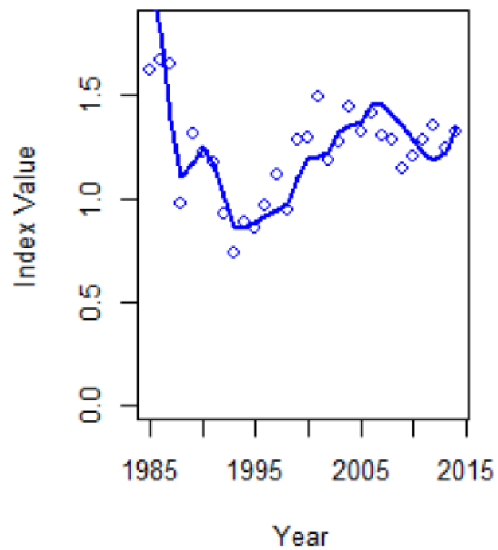


Figure 1. Bluefish model (solid line) fit to the MRIP CPUE index (open circles; from NEFSC, 2015a).

#### Appendix 4: Introduction of Bias in CPUE from case selection based on relative fraction of target species.

Simple Example in Excel

In many assessments the determination of target species for a trip is done post hoc, using existing data. For example in such an analysis the target species could be defined as the species whose total weight exceeds some fraction of the total weight for the trip. Under this criteria the CPUE index is based on the subset of trips which have target species ratios above the cut point. Table 1 shows the ratios for catches to the target species (an arbitrary range from 0 to 10) compared to the catch of non-target species, also ranging from 0 to 10. Suppose the analyst chose a ratio of 0.5 as the threshold criteria. Table 2 shows in red shading (and the value 1) those trips that would be included in the analysis of CPUE. However it is immediately clear that many trips that caught the target species will be excluded from the analysis.

Table 1 . Ratio of target species to total catch for a two species system. Observations would be excluded when ratio falls below user specified criteria

|                               |    | Catch of Target species |          |          |          |          |          |          |          |          |          |          |
|-------------------------------|----|-------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                               |    | 0                       | 1        | 2        | 3        | 4        | 5        | 6        | 7        | 8        | 9        | 10       |
| Catches of non-target species | 0  | 0                       | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1        | 1        |
|                               | 1  | 0                       | 0.5      | 0.666667 | 0.75     | 0.8      | 0.833333 | 0.857143 | 0.875    | 0.888889 | 0.9      | 0.909091 |
|                               | 2  | 0                       | 0.333333 | 0.5      | 0.6      | 0.666667 | 0.714286 | 0.75     | 0.777778 | 0.8      | 0.818182 | 0.833333 |
|                               | 3  | 0                       | 0.25     | 0.4      | 0.5      | 0.571429 | 0.625    | 0.666667 | 0.7      | 0.727273 | 0.75     | 0.769231 |
|                               | 4  | 0                       | 0.2      | 0.333333 | 0.428571 | 0.5      | 0.555556 | 0.6      | 0.636364 | 0.666667 | 0.692308 | 0.714286 |
|                               | 5  | 0                       | 0.166667 | 0.285714 | 0.375    | 0.444444 | 0.5      | 0.545455 | 0.583333 | 0.615385 | 0.642857 | 0.666667 |
|                               | 6  | 0                       | 0.142857 | 0.25     | 0.333333 | 0.4      | 0.454545 | 0.5      | 0.538462 | 0.571429 | 0.6      | 0.625    |
|                               | 7  | 0                       | 0.125    | 0.222222 | 0.3      | 0.363636 | 0.416667 | 0.461538 | 0.5      | 0.533333 | 0.5625   | 0.588235 |
|                               | 8  | 0                       | 0.111111 | 0.2      | 0.272727 | 0.333333 | 0.384615 | 0.428571 | 0.466667 | 0.5      | 0.529412 | 0.555556 |
|                               | 9  | 0                       | 0.1      | 0.181818 | 0.25     | 0.307692 | 0.357143 | 0.4      | 0.4375   | 0.470588 | 0.5      | 0.526316 |
|                               | 10 | 0                       | 0.090909 | 0.166667 | 0.230769 | 0.285714 | 0.333333 | 0.375    | 0.411765 | 0.444444 | 0.473684 | 0.5      |

Table 2. Cells included in computations when threshold for percent composition is equal to 0.5

|                               |    | Catch of Target species |   |   |   |   |   |   |   |   |   |    |
|-------------------------------|----|-------------------------|---|---|---|---|---|---|---|---|---|----|
|                               |    | 0                       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Catches of non-target species | 0  | 0                       | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |
|                               | 1  | 0                       | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |
|                               | 2  | 0                       | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |
|                               | 3  | 0                       | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |
|                               | 4  | 0                       | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |
|                               | 5  | 0                       | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1  |
|                               | 6  | 0                       | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1  |
|                               | 7  | 0                       | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1  |
|                               | 8  | 0                       | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1  |
|                               | 9  | 0                       | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1  |
|                               | 10 | 0                       | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1  |

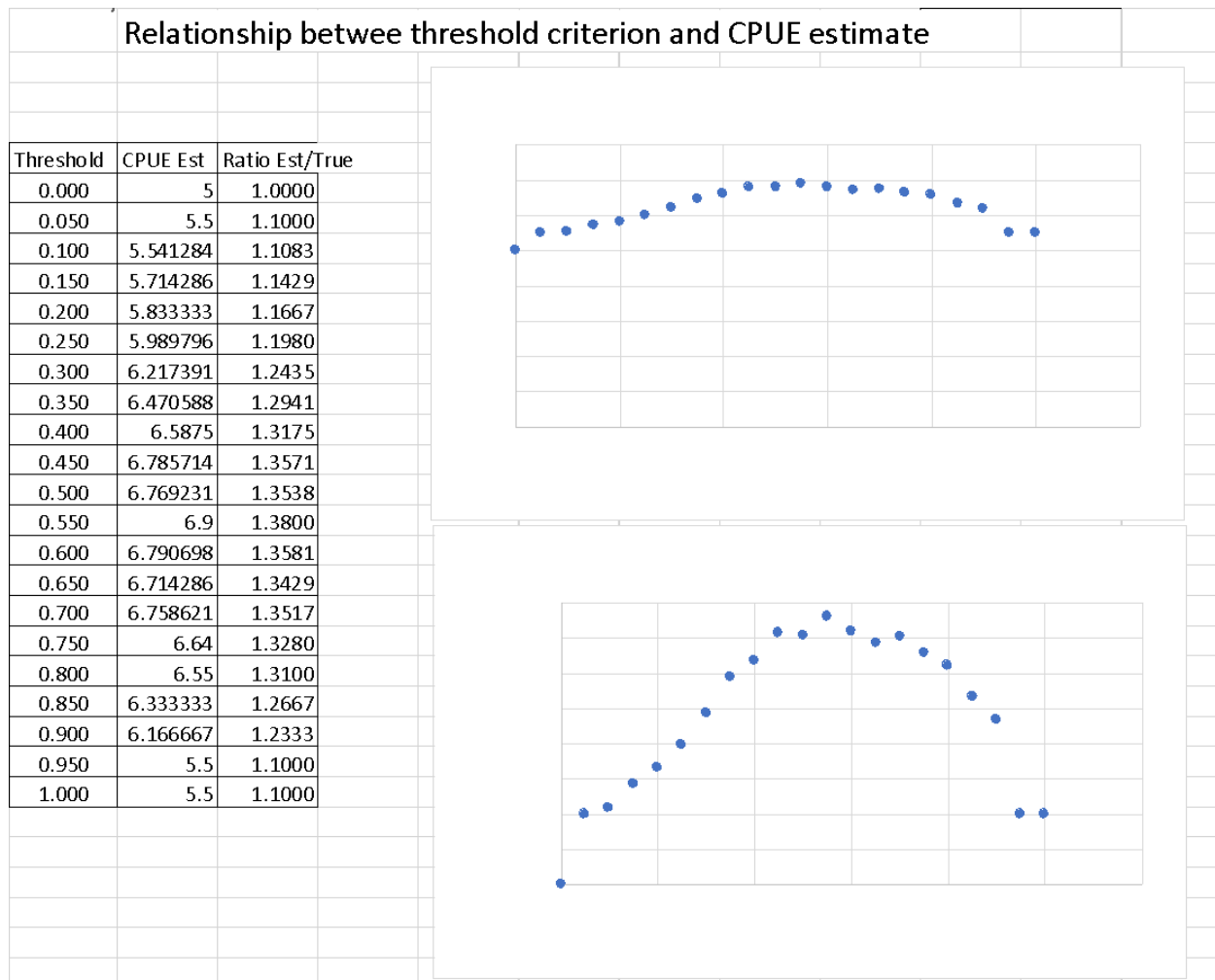
Thus far we have not considered the probability of observing the catches of target and non-target species. As a simplification, assume that the chances of observing catches of the target species of 0, 1, 2, ...10 are equally probable, i.e,  $P=1/11$ . Similarly assume that the non-target species has the same probability ( $P=1/11$ ). The joint probability is the product of the two independent probabilities or  $(1/11)*(1/11)= 0.008264$  as shown in Table 3. Note that the total probability of

all the cells in Table 3 is one. The CPUE index over the entire sample space is simply the value of the target species multiplied by the product of the joint probabilities. When all the data are used the CPUE is 5.5. If however, the threshold criteria of 0.5 is used, the CPUE estimate is higher, because only 53.719% of the observation are used (Table 4). The CPUE estimate based on the truncated sample is 6.77 as shown in Table 5. This is 23% higher than the CPUE estimate over the original set of trips. If the relationship between the target and non-target species were to remain constant over time, then a 23% bias in the CPUE would not be important because the trends would be the same. However, this assumption strains credulity given the dynamics of stocks that constitute the multispecies groundfish fishery. The relative abundances of the typical groundfish species are likely to vary over time, resulting in variable biases over time.

|                                                                                                                       |       |                         |          |          |          |          |          |          |          |          |          |          |             |
|-----------------------------------------------------------------------------------------------------------------------|-------|-------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-------------|
| Table 3. Joint probability of occurrence when Target species is between zero and 10 and non-target species is 0 to 10 |       |                         |          |          |          |          |          |          |          |          |          |          |             |
|                                                                                                                       |       | Catch of Target species |          |          |          |          |          |          |          |          |          |          |             |
|                                                                                                                       |       | 0                       | 1        | 2        | 3        | 4        | 5        | 6        | 7        | 8        | 9        | 10       | Value       |
|                                                                                                                       | value | Prob                    | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | Probability |
| value                                                                                                                 | 0     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 1     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 2     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 3     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 4     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 5     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 6     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 7     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 8     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 9     | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 10    | 0.09091                 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
| Total Prob                                                                                                            |       |                         |          |          |          |          |          |          |          |          |          | 1        |             |
| Table 4. Probability of occurrence for filtered observations.                                                         |       |                         |          |          |          |          |          |          |          |          |          |          |             |
|                                                                                                                       |       | Catch of Target species |          |          |          |          |          |          |          |          |          |          |             |
|                                                                                                                       |       | 0                       | 1        | 2        | 3        | 4        | 5        | 6        | 7        | 8        | 9        | 10       | Value       |
|                                                                                                                       | value | Prob                    | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | Probability |
| value                                                                                                                 | 0     | 0.09091                 | 0        | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 1     | 0.09091                 | 0        | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 2     | 0.09091                 | 0        | 0        | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 3     | 0.09091                 | 0        | 0        | 0        | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 4     | 0.09091                 | 0        | 0        | 0        | 0        | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 5     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0.008264 | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 6     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0.008264 | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 7     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.008264 | 0.008264 | 0.008264 |             |
|                                                                                                                       | 8     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.008264 | 0.008264 |             |
|                                                                                                                       | 9     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.008264 |             |
|                                                                                                                       | 10    | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.008264 |             |
| Total Prob                                                                                                            |       |                         |          |          |          |          |          |          |          |          |          | 0.53719  |             |
| Table 5. Product of Catch value * probability of occurrence for filtered observations.                                |       |                         |          |          |          |          |          |          |          |          |          |          |             |
|                                                                                                                       |       | Catch of Target species |          |          |          |          |          |          |          |          |          |          |             |
|                                                                                                                       |       | 0                       | 1        | 2        | 3        | 4        | 5        | 6        | 7        | 8        | 9        | 10       | Value       |
|                                                                                                                       | value | Prob                    | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | 0.09091  | Probability |
| value                                                                                                                 | 0     | 0.09091                 | 0        | 0.008264 | 0.016529 | 0.024793 | 0.033058 | 0.041322 | 0.049587 | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 1     | 0.09091                 | 0        | 0.008264 | 0.016529 | 0.024793 | 0.033058 | 0.041322 | 0.049587 | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 2     | 0.09091                 | 0        | 0        | 0.016529 | 0.024793 | 0.033058 | 0.041322 | 0.049587 | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 3     | 0.09091                 | 0        | 0        | 0        | 0.024793 | 0.033058 | 0.041322 | 0.049587 | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 4     | 0.09091                 | 0        | 0        | 0        | 0        | 0.033058 | 0.041322 | 0.049587 | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 5     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0.041322 | 0.049587 | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 6     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0.049587 | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 7     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.057851 | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 8     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.066116 | 0.07438  | 0.082645    |
|                                                                                                                       | 9     | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.07438  | 0.082645    |
|                                                                                                                       | 10    | 0.09091                 | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0        | 0.082645 |             |
| Total CPUE                                                                                                            |       |                         |          |          |          |          |          |          |          |          |          | 6.769231 |             |

The degree of bias as a function of the threshold criterion was examined for thresholds from 0 to 1 and is shown in the two graphs below. The ratio of the derived estimate to the true CPUE ranges from 1 to 1.36 in this hypothetical example.





More realistic example in R.

The above “toy” example assumes a uniform distribution of catches in both the species 1 and 2. More realistic simulations can be used to show the effects of alternative distributions of catch and the magnitude of bias induced when the abundance of the target species declines between sampling periods:

R code

```
# Quick simulation model to demonstrate the bias of defining cpue based on % composition of
target species
require(graphics)
```

```
B1t1<-10000 # Abundance of species 1 in first time period
B2t1<-10000 # Abundance of species 2 in first time period
B1t2<-5000 # Abundance of species 1 in second time period
B2t2<-10000 # Abundance of species 2 in second time period
```

```

p<-0.001 #Probability of capture for species 1 and 2 per unit of effort
ns<-10000 #Total units of effort in both time period 1 and 2
rcut<-seq(0.05, 0.75, by= 0.05) #This is the threshold applied to trips to identify targetted trips

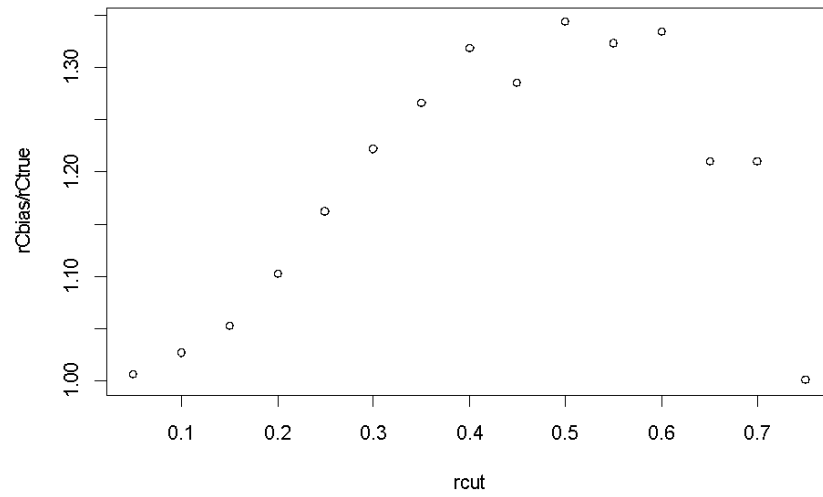
for(i in 1:15){
  #Compute the random catches for each unit of effort using binomial distr,
  #C1t1<-rbinom(ns,B1t1,p)
  #C2t1<-rbinom(ns,B2t1,p)
  #C1t2<-rbinom(ns,B1t2,p)
  #C2t2<-rbinom(ns,B2t2,p)
  #Compute random catches for each unit of effort using the log normal distribution

  C1t1<-rlnorm(ns,meanlog=log(B1t1),sdlog=sqrt(log(B1t1)))
  C2t1<-rlnorm(ns,meanlog=log(B2t1),sdlog=sqrt(log(B2t1)))
  C1t2<-rlnorm(ns,meanlog=log(B1t2),sdlog=sqrt(log(B1t2)))
  C2t2<-rlnorm(ns,meanlog=log(B2t2),sdlog=sqrt(log(B2t2)))

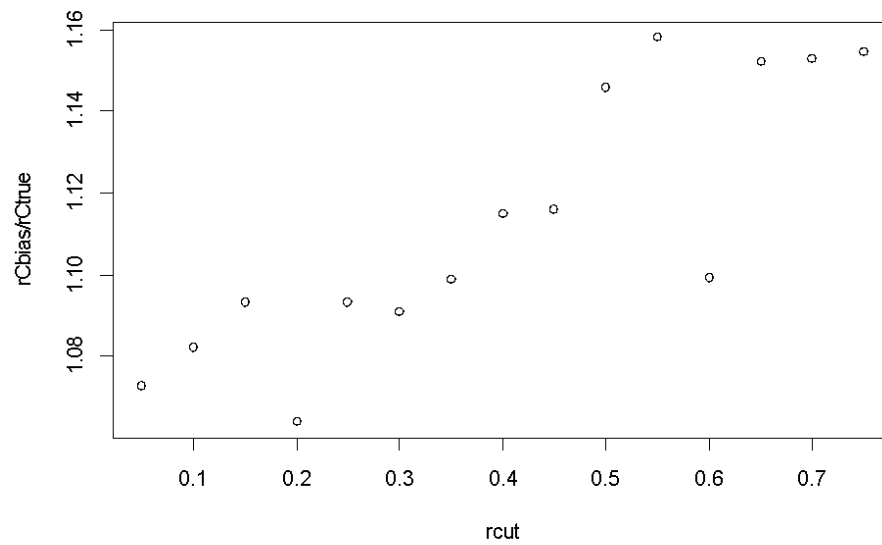
  #Compute the fraction of species 1 in total catch for each time period
  f1t1<-C1t1/(C1t1+C2t1)
  f1t2<-C1t2/(C1t2+C2t2)
  #Misc intermediate computations
  #max(f1t1)
  #max(f1t2)
  #mean(C1t1)
  #mean(C1t2)
  #mean(C1t1[f1t1>rcut[i]])
  #mean(C1t2[f1t2>rcut[i]])
  rBtrue[i]<-B1t2/B1t1 #This is the true ratio of abundance between time periods
  rCtrue[i]<-mean(C1t2)/mean(C1t1) # This the ratio of CPUE using all the data
  # This is the ratio of CPUE truncated by the Fraction of targeting
  rCbias[i]<-mean(C1t2[f1t2>rcut[i]])/mean(C1t1[f1t1>rcut[i]])
  #ratiobias[i]<-rCbias[i]/rCtrue[i]
}
rcut
rBtrue
rCtrue
rCbias
rCbias/rCtrue # This is the relative bias induced by the selection criteria for targetting
plot(rcut,rCbias/rCtrue)

```

Example with binomial distribution



Example with lognormal distribution



The above graphs demonstrate that the degree of bias varies with the cut points selected. In this example the true abundance changes by 50% between sampling events, but the bias can exceed 30%. Thus the bias induced by post hoc determination of target species could obscure the ability to detect reduction in abundance of 50%.

# Evaluating the Observer Effect for the Northeast U.S. Groundfish Fishery

*Chad Demarest*

*May 31, 2018*

## **Groundfish Plan Development Team - White Paper**

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– DRAFT –

## **Introduction**

The commercial component of the Northeast U.S. Multispecies fishery comprises 20 individual fish stocks and 2 management units<sup>1</sup>. Of these, commercial fisherman are allocated quota for 15 stocks, leaving 5 for which retention is prohibited. Fishing quota is allocated to approximately 1,000 permits and actively fished by around 200 participating commercial vessels (NEFMC 2017). The majority of the commercial fishery for groundfish (~98% of landings) is managed under the Sector system whereby individual vessel owners pool stock-level quota into 21 sectors, each operating as a collective, pooling the quota and allocating it to individual member fisherman. Observers are deployed on participating vessels to estimate discarded catch for each of the 22 fish stocks on each trip. Observer coverage levels vary across stocks but in general observers have been onboard trips accounting for between 15-40% of all trips taken in any given fishing year. Actual discards are calculated by dividing the sum of stock-level discards observed for observed tows by the total amount of retained catch on these trips. For trips with no observer coverage, discards are estimated by stratifying the population of fishing trips by broad stock area, sector and fishing gear and applying the annualized real time observed discard rate for each sector's strata. Estimates are applied to the corresponding strata's unobserved trips. Discards count against a sector's quota after adjusting for gear and stock-specific discard mortality rates. Vessels are assessed estimated discards on unobserved trips based on their strata, regardless of whether or not an individual species was reported on that trip. Sectors must have adequate quota reserves for all species in a given stock area prior to any member vessels fishing in that area.

As observer coverage represents only a fraction of the total fishing activity in the sector component of the commercial groundfish fishery, obvious questions arise: Does data generated on observed fishing trips reflect the activities of the whole fleet? Are estimates generated from these data unbiased? Bias may be induced by either a deployment effect, where the assignment of observers to vessels is non-random, or an observer effect, where the fishing activities on observed trips vary in detectable ways from those on unobserved trips (Benoit and Allard 2009). These two effects, deployment and observer, may act separately and in combination to render data collected by on board observers biased. This paper focuses specifically on one component of the the latter effect: do individual vessels alter their behavior in response to the presence of an observer?

Fisherman may alter their fishing behavior when carrying an observer for any one of at least five reasons: (1) people may act differently as a response to simply being watched, an established phenomena referred to as the Hawthorne Effect (McCambridge et al. 2018); (2) fisherman may not want to impart their individual discarding preferences on the other members of their sector, an effect driven primarily by within-strata target

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<sup>1</sup>George's Bank is divided into a "west" component for which haddock and cod stocks are assessed exclusively by NOAA fisheries, and an "east" component for which these stocks together with yellowtail flounder are jointly assessed with the Canadian Department of Fisheries and Oceans under a trans-boundary management agreement.

species and fishing practice heterogeneity; (3) observers incur costs associated with slower fish processing and handling times, carrying extra food, and general inconvenience, all of which may incentivize fisherman to make shorter trips when observers are on board; (4) catch of undersized fish varies across space and fishing in areas and at times where undersized fish are relatively less abundant may minimize discard rates, though presumably at a cost in terms of reduced total trip revenues; and (5) binding quota constraints impart strong economic incentives to discard legal-sized fish when an observer is not on board and to avoid these stocks in the presence of an observer, again presumably at a cost in terms of reduced total trip revenues.

This paper employs an exact matching method to determine if vessel performance along several metrics vary in a detectable way when an observer is on board, and when one is not.

## Methods

Following a procedure laid out by Benoit and Allard, same-vessel trip sequences are analyzed to test for differences among various metrics. These trip sequences take the form of either: (1) three unobserved trips in a row (UUU), or (2) one observed trip between unobserved trips (UOU). To attenuate the possibility of interpreting seasonal effects as behavioral effects, only trips occurring within 45 days of each other are included. Trips are not repeated in multiple sequences. Vessels with less than two sequences are excluded from the analysis.

Triplet sequences are winnowed to pairs by taking the difference of either the leading or lagging trip with respect to the middle trip. The variable  $U$  in equation (1) and  $U^1$  in equation (2), below, are selected randomly as either the leading or trailing trip in the triplet sequence, while the middle trip in the sequence is always the reference trip ( $O$  or  $U^1$ , below). To mitigate against regulatory changes affecting fishing behavior within trip sequences while maximizing particularly the number of OU pairs for analysis, sequences overlapping the start of a new fishing year change (May 1 of each year) select only the lead or lag pair occurring in the same FY as the reference trip.

Differences are calculated as

$$\Delta O_{yfv} = (O - U/U)_{yfv} * 100$$

(Equation 1)

$$\Delta U_{yfv} = (U^1 - U^2/U)_{yfv} * 100$$

(Equation 2)

where  $y$  is a fishing year,  $f$  is fishing vessel and  $v$  is any one of the metrics evaluated.  $U$  is the mean unobserved value for each year, vessel and metric combination.

Metrics evaluated,  $v$ , are:

1. Trip duration
2. Kept catch
3. Total revenue
4. Kept groundfish
5. Kept non-groundfish
6. Groundfish average price
7. Non-groundfish average price
8. Number of market categories included in kept catch

The difference between the median values for  $\Delta U$ 's and  $O$ 's is calculated as



$$(M_{\Delta U - \Delta O})_{yfv} = \text{median}(\Delta U)_{yfv} - \text{median}(\Delta O)_{yfv}$$

(Equation 3)

Differences between observed and unobserved trips are tested in three ways: (1) location differences<sup>2</sup> are observed in  $M_{\Delta U - \Delta O}$ , with 95% confidence intervals estimated using bootstrap sampling (1,000 replicates) from the  $U_{yfv}$  and  $O_{yfv}$  values, where a lack of overlap with zero implies a 95% probability that the true median values for each population are significantly different; (2) the Kolmogorov-Smirnov statistic is used to test for general differences in shape of the  $U_{yfv}$  and  $O_{yfv}$  distributions; and (3) the Kuiper statistic is used to test for differences in the extremities of the distributions.

Multiple hypothesis tests are performed with the Kolmogorov-Smirnov (KSA) and Kuiper (KA) statistics. For these, a p-value of 0.005 is considered to be significant. Statistical significance should be considered in light of the data and research question. All p-values are reported.

## Data

Vessel Trip Report (VTR) and Commercial Fishery Dealer (CFDBS) data are combined to construct trip-level data using the Data Matching and Imputation System (DMIS) database [cite needed]. Trips with an Allocation Management System (AMS) declaration code of “NMS” are included in the initial dataset. Only vessels fishing with trawl or gillnet gears are retained. Observer trips are matched by a step-wise algorithm, focusing on permit number, VTR serial number, days-at-sea (DAS) identification number, date and time sailed. For the post-Sector years, both Northeast Fishery Observer Program (NEFOP) and at-sea monitoring (ASM) data are matched.

UUU and UOU triplets are extracted from these data, and annual fishing year data sets are built (May 1 – April 30) with same-vessel two-trip sequences constructed from the UUU and UOU triplets.

Trips in the United States-Canada Resource Sharing Agreement Area (USCA area) are removed from the pre-sector (FY 2007-2009) dataset, as these trips were subject to observer coverage at higher rates than trips outside the area. All trips fishing with extra large mesh (ELM) under the conditions of the 2015 ELM exemption are excluded for all years, as are all trips by vessels enrolled in the Common Pool from 2010-2017. All excluded trips and their corresponding triplets are retained and, to better understand the potential drivers of observer effects, may be analyzed separately in the future.

## Results

Results are reported based on two levels of aggregation:

- regulatory regime, as
  - pre-Sector years (FY’s 2007-2009),
  - initial Sector years (FY’s 2010-2012),
  - intermediate Sector years (FY’s 2013-2015),
  - contemporary Sector years (FY’s 2016-2017); and
- gear type, distinguishing between trawl and gillnet gears<sup>3</sup>.

<sup>2</sup>“Location” refers to the central tendency of the data, in this case the median values, and has no geographic connotation here.

<sup>3</sup>Trawl gears include the Vessel Trip Report (VTR) codes ‘OHS’, ‘OTB’, ‘OTC’, ‘OTF’, ‘OTM’, ‘OTO’, ‘OTR’, ‘OTS’, and ‘OTT’. Gillnet gears include the codes ‘GNR’, ‘GNS’, and ‘GNT’.

Preliminarily, results at the fishing year (FY) level, dis-aggregated by gillnet and trawl, are included for context. Separate analyses have also been completed for single-day and multi-day trips, as well as a stock-level analysis of kept catch, number of market categories and average price for 15 individual groundfish stocks. The results are still being analyzed and will be integrated in the future.

## Tests for differences in central tendency

Equations (1) and (2) are scaled by each vessel's mean annual values and median value differences are represented as percentages. For example, a median value of -0.042 for the kept catch variable implies that vessels catch roughly 4.2% less fish on an observed trip, relative to a neighboring unobserved trip by that same vessel, as measured across all vessels in the dataset. If the bootstrapped 95% confidence intervals fail to overlap with zero, the value is interpreted as significant using the confidence interval test.

Trawl vessels catch less fish when an observer is onboard. In the stanzas after 2009, they fish for less time and land less groundfish in particular. Statistical significance is obtained for kept catch in all four stanzas, and for trip duration, groundfish kept catch and total revenues in the three post-2009 stanzas. Groundfish average prices are statically higher for three of the four stanzas, the exception being the period from 2010-2012, indicating that composition of groundfish catch on observed and unobserved trips is different. Based on the reductions in catch and fishing time on observed trips after 2009, the changes in response to observer presence appear to be related to incentives embedded in catch accountability and the sector management system.

Gillnet vessels consistently made shorter trips, generate less revenue and appear to retain slightly less catch overall in the presence of an observer, but the results are more variable relative to trawl vessels. There is a trend in later stanzas toward more groundfish and less non-groundfish on observed trips for these vessels, indicating a difference in the mix of species landed in response to an observer. The increase in the number of groundfish market categories in the last stanza may indicate differential groundfish targeting, or perhaps high-grading of specific species. Statistically different behavior in response to an observer is equally prevalent for gillnet vessels and trawl vessels, but the magnitude of the effect appears to be slightly smaller for gillnet vessels. This may reflect a truly smaller behavioral response, or it may be due to a smaller number of paired trips, particularly in the later stanzas, or some combination of both. There is a less clear distinction in response before and after the implementation of sectors, where gillnet vessels demonstrated a significant response before sectors and trawl vessels, for the most part, did not.

## Tests for differences in distribution shape

*TBC*

## Discussion

Fishing vessels alter their behavior in response to observers. Estimated median paired trip differences are zero for only a handful of the metrics evaluated across stanzas or fishing years. Generally, the most pronounced effects are seen across trip duration, kept catch, kept groundfish and trip revenue. Observer presence has the smallest affect on the number of groundfish market categories and non-groundfish average prices, but even here we see differences.

Incentives to alter fishing behavior have varied across time. Prior to sector implementation discards had no direct cost to fisherman and trip limits required discarding certain species. These factors may have reduced the incentive to alter fishing practices in response to an observer, noting that gillnet vessels did demonstrate a significant behavioral response prior to sectors. After full sector implementation, the accountability of discards and the application of sector/gear specific discard rates to unobserved trips, together with the potential catch of constraining stocks, increased the incentive to change behavior in response to an observer.

There may be off-setting incentives due to quota allocations, fishing preferences or other factors. One vessel may attempt to minimize observed discarding of flatfish at the expense of cod, while another vessel may take the exact opposite approach. Such offsetting behavior could change the central tendency of the distribution of  $M_{\Delta U - \Delta O}$  very little, but may affect the shape of the distribution, particularly at the tails. This is where the Kuiper and Kolmogorov-Smirnov (K-S) tests become valuable. The K-S evaluates changes in the overall shape of the distribution, while the Kuiper tests for changes in the the tails.

These analyses point toward a consistent pattern of different fishing behaviors when an observer is on board. The Benoit and Allard method isolates vessel effects by focusing on the differences in behavior in response to an observer *for the same vessel*. The data show a clear trend for three key metrics—in almost all circumstances vessels appear to retain less fish, fish for less time and obtain lower revenues when an observer is on board. Persistent differences such as higher average groundfish prices with an observer on board (trawl vessels) and emerging differences like a greater number of market categories retained with an observer (gillnet vessels) indicate that the composition of catch on observed trips is different. This suggests that data collected by observers are not merely a compressed representation of unobserved fishing practices but, rather, they may be non-representative along critical dimensions such as proportions and quantities of fish discarded and retained.

## Tables and figures

Table 1: Stanza 1, 2007-2009

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     |          | -1.4 %      | -0.4 % | 0.3 %        | 21,734       | 750        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 0 %          | 21,734       | 750        |
| Trawl   | Groundfish avg price                | *        | 0.9 %       | 1.4 %  | 1.9 %        | 21,734       | 750        |
| Trawl   | Kept catch                          | *        | -4.6 %      | -3.5 % | -2.4 %       | 21,734       | 750        |
| Trawl   | Kept non-groundfish                 |          | 0 %         | 0 %    | 0 %          | 21,734       | 750        |
| Trawl   | Non-groundfish avg price            |          | 0 %         | 0 %    | 0 %          | 21,734       | 750        |
| Trawl   | Total revenue                       |          | -1 %        | 0.2 %  | 1.4 %        | 21,734       | 750        |
| Trawl   | Trip duration                       |          | -0.1 %      | 0.4 %  | 1.2 %        | 21,734       | 750        |
| Gillnet | Kept groundfish                     | *        | -2.6 %      | -1.9 % | -1.2 %       | 21,530       | 532        |
| Gillnet | Number groundfish market categories | *        | -3.5 %      | -2.1 % | -1 %         | 21,530       | 532        |
| Gillnet | Groundfish avg price                | *        | 1 %         | 1.5 %  | 2 %          | 21,530       | 532        |
| Gillnet | Kept catch                          | *        | -2.7 %      | -1.9 % | -1.1 %       | 21,530       | 532        |
| Gillnet | Kept non-groundfish                 | *        | -1 %        | -0.7 % | -0.4 %       | 21,530       | 532        |
| Gillnet | Non-groundfish avg price            |          | -0.3 %      | 0 %    | 0 %          | 21,530       | 532        |
| Gillnet | Total revenue                       | *        | -4.4 %      | -3.5 % | -2.6 %       | 21,530       | 532        |
| Gillnet | Trip duration                       | *        | -4.9 %      | -4.3 % | -3.9 %       | 21,530       | 532        |

Table 2: Stanza 2, 2010-2012

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -11.7 %     | -9.2 % | -6.8 %       | 5,756        | 1,616      |
| Trawl   | Number groundfish market categories |          | -0.9 %      | 0 %    | 0 %          | 5,756        | 1,616      |
| Trawl   | Groundfish avg price                |          | -1.3 %      | -0.3 % | 0.6 %        | 5,756        | 1,616      |
| Trawl   | Kept catch                          | *        | -11 %       | -8.5 % | -6.2 %       | 5,756        | 1,616      |
| Trawl   | Kept non-groundfish                 |          | -3.6 %      | -1.6 % | 0 %          | 5,756        | 1,616      |
| Trawl   | Non-groundfish avg price            |          | -0.2 %      | 0.5 %  | 1.8 %        | 5,756        | 1,616      |
| Trawl   | Total revenue                       | *        | -8.9 %      | -6.7 % | -4.4 %       | 5,756        | 1,616      |
| Trawl   | Trip duration                       | *        | -4.3 %      | -3 %   | -1.7 %       | 5,756        | 1,616      |
| Gillnet | Kept groundfish                     |          | -3.3 %      | -1 %   | 1.3 %        | 5,234        | 1,365      |
| Gillnet | Number groundfish market categories |          | 0 %         | 0.8 %  | 2.9 %        | 5,234        | 1,365      |
| Gillnet | Groundfish avg price                | *        | 0.3 %       | 1.2 %  | 2 %          | 5,234        | 1,365      |
| Gillnet | Kept catch                          |          | -3.6 %      | -1.6 % | 0.5 %        | 5,234        | 1,365      |
| Gillnet | Kept non-groundfish                 |          | -0.8 %      | -0.2 % | 0.2 %        | 5,234        | 1,365      |
| Gillnet | Non-groundfish avg price            |          | -1 %        | -0.1 % | 0.5 %        | 5,234        | 1,365      |
| Gillnet | Total revenue                       |          | -4.3 %      | -2.1 % | 0 %          | 5,234        | 1,365      |
| Gillnet | Trip duration                       | *        | -4 %        | -3.2 % | -2.5 %       | 5,234        | 1,365      |

Table 3: Stanza 3, 2013-2015

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -10.2 %     | -7.9 % | -5.4 %       | 5,944        | 1,026      |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 0 %          | 5,944        | 1,026      |
| Trawl   | Groundfish avg price                | *        | 0.9 %       | 1.9 %  | 3 %          | 5,944        | 1,026      |
| Trawl   | Kept catch                          | *        | -10.7 %     | -8.6 % | -6.1 %       | 5,944        | 1,026      |
| Trawl   | Kept non-groundfish                 |          | -5.1 %      | -2.4 % | 0.1 %        | 5,944        | 1,026      |
| Trawl   | Non-groundfish avg price            |          | -1.9 %      | -0.3 % | 0.9 %        | 5,944        | 1,026      |
| Trawl   | Total revenue                       | *        | -7.2 %      | -5 %   | -2.8 %       | 5,944        | 1,026      |
| Trawl   | Trip duration                       | *        | -4.6 %      | -3.3 % | -2.1 %       | 5,944        | 1,026      |
| Gillnet | Kept groundfish                     |          | -2.2 %      | 0.8 %  | 4 %          | 3,287        | 447        |
| Gillnet | Number groundfish market categories |          | 0 %         | 0 %    | 1.6 %        | 3,287        | 447        |
| Gillnet | Groundfish avg price                |          | -0.8 %      | 0.3 %  | 1.6 %        | 3,287        | 447        |
| Gillnet | Kept catch                          |          | -2.1 %      | 0.7 %  | 3.3 %        | 3,287        | 447        |
| Gillnet | Kept non-groundfish                 |          | -3.9 %      | -2 %   | 0.2 %        | 3,287        | 447        |
| Gillnet | Non-groundfish avg price            | *        | 0.3 %       | 2.1 %  | 4.2 %        | 3,287        | 447        |
| Gillnet | Total revenue                       |          | -0.1 %      | 2.7 %  | 5.3 %        | 3,287        | 447        |
| Gillnet | Trip duration                       | *        | -4.4 %      | -3.3 % | -2.4 %       | 3,287        | 447        |

Table 4: Stanza 4, 2016-2017

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -9.5 %      | -6.8 % | -4.1 %       | 3,559        | 571        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 0 %          | 3,559        | 571        |
| Trawl   | Groundfish avg price                | *        | 0.9 %       | 2 %    | 3.3 %        | 3,559        | 571        |
| Trawl   | Kept catch                          | *        | -7 %        | -4.4 % | -1.5 %       | 3,559        | 571        |
| Trawl   | Kept non-groundfish                 |          | -3.1 %      | -0.2 % | 2.4 %        | 3,559        | 571        |
| Trawl   | Non-groundfish avg price            |          | -2.4 %      | -0.6 % | 1 %          | 3,559        | 571        |
| Trawl   | Total revenue                       | *        | -5.4 %      | -2.8 % | -0.1 %       | 3,559        | 571        |
| Trawl   | Trip duration                       | *        | -4.3 %      | -2.8 % | -1.3 %       | 3,559        | 571        |
| Gillnet | Kept groundfish                     |          | -1.4 %      | 4.1 %  | 10.1 %       | 996          | 197        |
| Gillnet | Number groundfish market categories |          | 0 %         | 5.4 %  | 9.5 %        | 996          | 197        |
| Gillnet | Groundfish avg price                |          | -0.5 %      | 2.4 %  | 5.5 %        | 996          | 197        |
| Gillnet | Kept catch                          |          | -8.1 %      | -3.8 % | 0.8 %        | 996          | 197        |
| Gillnet | Kept non-groundfish                 | *        | -13 %       | -8.1 % | -4 %         | 996          | 197        |
| Gillnet | Non-groundfish avg price            |          | -1.7 %      | 0.9 %  | 3.6 %        | 996          | 197        |
| Gillnet | Total revenue                       |          | -7.3 %      | -3.1 % | 1 %          | 996          | 197        |
| Gillnet | Trip duration                       | *        | -4.7 %      | -3.2 % | -1.3 %       | 996          | 197        |



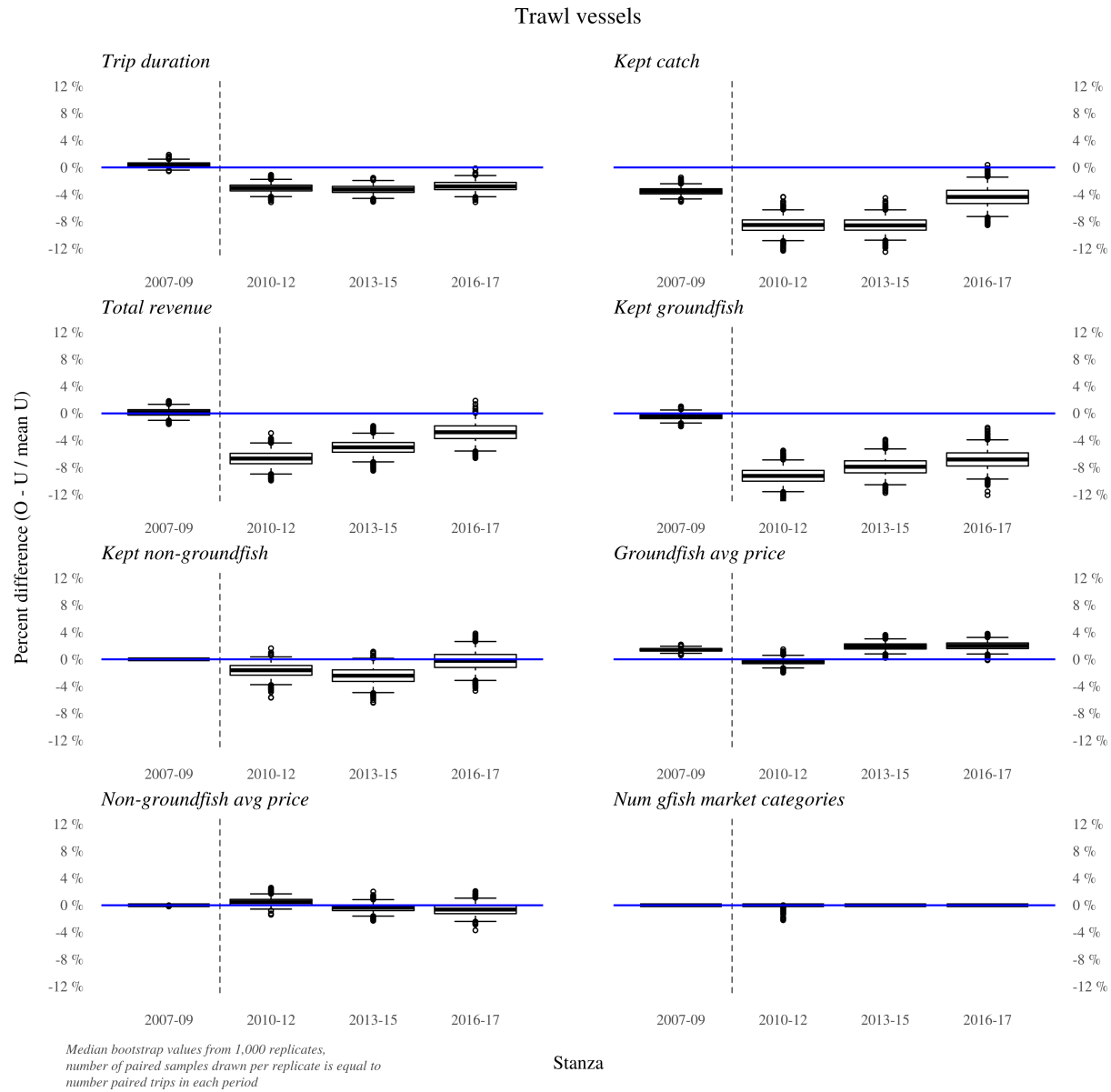


Figure 1: Results of bootstrap analysis, observed and unobserved same-vessel paired trips by stanza

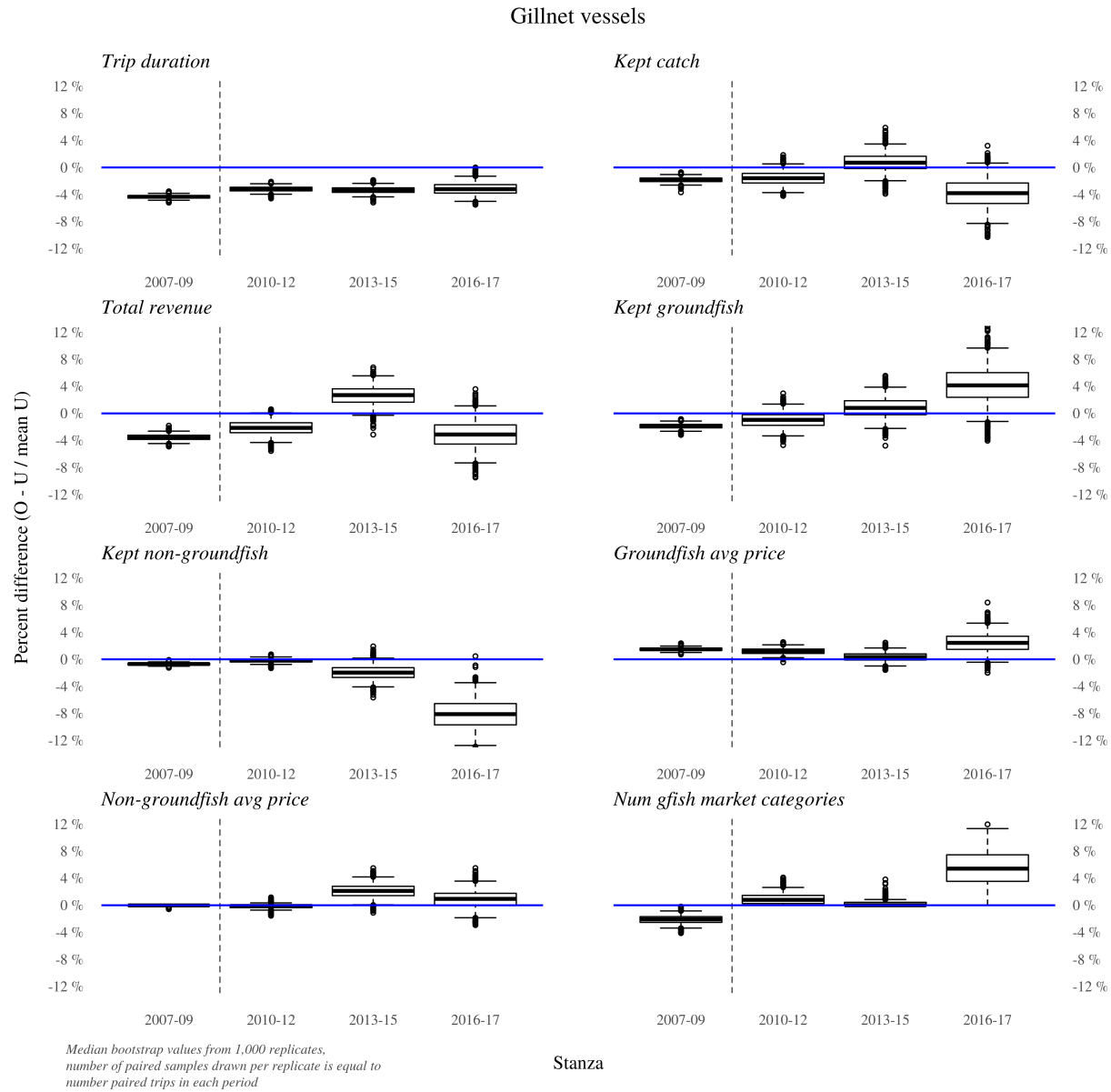


Figure 2: Results of bootstrap analysis, observed and unobserved same-vessel paired trips by stanza

Table 5: Fishing Year 2007

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -4.7 %      | -2.8 % | -0.9 %       | 8,076        | 247        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 0 %          | 8,076        | 247        |
| Trawl   | Groundfish avg price                | *        | 0.3 %       | 1 %    | 1.7 %        | 8,076        | 247        |
| Trawl   | Kept catch                          | *        | -8.1 %      | -6.2 % | -4.4 %       | 8,076        | 247        |
| Trawl   | Kept non-groundfish                 |          | -3.8 %      | -1.8 % | 0 %          | 8,076        | 247        |
| Trawl   | Non-groundfish avg price            |          | 0 %         | 0 %    | 0.1 %        | 8,076        | 247        |
| Trawl   | Total revenue                       |          | -3.2 %      | -1.4 % | 0.6 %        | 8,076        | 247        |
| Trawl   | Trip duration                       |          | -2.1 %      | -0.9 % | 0 %          | 8,076        | 247        |
| Gillnet | Kept groundfish                     | *        | -4.7 %      | -2.9 % | -1.3 %       | 6,172        | 154        |
| Gillnet | Number groundfish market categories | *        | -6.7 %      | -4.2 % | -1.9 %       | 6,172        | 154        |
| Gillnet | Groundfish avg price                |          | -0.3 %      | 0.5 %  | 1.3 %        | 6,172        | 154        |
| Gillnet | Kept catch                          |          | -1.5 %      | 0 %    | 1.5 %        | 6,172        | 154        |
| Gillnet | Kept non-groundfish                 |          | -0.6 %      | 0 %    | 0 %          | 6,172        | 154        |
| Gillnet | Non-groundfish avg price            |          | 0 %         | 0 %    | 0 %          | 6,172        | 154        |
| Gillnet | Total revenue                       | *        | -4.1 %      | -2.5 % | -0.9 %       | 6,172        | 154        |
| Gillnet | Trip duration                       | *        | -4.2 %      | -3.2 % | -2.3 %       | 6,172        | 154        |

Table 6: Fishing Year 2008

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     |          | -3.1 %      | -1.2 % | 0.5 %        | 7,348        | 303        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 0 %          | 7,348        | 303        |
| Trawl   | Groundfish avg price                | *        | 1.2 %       | 2.2 %  | 3.2 %        | 7,348        | 303        |
| Trawl   | Kept catch                          | *        | -7.6 %      | -5.7 % | -3.6 %       | 7,348        | 303        |
| Trawl   | Kept non-groundfish                 |          | 0 %         | 0 %    | 0 %          | 7,348        | 303        |
| Trawl   | Non-groundfish avg price            |          | -0.6 %      | 0 %    | 0 %          | 7,348        | 303        |
| Trawl   | Total revenue                       | *        | -5.7 %      | -3.4 % | -1.3 %       | 7,348        | 303        |
| Trawl   | Trip duration                       |          | -2.1 %      | -0.8 % | 0.3 %        | 7,348        | 303        |
| Gillnet | Kept groundfish                     | *        | -6.4 %      | -4.8 % | -3.3 %       | 6,903        | 180        |
| Gillnet | Number groundfish market categories |          | -2 %        | -0.2 % | 0 %          | 6,903        | 180        |
| Gillnet | Groundfish avg price                | *        | 2.5 %       | 3.4 %  | 4.3 %        | 6,903        | 180        |
| Gillnet | Kept catch                          | *        | -6.3 %      | -4.9 % | -3.5 %       | 6,903        | 180        |
| Gillnet | Kept non-groundfish                 | *        | -2.4 %      | -1.9 % | -1.3 %       | 6,903        | 180        |
| Gillnet | Non-groundfish avg price            | *        | -2.4 %      | -1.3 % | -0.5 %       | 6,903        | 180        |
| Gillnet | Total revenue                       | *        | -5.4 %      | -3.7 % | -2.1 %       | 6,903        | 180        |
| Gillnet | Trip duration                       | *        | -4.4 %      | -3.6 % | -2.7 %       | 6,903        | 180        |

Table 7: Fishing Year 2009

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | 0.6 %       | 1.7 %  | 3 %          | 6,310        | 200        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 2.1 %        | 6,310        | 200        |
| Trawl   | Groundfish avg price                | *        | 0.1 %       | 0.9 %  | 1.9 %        | 6,310        | 200        |
| Trawl   | Kept catch                          |          | 0 %         | 1.8 %  | 3.5 %        | 6,310        | 200        |
| Trawl   | Kept non-groundfish                 | *        | 0.6 %       | 2 %    | 3.7 %        | 6,310        | 200        |
| Trawl   | Non-groundfish avg price            |          | -0.3 %      | 0 %    | 0 %          | 6,310        | 200        |
| Trawl   | Total revenue                       | *        | 5.1 %       | 7.1 %  | 9.1 %        | 6,310        | 200        |
| Trawl   | Trip duration                       | *        | 3.5 %       | 5 %    | 6.6 %        | 6,310        | 200        |
| Gillnet | Kept groundfish                     |          | -0.4 %      | 0 %    | 0.5 %        | 8,455        | 198        |
| Gillnet | Number groundfish market categories | *        | -5.4 %      | -2.5 % | -0.1 %       | 8,455        | 198        |
| Gillnet | Groundfish avg price                |          | -0.2 %      | 0.5 %  | 1.4 %        | 8,455        | 198        |
| Gillnet | Kept catch                          |          | -1.7 %      | -0.5 % | 0.3 %        | 8,455        | 198        |
| Gillnet | Kept non-groundfish                 |          | -0.7 %      | -0.4 % | 0 %          | 8,455        | 198        |
| Gillnet | Non-groundfish avg price            |          | -0.1 %      | 0 %    | 0 %          | 8,455        | 198        |
| Gillnet | Total revenue                       | *        | -5.5 %      | -4.2 % | -2.7 %       | 8,455        | 198        |
| Gillnet | Trip duration                       | *        | -6.9 %      | -6 %   | -5.2 %       | 8,455        | 198        |

Table 8: Fishing Year 2010

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median  | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|---------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -19.1 %     | -14.2 % | -8.8 %       | 1,226        | 456        |
| Trawl   | Number groundfish market categories |          | -5.2 %      | -1.2 %  | 0 %          | 1,226        | 456        |
| Trawl   | Groundfish avg price                |          | -2.2 %      | 0.1 %   | 2 %          | 1,226        | 456        |
| Trawl   | Kept catch                          | *        | -15.2 %     | -10.4 % | -5.5 %       | 1,226        | 456        |
| Trawl   | Kept non-groundfish                 | *        | -10.4 %     | -5.5 %  | -0.7 %       | 1,226        | 456        |
| Trawl   | Non-groundfish avg price            |          | -0.6 %      | 1 %     | 3.6 %        | 1,226        | 456        |
| Trawl   | Total revenue                       | *        | -15.2 %     | -10.5 % | -5.4 %       | 1,226        | 456        |
| Trawl   | Trip duration                       | *        | -9.4 %      | -6.1 %  | -2.4 %       | 1,226        | 456        |
| Gillnet | Kept groundfish                     | *        | -12.2 %     | -7.5 %  | -2.6 %       | 1,385        | 460        |
| Gillnet | Number groundfish market categories |          | 0 %         | 0.7 %   | 6.3 %        | 1,385        | 460        |
| Gillnet | Groundfish avg price                | *        | 0.3 %       | 2 %     | 3.6 %        | 1,385        | 460        |
| Gillnet | Kept catch                          |          | -6.7 %      | -2.1 %  | 2.2 %        | 1,385        | 460        |
| Gillnet | Kept non-groundfish                 |          | -0.6 %      | 0 %     | 0.4 %        | 1,385        | 460        |
| Gillnet | Non-groundfish avg price            |          | -2.4 %      | -0.1 %  | 0.9 %        | 1,385        | 460        |
| Gillnet | Total revenue                       |          | -6.7 %      | -2.4 %  | 2.4 %        | 1,385        | 460        |
| Gillnet | Trip duration                       | *        | -6 %        | -4.5 %  | -2.7 %       | 1,385        | 460        |

Table 9: Fishing Year 2011

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -11 %       | -6.6 % | -1.9 %       | 1,826        | 606        |
| Trawl   | Number groundfish market categories |          | -1.1 %      | 0 %    | 0 %          | 1,826        | 606        |
| Trawl   | Groundfish avg price                |          | -1.8 %      | -0.1 % | 1.4 %        | 1,826        | 606        |
| Trawl   | Kept catch                          | *        | -9.6 %      | -5.8 % | -1.8 %       | 1,826        | 606        |
| Trawl   | Kept non-groundfish                 |          | -5 %        | -1.4 % | 1.3 %        | 1,826        | 606        |
| Trawl   | Non-groundfish avg price            |          | -0.5 %      | 1.1 %  | 3.4 %        | 1,826        | 606        |
| Trawl   | Total revenue                       |          | -7.3 %      | -3.3 % | 0.8 %        | 1,826        | 606        |
| Trawl   | Trip duration                       | *        | -5.4 %      | -3.3 % | -1.2 %       | 1,826        | 606        |
| Gillnet | Kept groundfish                     | *        | 1.6 %       | 4.9 %  | 8.4 %        | 1,775        | 545        |
| Gillnet | Number groundfish market categories | *        | 0.4 %       | 3 %    | 6.6 %        | 1,775        | 545        |
| Gillnet | Groundfish avg price                |          | -0.4 %      | 0.8 %  | 2 %          | 1,775        | 545        |
| Gillnet | Kept catch                          |          | -2.6 %      | 0.7 %  | 4 %          | 1,775        | 545        |
| Gillnet | Kept non-groundfish                 |          | -1.8 %      | -0.8 % | 0 %          | 1,775        | 545        |
| Gillnet | Non-groundfish avg price            |          | -2.2 %      | -0.3 % | 1.1 %        | 1,775        | 545        |
| Gillnet | Total revenue                       |          | -3.1 %      | 0.2 %  | 3.5 %        | 1,775        | 545        |
| Gillnet | Trip duration                       | *        | -2.7 %      | -1.6 % | -0.2 %       | 1,775        | 545        |



Table 10: Fishing Year 2012

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median  | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|---------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -12 %       | -8.1 %  | -4.6 %       | 2,704        | 554        |
| Trawl   | Number groundfish market categories |          | -1.4 %      | 0 %     | 0 %          | 2,704        | 554        |
| Trawl   | Groundfish avg price                |          | -2.7 %      | -1.1 %  | 0.4 %        | 2,704        | 554        |
| Trawl   | Kept catch                          | *        | -13.9 %     | -10.5 % | -6.9 %       | 2,704        | 554        |
| Trawl   | Kept non-groundfish                 |          | -2 %        | 0.6 %   | 4 %          | 2,704        | 554        |
| Trawl   | Non-groundfish avg price            |          | -3 %        | -0.5 %  | 1.5 %        | 2,704        | 554        |
| Trawl   | Total revenue                       | *        | -11.2 %     | -7.8 %  | -4.3 %       | 2,704        | 554        |
| Trawl   | Trip duration                       |          | -2.9 %      | -1 %    | 0.6 %        | 2,704        | 554        |
| Gillnet | Kept groundfish                     |          | -5.2 %      | -1.4 %  | 2.1 %        | 2,074        | 360        |
| Gillnet | Number groundfish market categories |          | 0 %         | 0 %     | 0.1 %        | 2,074        | 360        |
| Gillnet | Groundfish avg price                |          | -1.1 %      | 0.4 %   | 2 %          | 2,074        | 360        |
| Gillnet | Kept catch                          |          | -6 %        | -2.9 %  | 0.4 %        | 2,074        | 360        |
| Gillnet | Kept non-groundfish                 |          | -1.7 %      | 0.2 %   | 2.1 %        | 2,074        | 360        |
| Gillnet | Non-groundfish avg price            |          | -1.7 %      | 0 %     | 1.6 %        | 2,074        | 360        |
| Gillnet | Total revenue                       | *        | -8.8 %      | -5.2 %  | -2 %         | 2,074        | 360        |
| Gillnet | Trip duration                       | *        | -5.5 %      | -4.5 %  | -3.2 %       | 2,074        | 360        |

Table 11: Fishing Year 2013

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median  | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|---------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -16.7 %     | -12.8 % | -8.9 %       | 2,294        | 320        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %     | 0.8 %        | 2,294        | 320        |
| Trawl   | Groundfish avg price                | *        | 1.1 %       | 2.9 %   | 4.9 %        | 2,294        | 320        |
| Trawl   | Kept catch                          | *        | -13.9 %     | -10.2 % | -6.6 %       | 2,294        | 320        |
| Trawl   | Kept non-groundfish                 |          | -1.6 %      | 2.7 %   | 7.2 %        | 2,294        | 320        |
| Trawl   | Non-groundfish avg price            |          | -3.2 %      | -1.3 %  | 0.4 %        | 2,294        | 320        |
| Trawl   | Total revenue                       | *        | -7.4 %      | -3.8 %  | -0.5 %       | 2,294        | 320        |
| Trawl   | Trip duration                       | *        | -5.6 %      | -3.5 %  | -1.5 %       | 2,294        | 320        |
| Gillnet | Kept groundfish                     |          | -3 %        | 1.4 %   | 6.1 %        | 1,521        | 167        |
| Gillnet | Number groundfish market categories |          | -3.1 %      | -0.3 %  | 0 %          | 1,521        | 167        |
| Gillnet | Groundfish avg price                |          | -1.6 %      | 0.2 %   | 1.8 %        | 1,521        | 167        |
| Gillnet | Kept catch                          |          | -3.7 %      | 0.7 %   | 5.2 %        | 1,521        | 167        |
| Gillnet | Kept non-groundfish                 |          | -3.3 %      | -0.2 %  | 2.6 %        | 1,521        | 167        |
| Gillnet | Non-groundfish avg price            |          | -3.2 %      | -0.6 %  | 1.7 %        | 1,521        | 167        |
| Gillnet | Total revenue                       |          | -2.4 %      | 1.8 %   | 6.4 %        | 1,521        | 167        |
| Gillnet | Trip duration                       | *        | -6.5 %      | -5.1 %  | -3.8 %       | 1,521        | 167        |

Table 12: Fishing Year 2014

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     |          | -7.4 %      | -3.3 % | 0.6 %        | 1,683        | 342        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 1.5 %        | 1,683        | 342        |
| Trawl   | Groundfish avg price                |          | -0.2 %      | 1.7 %  | 4 %          | 1,683        | 342        |
| Trawl   | Kept catch                          | *        | -12.5 %     | -8.2 % | -3.8 %       | 1,683        | 342        |
| Trawl   | Kept non-groundfish                 | *        | -9.7 %      | -5.1 % | -0.3 %       | 1,683        | 342        |
| Trawl   | Non-groundfish avg price            |          | -2.3 %      | 0.3 %  | 3.2 %        | 1,683        | 342        |
| Trawl   | Total revenue                       | *        | -9.9 %      | -6.2 % | -2.2 %       | 1,683        | 342        |
| Trawl   | Trip duration                       | *        | -7.1 %      | -4.8 % | -2.4 %       | 1,683        | 342        |
| Gillnet | Kept groundfish                     |          | -4.2 %      | 1.1 %  | 7.4 %        | 1,119        | 176        |
| Gillnet | Number groundfish market categories |          | 0 %         | 2.4 %  | 7.4 %        | 1,119        | 176        |
| Gillnet | Groundfish avg price                |          | -2 %        | 0.1 %  | 2.1 %        | 1,119        | 176        |
| Gillnet | Kept catch                          |          | -0.2 %      | 4 %    | 8.4 %        | 1,119        | 176        |
| Gillnet | Kept non-groundfish                 |          | -5 %        | -1.1 % | 2.6 %        | 1,119        | 176        |
| Gillnet | Non-groundfish avg price            |          | -0.9 %      | 3 %    | 7.2 %        | 1,119        | 176        |
| Gillnet | Total revenue                       | *        | 2.4 %       | 6.7 %  | 11.1 %       | 1,119        | 176        |
| Gillnet | Trip duration                       |          | -2 %        | 0 %    | 1.6 %        | 1,119        | 176        |

Table 13: Fishing Year 2015

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -11.4 %     | -7 %   | -2.8 %       | 1,967        | 364        |
| Trawl   | Number groundfish market categories |          | -1.8 %      | 0 %    | 0 %          | 1,967        | 364        |
| Trawl   | Groundfish avg price                |          | -0.3 %      | 1.3 %  | 2.9 %        | 1,967        | 364        |
| Trawl   | Kept catch                          | *        | -11.1 %     | -7 %   | -3.2 %       | 1,967        | 364        |
| Trawl   | Kept non-groundfish                 | *        | -8.6 %      | -4.1 % | -0.3 %       | 1,967        | 364        |
| Trawl   | Non-groundfish avg price            |          | -2.1 %      | 0.1 %  | 2.7 %        | 1,967        | 364        |
| Trawl   | Total revenue                       | *        | -8.7 %      | -5.2 % | -1.6 %       | 1,967        | 364        |
| Trawl   | Trip duration                       |          | -3.9 %      | -1.9 % | 0.1 %        | 1,967        | 364        |
| Gillnet | Kept groundfish                     |          | -6.7 %      | -0.4 % | 6.9 %        | 647          | 104        |
| Gillnet | Number groundfish market categories |          | 0 %         | 0.3 %  | 7.3 %        | 647          | 104        |
| Gillnet | Groundfish avg price                |          | -2.3 %      | 1.3 %  | 4.6 %        | 647          | 104        |
| Gillnet | Kept catch                          |          | -9.5 %      | -4.8 % | 0.4 %        | 647          | 104        |
| Gillnet | Kept non-groundfish                 | *        | -10.6 %     | -5.7 % | -1.6 %       | 647          | 104        |
| Gillnet | Non-groundfish avg price            | *        | 2.4 %       | 6.5 %  | 11.3 %       | 647          | 104        |
| Gillnet | Total revenue                       |          | -7.6 %      | -2.3 % | 2.7 %        | 647          | 104        |
| Gillnet | Trip duration                       | *        | -7.8 %      | -5.5 % | -3.6 %       | 647          | 104        |

Table 14: Fishing Year 2016

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     |          | -8.3 %      | -4.1 % | 0 %          | 1,951        | 280        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 0 %          | 1,951        | 280        |
| Trawl   | Groundfish avg price                |          | -0.6 %      | 0.8 %  | 2.4 %        | 1,951        | 280        |
| Trawl   | Kept catch                          | *        | -10.1 %     | -6.5 % | -2.8 %       | 1,951        | 280        |
| Trawl   | Kept non-groundfish                 |          | -5.6 %      | -1.4 % | 2.6 %        | 1,951        | 280        |
| Trawl   | Non-groundfish avg price            |          | -1.4 %      | 0.9 %  | 3.3 %        | 1,951        | 280        |
| Trawl   | Total revenue                       |          | -6.6 %      | -2.9 % | 0.9 %        | 1,951        | 280        |
| Trawl   | Trip duration                       | *        | -5.2 %      | -3 %   | -0.9 %       | 1,951        | 280        |
| Gillnet | Kept groundfish                     |          | -6.6 %      | 1.4 %  | 10 %         | 494          | 112        |
| Gillnet | Number groundfish market categories |          | 0 %         | 3.8 %  | 9.7 %        | 494          | 112        |
| Gillnet | Groundfish avg price                |          | -0.4 %      | 3.4 %  | 6.7 %        | 494          | 112        |
| Gillnet | Kept catch                          |          | -11 %       | -3.6 % | 2.7 %        | 494          | 112        |
| Gillnet | Kept non-groundfish                 | *        | -14.2 %     | -7.6 % | -0.8 %       | 494          | 112        |
| Gillnet | Non-groundfish avg price            |          | -3.6 %      | 0.3 %  | 4.5 %        | 494          | 112        |
| Gillnet | Total revenue                       |          | -8.4 %      | -2.3 % | 3.4 %        | 494          | 112        |
| Gillnet | Trip duration                       | *        | -6.9 %      | -4.4 % | -2.2 %       | 494          | 112        |

Table 15: Fishing Year 2017

| Gear    | Variable                            | CIs <> 0 | 95% CI, low | Median | 95% CI, high | n Unobserved | n Observed |
|---------|-------------------------------------|----------|-------------|--------|--------------|--------------|------------|
| Trawl   | Kept groundfish                     | *        | -13.2 %     | -8.9 % | -5.2 %       | 1,608        | 291        |
| Trawl   | Number groundfish market categories |          | 0 %         | 0 %    | 0 %          | 1,608        | 291        |
| Trawl   | Groundfish avg price                | *        | 1.5 %       | 3.3 %  | 5.1 %        | 1,608        | 291        |
| Trawl   | Kept catch                          |          | -6.3 %      | -2.1 % | 1.9 %        | 1,608        | 291        |
| Trawl   | Kept non-groundfish                 |          | -2.9 %      | 1.3 %  | 5.3 %        | 1,608        | 291        |
| Trawl   | Non-groundfish avg price            |          | -4.7 %      | -2.2 % | 0.2 %        | 1,608        | 291        |
| Trawl   | Total revenue                       |          | -6.9 %      | -2.9 % | 0.7 %        | 1,608        | 291        |
| Trawl   | Trip duration                       | *        | -4.5 %      | -2.4 % | -0.2 %       | 1,608        | 291        |
| Gillnet | Kept groundfish                     | *        | 0.8 %       | 8.3 %  | 15.7 %       | 502          | 85         |
| Gillnet | Number groundfish market categories |          | 0 %         | 8 %    | 13.6 %       | 502          | 85         |
| Gillnet | Groundfish avg price                |          | -3.7 %      | 1.5 %  | 6.2 %        | 502          | 85         |
| Gillnet | Kept catch                          |          | -9.4 %      | -3.3 % | 2.1 %        | 502          | 85         |
| Gillnet | Kept non-groundfish                 | *        | -15 %       | -8.8 % | -2.6 %       | 502          | 85         |
| Gillnet | Non-groundfish avg price            |          | -1.6 %      | 1.7 %  | 5.2 %        | 502          | 85         |
| Gillnet | Total revenue                       |          | -9.5 %      | -3.8 % | 1.5 %        | 502          | 85         |
| Gillnet | Trip duration                       |          | -3.8 %      | -1.5 % | 1.1 %        | 502          | 85         |

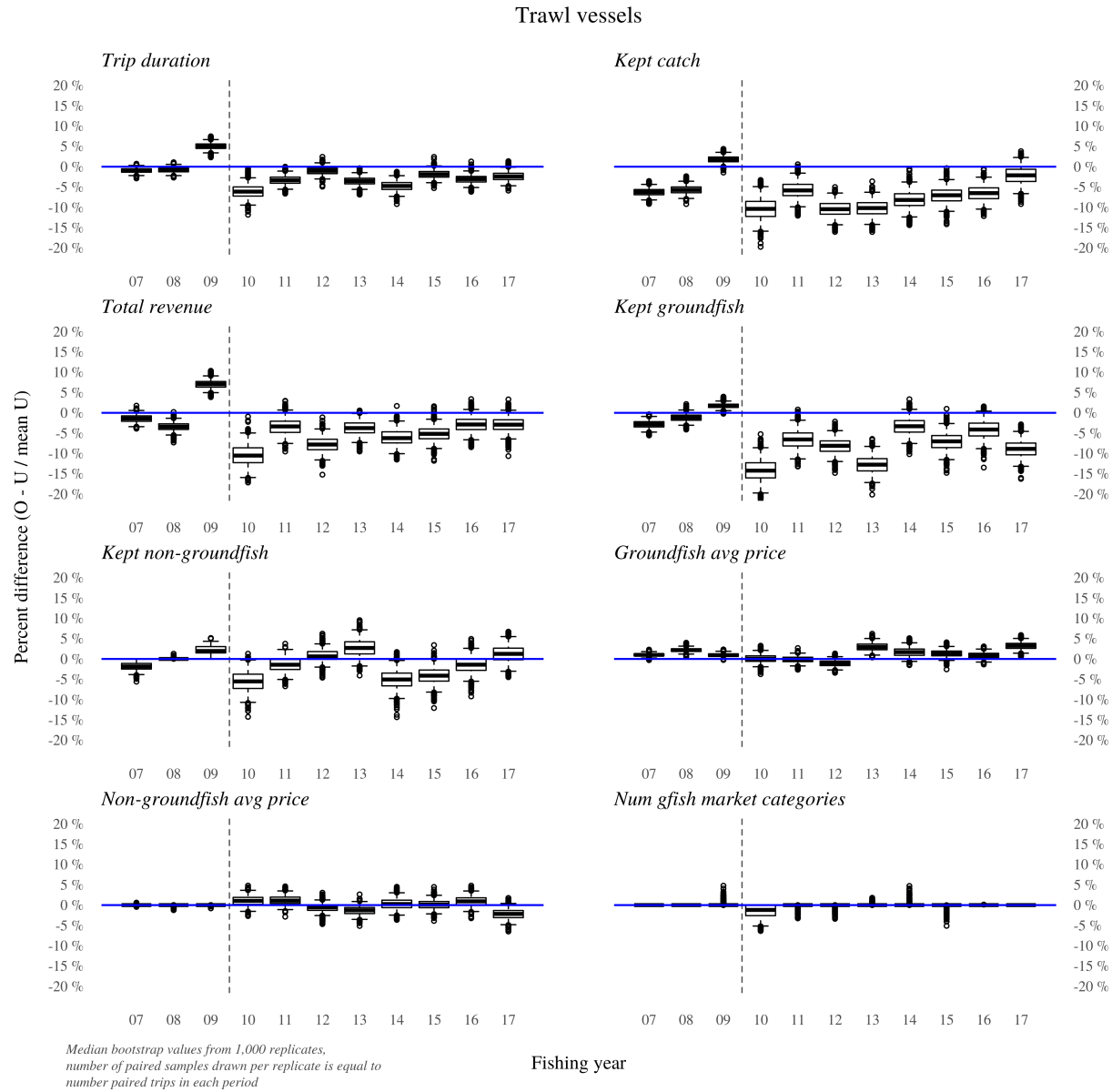


Figure 3: Results of bootstrap analysis, observed and unobserved same-vessel paired trips by fishing year



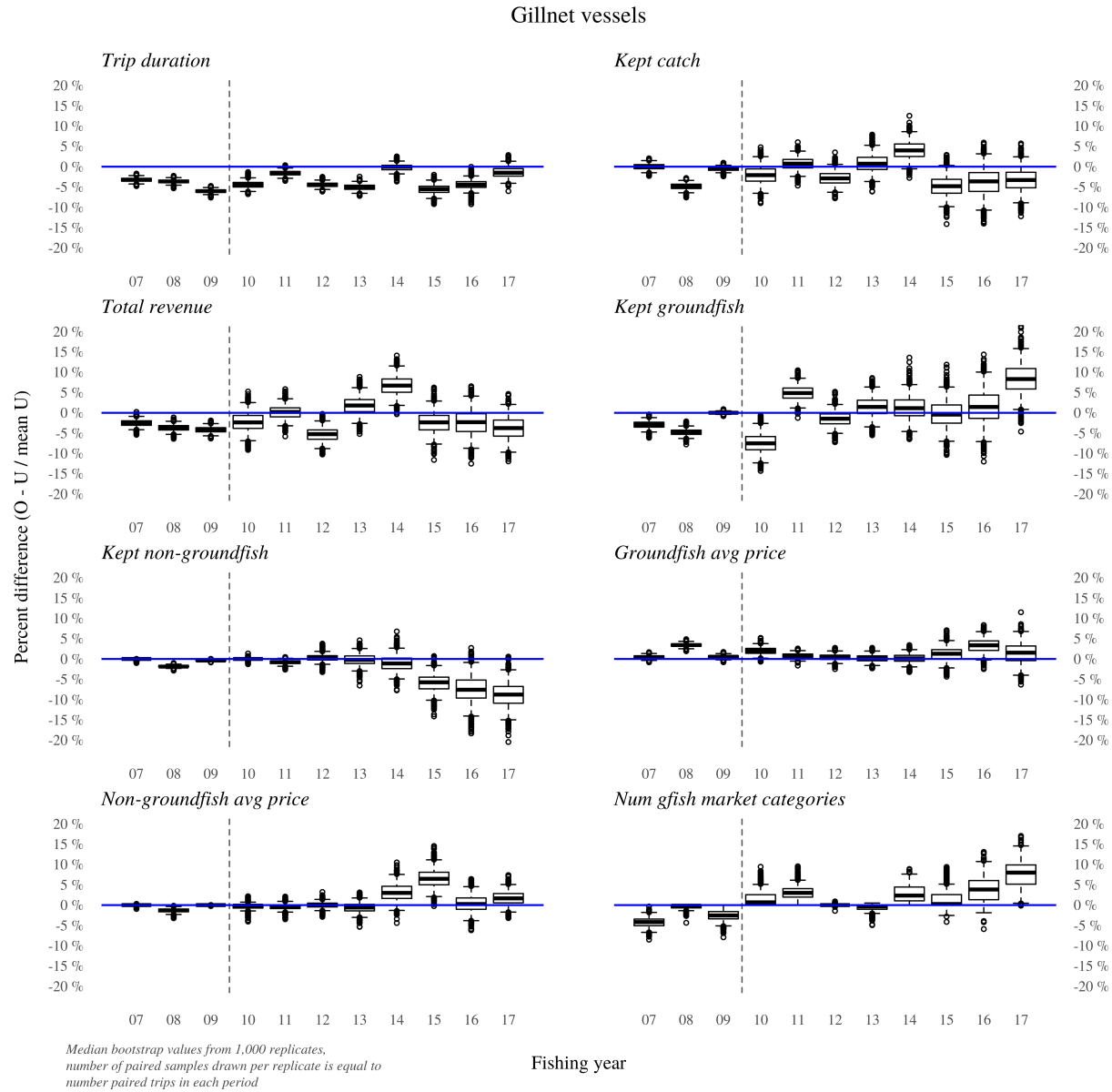


Figure 4: Results of bootstrap analysis, observed and unobserved same-vessel paired trips by fishing year

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## ***Appendix 6: Use of Fishermen's Questionnaires in ICES Assessments.***

### **2011 Survey of North Sea Stocks - as an example fishermen's questionnaire:**

A survey of North Sea fishermen in five countries - Belgium, Denmark, England, the Netherlands, and Scotland - has been carried out annually since 2003 (following a pilot in 2002) with the aim of making their knowledge of the state of fish stocks available to fisheries scientists and fisheries managers. Results of the survey are provided to the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). Below is a blank copy of the 2011 survey, provided as an example of the types of questions asked of fishermen, which include questions about fishermen's perceptions of changes in their economic circumstances and in the state of selected fish stocks from the previous year to the current year.

### **2014 Fishers' North Sea Stock Survey Results:**

As described above, a questionnaire is distributed annually to North Sea fishermen, with the purpose of ensuring that fishermen's knowledge of the state of fish stocks is considered during the development of TACs. The results of the survey are provided to the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). Below is a summary of the 2014 Fisher's North Sea Stock Survey results, provided as an example. Included is a summary of fishermen's responses on perceptions of economic circumstances, which fall under the following categories: Difficulty of Getting/Retaining Crew, Operating Costs, Profits, and Optimism for the Future. Fishermen's responses on perceptions of stock abundance are also summarized for each stock (cod, haddock, whiting, saithe, monkfish, *Nephrops* (Norway lobster), common sole, and plaice), and include perceptions on Stock Abundance, Size Class, Discards, and Recruitment. The fishermen's perceptions of changes in the abundance of fish (from the responses to the survey) were compared with ICES assessments of changes in their abundance. A comparison of the index of abundance derived from the fishers' survey responses (the methodology for deriving this index is described in the Survey Results) and the ICES abundance estimate is provided for each stock.

# 2011 Survey of North Sea Stocks

The purpose of this questionnaire is to ensure that fishermen's knowledge of the state of fish stocks is considered during the development of TACs.

The questionnaire should be completed by  
**comparing conditions in January - June this year  
with conditions in January - June last year.**

All information will remain strictly confidential. Data will be pooled before presentation to the Advisory Committee on Fisheries Management. To ensure complete confidentiality please *do not* write your name, or the name of your vessel, on this questionnaire.

## Instructions

1. The questionnaire refers to the **North Sea only**.
2. The questionnaire is in four sections that will help us use the data
  1. Vessel size and gear type
  2. Information on the eight main species
  3. Your financial status compared to last year
  4. Any other information you may wish us to know
3. Questions should be answered by putting a tick in the appropriate box (see example below).

| EXAMPLE    |          |                                     |
|------------|----------|-------------------------------------|
| Question 1 | Answer 1 | <input checked="" type="checkbox"/> |

|          |                          |
|----------|--------------------------|
| Answer 2 | <input type="checkbox"/> |
|----------|--------------------------|

|          |                          |
|----------|--------------------------|
| Answer 3 | <input type="checkbox"/> |
|----------|--------------------------|

4. Please return your completed questionnaire to **[national coordinator]** by Friday 15<sup>th</sup> July 2011

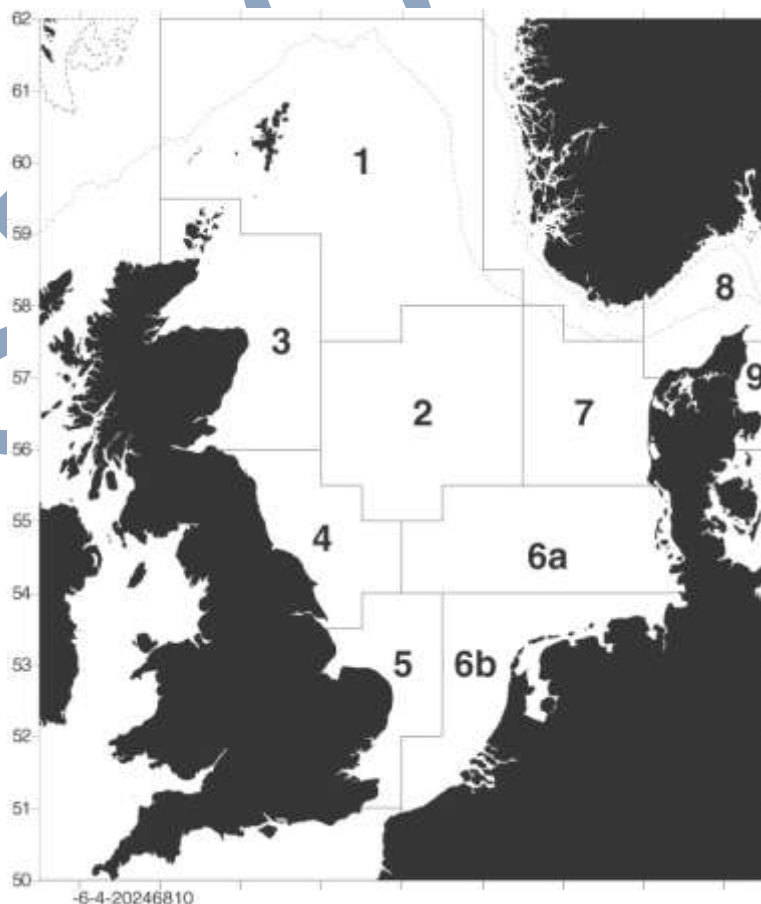
## SECTION 1

| VESSEL & GEAR                        |                                                                              |  |                |  |            |  |          |  |        |
|--------------------------------------|------------------------------------------------------------------------------|--|----------------|--|------------|--|----------|--|--------|
| Size                                 | Under 15m                                                                    |  | 15-24m         |  | Over 24m   |  |          |  |        |
| Main fishing method <b>last year</b> | Trawl                                                                        |  | Nephrops Trawl |  | Beam Trawl |  | Gill Net |  | Seine* |
|                                      | *Seine = Scottish Seine, Pair Seine, or Danish Seine (please indicate which) |  |                |  |            |  |          |  |        |
|                                      | Other (please specify)                                                       |  |                |  |            |  |          |  |        |
| Main fishing method <b>this year</b> | Trawl                                                                        |  | Nephrops Trawl |  | Beam Trawl |  | Gill Net |  | Seine* |
|                                      | *Seine = Scottish Seine, Pair Seine, or Danish Seine (please indicate which) |  |                |  |            |  |          |  |        |
|                                      | Other (please specify)                                                       |  |                |  |            |  |          |  |        |

## SECTION 2

When completing the question on fishing area in this section, reference should be made to the numbered boxes on the map below.

Information on abundance should be provided on the basis of **catch** not landings



|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| <b>COD</b>                        |    |  |    |  |   |  |   |  |   |  |
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of cod changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of cod discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

**For this year:**

|                                                |              |  |  |          |           |  |      |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|--|------|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |  |      |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           |  | High |  | Don't know   |  |

|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| <b>HADDOCK</b>                    |    |  |    |  |   |  |   |  |   |  |
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of haddock changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of haddock discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

**For this year:**

|                                                |              |  |  |          |           |  |      |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|--|------|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |  |      |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           |  | High |  | Don't know   |  |

|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| <b>WHITING</b>                    |    |  |    |  |   |  |   |  |   |  |
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of whiting changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of whiting discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

**For this year:**

|                                                |              |  |  |          |           |  |      |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|--|------|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |  |      |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           |  | High |  | Don't know   |  |

|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| <b>SAITHE</b>                     |    |  |    |  |   |  |   |  |   |  |
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of saithe changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of saithe discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

**For this year:**

|                                                |              |  |  |          |           |  |      |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|--|------|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |  |      |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           |  | High |  | Don't know   |  |



|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| <b>MONKFISH</b>                   |    |  |    |  |   |  |   |  |   |  |
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of monkfish changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of monkfish discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

**For this year:**

|                                                |              |  |  |          |           |      |  |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|------|--|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |      |  |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           | High |  |  | Don't know   |  |

|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| <b>NEPHROPS</b>                   |    |  |    |  |   |  |   |  |   |  |
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of Nephrops changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of Nephrops discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

**For this year:**

|                                                |              |  |  |          |           |      |  |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|------|--|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |      |  |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           | High |  |  | Don't know   |  |

## COMMON (DOVER) SOLE

|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of sole changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of sole discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

For this year:

|                                                |              |  |  |          |           |  |      |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|--|------|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |  |      |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           |  | High |  | Don't know   |  |

## PLAICE

|                                   |    |  |    |  |   |  |   |  |   |  |
|-----------------------------------|----|--|----|--|---|--|---|--|---|--|
| Area of fishing<br>(refer to map) | 1  |  | 2  |  | 3 |  | 4 |  | 5 |  |
|                                   | 6a |  | 6b |  | 7 |  | 8 |  | 9 |  |

Has the abundance of plaice changed since last year? No ☐ Yes ☐

If yes:

|                     |           |  |      |  |      |  |           |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Abundance | Much less |  | Less |  | More |  | Much more |  |
|---------------------|-----------|--|------|--|------|--|-----------|--|

Has your level of plaice discarding changed since last year? No ☐ Yes ☐

If yes:

|                    |           |  |      |  |      |  |           |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|
| Change in Discards | Much less |  | Less |  | More |  | Much more |  |
|--------------------|-----------|--|------|--|------|--|-----------|--|

For this year:

|                                                |              |  |  |          |           |  |      |  |              |  |
|------------------------------------------------|--------------|--|--|----------|-----------|--|------|--|--------------|--|
| Size range                                     | Mostly small |  |  |          | All sizes |  |      |  | Mostly large |  |
| Abundance of young fish about to enter fishery | Low          |  |  | Moderate |           |  | High |  | Don't know   |  |

### SECTION 3

#### ECONOMIC CIRCUMSTANCES

*Have your economic circumstances changed since last year?*

|                                                    |           |  |      |  |      |  |      |  |           |  |
|----------------------------------------------------|-----------|--|------|--|------|--|------|--|-----------|--|
| <i>Difficulties in obtaining or retaining crew</i> | Much less |  | Less |  | Same |  | More |  | Much more |  |
|----------------------------------------------------|-----------|--|------|--|------|--|------|--|-----------|--|

|                        |           |  |      |  |      |  |      |  |           |  |
|------------------------|-----------|--|------|--|------|--|------|--|-----------|--|
| <i>Operating costs</i> | Much less |  | Less |  | Same |  | More |  | Much more |  |
|------------------------|-----------|--|------|--|------|--|------|--|-----------|--|

|                |           |  |      |  |      |  |      |  |           |  |
|----------------|-----------|--|------|--|------|--|------|--|-----------|--|
| <i>Profits</i> | Much less |  | Less |  | Same |  | More |  | Much more |  |
|----------------|-----------|--|------|--|------|--|------|--|-----------|--|

|                                                          |           |  |      |  |      |  |      |  |           |  |
|----------------------------------------------------------|-----------|--|------|--|------|--|------|--|-----------|--|
| <i>Are you more or less optimistic about the future?</i> | Much less |  | Less |  | Same |  | More |  | Much more |  |
|----------------------------------------------------------|-----------|--|------|--|------|--|------|--|-----------|--|

### SECTION 4

Have you any additional information on the fisheries?

|  |
|--|
|  |
|--|

Thank you for your contribution.

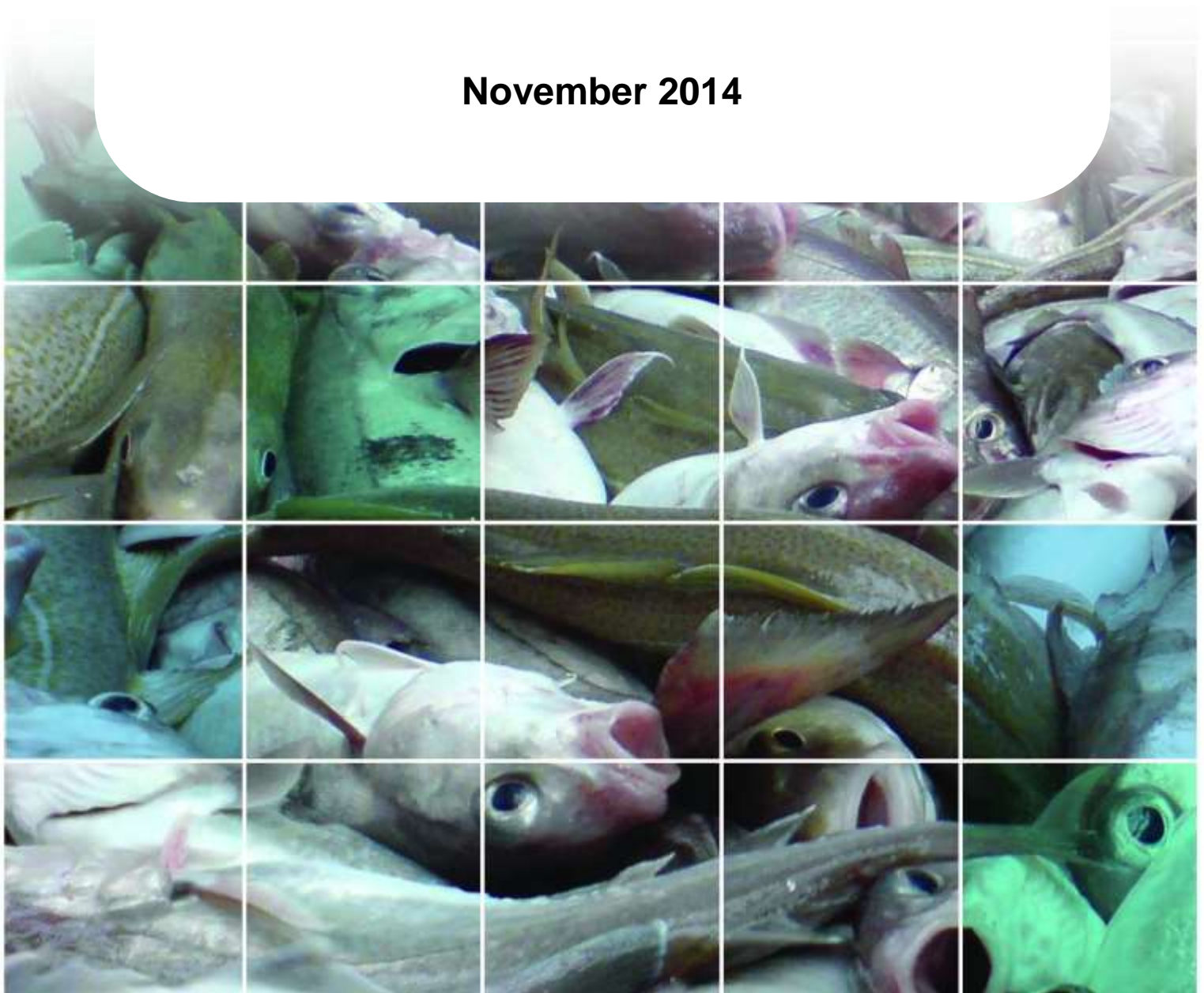
SPECIMEN



NAFC Marine Centre  
University of the  
Highlands and Islands

# Fishers' North Sea Stock Survey 2014

November 2014





# **Fishers' North Sea Stock Survey 2014**

**November 2014**

**Author:            Ian R. Napier**  
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## **Acknowledgements**

The cooperation and assistance of the national coordinators (see p. 13), without whom this survey would not have been possible, is gratefully acknowledged, as is the contribution of the individual fishermen who completed questionnaires.

Thanks are also due to John Clayton for maintaining the survey website and providing IT support.

The data analysis and preparation of this report was funded by the survey partners.

## **Disclaimer**

The contents of this report reflect the perceptions and opinions of the respondents to the survey. They do not reflect the views or opinions of the NAFC Marine Centre, the author, or the sponsoring or coordinating organisations.

## **Data Ownership**

The data collected through the Fishers' North Sea Stock Survey are collated and analysed by the NAFC Marine Centre and used to prepare this report, but ownership of the raw data remains with the national coordinating organisations responsible for their collection.

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## Summary

**Given the non-quantitative and subjective nature of this survey the results contained in this report should be interpreted and used with caution.**

This report presents the results of an analysis of the data collected through the Fishers' North Sea Stock Survey in 2014. As in previous years, the survey was carried out using a questionnaire circulated to North Sea fishermen in five countries; Belgium, Denmark, England, the Netherlands, and Scotland. Fishermen were asked to record their perceptions of changes in their economic circumstances and in the state of selected fish stocks from 2013 to 2014.

A total of 196 completed questionnaires were returned in 2014, of which 177 were included in the analysis. The number of questionnaires returned was higher than in 2013, but still below that in 2012.

The results of the analysis of economic perceptions are summarised in Table 1 and, in somewhat more detail, in Table 2. Overall, the economic perceptions were fairly negative with most responses reporting higher costs, lower profits and lower optimism, although most responses reported no change in the level of difficulty of getting crew.

The results of the analysis of perceptions of the state of fish stocks are summarised in Table 3 and Table 4. The overall picture appears fairly optimistic: the majority of responses reported the same or higher levels of abundance for all eight species; all sizes of fish, the same level of discards and moderate or high levels of recruitment for all eight.

Table 1 Summary of perceptions and trends in relation to economic circumstances in responses to the Fishers' North Sea Stock Survey:  
Top: Perceptions; response category with largest proportion of responses.  
Bottom: Trends; response category with largest increase from last year to this year in proportion of responses. (It should be borne in mind that the category with the largest increase may still only account for a small proportion of responses. See Table 2 for more details.)

|                   | Crew | Costs | Profits | Optimism |
|-------------------|------|-------|---------|----------|
| <b>Perception</b> | same | more  | less    | less     |
| <b>Trend</b>      | same | same  | same    | more     |

Table 2 Summary of perceptions of economic circumstances from the Fishers' North Sea Stock Survey: proportions of responses in each category, and the change in proportions from last year to this year (+/- %). The largest proportion for each parameter and the category with the largest increase are highlighted.

|                 | 'Less' | Same | 'More' |
|-----------------|--------|------|--------|
| <b>Crew</b>     | 10%    | 71%  | 19%    |
|                 | -0%    | +1%  | -0%    |
| <b>Costs</b>    | 7%     | 40%  | 53%    |
|                 | -3%    | +10% | -7%    |
| <b>Profits</b>  | 51%    | 35%  | 14%    |
|                 | -12%   | +12% | +1%    |
| <b>Optimism</b> | 46%    | 34%  | 20%    |
|                 | -16%   | +5%  | +11%   |

Table 3 Summary of perceptions and trends in relation to the state of fish stocks in responses to the Fishers' North Sea Stock Survey:

Top: *Perceptions*; response category with largest proportion of responses.

Bottom: *Trends*; response category with largest change from last year to this year in proportion of responses. (It should be borne in mind that the category with the largest change may still only account for a small proportion of responses. See Table 4 for more details.)

| <b><i>Perception</i></b> | <b>Abundance</b> | <b>Size Range</b> | <b>Discards</b> | <b>Recruitment</b> |
|--------------------------|------------------|-------------------|-----------------|--------------------|
| <b>Cod</b>               | more             | all               | same            | moderate           |
| <b>Haddock</b>           | same             | all               | same            | moderate           |
| <b>Whiting</b>           | same             | all               | same            | moderate           |
| <b>Saithe</b>            | same             | all               | same            | mod./high          |
| <b>Monkfish</b>          | same             | all               | same            | moderate           |
| <b><i>Nephrops</i></b>   | more             | all               | same            | moderate           |
| <b>Sole</b>              | more             | all               | same            | high               |
| <b>Plaice</b>            | more             | all               | same            | high               |
|                          |                  |                   |                 |                    |
| <b><i>Trend</i></b>      | <b>Abundance</b> | <b>Size Range</b> | <b>Discards</b> | <b>Recruitment</b> |
| <b>Cod</b>               | more             | small             | more            | high               |
| <b>Haddock</b>           | more             | all               | same            | high               |
| <b>Whiting</b>           | less             | small             | less            | mod'               |
| <b>Saithe</b>            | same             | all               | same            | high               |
| <b>Monkfish</b>          | more             | large             | more            | high               |
| <b><i>Nephrops</i></b>   | more             | large             | more            | high               |
| <b>Sole</b>              | more             | small             | same            | high               |
| <b>Plaice</b>            | same             | small             | more            | high               |

Table 4 Summary of perceptions of the state of fish stocks from the Fishers' North Sea Stock Survey: Proportions of responses in each category and the change in proportions from last year to this year (+/- %). The largest proportion for each parameter and the category with the largest increase are highlighted for each species. (Continued overleaf.)

|                 | Abundance |             |             | Fish Size    |            |              |
|-----------------|-----------|-------------|-------------|--------------|------------|--------------|
|                 | 'Less'    | No Change   | 'More'      | Mostly Small | All Sizes  | Mostly Large |
| <b>Cod</b>      | 13%       | 27%         | <b>60%</b>  | 13%          | <b>82%</b> | 4%           |
|                 | -14%      | -4%         | <b>+19%</b> | <b>+2%</b>   | +1%        | -3%          |
| <b>Haddock</b>  | 14%       | <b>44%</b>  | 42%         | 13%          | <b>87%</b> | 0%           |
|                 | -13%      | <b>+12%</b> | +1%         | +1%          | <b>+6%</b> | -8%          |
| <b>Whiting</b>  | 21%       | <b>57%</b>  | 22%         | 21%          | <b>78%</b> | 1%           |
|                 | -7%       | <b>+26%</b> | -19%        | <b>+9%</b>   | -3%        | -7%          |
| <b>Saithe</b>   | 12%       | <b>52%</b>  | 37%         | 21%          | <b>71%</b> | 7%           |
|                 | -16%      | <b>+21%</b> | -5%         | <b>+10%</b>  | -10%       | -0%          |
| <b>Monkfish</b> | 9%        | <b>54%</b>  | 38%         | 16%          | <b>79%</b> | 5%           |
|                 | -19%      | <b>+22%</b> | -3%         | <b>+4%</b>   | -2%        | -2%          |
| <b>Nephrops</b> | 13%       | 17%         | <b>70%</b>  | 16%          | <b>69%</b> | 15%          |
|                 | -15%      | -14%        | <b>+29%</b> | +5%          | -12%       | <b>+7%</b>   |
| <b>Sole</b>     | 24%       | 29%         | <b>47%</b>  | 31%          | <b>65%</b> | 3%           |
|                 | -4%       | -2%         | <b>+6%</b>  | <b>+20%</b>  | -16%       | -4%          |
| <b>Plaice</b>   | 14%       | 27%         | <b>59%</b>  | 27%          | <b>65%</b> | 7%           |
|                 | -13%      | -4%         | <b>+17%</b> | <b>+15%</b>  | -15%       | -0%          |

cont./



Table 4 cont.

|                 | Discards |             |            | Recruitment |             |             |
|-----------------|----------|-------------|------------|-------------|-------------|-------------|
|                 | 'Less'   | No Change   | 'More'     | Low         | Moderate    | High        |
| <b>Cod</b>      | 17%      | <b>53%</b>  | 29%        | 14%         | <b>47%</b>  | 40%         |
|                 | -9%      | +1%         | <b>+9%</b> | -1%         | -2%         | <b>+3%</b>  |
| <b>Haddock</b>  | 13%      | <b>78%</b>  | 8%         | 15%         | <b>52%</b>  | 32%         |
|                 | -13%     | <b>+26%</b> | -12%       | +1%         | <b>+3%</b>  | -4%         |
| <b>Whiting</b>  | 19%      | <b>66%</b>  | 16%        | 19%         | <b>56%</b>  | 24%         |
|                 | -8%      | <b>+13%</b> | -5%        | +5%         | <b>+7%</b>  | -12%        |
| <b>Saithe</b>   | 10%      | <b>67%</b>  | 23%        | 5%          | <b>47%</b>  | <b>47%</b>  |
|                 | -17%     | <b>+15%</b> | +2%        | -9%         | -2%         | <b>+11%</b> |
| <b>Monkfish</b> | 11%      | <b>83%</b>  | 6%         | 12%         | <b>55%</b>  | 33%         |
|                 | -16%     | <b>+30%</b> | -14%       | -2%         | <b>+6%</b>  | -4%         |
| <b>Nephrops</b> | 20%      | <b>62%</b>  | 18%        | 2%          | <b>80%</b>  | 17%         |
|                 | -7%      | <b>+9%</b>  | -2%        | -12%        | <b>+31%</b> | -19%        |
| <b>Sole</b>     | 20%      | <b>58%</b>  | 21%        | 13%         | 42%         | <b>45%</b>  |
|                 | -6%      | <b>+6%</b>  | +0%        | -1%         | -8%         | <b>+9%</b>  |
| <b>Plaice</b>   | 12%      | <b>62%</b>  | 26%        | 3%          | 42%         | <b>55%</b>  |
|                 | -15%     | <b>+9%</b>  | +5%        | -11%        | -7%         | <b>+19%</b> |



# Introduction

This report presents the results of an analysis of the data collected through the Fishers' North Sea Stock Survey in 2014.

**Given the non-quantitative and subjective nature of this survey the results contained in this report should be interpreted and used with caution.**

## Background

A survey of North Sea fishermen in five countries - Belgium, Denmark, England, the Netherlands, and Scotland - has been carried out annually since 2003 (following a pilot in 2002) with the aim of making their knowledge of the state of fish stocks available to fisheries scientists and fisheries managers. The results of the survey are provided to the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK).

The questionnaire-based survey collects information on vessel size and fishing gear type, on the status of key fish species, and on the fishermen's economic circumstances (further information on the survey is provided below) across 10 areas of the North Sea (Figure 1). These areas are based on the standard roundfish sampling areas defined by ICES<sup>1</sup>, with their area 6 divided into two parts (6a & 6b).

The survey was repeated in 2014, with funding for the collation and analysis of the data provided by the project participants under the auspices of the North Sea Advisory Council.

## Reviews of the Survey by ICES

The survey was reviewed by ICES in 2006<sup>2</sup> and was discussed by the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) in 2012<sup>3</sup>. The working group comments are summarised in the report of the 2012 Fishers' North Sea Stock Survey.

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<sup>1</sup> See ICES Manual for the International Bottom Trawl Surveys, Fig. 6.2 (p 45). Available online at: [datras.ices.dk/Documents/Manuals/Addendum\\_1\\_Manual\\_for\\_the\\_IBTS\\_Revision\\_VIII.pdf](http://datras.ices.dk/Documents/Manuals/Addendum_1_Manual_for_the_IBTS_Revision_VIII.pdf)

<sup>2</sup> Report of the Review Group on Fisheries Surveys of North Sea Stocks (RGFS). ICES CM 2006 / ACFM:38. Available at: [www.ices.dk/products/CMdocs/2006/ACFM/ACFM3806.pdf](http://www.ices.dk/products/CMdocs/2006/ACFM/ACFM3806.pdf)

<sup>3</sup> Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 27 April - 3 May 2012. Section 1.6, pp. 16-18. Available at: [www.ices.dk/reports/ACOM/2012/WGNSSK/Sec\\_01\\_General.pdf](http://www.ices.dk/reports/ACOM/2012/WGNSSK/Sec_01_General.pdf)

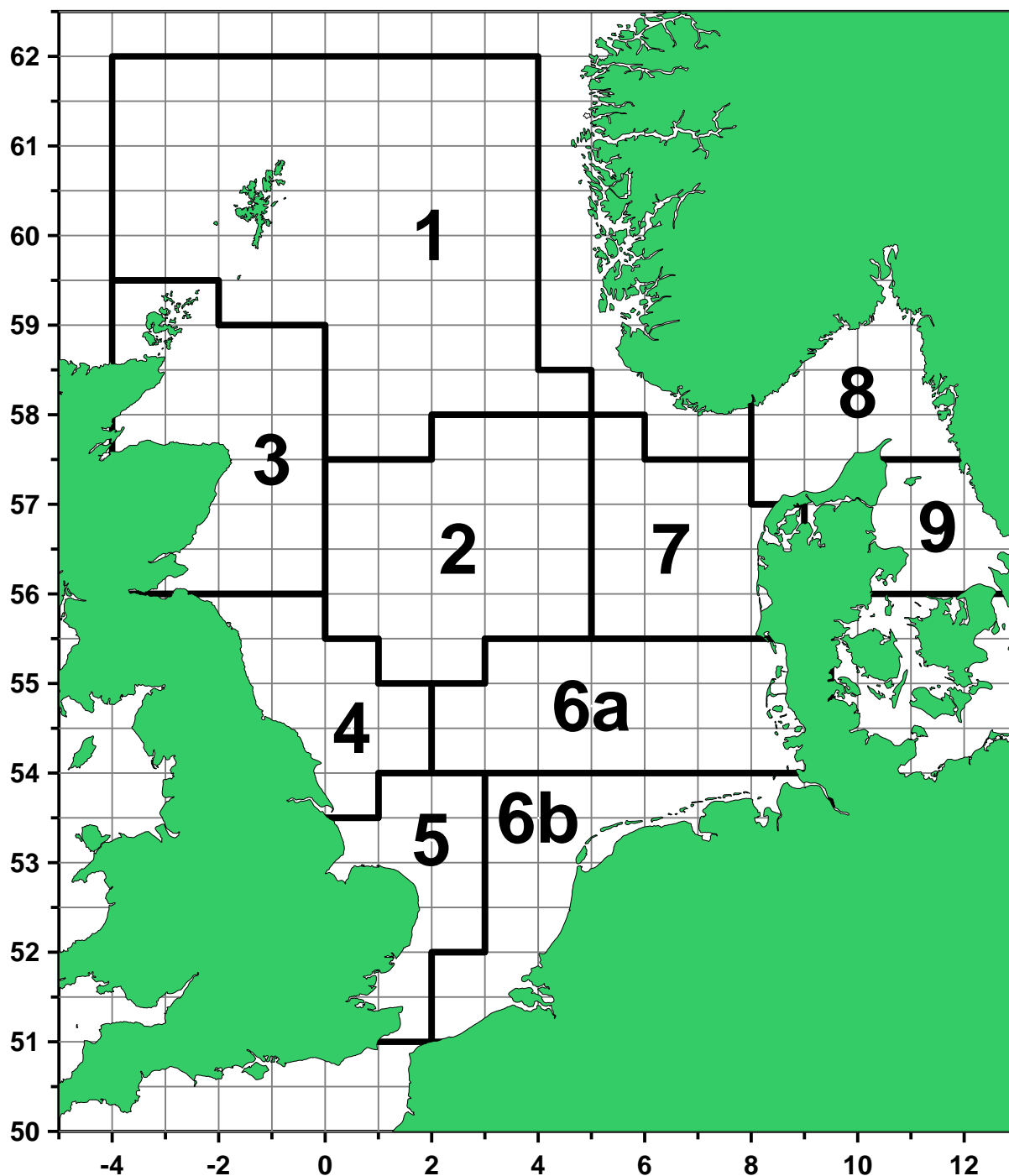


Figure 1 The areas of the North Sea used in the survey. Based on the ICES standard roundfish sampling areas with area 6 divided into two parts.

# Methodology

The methodology of the survey in 2014 was largely unchanged from the previous years. Questionnaires<sup>1</sup> were translated and circulated to North Sea fishermen by coordinators in the five participating countries (Table 5).

As in previous years the questionnaire asked fishermen for three types of information:

- ◆ the size of their fishing vessel and the fishing gear used (Table 6).
- ◆ their perceptions of changes from 2013 to 2014 in the abundance, level of discards, size range, and level of recruitment of eight species of fish (Table 7) in each of 10 areas of the North Sea (Figure 1).
- ◆ their perceptions of changes from 2013 to 2014 in the difficulty in obtaining or retaining crew, their operating costs and profits, and their degree of optimism about the future.

In each case, respondents were asked to compare the first half of 2014 (January to June) with the same period of 2013. The questionnaire is not quantitative but asks respondents to select from response categories, e.g. for abundance: 'much less', 'less', 'no change', 'more' or 'much more'. Respondents could also provide any additional information or comments that they wished to.

Fishermen in each country returned the completed questionnaires to their national coordinators, who entered the information provided into a single central database via a web-based data entry system. The analysis of these data and the preparation of this report were undertaken by the NAFC Marine Centre.

## *Nephrops*

In 2012 an additional question was included that asked fishermen to record their perceptions of *Nephrops* in relation to the areas of the Functional Units (FUs) used by ICES in their assessment of the North Sea *Nephrops* stock. (No responses to this question were received in 2014.)

## **Pulse Trawl<sup>2</sup>**

In recent years a number of Dutch respondents have reported using 'Pulse' Trawls (Pulskor). Previously these responses were excluded from the analyses, as this was

<sup>1</sup> A specimen questionnaire can be downloaded from the Fishers' North Sea Stock Survey website at: [www.nsss.eu](http://www.nsss.eu).

<sup>2</sup> Pulse trawls resemble beam trawls, but use electric currents rather than tickler chains to disturb flatfish lying on the sea-bed (see: [britishseafishing.co.uk/pulse-trawling/](http://britishseafishing.co.uk/pulse-trawling/)). Pulse trawling is permitted in EU waters on an experimental basis.

not one of the gear types covered by the survey. The decision was taken to add this fishing gear category to the analysis of the 2013 data, and it was added to the questionnaire in 2014.

Table 5 Countries participating in the North Sea Stock Survey and the coordinating organisation and principle coordinators in each.

| Country            | Coordinating Organisation                                                                | Coordinators                   |
|--------------------|------------------------------------------------------------------------------------------|--------------------------------|
| <b>Belgium</b>     | Rederscentrale<br>(Belgian Fishing Vessel Owners Association and Producers Organisation) | Céline Van den Bosch           |
| <b>Denmark</b>     | Danmarks Fiskeriforening<br>(Danish Fishermen's Association)                             | Michael Andersen               |
| <b>England</b>     | National Federation of Fishermen's Organisations                                         | Joanna Lenehan<br>Dale Rodmell |
| <b>Netherlands</b> | Coöperatieve Visserij Organisatie<br>(Co-operative Fisheries Organisation)               | Inger Wilms                    |
| <b>Scotland</b>    | Scottish Fishermen's Federation                                                          | Kenny Coull<br>Fiona Lord      |

Table 6 The fishing gears covered by the survey.

|                                                       |
|-------------------------------------------------------|
| <b>Trawl (Otter Trawl)</b>                            |
| <b>Beam Trawl</b>                                     |
| <b>Pulse Trawl (Electric Beam Trawl) - added 2013</b> |
| <b><i>Nephrops</i> Trawl</b>                          |
| <b>Gill Nets</b>                                      |
| <b>Seine Net (Scottish seining / fly-dragging)</b>    |

Table 7 The species covered by the survey.

|                            |                                 |
|----------------------------|---------------------------------|
| <b>Cod</b>                 | <i>Gadus morhua</i>             |
| <b>Haddock</b>             | <i>Melanogrammus aeglefinus</i> |
| <b>Whiting</b>             | <i>Merlangius merlangus</i>     |
| <b>Saithe</b>              | <i>Pollachius virens</i>        |
| <b>Monkfish</b>            | <i>Lophius piscatorius</i>      |
| <b><i>Nephrops</i></b>     | <i>Nephrops norvegicus</i>      |
| <b>Common (Dover) Sole</b> | <i>Solea solea</i>              |
| <b>Plaice</b>              | <i>Pleuronectes platessa</i>    |

## **Data Analysis**

### **Times Series Index**

Although the results are not quantitative, an index of abundance is calculated for each species in each area by assigning scores to the response categories as follows: 'much less' = -1; 'less' = -0.5; 'no change' = 0; 'more' = 0.5; and 'much more' = 1. A weighted score is then calculated for each species in each area by multiplying the percentage of responses in each category by the score for that category and summing the results:

$$Index = \sum score_{category} \times percentage\ of\ responses_{category}$$

A time series has been generated from previous survey results by assigning a value of zero to 2001 and cumulatively summing the annual indices for each species in each area since then. These indices were updated in 2014.

### **Comparison with ICES Abundance Estimates**

Following the method developed by Henrik Sparholt of ICES following the 2009 Fishers' North Sea Stock Survey<sup>1</sup>, the fishermen's perceptions of changes in the abundance of fish (from this survey) were compared with ICES assessments of changes in their abundance.

An annual index of abundance for each species each year was calculated from the Fishers' North Sea Stock Survey data as follows (illustrated in Table 8):

- 1) The percentages of responses in each of the abundance categories were calculated for each species and area.
- 2) These percentages were multiplied by a weighting factor (-2, -1, 0, 1, 2).
- 3) The resulting values were added to give a single index for each species and area.
- 4) Finally, the indices for each species were averaged to give an overall annual North Sea index for each species which could be compared with the annual ICES abundance estimates.

These overall indices - which reflect fishermen's perceptions of changes in the abundance of fish - were compared to changes in the ICES estimates of spawning stock biomass (SSB) in the North Sea. (It should be noted that the areas for which ICES provides biomass estimates may not correspond exactly with the area covered

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<sup>1</sup> For further details of Sparholt's methods and analysis see the report of the 2010 Fishers' North Sea Stock Survey, pp. 89-93 & Appendix 2. Available online at: [www.nsss.eu](http://www.nsss.eu).



by the Fishers' North Sea Stock Survey. For example, the NSSS survey area includes the Kattegat which is generally not included in the ICES North Sea Area.)

To compensate for the fact that ICES estimates the SSB on the 1<sup>st</sup> of January each year while the Fishers' North Sea Stock Survey covers the period from mid-year to mid-year, the SSB in the middle of each year was estimated as the average of the SSB at the start of that year and at the start of the following year. The percentage changes between these estimated mid-year SSBs were calculated and compared to the Fishers' North Sea Stock Survey indices.

To provide a mid-year SSB estimate for 2014 the predicted SSB for 2015 was used. (All SSB data, including the predicted 2015 values, were taken from the latest ICES Advice<sup>1</sup>.)

Table 8 Illustration of Sparholt's method of calculating an abundance index from Fishers' North Sea Stock Survey data for one species in one area. In the final step (not shown) these area indices are averaged to give an overall index for each species for the North Sea. See text for full explanation.

| Category    | (1)              |                | (2)                     |            |
|-------------|------------------|----------------|-------------------------|------------|
|             | No. of Responses | % of Responses | Weighting Factor        | % × Factor |
| 'Much Less' | 2                | 4%             | -2                      | -0.08      |
| 'Less'      | 10               | 19%            | -1                      | -0.19      |
| 'No Change' | 22               | 42%            | 0                       | 0.00       |
| 'More'      | 15               | 29%            | 1                       | 0.29       |
| 'Much More' | 3                | 6%             | 2                       | 0.12       |
| TOTAL       | 52               |                | index = <b>0.13</b> (3) |            |

## Comparison of Areas

Indices of abundance were calculated for each area to provide a means of comparing trends in perceptions of changes in abundance across different areas of the North Sea. The method used followed steps 1 to 3 described above for the calculation of indices for comparison with ICES abundance estimates.

However, in the final step the individual species-area indices were averaged across all species in each area, thus giving a single index for each area. Broadly speaking,

<sup>1</sup> Available online at: [www.ices.dk/community/advisory-process/Pages/Latest-Advice.aspx](http://www.ices.dk/community/advisory-process/Pages/Latest-Advice.aspx)

a higher index indicates that a greater proportion of responses from that area perceived that abundances of fish were higher in that area in 2013.

Similar indices were calculated for perceptions of changes in the size range of fish (using weighting factors -1, 0 & 1 for the three categories of response for that parameter), discards (-2, -1, 0, 1 & 2) and recruitment (1, 2 & 3).

Similar indices were also calculated for perceptions of changes in the economic parameters surveyed: difficulty of getting/obtaining crew (using weighting factors (2, 1, 0, -1 & -2); costs (2, 1, 0, -1 & -2); optimism (-2, -1, 0, 1 & 2); and profits (-2, -1, 0, 1 & 2). The weighting factors were adjusted for each parameter to give negative values to more 'negative' responses, e.g. low costs would be perceived as 'good' so received a positive weighting factor (1 or 2) while low profits would be perceived as 'bad' and so received a negative weighting factor (-1 or -2). An overall economic index was calculated by averaging the individual economic indices for each area.

As an additional overall measure of changes in perceptions of abundance the percentage changes in the time series indices (see above) for all species in each area were averaged.

## **General Results**

A total of 196 completed questionnaires were returned in 2014 (Figure 2). This was substantially (39%) more than in 2013 (141), but was still lower than the number received in 2012 and the second lowest since the survey started. Nineteen questionnaires (10%) were omitted for various reasons, including: major changes in fishing gear used from 2013 to 2014; not specifying the fishing gear used; not providing information on any of the species or areas covered by the survey; or using fishing gears other than those covered by the survey.

This left 177 questionnaires that were included in the analyses: 8 from Belgium, 73 from Denmark, 14 from England, 56 from the Netherlands, and 26 from Scotland. (Unlike some previous years there were no returns from Netherlands 'flagships'.)

There were increases in the numbers of responses from all countries, except Belgium (Figure 3), and all areas, except Area 5 (Figure 4). The balance of responses between the different species remained roughly in line with that of the last few years (Figure 5), with increases in the numbers of responses for all species.

Figure 6 shows a breakdown of the valid questionnaires received in 2014 by nationality, area fished, fishing gear used, and size of fishing vessel. Overall, rather more responses were received for the southern and eastern North Sea (areas 6b, 7 & 8), and for gill nets and otter trawls. Numbers of responses were fairly evenly split by vessel size class. As may be seen from Figure 6 there were marked variations in all the parameters between the different countries.

The number of questionnaires received (both total and 'valid') was substantially greater than in 2013, but still less than in 2012 and continuing a downwards trend seen for a number of years. Anecdotal information from at least some national coordinators suggests that, as in previous years, fishermen may be 'losing faith' in the survey as they do not perceive that the results have any influence on assessments of fish stocks or on management decisions.

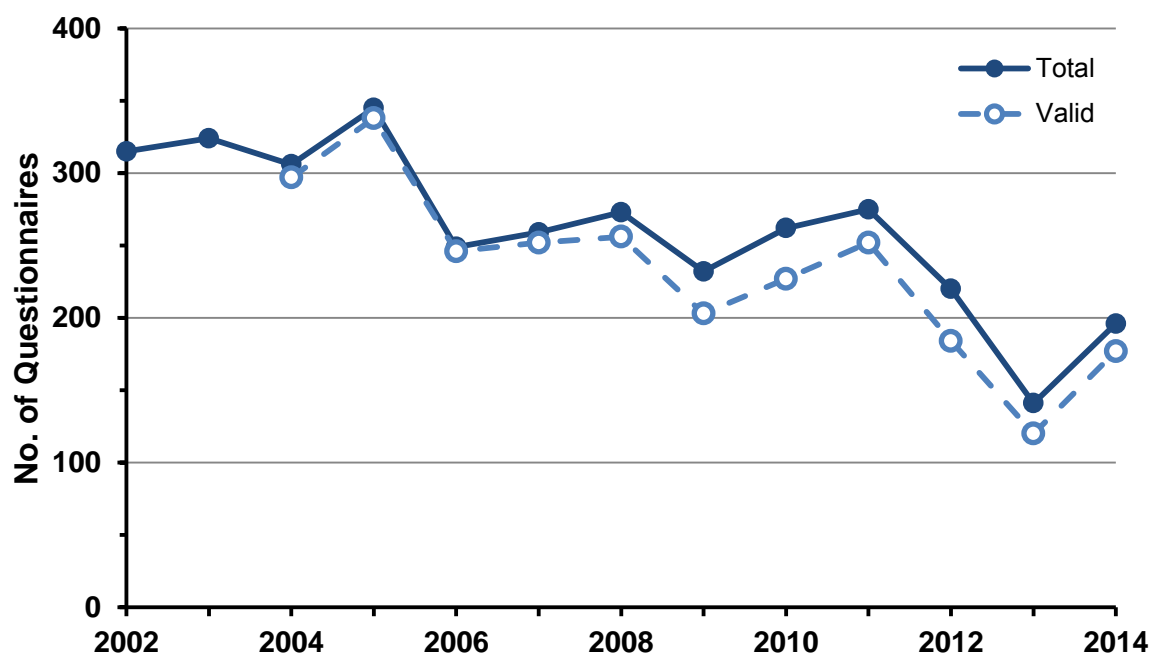


Figure 2 The total number of questionnaires returned each year, and the number of valid questionnaires included in the analysis.

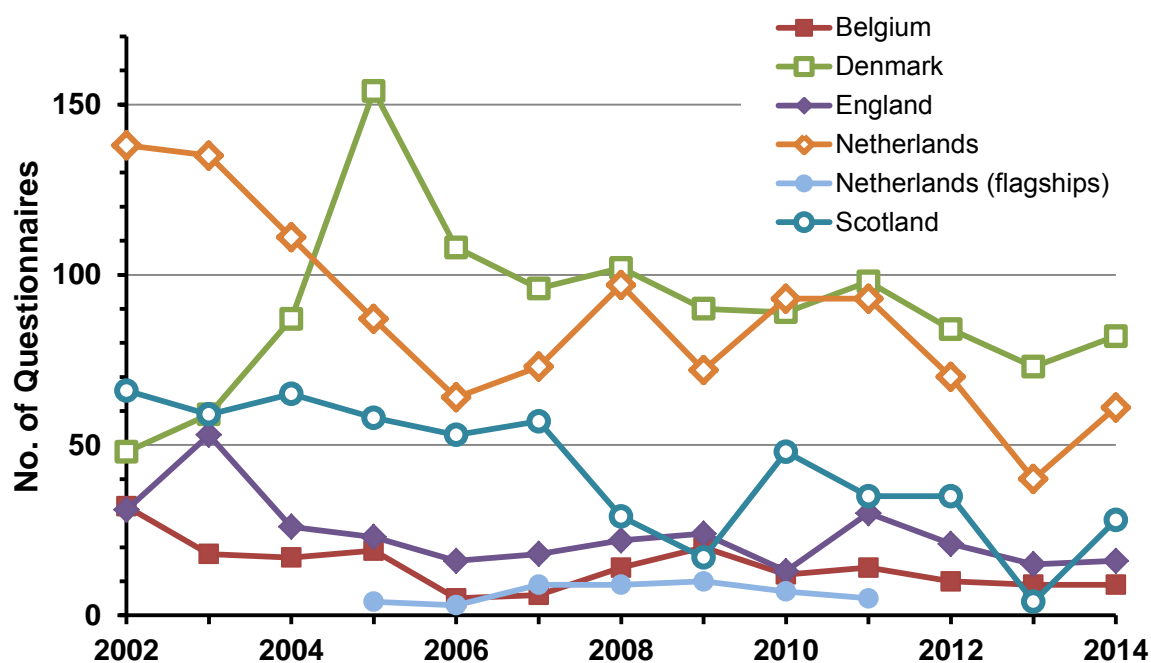


Figure 3 The total number of questionnaires returned each year, by country (all responses).

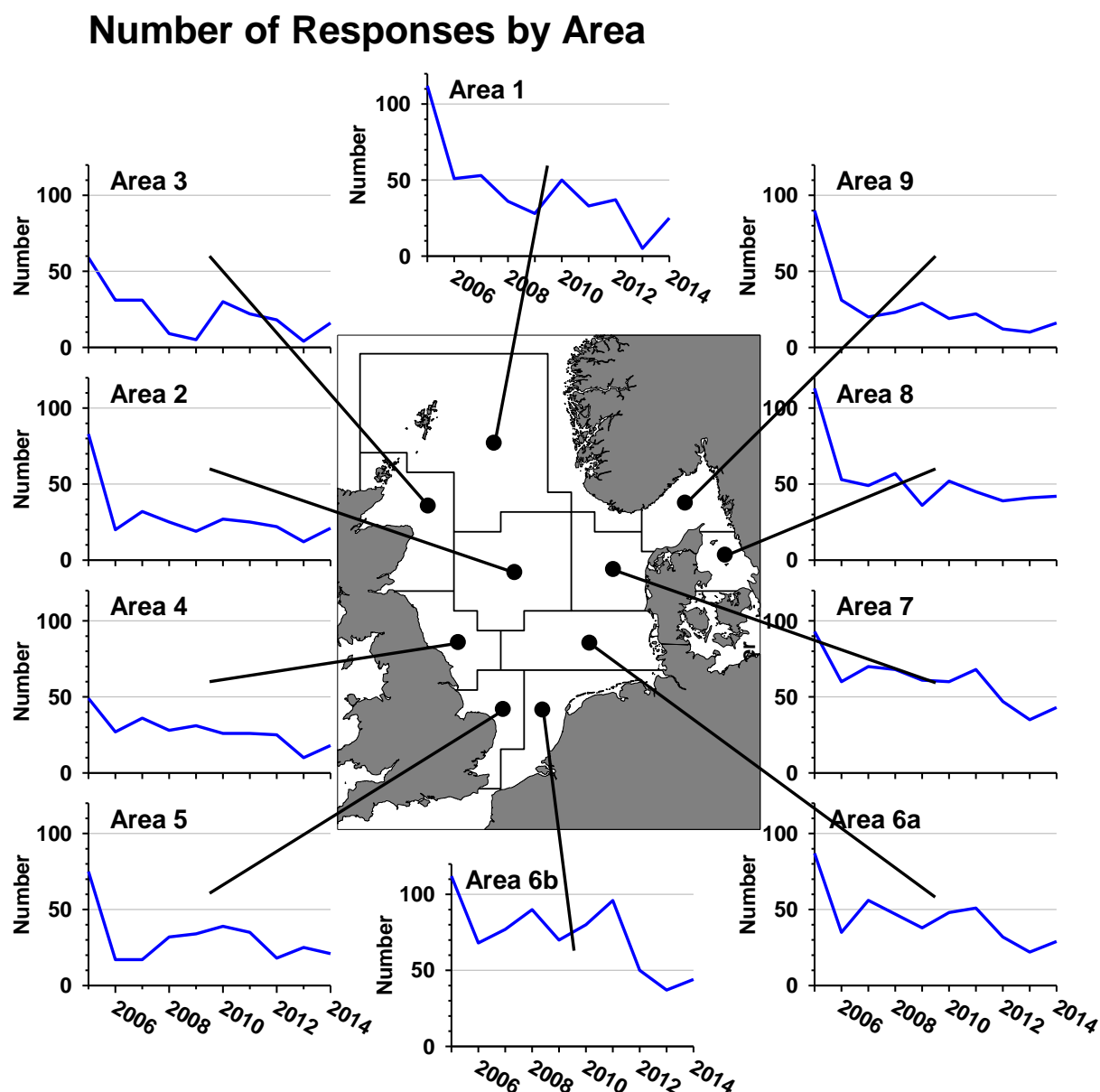


Figure 4 The number of valid questionnaires returned each year, by area. Number of responses providing information on at least one species in each area.

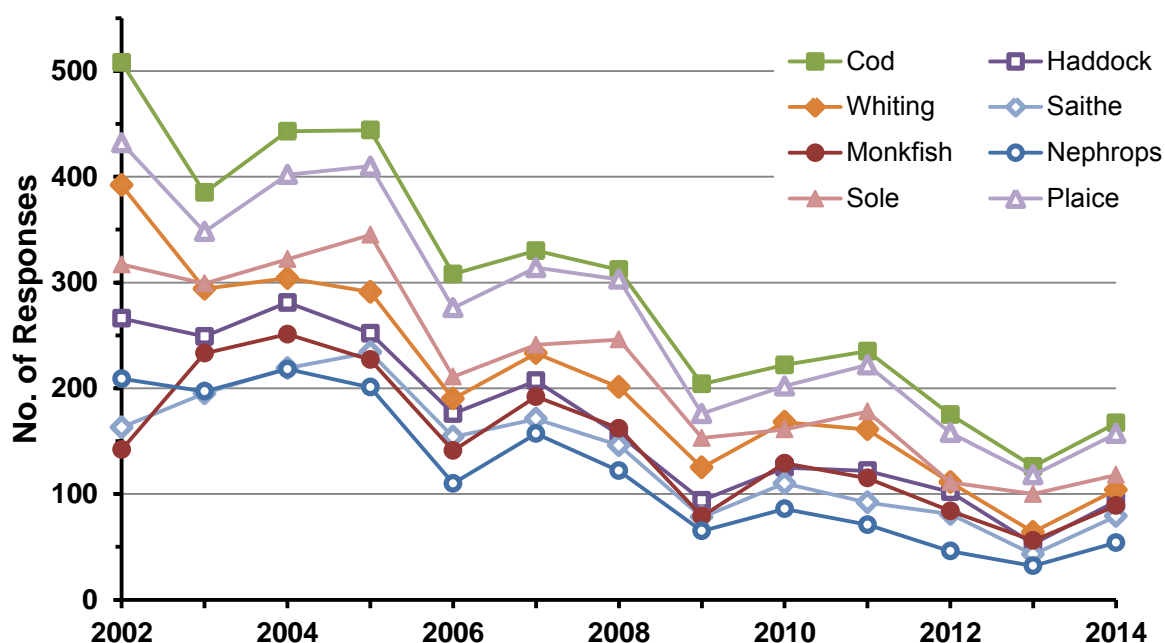


Figure 5 The number of valid questionnaires returned each year giving information for each species (most responses give information for more than one species).

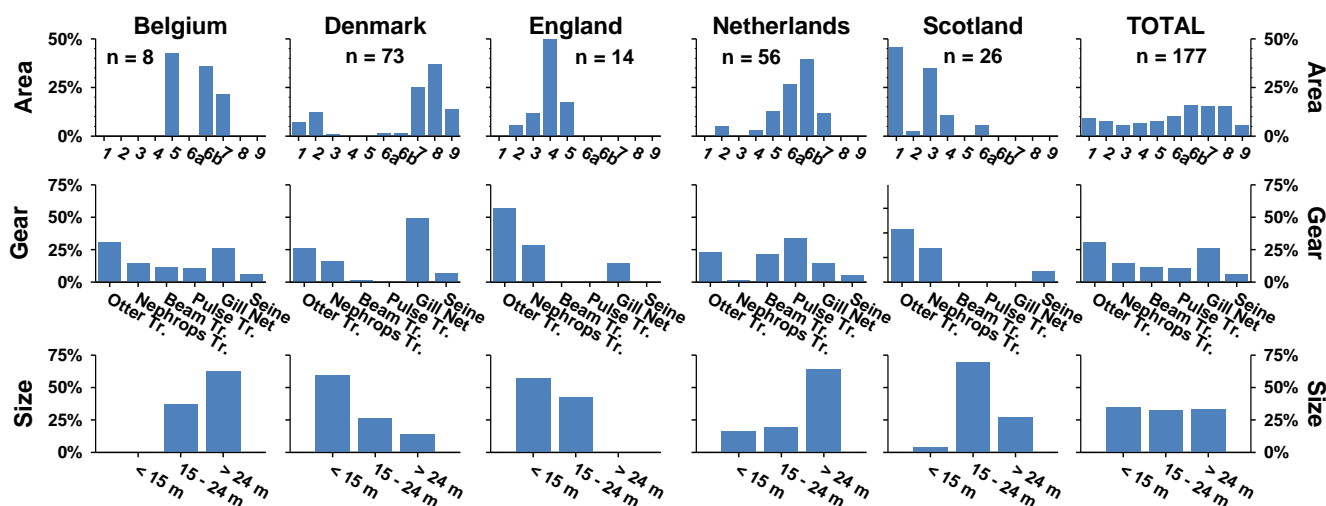


Figure 6 Breakdown of valid questionnaires received in 2014 by country, area fished, fishing gear, and vessel size. Numbers displayed on top row of charts ('n = X') are total numbers of valid questionnaires for that country.

# Economic Circumstances

Most of the 177 valid questionnaires received provided information on perceptions of economic circumstances. These responses are summarised in Table 9 and Table 10, and in Figure 7 to Figure 9.

Table 9 Summary of perceptions of economic circumstances this year and last year: Difficulty of obtaining/retaining crew; operating costs; profits; and optimism about the future. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| <b>Crew</b>                | <b>2013</b> | <b>2014</b> | <b>+/-</b> | <b>Costs</b>               | <b>2013</b> | <b>2014</b> | <b>+/-</b> |
|----------------------------|-------------|-------------|------------|----------------------------|-------------|-------------|------------|
| <b>'Less'</b> <sup>1</sup> | 11%         | 10%         | -0%        | <b>'Less'</b> <sup>1</sup> | 11%         | 7%          | -3%        |
| <b>Same</b>                | 70%         | 71%         | +1%        | <b>Same</b>                | 29%         | 40%         | +10%       |
| <b>'More'</b> <sup>2</sup> | 19%         | 19%         | -0%        | <b>'More'</b> <sup>2</sup> | 60%         | 53%         | -7%        |
| <b>Profits</b>             | <b>2013</b> | <b>2014</b> | <b>+/-</b> | <b>Optimism</b>            | <b>2013</b> | <b>2014</b> | <b>+/-</b> |
| <b>'Less'</b> <sup>1</sup> | 64%         | 51%         | -12%       | <b>'Less'</b> <sup>1</sup> | 62%         | 46%         | -16%       |
| <b>Same</b>                | 23%         | 35%         | +12%       | <b>Same</b>                | 29%         | 34%         | +5%        |
| <b>'More'</b> <sup>2</sup> | 13%         | 14%         | +1%        | <b>'More'</b> <sup>2</sup> | 9%          | 20%         | +11%       |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

## Difficulty of Getting / Retaining Crew

Overall, just under three-quarters of respondents reported the same level of difficulty in getting or retaining crew in 2014 (Table 9), almost unchanged from 2013. Of the remaining responses more (19%) reported more difficulty, again almost unchanged from 2013.

The picture was broadly similar whether the responses were broken down by area (Figure 7), species (Figure 8), fishing gear type (Figure 9) or vessel size (Figure 10), with the majority of responses in each case reporting the 'same' level of difficulty in getting or retaining crew. No clear patterns were apparent in the balance of the remaining responses between lower and higher levels of difficulty.

## Operating Costs

Just over half of responses reported that their operating costs were higher in 2014, somewhat less than in 2013 (Table 9). Most of the balance reported the same costs,



more than in 2013. The proportion of responses reporting lower costs fell slightly and remained relatively small.

The picture was broadly similar across individual areas (Figure 7) and species (Figure 8). By fishing gear type, otter trawls, *Nephrops* trawls and gill nets were more likely than the other gear types to report higher costs (Figure 9), as were smaller vessels (Figure 10).

### **Profits**

About half of responses reported lower profits in 2014 (Table 9), less than in 2013. About one-third of responses reported the same level of profits, more than in 2013, while the (small) proportion reporting greater profits was almost unchanged.

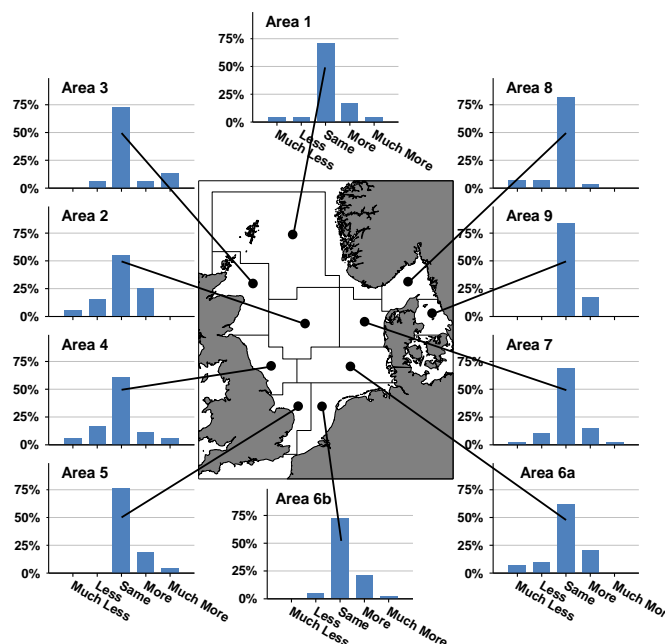
The picture was broadly similar across individual areas (Figure 7), species (Figure 8) and vessel sizes (Figure 10). By fishing gear type, beam trawlers and pulse trawlers were more likely than the other gear types to report the same level of profits (Figure 9).

### **Optimism for the Future**

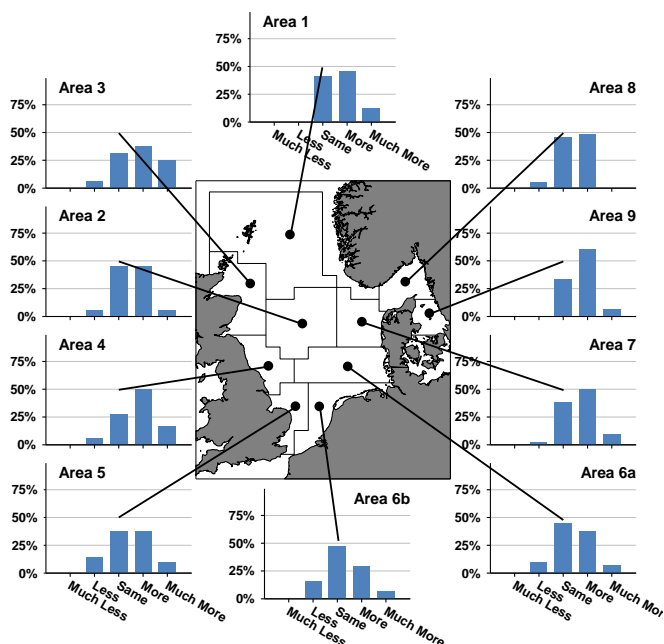
Levels of optimism in 2014 were generally higher than in 2013 (Table 9), with just over half of responses reporting the same or higher levels of optimism and a fairly large fall in the proportion reporting less optimism.

The picture was broadly similar across individual areas (Figure 7), species (Figure 8) and vessel sizes (Figure 10). By fishing gear type, otter trawls, *Nephrops* trawls and gill nets were most likely to report lower levels of optimism (Figure 9).

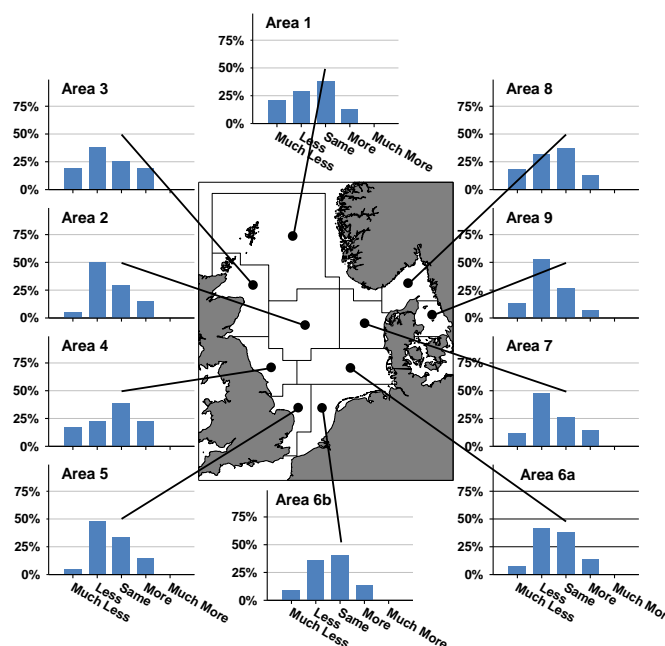
## Difficulty of Getting / Retaining Crew



## Operating Costs



## Profits



## Optimism for the Future

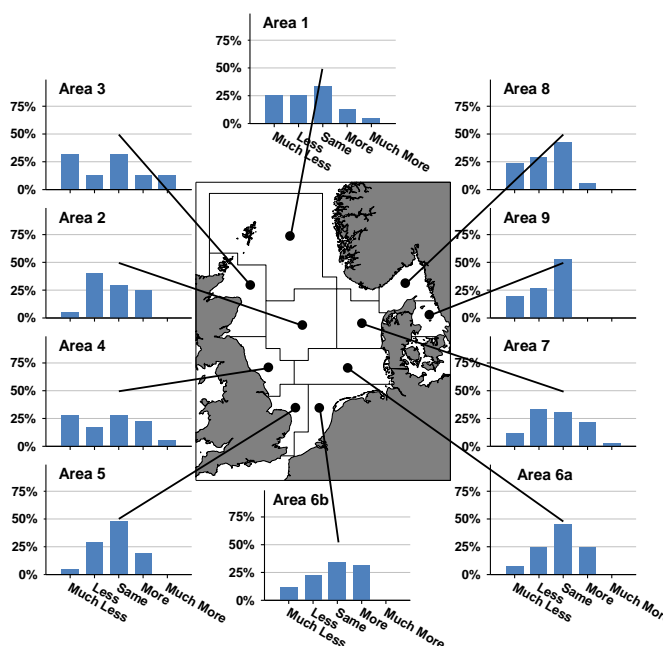


Figure 7 Breakdown by area of perceptions of changes in the difficulty of getting or retaining crew; of operating costs; of profit levels; and of optimism for the future. Percentage of responses from each area in each category.

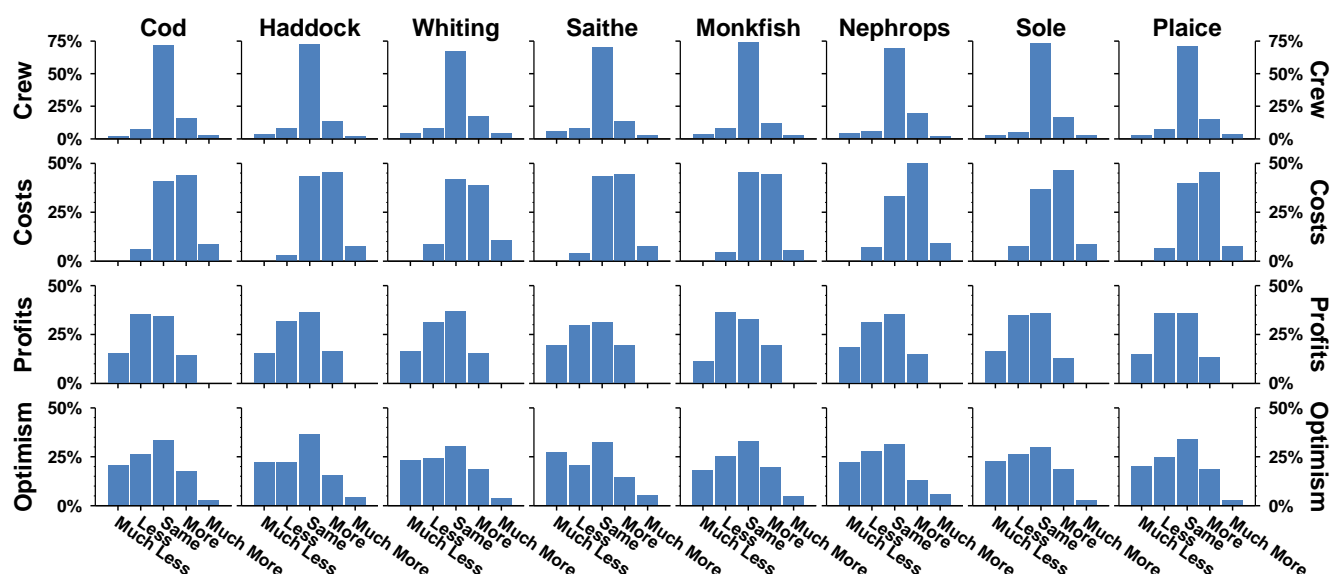


Figure 8 Breakdown of economic perceptions by species: difficulty of obtaining/retaining crew, operating costs, profits, and optimism about the future. Percentage of responses for each species in each category.

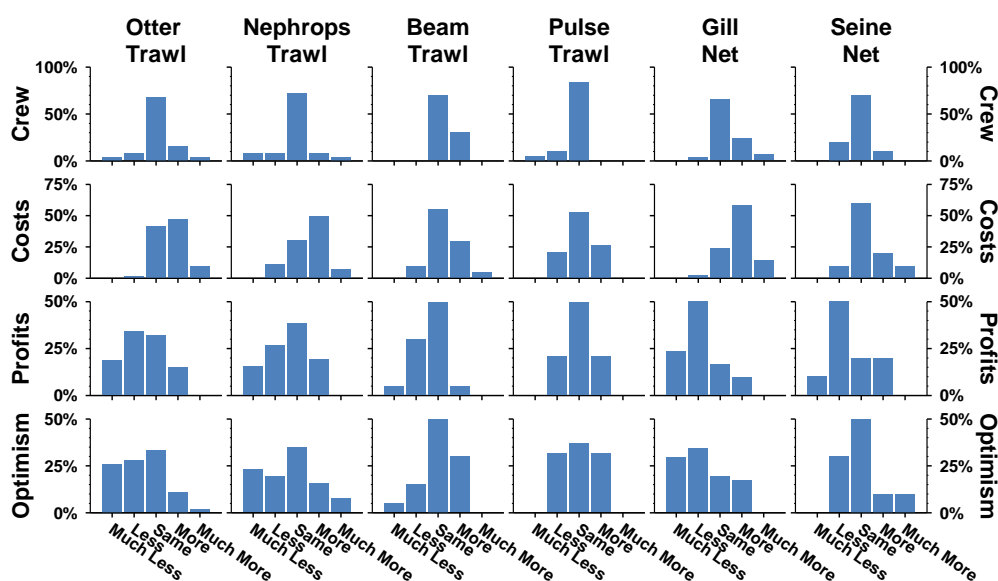


Figure 9 Breakdown of economic perceptions by fishing gear type: difficulty of obtaining/retaining crew, operating costs, profits, and optimism about the future. Percentage of responses in each category for all responses for each gear type.

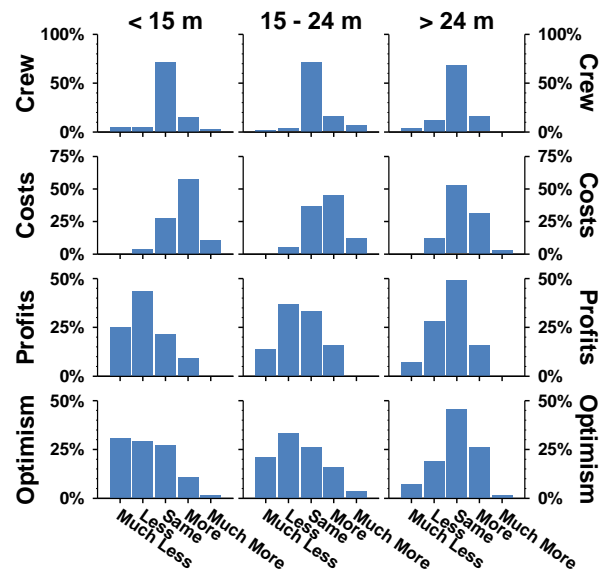


Figure 10 Breakdown of economic perceptions by fishing vessel size: difficulty of obtaining/retaining crew, operating costs, profits, and optimism about the future. Percentage of responses in each category for all responses for each vessel size.

Table 10 Numbers of responses per category by area, species, gear type (otter trawl, *Nephrops* trawl, beam trawl, pulse trawl, gill nets and seine net) and vessel size for perceptions of difficulty of obtaining/retaining crew, operating costs, profits, and optimism about the future.

|         |           | Crew      |      |      |      |           | Costs     |           |      |      |      | Profits   |           |           |      |      | Optimism |           |           |           |      | TOTAL |      |      |           |           |
|---------|-----------|-----------|------|------|------|-----------|-----------|-----------|------|------|------|-----------|-----------|-----------|------|------|----------|-----------|-----------|-----------|------|-------|------|------|-----------|-----------|
|         |           | Much Less | Less | Same | More | Much More | No Answer | Much Less | Less | Same | More | Much More | No Answer | Much Less | Less | Same | More     | Much More | No Answer | Much Less | Less |       | Same | More | Much More | No Answer |
| Area    | 1         | 1         | 1    | 17   | 4    | 1         | 1         | 0         | 0    | 10   | 11   | 3         | 1         | 5         | 7    | 9    | 3        | 0         | 1         | 6         | 6    | 8     | 3    | 1    | 1         | 25        |
|         | 2         | 1         | 3    | 11   | 5    | 0         | 1         | 0         | 1    | 9    | 9    | 1         | 1         | 1         | 10   | 6    | 3        | 0         | 1         | 1         | 8    | 6     | 5    | 0    | 1         | 21        |
|         | 3         | 0         | 1    | 11   | 1    | 2         | 1         | 0         | 1    | 5    | 6    | 4         | 0         | 3         | 6    | 4    | 3        | 0         | 0         | 5         | 2    | 5     | 2    | 2    | 0         | 16        |
|         | 4         | 1         | 3    | 11   | 2    | 1         | 0         | 0         | 1    | 5    | 9    | 3         | 0         | 3         | 4    | 7    | 4        | 0         | 0         | 5         | 3    | 5     | 4    | 1    | 0         | 18        |
|         | 5         | 0         | 0    | 16   | 4    | 1         | 0         | 0         | 3    | 8    | 8    | 2         | 0         | 1         | 10   | 7    | 3        | 0         | 0         | 1         | 6    | 10    | 4    | 0    | 0         | 21        |
|         | 6a        | 2         | 3    | 18   | 6    | 0         | 0         | 0         | 3    | 13   | 11   | 2         | 0         | 2         | 12   | 11   | 4        | 0         | 0         | 2         | 7    | 13    | 7    | 0    | 0         | 29        |
|         | 6b        | 0         | 2    | 31   | 9    | 1         | 1         | 0         | 7    | 21   | 13   | 3         | 0         | 4         | 16   | 18   | 6        | 0         | 0         | 5         | 10   | 15    | 14   | 0    | 0         | 44        |
|         | 7         | 1         | 4    | 27   | 6    | 1         | 4         | 0         | 1    | 16   | 21   | 4         | 1         | 5         | 20   | 11   | 6        | 0         | 1         | 5         | 14   | 13    | 9    | 1    | 1         | 43        |
|         | 8         | 2         | 2    | 22   | 1    | 0         | 15        | 0         | 2    | 17   | 18   | 0         | 5         | 7         | 12   | 14   | 5        | 0         | 4         | 9         | 11   | 16    | 2    | 0    | 4         | 42        |
|         | 9         | 0         | 0    | 10   | 2    | 0         | 4         | 0         | 0    | 5    | 9    | 1         | 1         | 2         | 8    | 4    | 1        | 0         | 1         | 3         | 4    | 8     | 0    | 0    | 1         | 16        |
| Species | Cod       | 3         | 11   | 103  | 23   | 4         | 23        | 0         | 10   | 65   | 70   | 14        | 8         | 25        | 57   | 55   | 23       | 0         | 7         | 33        | 42   | 53    | 28   | 4    | 7         | 167       |
|         | Haddock   | 3         | 7    | 64   | 12   | 2         | 5         | 0         | 3    | 39   | 41   | 7         | 3         | 14        | 29   | 33   | 15       | 0         | 2         | 20        | 20   | 33    | 14   | 4    | 2         | 93        |
|         | Whiting   | 4         | 8    | 67   | 17   | 4         | 4         | 0         | 9    | 43   | 40   | 11        | 1         | 17        | 32   | 38   | 16       | 0         | 1         | 24        | 25   | 31    | 19   | 4    | 1         | 104       |
|         | Saithe    | 4         | 6    | 51   | 10   | 2         | 6         | 0         | 3    | 33   | 34   | 6         | 3         | 15        | 23   | 24   | 15       | 0         | 2         | 21        | 16   | 25    | 11   | 4    | 2         | 79        |
|         | Monkfish  | 3         | 7    | 63   | 10   | 2         | 4         | 0         | 4    | 40   | 39   | 5         | 1         | 10        | 32   | 29   | 17       | 0         | 1         | 16        | 22   | 29    | 17   | 4    | 1         | 89        |
|         | Nephrops  | 2         | 3    | 36   | 10   | 1         | 2         | 0         | 4    | 18   | 27   | 5         | 0         | 10        | 17   | 19   | 8        | 0         | 0         | 12        | 15   | 17    | 7    | 3    | 0         | 54        |
|         | Sole      | 3         | 5    | 77   | 17   | 3         | 13        | 0         | 9    | 42   | 53   | 10        | 4         | 19        | 40   | 41   | 15       | 0         | 3         | 26        | 30   | 34    | 21   | 3    | 4         | 118       |
|         | Plaice    | 4         | 10   | 98   | 21   | 5         | 19        | 0         | 10   | 61   | 70   | 12        | 4         | 23        | 55   | 55   | 21       | 0         | 3         | 31        | 38   | 52    | 28   | 4    | 4         | 157       |
| Gear    | Otter Tr. | 2         | 4    | 34   | 8    | 2         | 4         | 0         | 1    | 22   | 25   | 5         | 1         | 10        | 18   | 17   | 8        | 0         | 1         | 14        | 15   | 18    | 6    | 1    | 0         | 54        |
|         | Neph. Tr. | 2         | 2    | 18   | 2    | 1         | 1         | 0         | 3    | 8    | 13   | 2         | 0         | 4         | 7    | 10   | 5        | 0         | 0         | 6         | 5    | 9     | 4    | 2    | 0         | 26        |
|         | Beam Tr.  | 0         | 0    | 14   | 6    | 0         | 0         | 0         | 2    | 11   | 6    | 1         | 0         | 1         | 6    | 12   | 1        | 0         | 0         | 1         | 3    | 10    | 6    | 0    | 0         | 20        |
|         | Pulse Tr. | 1         | 2    | 16   | 0    | 0         | 0         | 0         | 4    | 10   | 5    | 0         | 0         | 0         | 4    | 11   | 4        | 0         | 0         | 0         | 6    | 7     | 6    | 0    | 0         | 19        |
|         | Gill Nets | 0         | 1    | 19   | 7    | 2         | 18        | 0         | 1    | 10   | 24   | 6         | 6         | 10        | 21   | 7    | 4        | 0         | 5         | 12        | 14   | 8     | 7    | 0    | 6         | 47        |
|         | Seine     | 0         | 2    | 7    | 1    | 0         | 1         | 0         | 1    | 6    | 2    | 1         | 1         | 1         | 5    | 2    | 2        | 0         | 1         | 0         | 3    | 5     | 1    | 1    | 1         | 11        |
| Size    | <15m      | 2         | 2    | 28   | 6    | 1         | 22        | 0         | 2    | 15   | 31   | 6         | 7         | 14        | 24   | 12   | 5        | 0         | 6         | 17        | 16   | 15    | 6    | 1    | 6         | 61        |
|         | 15-24m    | 1         | 2    | 40   | 9    | 4         | 1         | 0         | 3    | 21   | 26   | 7         | 0         | 8         | 21   | 19   | 9        | 0         | 0         | 12        | 19   | 15    | 9    | 2    | 0         | 57        |
|         | >24m      | 2         | 7    | 39   | 9    | 0         | 1         | 0         | 7    | 30   | 18   | 2         | 1         | 4         | 16   | 28   | 9        | 0         | 1         | 4         | 11   | 26    | 15   | 1    | 1         | 58        |
|         | Not Stat. | 0         | 0    | 1    | 0    | 0         | 0         | 0         | 0    | 1    | 0    | 0         | 0         | 0         | 0    | 0    | 1        | 0         | 0         | 0         | 0    | 1     | 0    | 0    | 0         | 1         |

# Species Accounts

One hundred and seventy seven (177) valid responses were received that provided information on at least one species in at least one area. Most responses provided information on several species, but most responses provided information on just one or two areas (Figure 11).

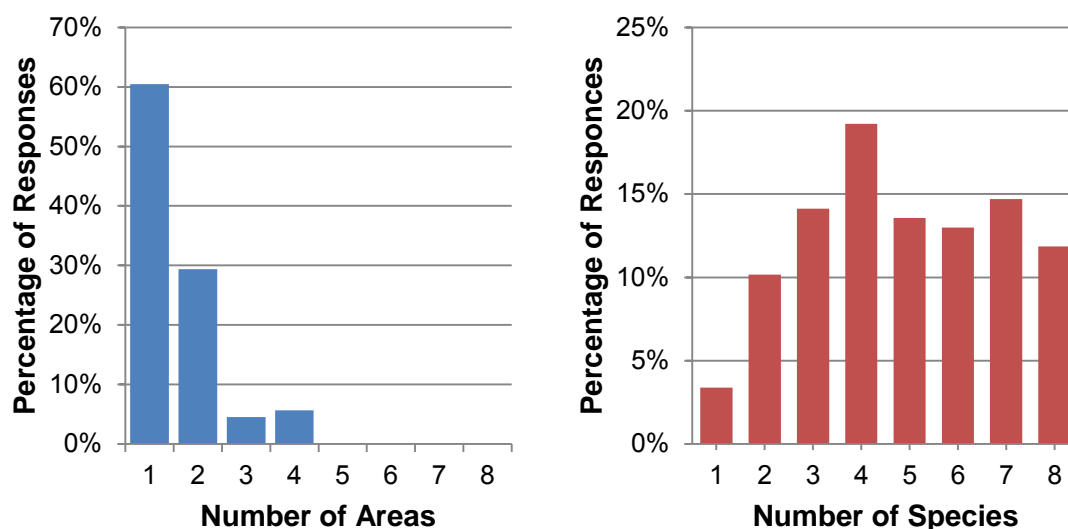


Figure 11 The proportions of responses providing information on different numbers of areas (left) and species (right).

A more detailed breakdown of responses by species and areas is provided in Table 11. Eight species and 10 areas provides a total of 80 possible species-area combinations. The number of responses per species-area combination varied from one to 40, with an average of 14. To reduce the potential for small numbers of responses to markedly skew the results, species-area combinations with less than three responses were omitted from the analyses. This affected five of the 80 species-area combinations in 2014 (Table 11), substantially fewer than in 2013. No area had more than one species with fewer than three responses, and saithe and common sole were the only species to have fewer than three responses in more than one area.

Table 11 The numbers of responses by area and species. Species-areas combinations with less than three responses (bracketed) were omitted from the analyses.

|                                                             | Area 1 | Area 2 | Area 3 | Area 4 | Area 5 | Area 6a | Area 6b | Area 7 | Area 8 | Area 9 | TOTAL |
|-------------------------------------------------------------|--------|--------|--------|--------|--------|---------|---------|--------|--------|--------|-------|
| <b>Number of responses for each species from each area:</b> |        |        |        |        |        |         |         |        |        |        |       |
| <b>Cod</b>                                                  | 25     | 16     | 14     | 15     | 13     | 11      | 34      | 36     | 38     | 15     | 167   |
| <b>Haddock</b>                                              | 23     | 11     | 15     | 16     | 5      | (2)     | 3       | 19     | 24     | 6      | 93    |
| <b>Whiting</b>                                              | 20     | 9      | 13     | 17     | 15     | 10      | 30      | 5      | 12     | 3      | 104   |
| <b>Saithe</b>                                               | 24     | 13     | 10     | 9      | (2)    | 4       | (1)     | 19     | 21     | 3      | 79    |
| <b>Monkfish</b>                                             | 21     | 14     | 10     | 14     | 8      | 7       | 3       | 18     | 19     | 3      | 89    |
| <b>Nephrops</b>                                             | 5      | 4      | 8      | 13     | 3      | 7       | 3       | 9      | 14     | 5      | 54    |
| <b>Common Sole</b>                                          | (2)    | (2)    | 4      | 11     | 18     | 11      | 40      | 13     | 21     | 13     | 118   |
| <b>Plaice</b>                                               | 17     | 16     | 9      | 14     | 13     | 25      | 29      | 40     | 34     | 9      | 157   |
| <b>TOTAL</b>                                                | 25     | 21     | 16     | 18     | 21     | 29      | 44      | 43     | 42     | 16     | 275   |
| <b>% of responses from each area for each species:</b>      |        |        |        |        |        |         |         |        |        |        |       |
| <b>Cod</b>                                                  | 100%   | 76%    | 88%    | 83%    | 62%    | 38%     | 77%     | 84%    | 90%    | 94%    | 79%   |
| <b>Haddock</b>                                              | 92%    | 52%    | 94%    | 89%    | 24%    | 7%      | 7%      | 44%    | 57%    | 38%    | 45%   |
| <b>Whiting</b>                                              | 80%    | 43%    | 81%    | 94%    | 71%    | 34%     | 68%     | 12%    | 29%    | 19%    | 49%   |
| <b>Saithe</b>                                               | 96%    | 62%    | 63%    | 50%    | 10%    | 14%     | 2%      | 44%    | 50%    | 19%    | 39%   |
| <b>Monkfish</b>                                             | 84%    | 67%    | 63%    | 78%    | 38%    | 24%     | 7%      | 42%    | 45%    | 19%    | 43%   |
| <b>Nephrops</b>                                             | 20%    | 19%    | 50%    | 72%    | 14%    | 24%     | 7%      | 21%    | 33%    | 31%    | 26%   |
| <b>Common Sole</b>                                          | 8%     | 10%    | 25%    | 61%    | 86%    | 38%     | 91%     | 30%    | 50%    | 81%    | 49%   |
| <b>Plaice</b>                                               | 68%    | 76%    | 56%    | 78%    | 62%    | 86%     | 66%     | 93%    | 81%    | 56%    | 75%   |
| <b>TOTAL</b>                                                | 100%   | 100%   | 100%   | 100%   | 100%   | 100%    | 100%    | 100%   | 100%   | 100%   | 100%  |
| <b>% of responses for each species from each area:</b>      |        |        |        |        |        |         |         |        |        |        |       |
| <b>Cod</b>                                                  | 12%    | 7%     | 6%     | 7%     | 6%     | 5%      | 16%     | 17%    | 18%    | 7%     | 100%  |
| <b>Haddock</b>                                              | 19%    | 9%     | 12%    | 13%    | 4%     | 2%      | 2%      | 15%    | 19%    | 5%     | 100%  |
| <b>Whiting</b>                                              | 15%    | 7%     | 10%    | 13%    | 11%    | 7%      | 22%     | 4%     | 9%     | 2%     | 100%  |
| <b>Saithe</b>                                               | 23%    | 12%    | 9%     | 8%     | 2%     | 4%      | 1%      | 18%    | 20%    | 3%     | 100%  |
| <b>Monkfish</b>                                             | 18%    | 12%    | 9%     | 12%    | 7%     | 6%      | 3%      | 15%    | 16%    | 3%     | 100%  |
| <b>Nephrops</b>                                             | 7%     | 6%     | 11%    | 18%    | 4%     | 10%     | 4%      | 13%    | 20%    | 7%     | 100%  |
| <b>Common Sole</b>                                          | 1%     | 1%     | 3%     | 8%     | 13%    | 8%      | 30%     | 10%    | 16%    | 10%    | 100%  |
| <b>Plaice</b>                                               | 8%     | 8%     | 4%     | 7%     | 6%     | 12%     | 14%     | 19%    | 17%    | 4%     | 100%  |
| <b>TOTAL</b>                                                | 9%     | 8%     | 6%     | 7%     | 8%     | 11%     | 16%     | 16%    | 15%    | 6%     | 100%  |



## Cod

Of the 177 valid responses received, 167 (94%) provided information on cod. The proportion of responses providing information on cod was lowest – at 38% – in the south-eastern North Sea (area 6a), but relatively high throughout most of the area covered by the survey (Figure 12).

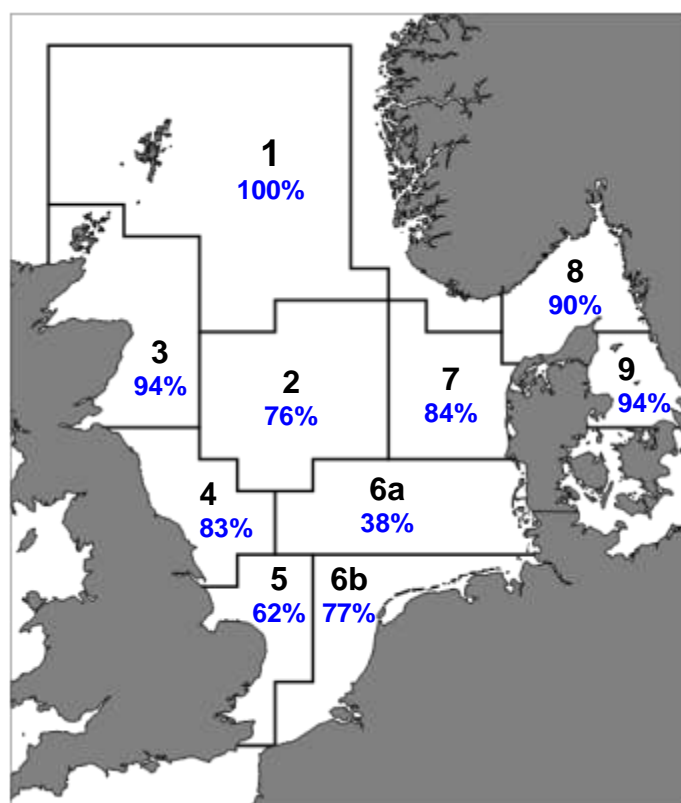


Figure 12 The proportions of responses from each area that provided information on cod.

Table 12 shows the responses broken down by fishing gear and vessel size class. Responses were roughly equally split between the three vessel size classes. Of the fishing gears, the otter trawl accounted for almost one-third of responses and gill nets about one quarter. Figure 13 and Figure 14 provide a more detailed breakdown of the responses for cod by vessel size and fishing gear.

Table 12 Numbers of responses for cod by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |     |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|-----|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |     | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 13     | 20   | 19  | 52             | 22%    | 38%  | 36%  | 31%  |
|              |           | Nephrops Trawl    | 8      | 16   | 1   | 25             | 13%    | 30%  | 2%   | 15%  |
|              |           | Beam Trawl        | 0      | 6    | 13  | 19             | 0%     | 11%  | 25%  | 11%  |
|              |           | Pulse Trawl       | 0      | 1    | 14  | 15             | 0%     | 2%   | 26%  | 9%   |
|              |           | Gill Net          | 39     | 5    | 0   | 44             | 65%    | 9%   | 0%   | 27%  |
|              |           | Seine Net         | 0      | 5    | 6   | 11             | 0%     | 9%   | 11%  | 7%   |
|              |           | ALL               | 60     | 53   | 53  | 166            | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 25%    | 38%  | 37% | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 32%    | 64%  | 4%  | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 32%  | 68% | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 7%   | 93% | 100%           |        |      |      |      |
|              |           | Gill Net          | 89%    | 11%  | 0%  | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 45%  | 55% | 100%           |        |      |      |      |
|              |           | ALL               | 36%    | 32%  | 32% | 100%           |        |      |      |      |

Table 13 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of cod this year and last year. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/-  | Fish Size    | 2013 | 2014 | +/- |
|---------------------|------|------|------|--------------|------|------|-----|
| 'Less' <sup>1</sup> | 27%  | 13%  | -14% | Mostly Small | 12%  | 13%  | +2% |
| No Change           | 31%  | 27%  | -4%  | All Sizes    | 81%  | 82%  | +1% |
| 'More' <sup>2</sup> | 41%  | 60%  | +19% | Mostly Large | 8%   | 4%   | -3% |
| Discards            | 2013 | 2014 | +/-  | Recruitment  | 2013 | 2014 | +/- |
| 'Less' <sup>1</sup> | 27%  | 17%  | -9%  | Low          | 15%  | 14%  | -1% |
| No Change           | 53%  | 53%  | +1%  | Moderate     | 49%  | 47%  | -2% |
| 'More' <sup>2</sup> | 21%  | 29%  | +9%  | High         | 36%  | 40%  | +3% |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

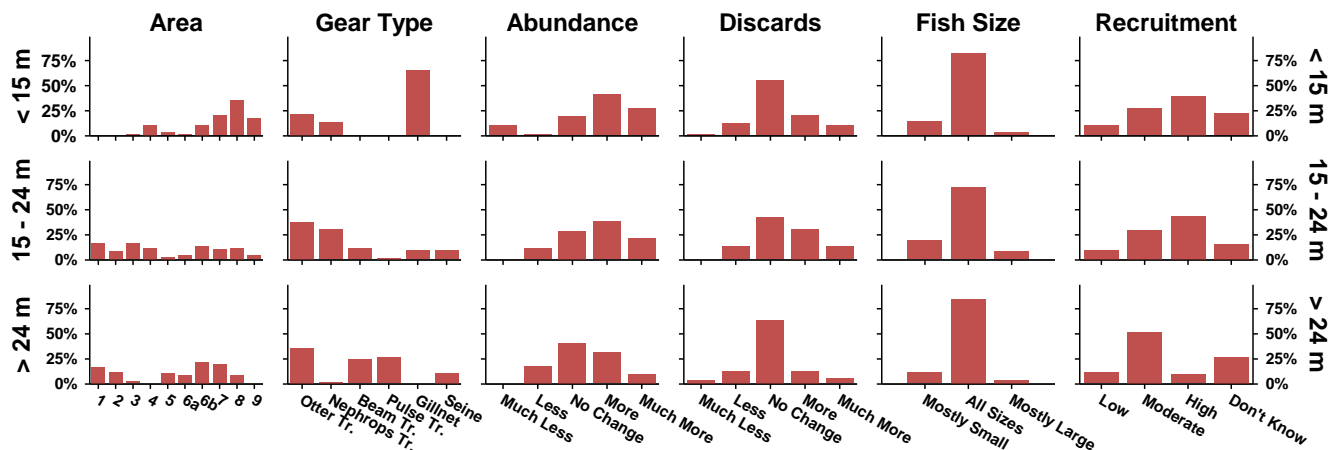


Figure 13 Breakdown of responses for cod by fishing vessel size class. Percentage of responses for each size class in each category.

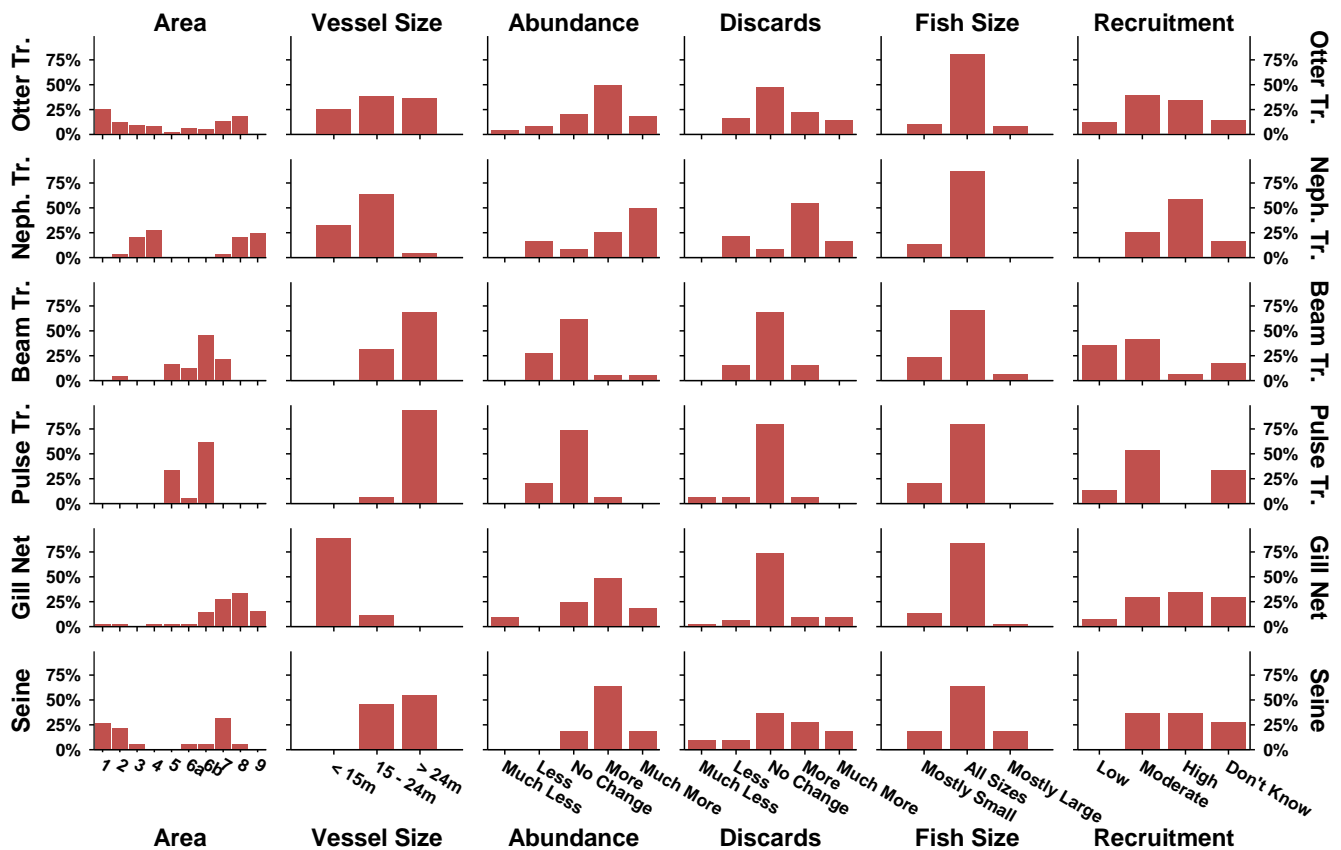


Figure 14 Breakdown of responses for cod by fishing gear (Otter Trawl, *Nephrops* Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

## **Abundance**

Overall, 60% of responses reported that cod were more abundant in 2014 (Table 13), a substantial increase from 2013. More than one-quarter reported no change in the abundance of cod in 2014, slightly less than in 2013, while there was a fairly large fall in the proportion reporting less cod.

By area, the proportions reporting greater abundances of cod were highest in the north and east (areas 1, 8 & 9) while the proportions reporting lower abundances were highest in the south and east (areas 4 & 6b) (Figure 16).

The cumulative index of perceptions of the abundance of cod increased in most areas (Figure 17), except the south and east (areas 4 & 6b).

## **Size Range**

Perceptions of the size range of cod in 2014 were similar to those in 2013, with the majority reporting catching all sizes (Table 13). Most of the balance reported catching mostly small cod, a small increase from 2013, while there was a small decrease in the proportion reporting mostly large cod.

The picture was broadly similar across all areas, with the majority of responses in each reporting all sizes of cod (Figure 16). The biggest proportions reporting mostly small cod were in the south west (areas 4, 5 & 6b).

## **Discards**

About half of responses reported no change in the level of discarding of cod in 2014 (Table 13), almost unchanged from 2013. Of the balance, more responses reported a higher level of discards, with a marked increase from 2013, while there was a comparable fall in the proportion reporting lower levels of cod discarding in 2014.

Across individual areas the proportions reporting no change in the levels of discards of cod tend to be highest in the central and south eastern North Sea (areas 2, 5, 6a, 6b, 7 & 8) (Figure 16), while the proportions reporting higher levels of discards tended to be highest in the north and west (areas 1 & 3), and the Kattegat (area 9).

## **Recruitment**

Almost half of responses reported moderate levels of recruitment of cod in 2014 while a somewhat smaller proportion reported high levels of recruitment (Table 13). These levels of response were little changed from 2013.

No clear patterns was apparent in the responses across individual areas (Figure 16).

### Comparison with ICES Stock Assessment

There was some agreement between the cod abundance index derived from the Fishers' North Sea Stock Survey and the ICES estimates of the North Sea cod spawning stock biomass, but the relationship was statistically weak (Figure 15).

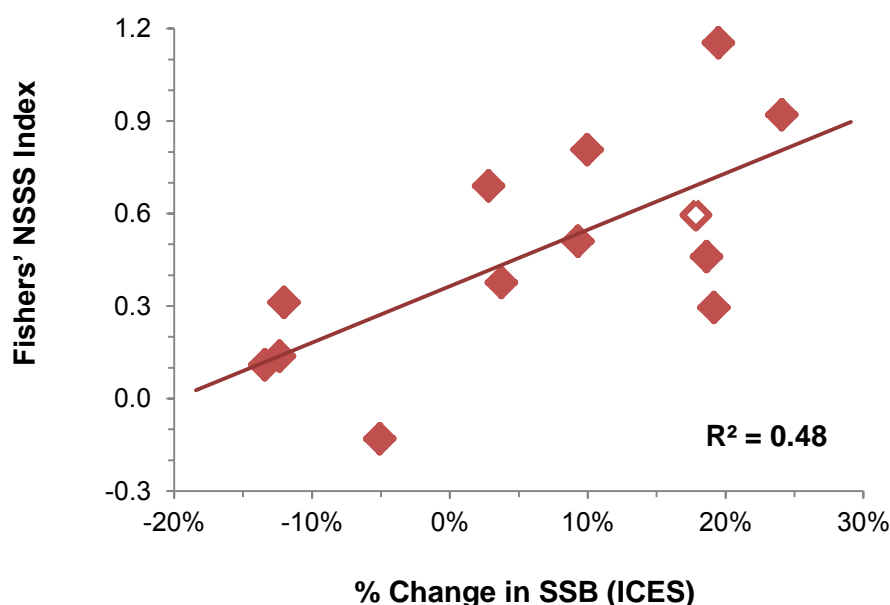


Figure 15 Plot of the annual Fishers' North Sea Stock Survey index against the percentage changes in the estimated mid-year North Sea cod spawning stock biomass (SSB), with fitted linear trend line and coefficient of determination ( $R^2$ ; values closer to 1 indicate a better agreement.) The unshaded point is based on the predicted year SSB for 2015.

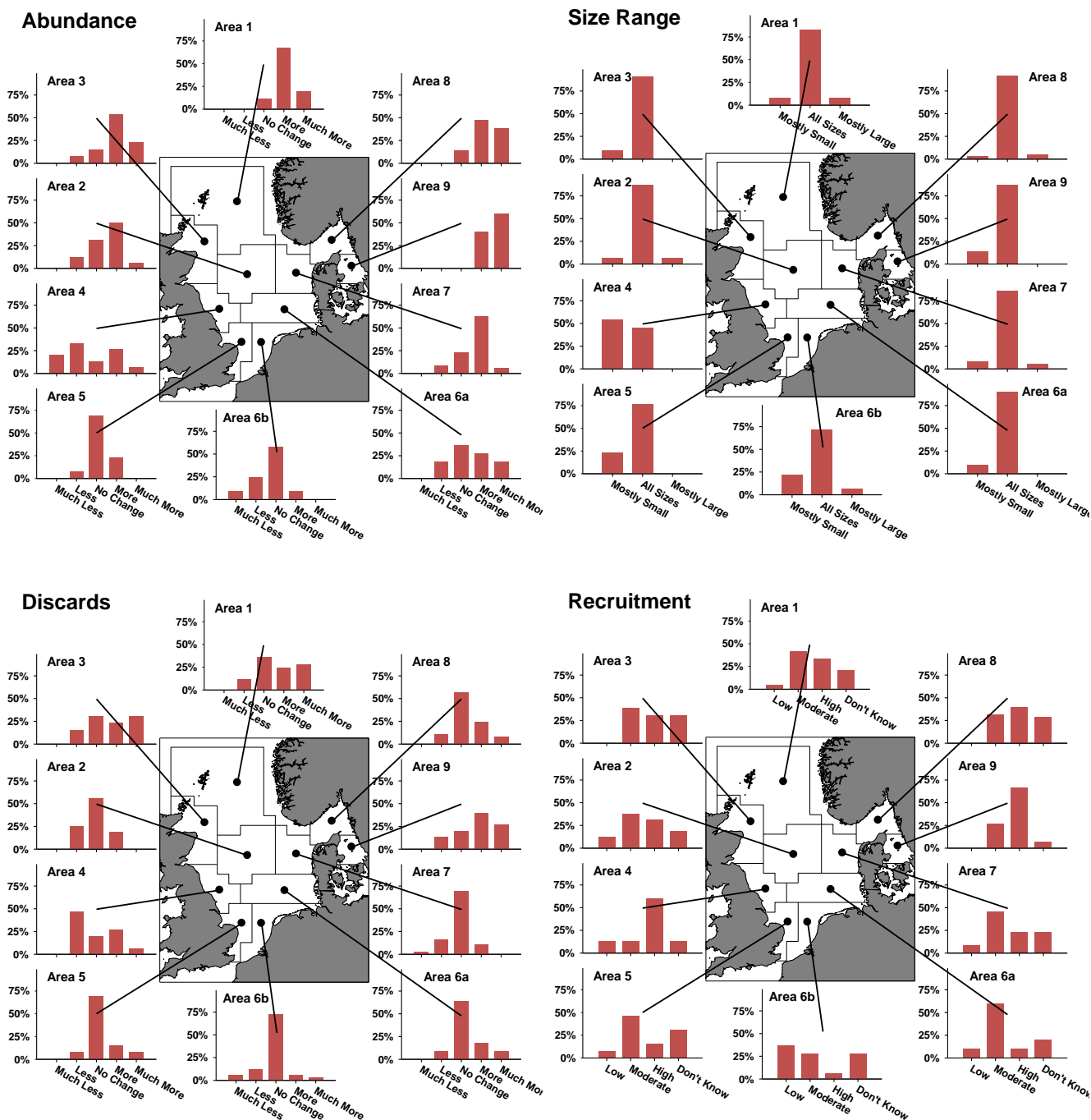


Figure 16 Perceptions of the abundance and size range of cod, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category.

## Abundance Index

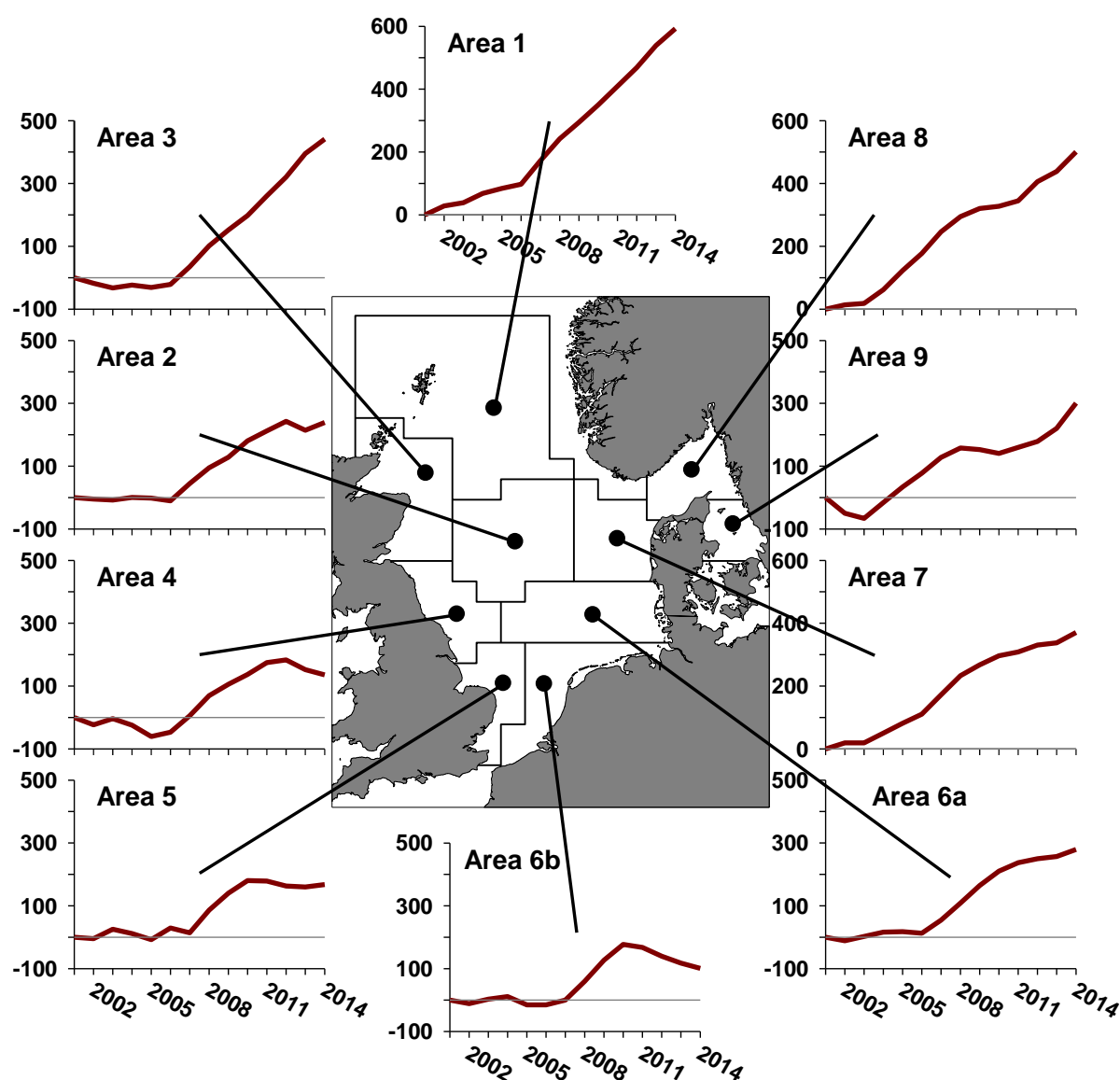


Figure 17 Cumulative time series of index of perceptions of abundance of cod, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)



Table 14 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of cod.

|                    | Area |    |    |    |    |    |    |    |    |    |
|--------------------|------|----|----|----|----|----|----|----|----|----|
|                    | 1    | 2  | 3  | 4  | 5  | 6a | 6b | 7  | 8  | 9  |
| Number             | 25   | 16 | 14 | 15 | 13 | 11 | 34 | 36 | 38 | 15 |
| <b>Abundance</b>   |      |    |    |    |    |    |    |    |    |    |
| Much Less          | 0    | 0  | 0  | 3  | 0  | 0  | 3  | 0  | 0  | 0  |
| Less               | 0    | 2  | 1  | 5  | 1  | 2  | 8  | 3  | 0  | 0  |
| No Change          | 3    | 5  | 2  | 2  | 9  | 4  | 19 | 8  | 5  | 0  |
| More               | 17   | 8  | 7  | 4  | 3  | 3  | 3  | 22 | 17 | 6  |
| Much More          | 5    | 1  | 3  | 1  | 0  | 2  | 0  | 2  | 14 | 9  |
| No Answer          | 0    | 0  | 1  | 0  | 0  | 0  | 1  | 1  | 2  | 0  |
| <b>Size</b>        |      |    |    |    |    |    |    |    |    |    |
| Mostly Small       | 2    | 1  | 1  | 6  | 3  | 1  | 7  | 3  | 1  | 2  |
| All Sizes          | 20   | 13 | 10 | 5  | 10 | 9  | 23 | 30 | 34 | 13 |
| Mostly Large       | 2    | 1  | 0  | 0  | 0  | 0  | 2  | 2  | 2  | 0  |
| No Answer          | 1    | 1  | 3  | 4  | 0  | 1  | 2  | 1  | 1  | 0  |
| <b>Discards</b>    |      |    |    |    |    |    |    |    |    |    |
| Much Less          | 0    | 0  | 0  | 0  | 0  | 0  | 2  | 1  | 0  | 0  |
| Less               | 3    | 4  | 2  | 7  | 1  | 1  | 4  | 6  | 4  | 2  |
| No Change          | 9    | 9  | 4  | 3  | 9  | 7  | 24 | 25 | 21 | 3  |
| More               | 6    | 3  | 3  | 4  | 2  | 2  | 2  | 4  | 9  | 6  |
| Much More          | 7    | 0  | 4  | 1  | 1  | 1  | 1  | 0  | 3  | 4  |
| No Answer          | 0    | 0  | 1  | 0  | 0  | 0  | 1  | 0  | 1  | 0  |
| <b>Recruitment</b> |      |    |    |    |    |    |    |    |    |    |
| Low                | 1    | 2  | 0  | 2  | 1  | 1  | 12 | 3  | 0  | 0  |
| Moderate           | 10   | 6  | 5  | 2  | 6  | 6  | 9  | 16 | 12 | 4  |
| High               | 8    | 5  | 4  | 9  | 2  | 1  | 2  | 8  | 15 | 10 |
| Don't Know         | 5    | 3  | 4  | 2  | 4  | 2  | 9  | 8  | 11 | 1  |
| No Answer          | 1    | 0  | 1  | 0  | 0  | 1  | 2  | 1  | 0  | 0  |

## Haddock

Of the 177 valid responses received, 93 (53%) provided information on haddock. The proportion of responses providing information on haddock was lowest in the south-eastern North Sea (areas 6a & 6b), and highest in the north and west (areas 1, 3 & 4) (Figure 18).

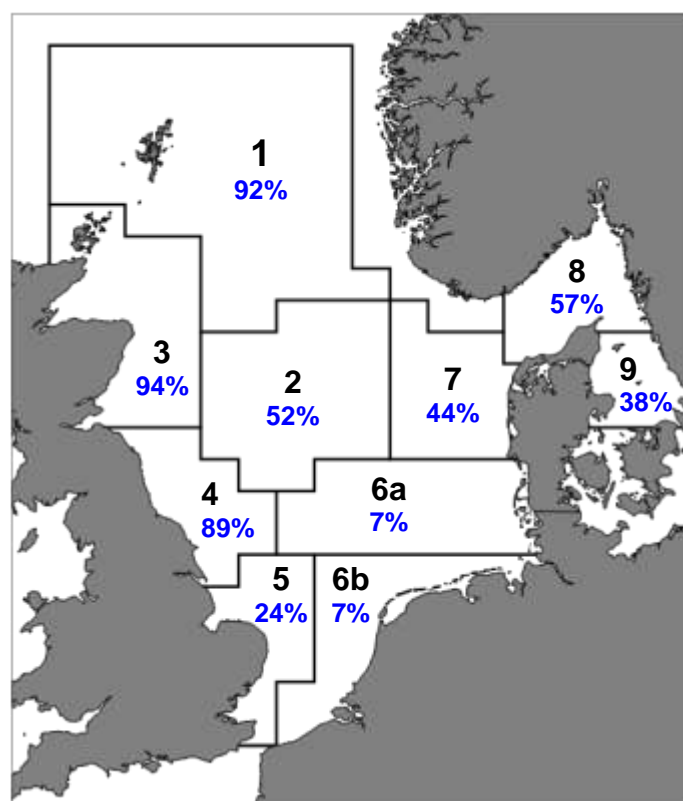


Figure 18 The proportions of responses from each area that provided information on haddock.

Table 15 shows the responses broken down by fishing gear and vessel size class. The largest proportion of responses was from medium-sized (15-24m) fishing vessels, and the smallest proportion from small (<15m) vessels. Of the fishing gears, the otter trawl accounted for the largest proportion of the responses followed by the *Nephrops* trawl, and the beam trawl and pulse trawl least.

Figure 19 and Figure 20 provide a more detailed breakdown of the responses for haddock by vessel size and fishing gear.

Table 15 Numbers of responses for haddock by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |     |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|-----|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |     | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 6      | 16   | 16  | 38             | 26%    | 41%  | 53%  | 41%  |
|              |           | Nephrops Trawl    | 8      | 15   | 0   | 23             | 35%    | 38%  | 0%   | 25%  |
|              |           | Beam Trawl        | 0      | 1    | 7   | 8              | 0%     | 3%   | 23%  | 9%   |
|              |           | Pulse Trawl       | 0      | 1    | 2   | 3              | 0%     | 3%   | 7%   | 3%   |
|              |           | Gill Net          | 9      | 1    | 0   | 10             | 39%    | 3%   | 0%   | 11%  |
|              |           | Seine Net         | 0      | 5    | 5   | 10             | 0%     | 13%  | 17%  | 11%  |
|              |           | ALL               | 23     | 39   | 30  | 92             | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 16%    | 42%  | 42% | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 35%    | 65%  | 0%  | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 13%  | 88% | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 33%  | 67% | 100%           |        |      |      |      |
|              |           | Gill Net          | 90%    | 10%  | 0%  | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 50%  | 50% | 100%           |        |      |      |      |
|              |           | ALL               | 25%    | 42%  | 33% | 100%           |        |      |      |      |

Table 16 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of haddock this year and last year. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/-  | Fish Size    | 2013 | 2014 | +/-  |
|---------------------|------|------|------|--------------|------|------|------|
| 'Less' <sup>1</sup> | 23%  | 14%  | -9%  | Mostly Small | 22%  | 13%  | -9%  |
| No Change           | 42%  | 44%  | +2%  | All Sizes    | 72%  | 87%  | +15% |
| 'More' <sup>2</sup> | 35%  | 42%  | +7%  | Mostly Large | 6%   | 0%   | -6%  |
| Discards            | 2013 | 2014 | +/-  | Recruitment  | 2013 | 2014 | +/-  |
| 'Less' <sup>1</sup> | 25%  | 13%  | -11% | Low          | 23%  | 15%  | -7%  |
| No Change           | 65%  | 78%  | +14% | Moderate     | 51%  | 52%  | +1%  |
| 'More' <sup>2</sup> | 11%  | 8%   | -2%  | High         | 26%  | 32%  | +7%  |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

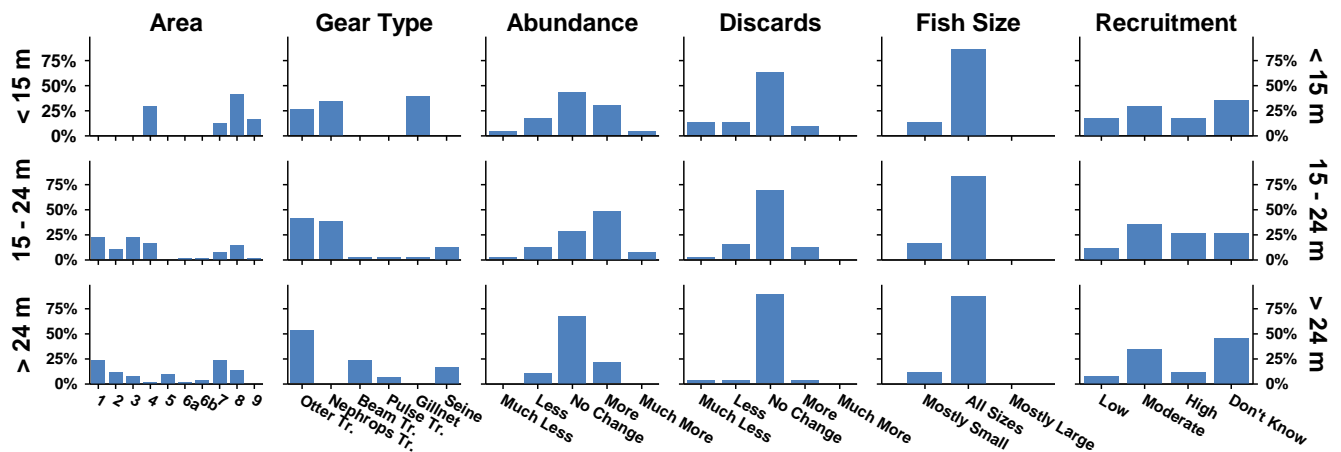


Figure 19 Breakdown of responses for haddock by fishing vessel size class. Percentage of responses for each size class in each category.

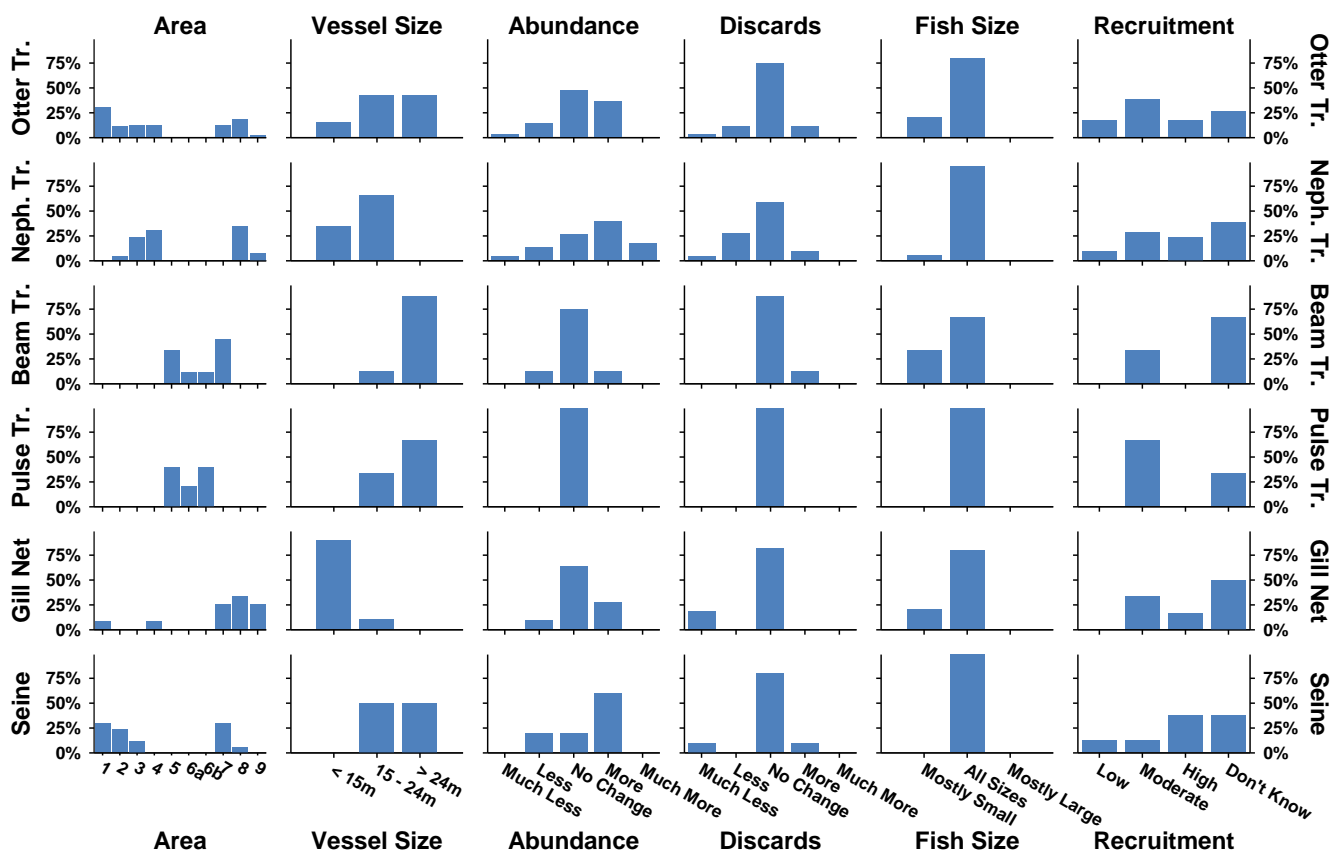


Figure 20 Breakdown of responses for haddock by fishing gear (Otter Trawl, *Nephrops* Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

## **Abundance**

Roughly equal proportions of responses reported no change and an increase in the abundance of haddock in 2014 (Table 16), with small increases in both from 2013, especially in the proportion reporting more haddock. There was a similar fall from 2013 in the proportion reporting less haddock.

The proportions reporting a greater abundance of haddock tended to be highest in the northern part of the North Sea (including areas 1, 2, 3, 8 & 9; Figure 22). The highest proportion reporting a lower abundance was in the west (area 4) while no change was most commonly reported in the south.

The cumulative index of perceptions of the abundance of haddock increased in most areas (Figure 23), the exceptions being in the west (area 4) where it declined, and the south (areas 6a & 6b) where it remained unchanged.

## **Size Range**

Well over three-quarters of responses reported catching all sizes of haddock in 2014 (Table 16), a marked increase from 2013. All the remaining responses reported catching mostly small haddock, although this proportion was less than in 2013.

Most responses reported catching all sizes of haddock in most areas (Figure 22).

## **Discards**

More than three-quarters of responses reported no change in the level of discarding of haddock in 2014 (Table 16), a marked increase from 2013. Of the remainder, slightly more reported lower levels of discards, a marked decrease from 2013.

Across most areas the majority of responses reported no change in levels of discarding of haddock (Figure 22). The highest proportions reporting lower levels of discarding of haddock were in the extreme west and east (areas 4 & 9), while the highest proportion reporting higher levels was in the central North Sea (area 2).

## **Recruitment**

Half of all responses reported moderate levels of recruitment of haddock in 2014, and one-third reported high levels (Table 16), with a small increase in the latter from 2013. There was a small fall in the proportion reporting low levels of recruitment

In general, the proportion of responses reporting high levels of recruitment tended to be greatest in the north (areas 1, 2, 3 & 8).

### Comparison with ICES Stock Assessment

There was little agreement between the haddock abundance index derived from the Fishers' North Sea Stock Survey and the ICES estimates of the North Sea haddock spawning stock biomass (Figure 21).

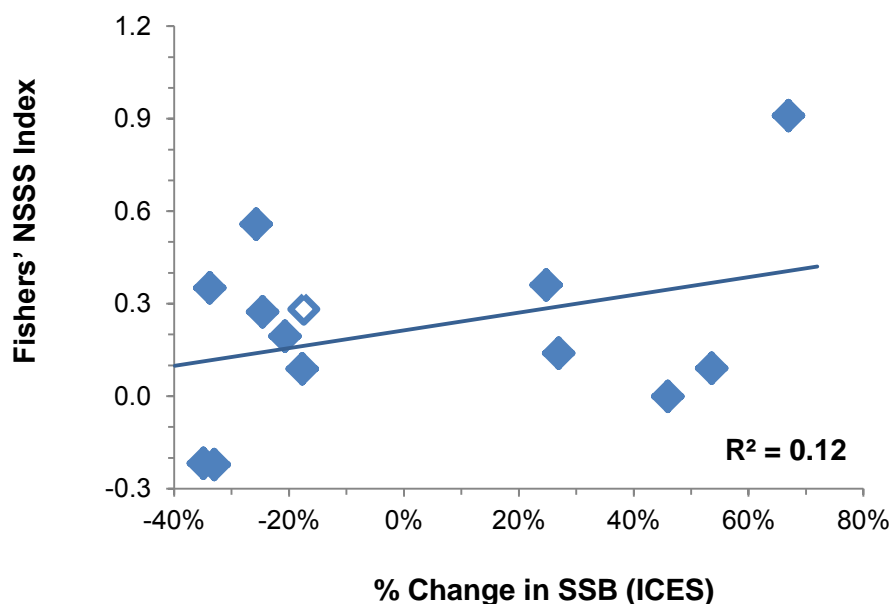


Figure 21 Plot of the annual Fishers' North Sea Stock Survey index against the percentage changes in the estimated mid-year North Sea haddock spawning stock biomass (SSB), with fitted linear trend line and coefficient of determination ( $R^2$ ; values closer to 1 indicate a better agreement). The unshaded point is based on the predicted SSB for 2015.

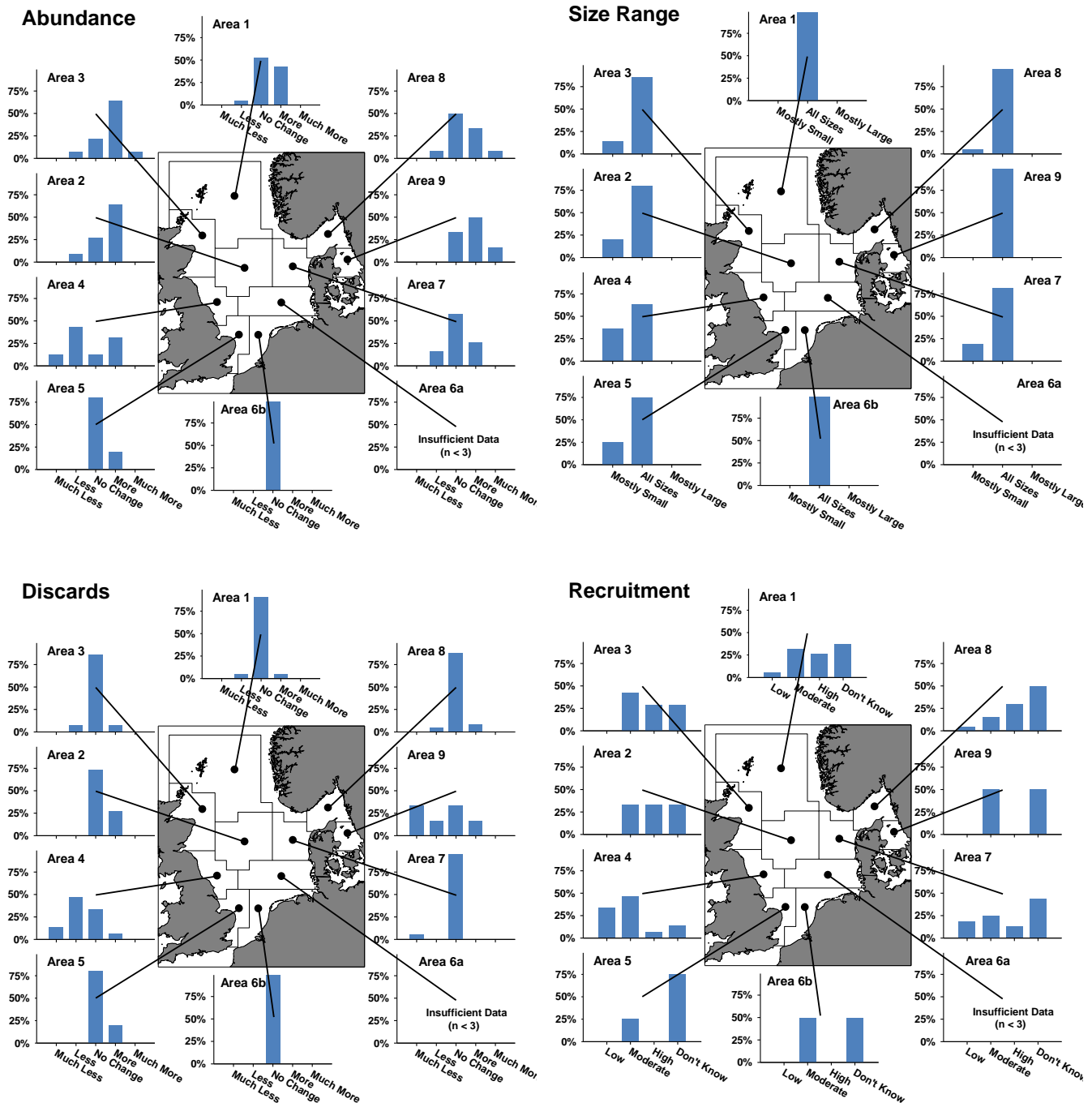


Figure 22 Perceptions of the abundance and size range of haddock, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category. No results are shown for Area 6a due to the small number of responses from that area (see Table 11, p. 28).



## Abundance Index

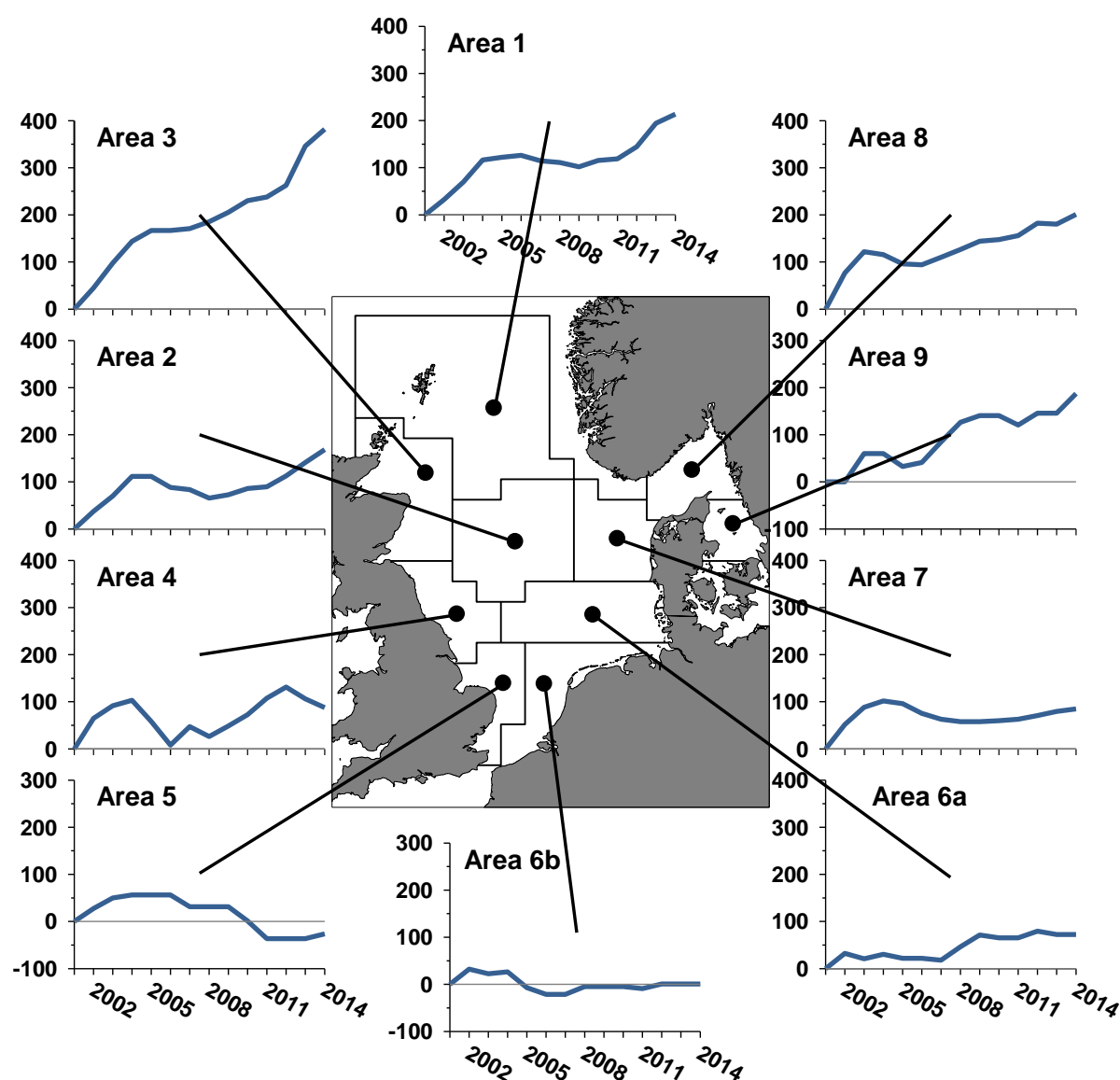


Figure 23 Cumulative time series of index of perceptions of abundance of haddock, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)

Table 17 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of haddock.

|                    | Area |    |    |    |   |    |    |    |    |   |
|--------------------|------|----|----|----|---|----|----|----|----|---|
|                    | 1    | 2  | 3  | 4  | 5 | 6a | 6b | 7  | 8  | 9 |
| Number             | 23   | 11 | 15 | 16 | 5 | 2  | 3  | 19 | 24 | 6 |
| <b>Abundance</b>   |      |    |    |    |   |    |    |    |    |   |
| Much Less          | 0    | 0  | 0  | 2  | 0 | 0  | 0  | 0  | 0  | 0 |
| Less               | 1    | 1  | 1  | 7  | 0 | 0  | 0  | 3  | 2  | 0 |
| No Change          | 11   | 3  | 3  | 2  | 4 | 2  | 3  | 11 | 12 | 2 |
| More               | 9    | 7  | 9  | 5  | 1 | 0  | 0  | 5  | 8  | 3 |
| Much More          | 0    | 0  | 1  | 0  | 0 | 0  | 0  | 0  | 2  | 1 |
| No Answer          | 2    | 0  | 1  | 0  | 0 | 0  | 0  | 0  | 0  | 0 |
| <b>Size</b>        |      |    |    |    |   |    |    |    |    |   |
| Mostly Small       | 0    | 2  | 2  | 4  | 1 | 0  | 0  | 3  | 1  | 0 |
| All Sizes          | 17   | 8  | 12 | 7  | 3 | 1  | 2  | 13 | 18 | 5 |
| Mostly Large       | 0    | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0 |
| No Answer          | 6    | 1  | 1  | 5  | 1 | 1  | 1  | 3  | 5  | 1 |
| <b>Discards</b>    |      |    |    |    |   |    |    |    |    |   |
| Much Less          | 0    | 0  | 0  | 2  | 0 | 0  | 0  | 1  | 0  | 2 |
| Less               | 1    | 0  | 1  | 7  | 0 | 0  | 0  | 0  | 1  | 1 |
| No Change          | 19   | 8  | 12 | 5  | 4 | 2  | 3  | 18 | 21 | 2 |
| More               | 1    | 3  | 1  | 1  | 1 | 0  | 0  | 0  | 2  | 1 |
| Much More          | 0    | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0 |
| No Answer          | 2    | 0  | 1  | 1  | 0 | 0  | 0  | 0  | 0  | 0 |
| <b>Recruitment</b> |      |    |    |    |   |    |    |    |    |   |
| Low                | 1    | 0  | 0  | 5  | 0 | 0  | 0  | 3  | 1  | 0 |
| Moderate           | 6    | 3  | 6  | 7  | 1 | 0  | 1  | 4  | 3  | 3 |
| High               | 5    | 3  | 4  | 1  | 0 | 0  | 0  | 2  | 6  | 0 |
| Don't Know         | 7    | 3  | 4  | 2  | 3 | 1  | 1  | 7  | 10 | 3 |
| No Answer          | 4    | 2  | 1  | 1  | 1 | 1  | 1  | 3  | 4  | 0 |

## Whiting

Of the 177 valid questionnaires received, 104 (59%) provided information on whiting. The proportion of responses providing information on whiting was lowest in central and eastern areas (areas 2, 7, 8 & 9), and highest in the north and west (areas 1, 3, 4 & 5) (Figure 24).

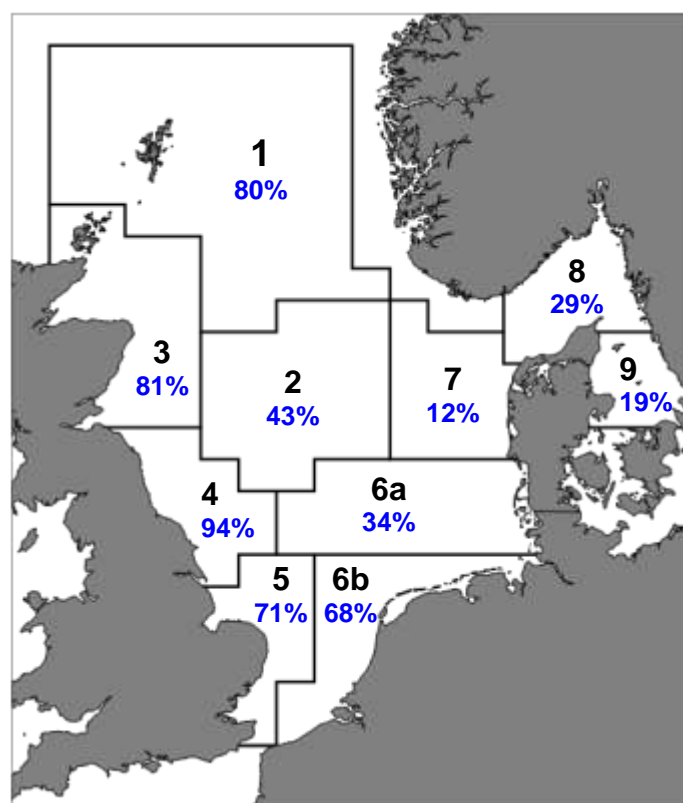


Figure 24 The proportions of responses from each area that provided information on whiting.

Table 18 shows the responses broken down by fishing gear and vessel size class. Equal proportions of responses were received from medium-sized (15-24m) and larger (>24m) vessels, with the smallest proportion from small (<15m) vessels. Of the fishing gears, otter trawls accounted for the largest proportions of responses, followed by *Nephrops* trawls and beam trawls.

Figure 25 and Figure 26 provide a more detailed breakdown of the responses for whiting by vessel size and fishing gear.

Table 18 Numbers of responses for whiting by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |     |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|-----|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |     | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 6      | 16   | 13  | 35             | 29%    | 39%  | 32%  | 34%  |
|              |           | Nephrops Trawl    | 5      | 15   | 1   | 21             | 24%    | 37%  | 2%   | 20%  |
|              |           | Beam Trawl        | 0      | 5    | 12  | 17             | 0%     | 12%  | 29%  | 17%  |
|              |           | Pulse Trawl       | 0      | 1    | 12  | 13             | 0%     | 2%   | 29%  | 13%  |
|              |           | Gill Net          | 10     | 1    | 0   | 11             | 48%    | 2%   | 0%   | 11%  |
|              |           | Seine Net         | 0      | 3    | 3   | 6              | 0%     | 7%   | 7%   | 6%   |
|              |           | ALL               | 21     | 41   | 41  | 103            | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 17%    | 46%  | 37% | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 24%    | 71%  | 5%  | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 29%  | 71% | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 8%   | 92% | 100%           |        |      |      |      |
|              |           | Gill Net          | 91%    | 9%   | 0%  | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 50%  | 50% | 100%           |        |      |      |      |
|              |           | ALL               | 20%    | 40%  | 40% | 100%           |        |      |      |      |

Table 19 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of whiting this year and last year. Proportion of responses in each category this year and last year for all areas combined, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/- | Fish Size    | 2013 | 2014 | +/-  |
|---------------------|------|------|-----|--------------|------|------|------|
| 'Less' <sup>1</sup> | 13%  | 21%  | +8% | Mostly Small | 13%  | 21%  | +8%  |
| No Change           | 55%  | 57%  | +2% | All Sizes    | 88%  | 78%  | -9%  |
| 'More' <sup>2</sup> | 31%  | 22%  | -9% | Mostly Large | 0%   | 1%   | +1%  |
| Discards            | 2013 | 2014 | +/- | Recruitment  | 2013 | 2014 | +/-  |
| 'Less' <sup>1</sup> | 16%  | 19%  | +3% | Low          | 26%  | 19%  | -7%  |
| No Change           | 64%  | 66%  | +1% | Moderate     | 42%  | 56%  | +14% |
| 'More' <sup>2</sup> | 20%  | 16%  | -4% | High         | 32%  | 24%  | -8%  |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

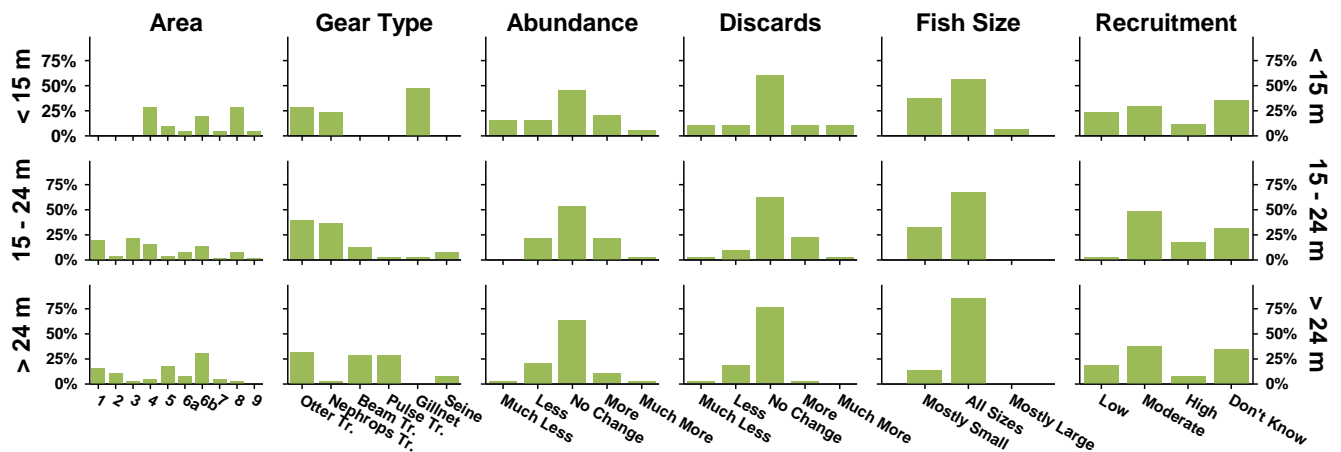


Figure 25 Breakdown of responses for whiting by fishing vessel size class. Percentage of responses for each size class in each category.

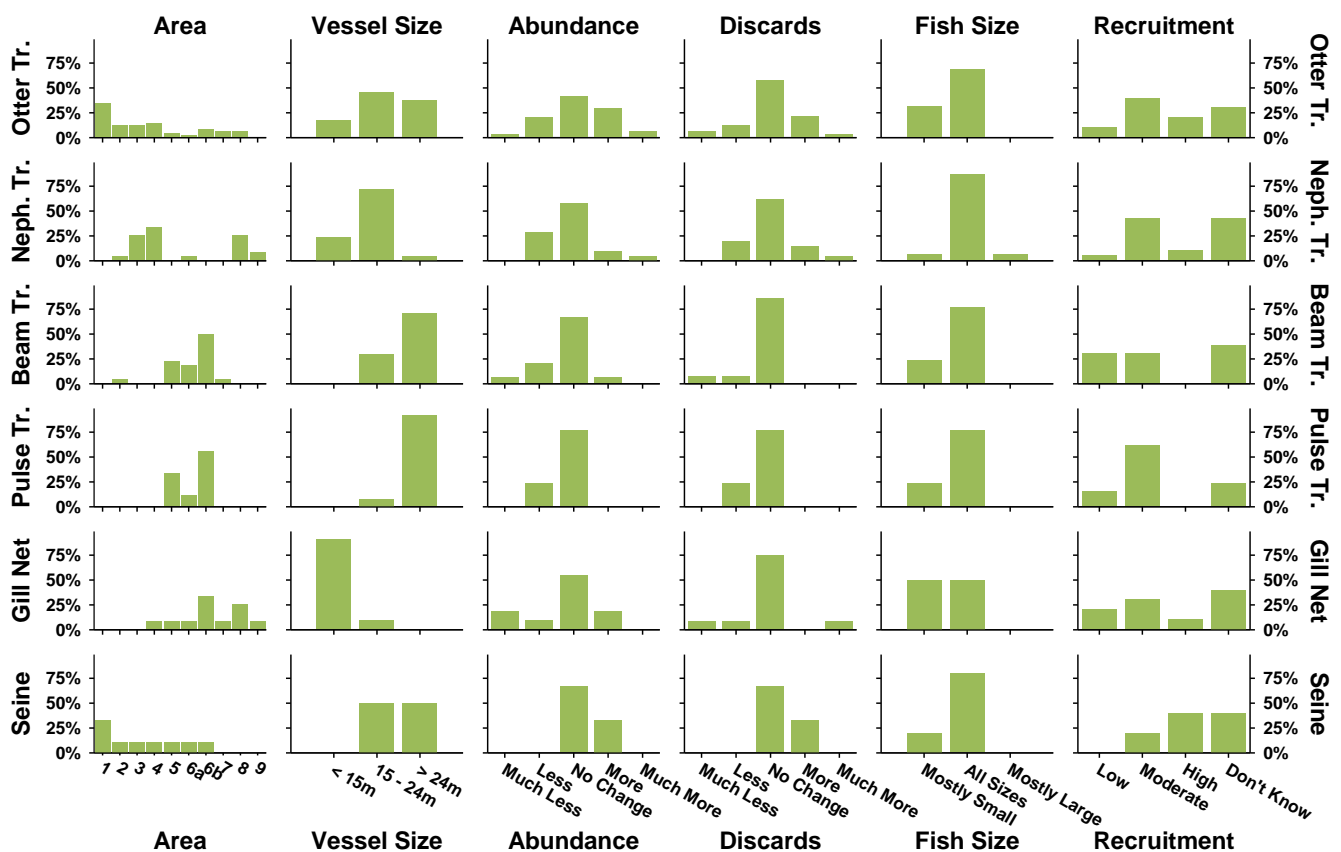


Figure 26 Breakdown of responses for whiting by fishing gear (Otter Trawl, *Nephrops* Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

## **Abundance**

More than half of responses (57%) reported no change in the abundance of whiting in 2014, slightly more than in 2013 (Table 19). The remaining responses were roughly equally split between reporting increased and decreased abundances. There was a fall in the proportion reporting a higher abundance of whiting in 2014, matched by a similar increase in the proportion reporting a lower abundance.

Across individual areas the majority of responses reported no change in the abundance of whiting in all areas (Figure 28). The proportions reporting higher abundances of whiting tended to be highest in the north and west (areas 1, 2 & 3) while the proportions reporting lower abundances tended to be higher in the south and east (areas 4, 5, 6a, 6b & 9).

The cumulative index of perceptions of the abundance of whiting (Figure 29) increased in about half of the areas, mainly in the north and west (areas 1, 2 & 3) and east (areas 7 & 8), albeit mostly by relatively small amounts.

## **Size Range**

More than three-quarters of responses reported all sizes of whiting in 2014 (Table 19), although this was less than in 2013. Almost all the remaining responses reported mostly small whiting, with an increase from 2013, while only a very small proportion reported mostly large whiting in 2014.

Across individual areas, reports of mostly small whiting tended to be more common in the south and east (areas 4, 5, 6b & 7) while reports of mostly large whiting were confined to the Kattegat (area 9) (Figure 29).

## **Discards**

Two-thirds of responses reported no change in the level of whiting discards in 2014, almost unchanged from 2013 (Table 19). The remaining responses were roughly evenly split between reporting lower and higher levels of discards, with a small increase in the former and a similar decrease in the latter.

No change in whiting discards was the most frequent response across all individual areas (Figure 29), but no clear pattern was apparent in the distribution of responses reporting lower or higher levels of whiting discard.

## **Recruitment**

More than half of responses reported a moderate level of recruitment in 2014 (Table 19), markedly more than in 2013. Almost one-quarter reported high levels of

recruitment, with a small decrease from 2013 and a similar decrease in the proportion reporting mostly small whiting.

No clear pattern in responses on recruitment of whiting were apparent across individual areas (Figure 29).

### Comparison with ICES Stock Assessment

There was some agreement between the abundance index derived from the Fishers' North Sea Stock Survey and the ICES estimates of the North Sea whiting spawning stock biomass (Figure 27), although the relationship was statistically weak.

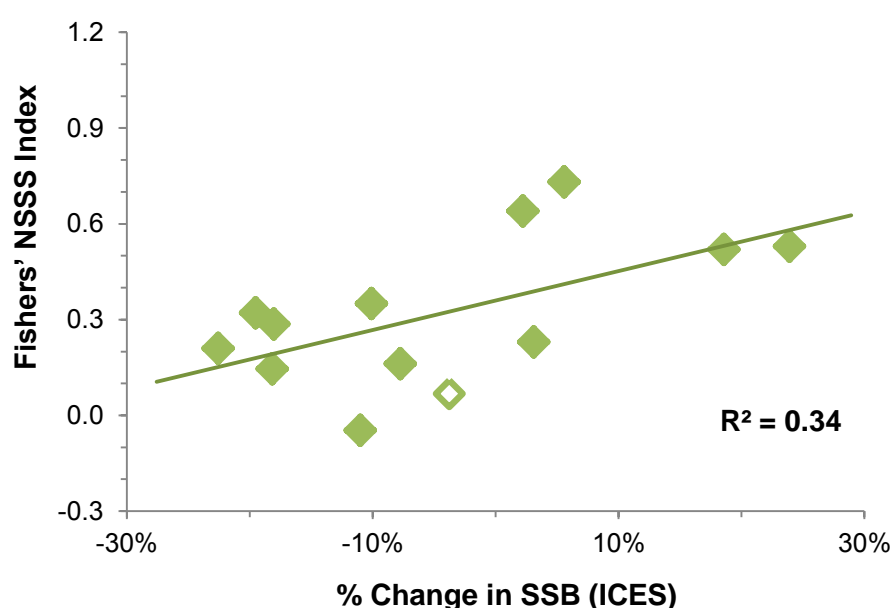


Figure 27 Plot of the annual Fishers' North Sea Stock Survey index against the percentage changes in the estimated mid-year North Sea whiting spawning stock biomass (SSB), with fitted linear trend line and coefficient of determination ( $R^2$  values closer to 1 indicate a better agreement). The unshaded point is based on the predicted SSB for 2015.

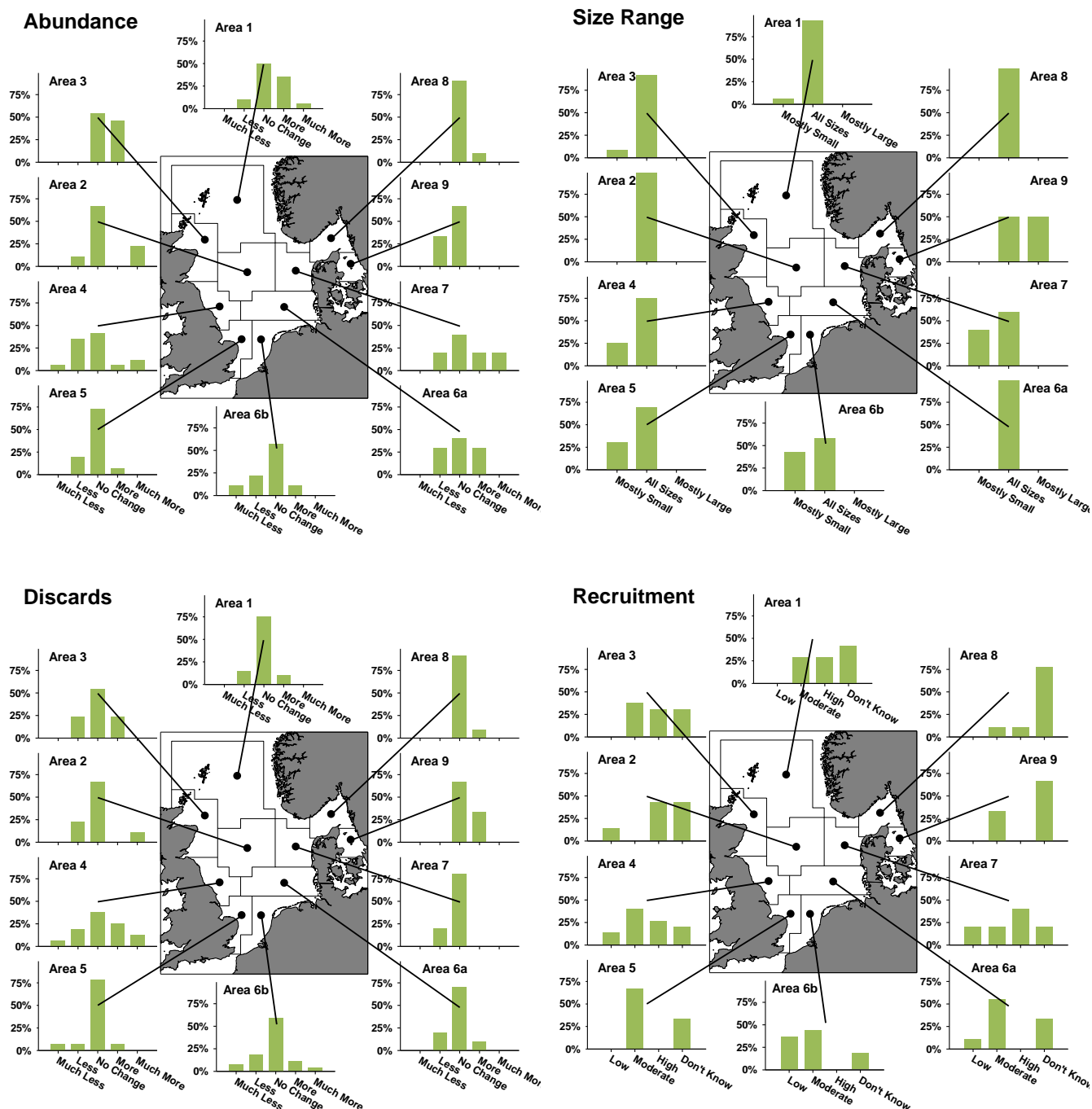


Figure 28 Perceptions of the abundance and size range of whiting, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category.



## Abundance Index

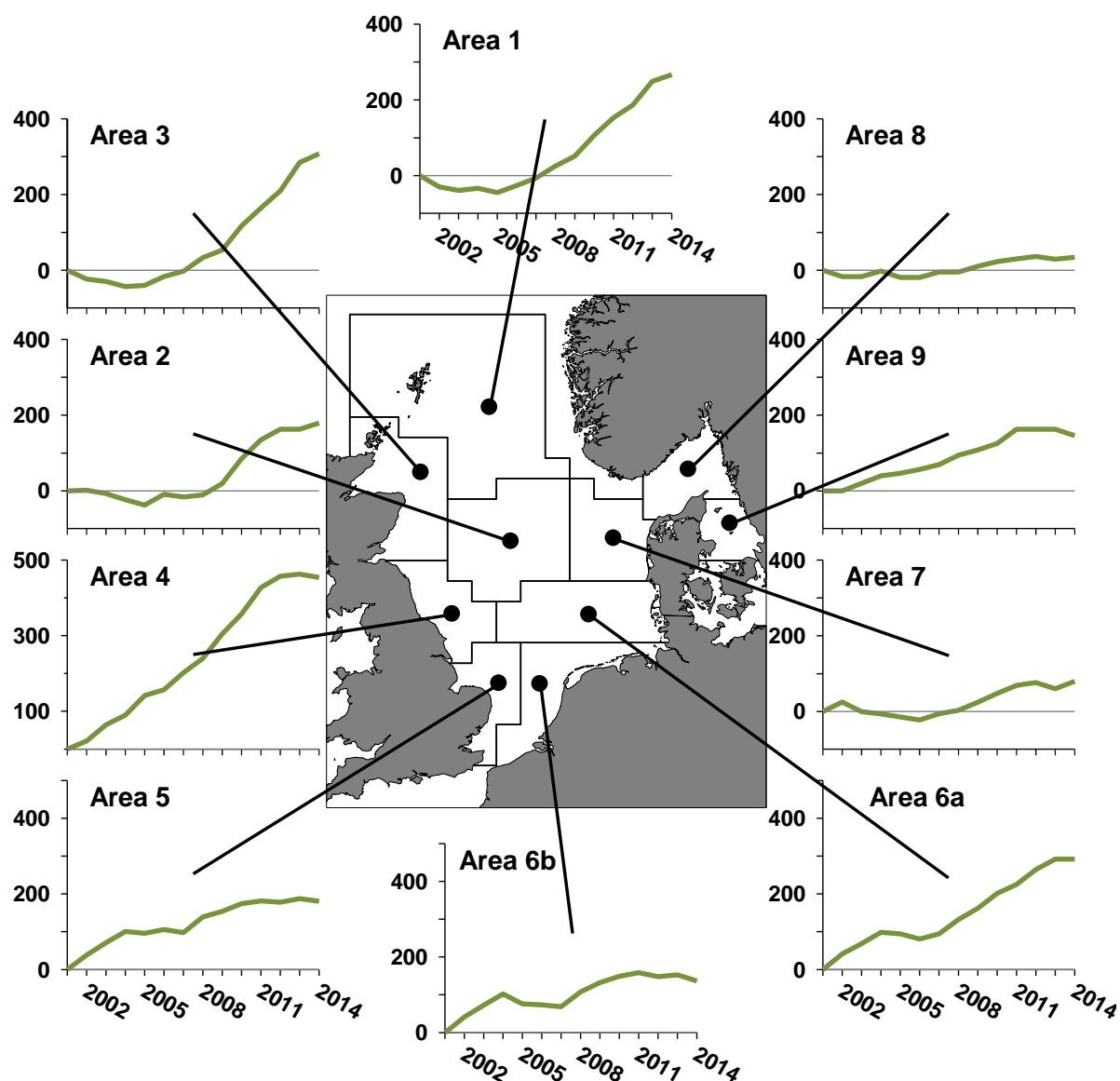


Figure 29 Cumulative time series of index of perceptions of abundance of whiting, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)

Table 20 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of whiting.

|                    | Area |   |    |    |    |    |    |   |    |   |
|--------------------|------|---|----|----|----|----|----|---|----|---|
|                    | 1    | 2 | 3  | 4  | 5  | 6a | 6b | 7 | 8  | 9 |
| <b>Number</b>      | 20   | 9 | 13 | 17 | 15 | 10 | 30 | 5 | 12 | 3 |
| <b>Abundance</b>   |      |   |    |    |    |    |    |   |    |   |
| Much Less          | 0    | 0 | 0  | 1  | 0  | 0  | 3  | 0 | 0  | 0 |
| Less               | 2    | 1 | 0  | 6  | 3  | 3  | 6  | 1 | 0  | 1 |
| No Change          | 10   | 6 | 7  | 7  | 11 | 4  | 16 | 2 | 9  | 2 |
| More               | 7    | 0 | 6  | 1  | 1  | 3  | 3  | 1 | 1  | 0 |
| Much More          | 1    | 2 | 0  | 2  | 0  | 0  | 0  | 1 | 0  | 0 |
| No Answer          | 0    | 0 | 0  | 0  | 0  | 0  | 2  | 0 | 2  | 0 |
| <b>Size</b>        |      |   |    |    |    |    |    |   |    |   |
| Mostly Small       | 1    | 0 | 1  | 4  | 4  | 0  | 11 | 2 | 0  | 0 |
| All Sizes          | 14   | 7 | 11 | 12 | 9  | 8  | 15 | 3 | 6  | 1 |
| Mostly Large       | 0    | 0 | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 1 |
| No Answer          | 5    | 2 | 1  | 1  | 2  | 2  | 4  | 0 | 6  | 1 |
| <b>Discards</b>    |      |   |    |    |    |    |    |   |    |   |
| Much Less          | 0    | 0 | 0  | 1  | 1  | 0  | 2  | 0 | 0  | 0 |
| Less               | 3    | 2 | 3  | 3  | 1  | 2  | 5  | 1 | 0  | 0 |
| No Change          | 15   | 6 | 7  | 6  | 11 | 7  | 16 | 4 | 10 | 2 |
| More               | 2    | 0 | 3  | 4  | 1  | 1  | 3  | 0 | 1  | 1 |
| Much More          | 0    | 1 | 0  | 2  | 0  | 0  | 1  | 0 | 0  | 0 |
| No Answer          | 0    | 0 | 0  | 1  | 1  | 0  | 3  | 0 | 1  | 0 |
| <b>Recruitment</b> |      |   |    |    |    |    |    |   |    |   |
| Low                | 0    | 1 | 0  | 2  | 0  | 1  | 10 | 1 | 0  | 0 |
| Moderate           | 5    | 0 | 5  | 6  | 8  | 5  | 12 | 1 | 1  | 1 |
| High               | 5    | 3 | 4  | 4  | 0  | 0  | 0  | 2 | 1  | 0 |
| Don't Know         | 7    | 3 | 4  | 3  | 4  | 3  | 5  | 1 | 7  | 2 |
| No Answer          | 3    | 2 | 0  | 2  | 3  | 1  | 3  | 0 | 3  | 0 |

## Saithe

Of the 177 valid responses received, 79 (45%) provided information on saithe. The proportion of responses providing information on saithe was highest in the northern North Sea (area 1), and lowest in the south (areas 5, 6a & 6b) (Figure 30).

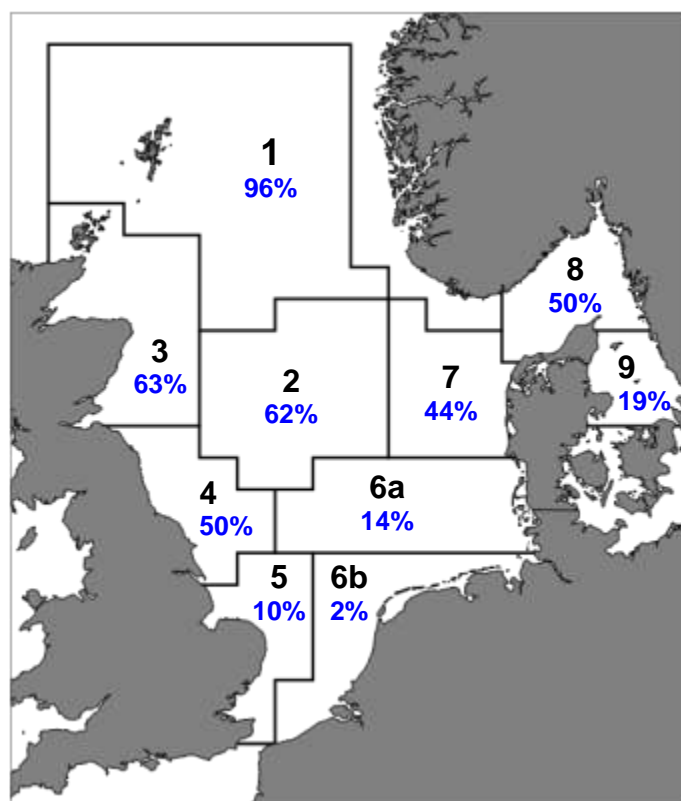


Figure 30 The proportions of responses from each area that provided information on saithe.

Table 21 shows the responses broken down by fishing gear and vessel size class. Almost half of responses were from medium-sized (15-24m) vessels, with the remainder roughly equally split between small (<15m) and large (>24m) vessels. By fishing gear, the biggest proportions of responses were from otter trawls and *Nephrops* trawls.

Figure 31 and Figure 32 provide a more detailed breakdown of the responses for saithe by vessel size and fishing gear.

Table 21 Numbers of responses for saithe by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |      |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|------|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |      | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL  | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 2      | 15   | 13   | 30             | 11%    | 39%  | 59%  | 38%  |
|              |           | Nephrops Trawl    | 7      | 15   | 0    | 22             | 39%    | 39%  | 0%   | 28%  |
|              |           | Beam Trawl        | 0      | 1    | 2    | 3              | 0%     | 3%   | 9%   | 4%   |
|              |           | Pulse Trawl       | 0      | 0    | 2    | 2              | 0%     | 0%   | 9%   | 3%   |
|              |           | Gill Net          | 9      | 3    | 0    | 12             | 50%    | 8%   | 0%   | 15%  |
|              |           | Seine Net         | 0      | 4    | 5    | 9              | 0%     | 11%  | 23%  | 12%  |
|              |           | ALL               | 18     | 38   | 22   | 78             | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 7%     | 50%  | 43%  | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 32%    | 68%  | 0%   | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 33%  | 67%  | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 0%   | 100% | 100%           |        |      |      |      |
|              |           | Gill Net          | 75%    | 25%  | 0%   | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 44%  | 56%  | 100%           |        |      |      |      |
|              |           | ALL               | 23%    | 49%  | 28%  | 100%           |        |      |      |      |

Table 22 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of saithe this year and last year. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/-  | Fish Size    | 2013 | 2014 | +/-  |
|---------------------|------|------|------|--------------|------|------|------|
| 'Less' <sup>1</sup> | 27%  | 12%  | -15% | Mostly Small | 33%  | 21%  | -12% |
| No Change           | 35%  | 52%  | +17% | All Sizes    | 64%  | 71%  | +7%  |
| 'More' <sup>2</sup> | 39%  | 37%  | -2%  | Mostly Large | 3%   | 7%   | +5%  |
| Discards            | 2013 | 2014 | +/-  | Recruitment  | 2013 | 2014 | +/-  |
| 'Less' <sup>1</sup> | 13%  | 10%  | -3%  | Low          | 16%  | 5%   | -10% |
| No Change           | 60%  | 67%  | +8%  | Moderate     | 50%  | 47%  | -3%  |
| 'More' <sup>2</sup> | 28%  | 23%  | -5%  | High         | 34%  | 47%  | +13% |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

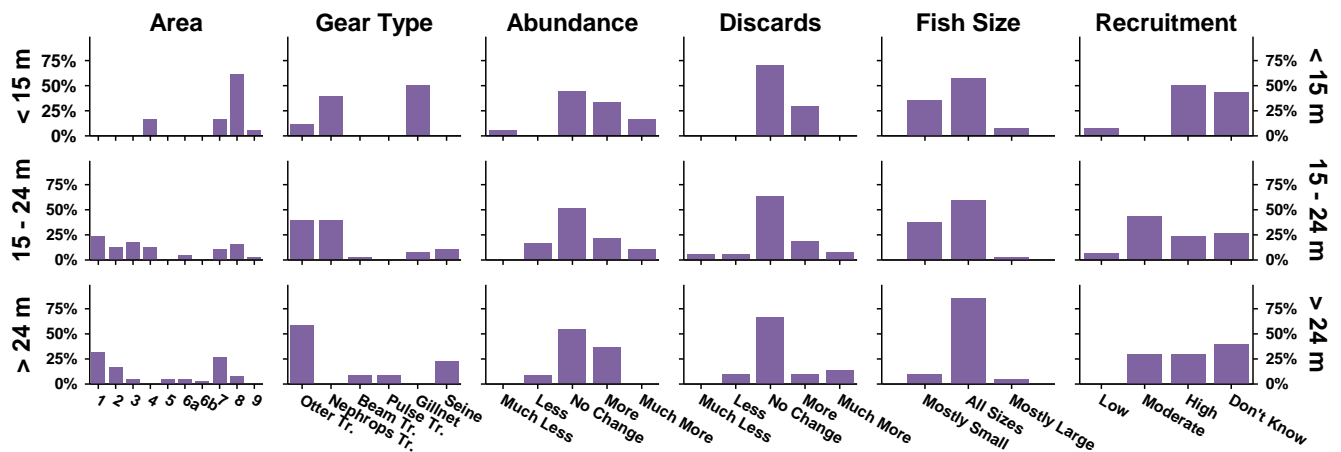


Figure 31 Breakdown of responses for saithe by fishing vessel size class. Percentage of responses for each size class in each category.

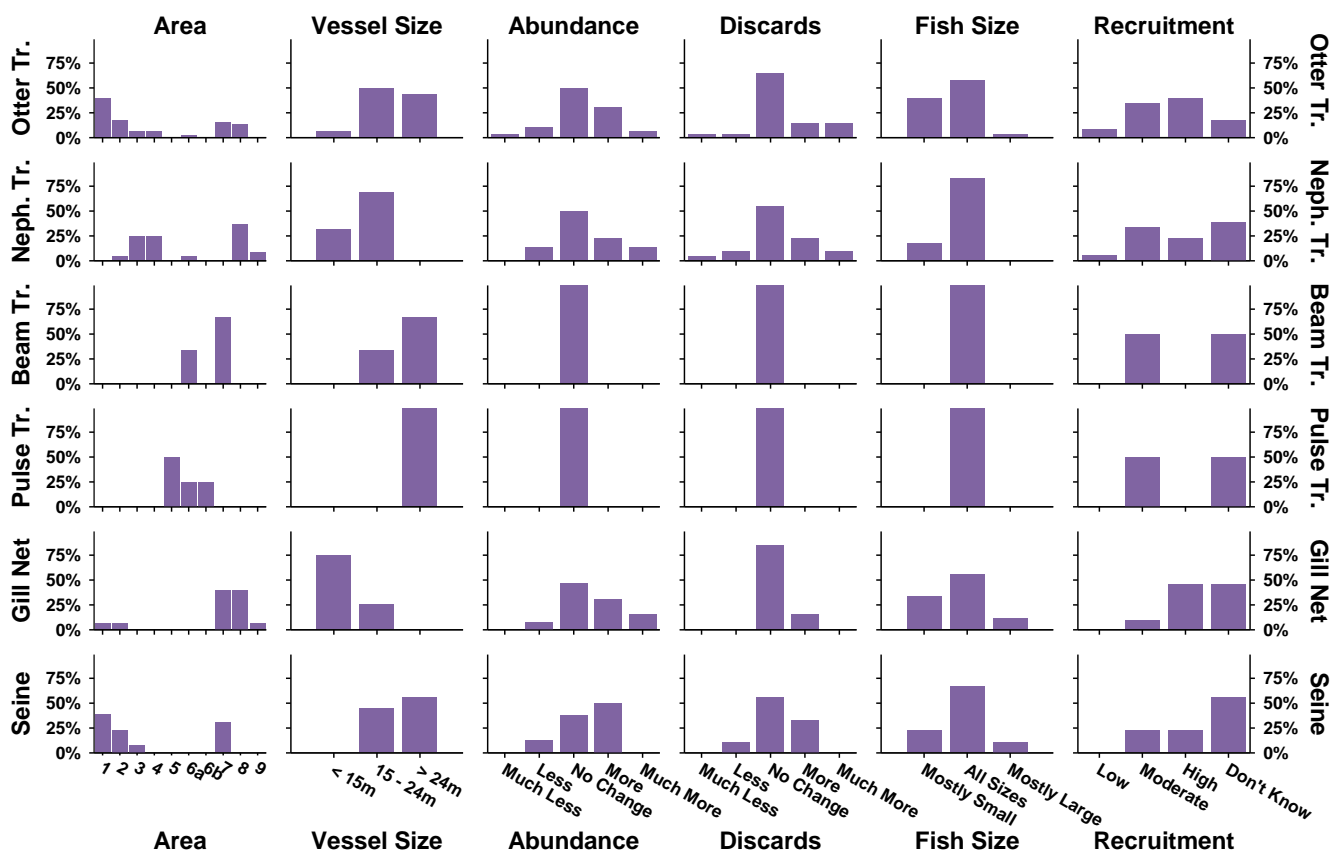


Figure 32 Breakdown of responses for saithe by fishing gear (Otter Trawl, *Nephrops* Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

## **Abundance**

Just over half of responses reported no change in the abundance of saithe in 2014, substantially more than in 2013 (Table 22). One-third of responses reported an increase in abundance, almost unchanged from 2013, while there was a marked fall in the proportion reporting a lower abundance of saithe in 2014.

Across individual areas the proportions reporting higher abundances of saithe in 2014 tended to be greater in more northern areas (areas 1, 2, 3 & 8), while the proportions reporting lower abundances tended to be higher in more southerly areas (areas 4, 6a & 7) (Figure 34).

The cumulative index of perceptions of the abundance of saithe (Figure 35) increased in just over half the areas, with the biggest increases in the north and west (areas 1, 2, 3 & 8).

## **Size Range**

Almost three-quarters of responses reported catching all sizes of saithe in 2014 (Table 22), with a small increase from 2013. Most of the remaining responses reported catching mostly small saithe, markedly less than in 2013, while there was a small increase in the (small) proportion reporting mostly large saithe in 2014.

Across most individual areas the majority of responses reported all sizes of saithe in 2014 (Figure 34). The proportions reporting mostly small saithe were higher in central, norther and western areas (area 1, 2 & 4).

## **Discards**

Two-thirds of responses reported no change in the level of discarding of saithe in 2014 (Table 22), somewhat more than in 2013. About one-quarter of responses reported higher levels of discarding, slightly less than in 2013, while the proportion reporting lower levels of discards fell slightly.

The majority of responses in all individual areas reported no change in the level of saithe discards in 2014 (Figure 34), but no clear pattern was apparent in the remaining responses.

## **Recruitment**

Almost all responses reported moderate or high levels of recruitment of saithe in 2014 (Table 22), with the same proportion of responses in each category. There was a marked increase in the proportion reporting high levels of recruitment in 2014, and a small decrease in the proportion reporting moderate levels. There was also a

marked decrease in the proportion of responses reporting low levels of recruitment of saithe in 2014.

No clear pattern was apparent across individual areas in the breakdown of responses on levels of recruitment (Figure 34).

### Comparison with ICES Stock Assessment

ICES assesses the abundance of a single saithe stock covering both the North Sea and West of Scotland (subarea VI) areas. There was little evidence of any relationship between these data and the saithe abundance index derived from the Fishers' North Sea Stock Survey (Figure 33).

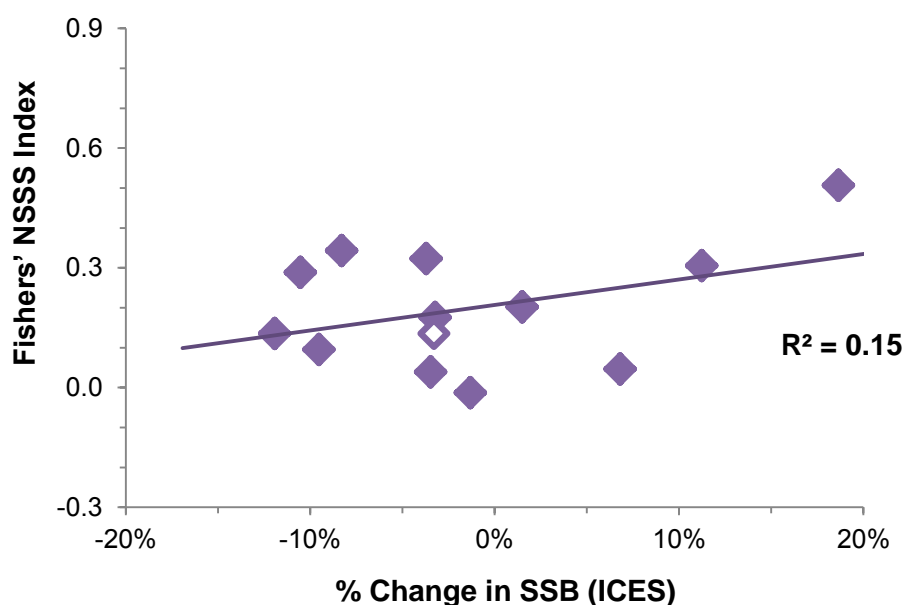


Figure 33 Plot of the annual Fishers' North Sea Stock Survey index against the percentage changes in the estimated mid-year North Sea and West of Scotland saithe spawning stock biomass (SSB), with fitted linear trend line and coefficient of determination ( $R^2$ ; values closer to 1 indicate a better agreement). The unshaded point is based on the predicted SSB for 2015.

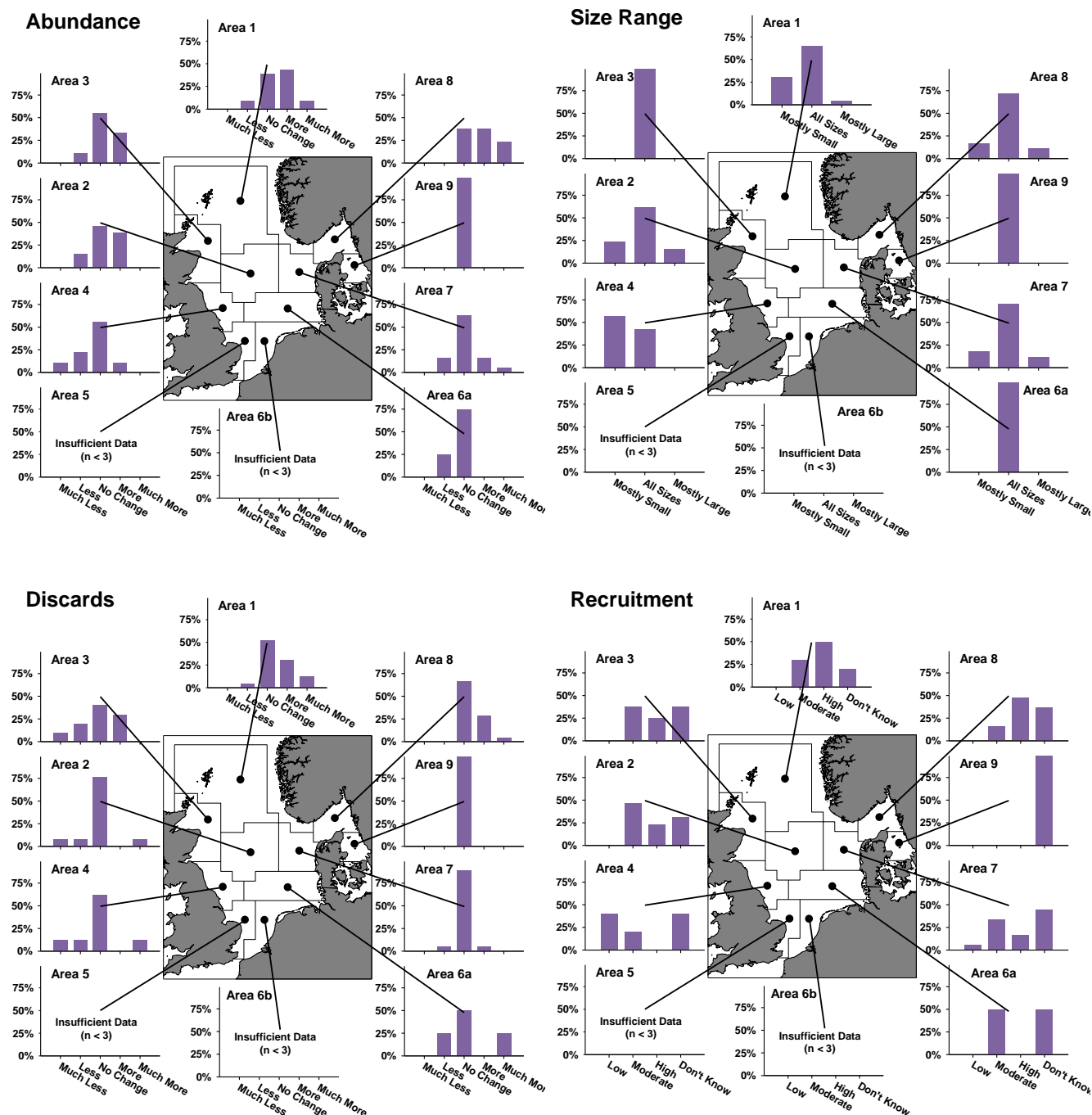


Figure 34 Perceptions of the abundance and size range of saithe, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category. No results are shown for Areas 5 and 6b due to the small number of responses from those areas (see Table 11, p. 28).



## Abundance Index

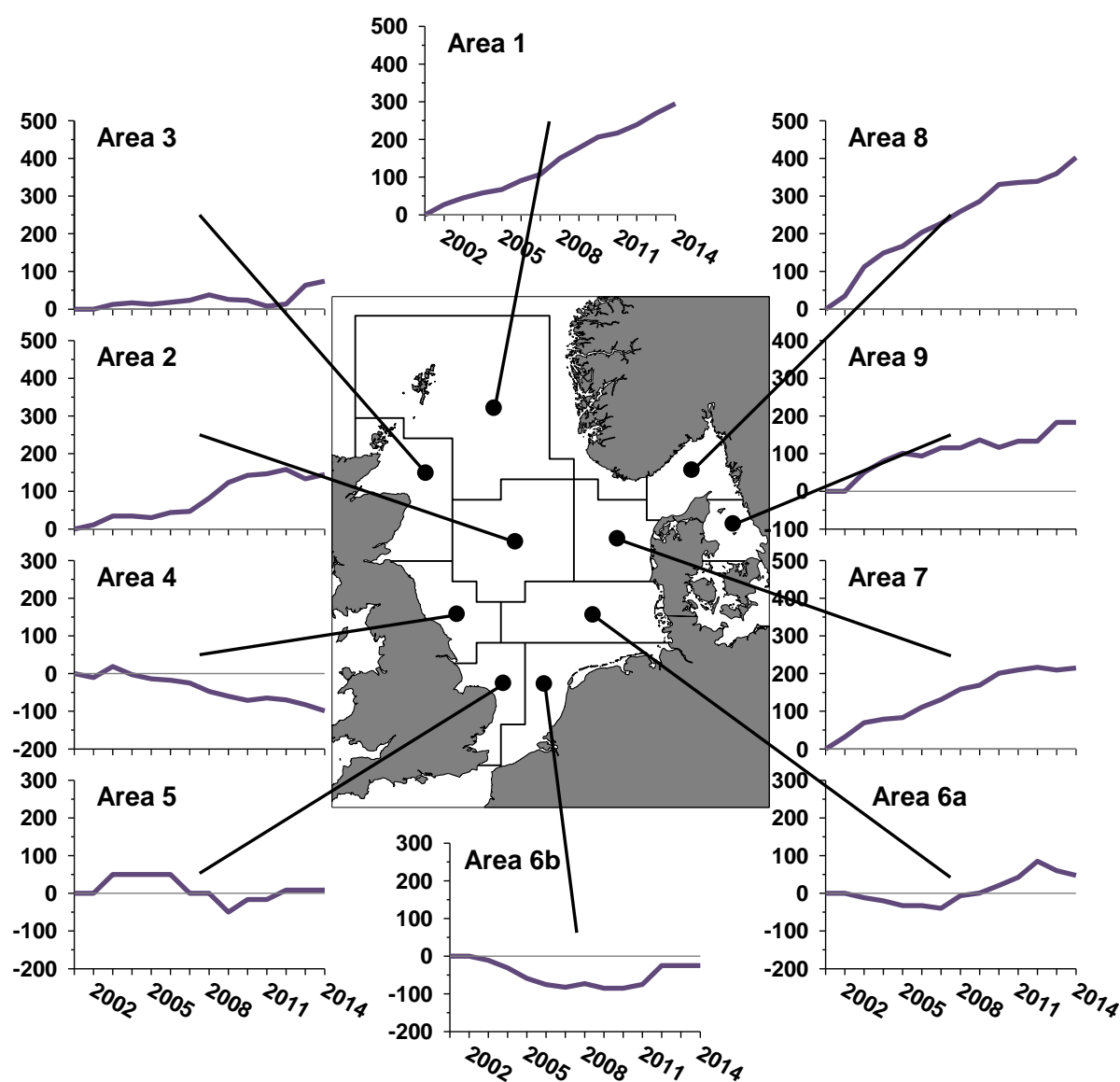


Figure 35 Cumulative time series of index of perceptions of abundance of saithe, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)

Table 23 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of saithe.

|                    | Area |    |    |   |   |    |    |    |    |   |
|--------------------|------|----|----|---|---|----|----|----|----|---|
|                    | 1    | 2  | 3  | 4 | 5 | 6a | 6b | 7  | 8  | 9 |
| Number             | 24   | 13 | 10 | 9 | 2 | 4  | 1  | 19 | 21 | 3 |
| <b>Abundance</b>   |      |    |    |   |   |    |    |    |    |   |
| Much Less          | 0    | 0  | 0  | 1 | 0 | 0  | 0  | 0  | 0  | 0 |
| Less               | 2    | 2  | 1  | 2 | 0 | 1  | 0  | 3  | 0  | 0 |
| No Change          | 9    | 6  | 5  | 5 | 2 | 3  | 1  | 12 | 8  | 3 |
| More               | 10   | 5  | 3  | 1 | 0 | 0  | 0  | 3  | 8  | 0 |
| Much More          | 2    | 0  | 0  | 0 | 0 | 0  | 0  | 1  | 5  | 0 |
| No Answer          | 1    | 0  | 1  | 0 | 0 | 0  | 0  | 0  | 0  | 0 |
| <b>Size</b>        |      |    |    |   |   |    |    |    |    |   |
| Mostly Small       | 7    | 3  | 0  | 4 | 0 | 0  | 0  | 3  | 3  | 0 |
| All Sizes          | 15   | 8  | 9  | 3 | 2 | 2  | 1  | 12 | 13 | 2 |
| Mostly Large       | 1    | 2  | 0  | 0 | 0 | 0  | 0  | 2  | 2  | 0 |
| No Answer          | 1    | 0  | 1  | 2 | 0 | 2  | 0  | 2  | 3  | 1 |
| <b>Discards</b>    |      |    |    |   |   |    |    |    |    |   |
| Much Less          | 0    | 1  | 1  | 1 | 0 | 0  | 0  | 0  | 0  | 0 |
| Less               | 1    | 1  | 2  | 1 | 0 | 1  | 0  | 1  | 0  | 0 |
| No Change          | 12   | 10 | 4  | 5 | 2 | 2  | 1  | 17 | 14 | 3 |
| More               | 7    | 0  | 3  | 0 | 0 | 0  | 0  | 1  | 6  | 0 |
| Much More          | 3    | 1  | 0  | 1 | 0 | 1  | 0  | 0  | 1  | 0 |
| No Answer          | 1    | 0  | 0  | 1 | 0 | 0  | 0  | 0  | 0  | 0 |
| <b>Recruitment</b> |      |    |    |   |   |    |    |    |    |   |
| Low                | 0    | 0  | 0  | 2 | 0 | 0  | 0  | 1  | 0  | 0 |
| Moderate           | 6    | 6  | 3  | 1 | 1 | 1  | 0  | 6  | 3  | 0 |
| High               | 10   | 3  | 2  | 0 | 0 | 0  | 0  | 3  | 9  | 0 |
| Don't Know         | 4    | 4  | 3  | 2 | 1 | 1  | 1  | 8  | 7  | 3 |
| No Answer          | 4    | 0  | 2  | 4 | 0 | 2  | 0  | 1  | 2  | 0 |

## Monkfish

Of the 177 valid questionnaires received, 89 (50%) provided information on monkfish. The proportion of responses providing information on monkfish was lowest in the southern North Sea (area 6b) and Kattegat (area 9), and highest in the north (area 1) (Figure 36).

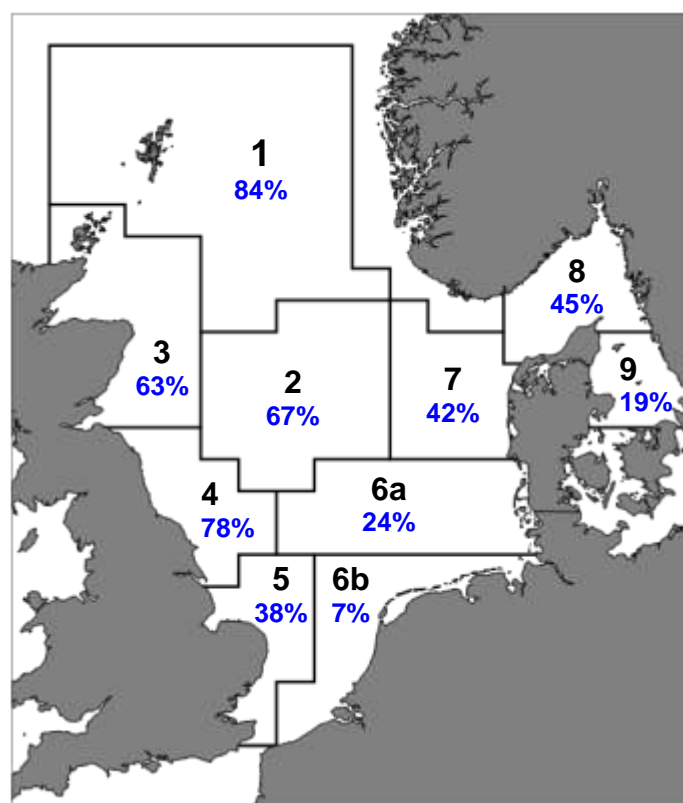


Figure 36 The proportions of responses from each area that provided information on monkfish.

Table 24 shows the responses broken down by fishing gear and vessel size class. By vessel size, most responses were received from medium sized vessels (15-24m), followed by large vessels (>24m) and small vessels (<15m). Of the fishing gears, otter trawls accounted for the largest number of responses, followed by *Nephrops* trawls.

Figure 37 and Figure 38 provide a more detailed breakdown of the responses for monkfish by vessel size and fishing gear.

Table 24 Numbers of responses for monkfish by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |      |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|------|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |      | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL  | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 6      | 15   | 14   | 35             | 27%    | 39%  | 50%  | 40%  |
|              |           | Nephrops Trawl    | 8      | 15   | 1    | 24             | 36%    | 39%  | 4%   | 27%  |
|              |           | Beam Trawl        | 0      | 2    | 6    | 8              | 0%     | 5%   | 21%  | 9%   |
|              |           | Pulse Trawl       | 0      | 0    | 5    | 5              | 0%     | 0%   | 18%  | 6%   |
|              |           | Gill Net          | 8      | 2    | 0    | 10             | 36%    | 5%   | 0%   | 11%  |
|              |           | Seine Net         | 0      | 4    | 2    | 6              | 0%     | 11%  | 7%   | 7%   |
|              |           | ALL               | 22     | 38   | 28   | 88             | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 17%    | 43%  | 40%  | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 33%    | 63%  | 4%   | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 25%  | 75%  | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 0%   | 100% | 100%           |        |      |      |      |
|              |           | Gill Net          | 80%    | 20%  | 0%   | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 67%  | 33%  | 100%           |        |      |      |      |
|              |           | ALL               | 25%    | 43%  | 32%  | 100%           |        |      |      |      |

Table 25 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of monkfish this year and last year. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/-  | Fish Size    | 2013 | 2014 | +/-  |
|---------------------|------|------|------|--------------|------|------|------|
| 'Less' <sup>1</sup> | 31%  | 9%   | -22% | Mostly Small | 14%  | 16%  | +2%  |
| No Change           | 46%  | 54%  | +7%  | All Sizes    | 86%  | 79%  | -7%  |
| 'More' <sup>2</sup> | 23%  | 38%  | +15% | Mostly Large | 0%   | 5%   | +5%  |
| Discards            | 2013 | 2014 | +/-  | Recruitment  | 2013 | 2014 | +/-  |
| 'Less' <sup>1</sup> | 13%  | 11%  | -2%  | Low          | 32%  | 12%  | -20% |
| No Change           | 84%  | 83%  | -2%  | Moderate     | 53%  | 55%  | +2%  |
| 'More' <sup>2</sup> | 3%   | 6%   | +4%  | High         | 15%  | 33%  | +18% |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

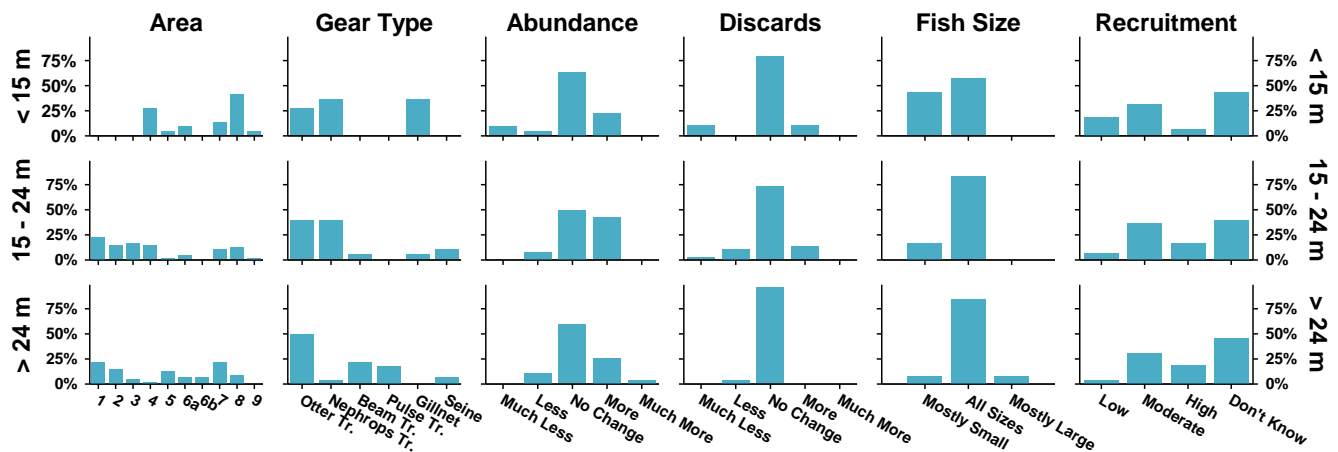


Figure 37 Breakdown of responses for monkfish by fishing vessel size class. Percentage of responses for each size class in each category.

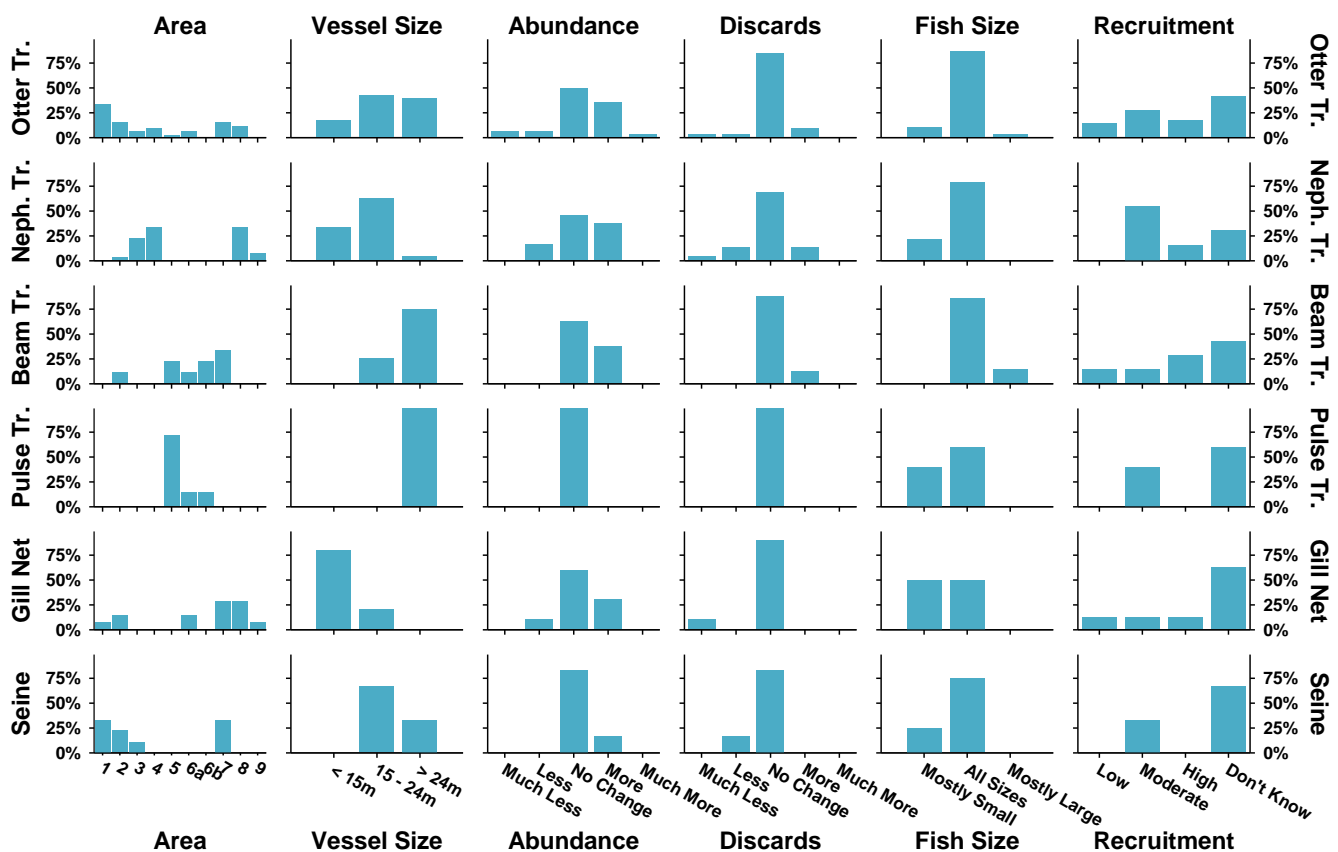


Figure 38 Breakdown of responses for monkfish by fishing gear (Otter Trawl, Nephrops Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

## **Abundance**

Just over half of responses reported no change in the abundance of monkfish in 2014, slightly more than in 2013 (Table 25). Of the balance, most responses – more than one-third overall – reported a higher abundance in 2014, markedly more than in 2013. There was a large fall in the proportion reporting a lower abundance of monkfish in 2014.

The majority of responses reported no change in the abundance of monkfish across most individual areas (Figure 40). Reports of higher abundances tended to be highest in central and northern areas (areas 1, 2, 3 & 7).

The cumulative index of perceptions of the abundance of monkfish increased in most areas (Figure 41), especially in the north and west (areas 1, 2 & 3).

## **Size Range**

More than three-quarters of responses reported catching all sizes of monkfish in 2014, slightly less than in 2013 (Table 25). Of the remainder, most reported catching mostly small monkfish, slightly more than in 2013, while there was also a small increase in the proportion reporting mostly large monkfish.

Across most individual areas the majority of responses reported all sizes of monkfish (Figure 40). The proportions reporting mostly small monkfish were highest in the south-west (areas 4 & 5), and also in the Kattegat (area 9).

## **Discards**

The majority of responses (83%) reported no change in the level of discards of monkfish in 2014 (Table 25), slightly less than in 2013. There was also a slight fall in the proportion reporting lower levels of monkfish discards in 2014 and a small increase in the (small) proportion reporting higher levels of discards.

Across most individual areas most, if not all, responses reported no change in the levels of monkfish discards (Figure 40). The exceptions tended to be in the central and western North Sea (areas 2, 3 & 4), although there responses tended to be split between reporting lower and higher levels of discards.

## **Recruitment**

More than half of responses reported a moderate level of monkfish recruitment in 2014 (Table 25), slightly more than in 2013, while a further third reported a high level of recruitment, markedly more than in 2013. There was a fairly large fall in the proportion reporting low levels of monkfish recruitment in 2014.

The picture was broadly similar across most individual areas (Figure 40). The proportions reporting low levels of monkfish recruitment were highest in the south (areas 5 & 6b).

### Comparison with ICES Stock Assessment

Estimates of the biomass of North Sea monkfish were published by ICES for the period from 2005 to 2012. There was no evidence of a relationship between these estimates and the NSSS index (Figure 33).

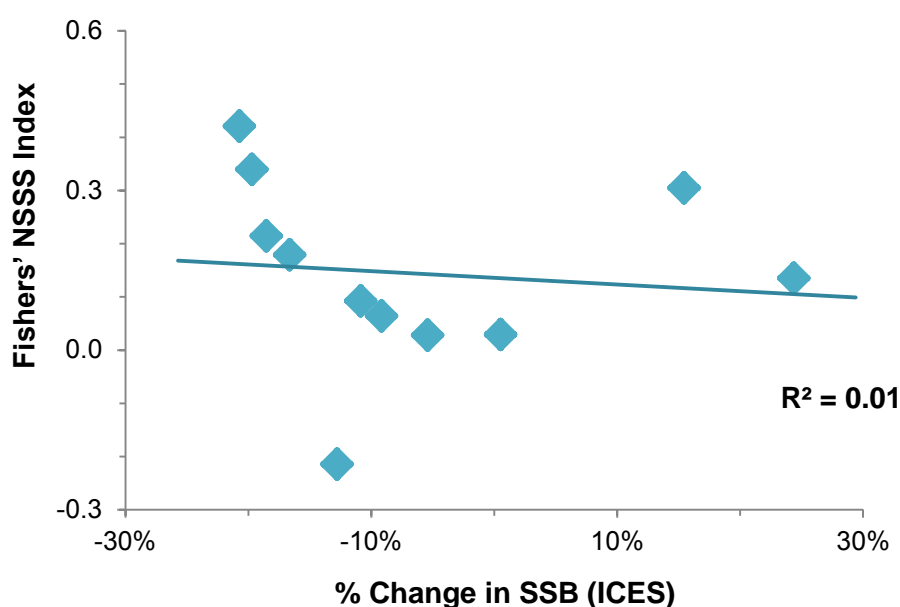


Figure 39 Plot of the annual Fishers' North Sea Stock Survey index against the percentage changes in the estimated mid-year North Sea monkfish biomass (B), with fitted linear trend line and coefficient of determination. ( $R^2$ ; values closer to 1 indicate a better agreement.)

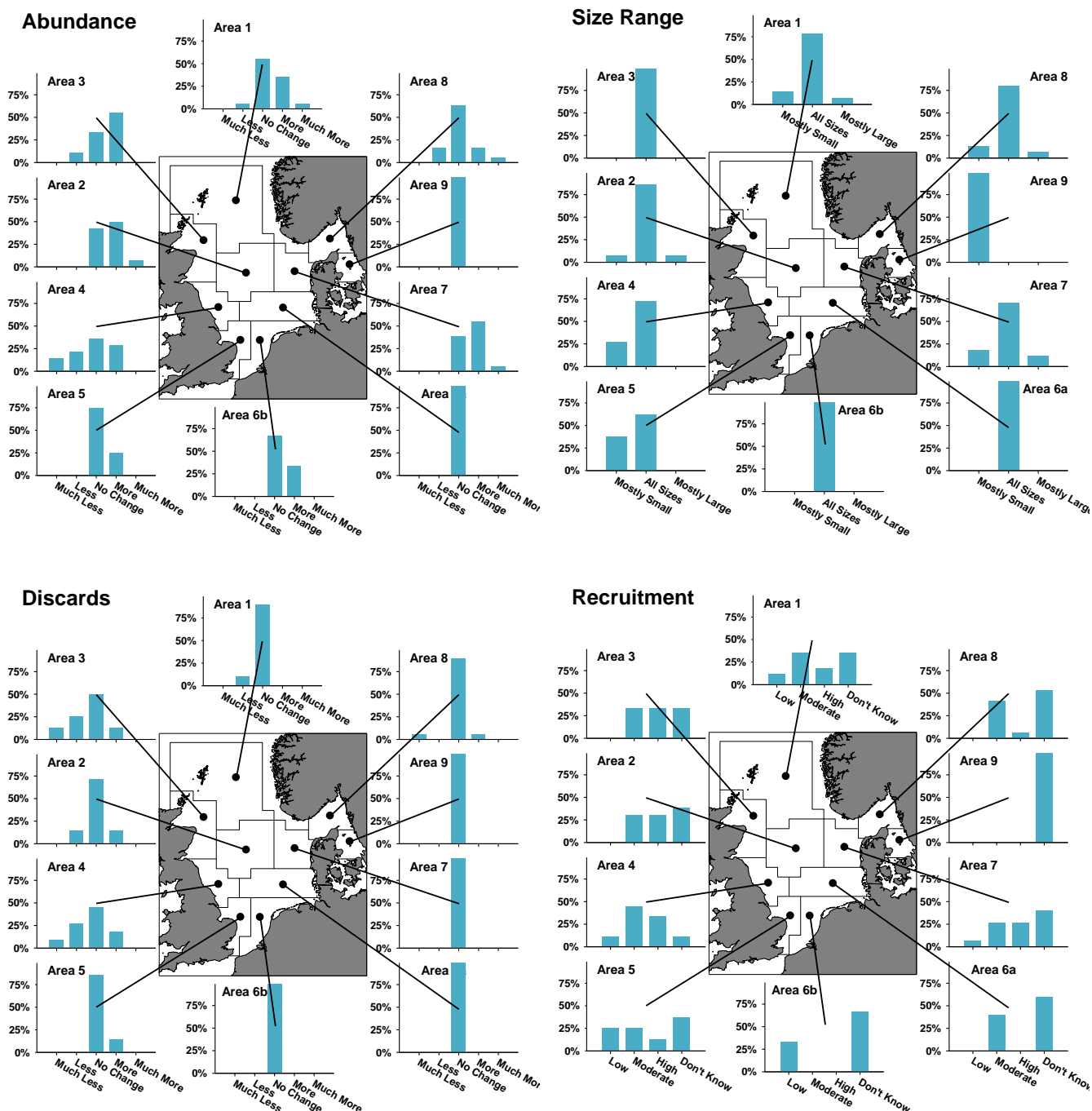


Figure 40 Perceptions of the abundance and size range of monkfish, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category.



## Abundance Index

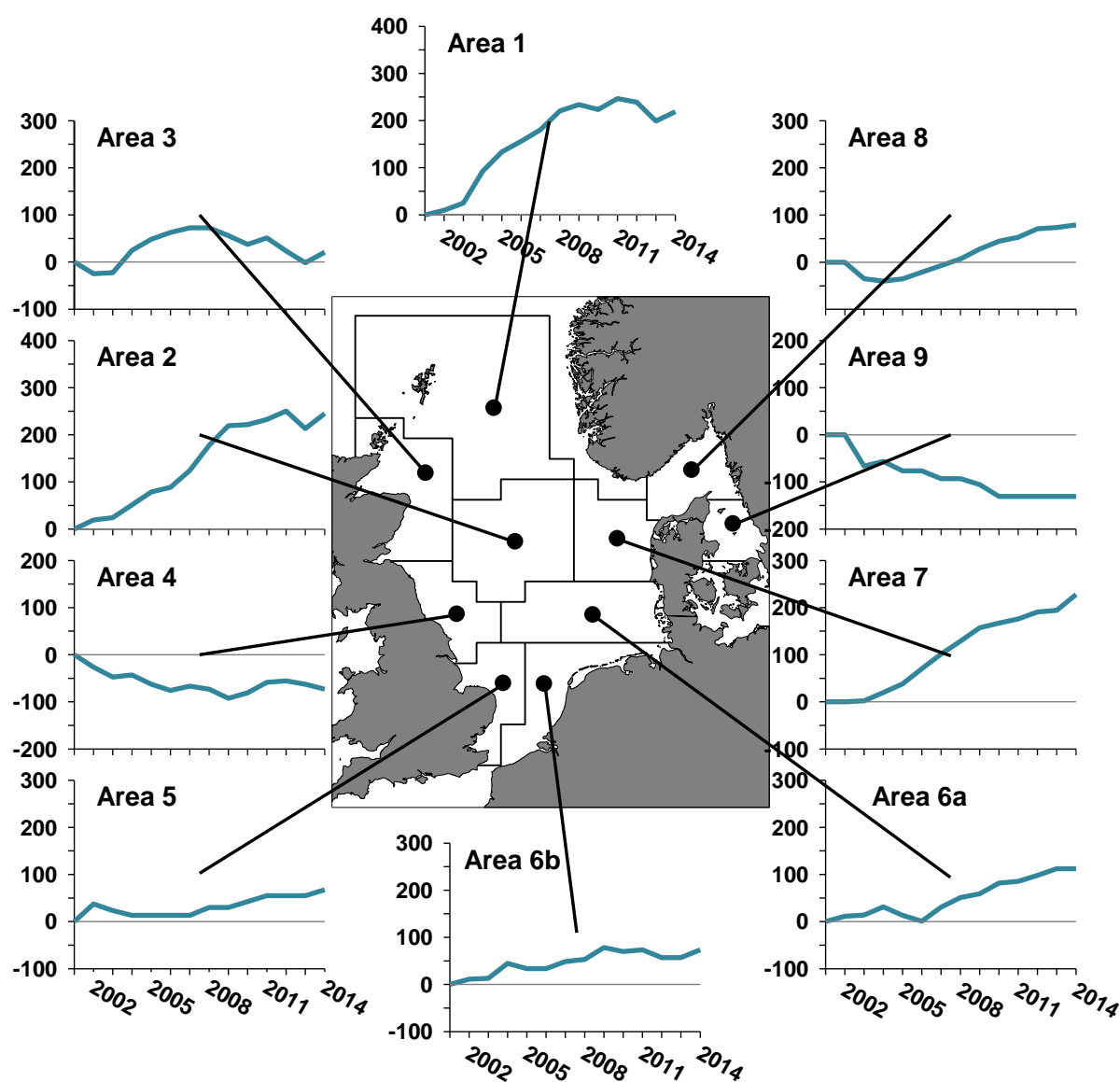


Figure 41 Cumulative time series of index of perceptions of abundance of monkfish, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)

Table 26 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of monkfish.

|                    | Area |    |    |    |   |    |    |    |    |   |
|--------------------|------|----|----|----|---|----|----|----|----|---|
|                    | 1    | 2  | 3  | 4  | 5 | 6a | 6b | 7  | 8  | 9 |
| <b>Number</b>      | 21   | 14 | 10 | 14 | 8 | 7  | 3  | 18 | 19 | 3 |
| <b>Abundance</b>   |      |    |    |    |   |    |    |    |    |   |
| Much Less          | 0    | 0  | 0  | 2  | 0 | 0  | 0  | 0  | 0  | 0 |
| Less               | 1    | 0  | 1  | 3  | 0 | 0  | 0  | 0  | 3  | 0 |
| No Change          | 11   | 6  | 3  | 5  | 6 | 7  | 2  | 7  | 12 | 2 |
| More               | 7    | 7  | 5  | 4  | 2 | 0  | 1  | 10 | 3  | 0 |
| Much More          | 1    | 1  | 0  | 0  | 0 | 0  | 0  | 1  | 1  | 0 |
| No Answer          | 1    | 0  | 1  | 0  | 0 | 0  | 0  | 0  | 0  | 1 |
| <b>Size</b>        |      |    |    |    |   |    |    |    |    |   |
| Mostly Small       | 2    | 1  | 0  | 3  | 3 | 0  | 0  | 3  | 2  | 1 |
| All Sizes          | 11   | 12 | 8  | 8  | 5 | 5  | 3  | 12 | 12 | 0 |
| Mostly Large       | 1    | 1  | 0  | 0  | 0 | 0  | 0  | 2  | 1  | 0 |
| No Answer          | 7    | 0  | 2  | 3  | 0 | 2  | 0  | 1  | 4  | 2 |
| <b>Discards</b>    |      |    |    |    |   |    |    |    |    |   |
| Much Less          | 0    | 0  | 1  | 1  | 0 | 0  | 0  | 0  | 1  | 0 |
| Less               | 2    | 2  | 2  | 3  | 0 | 0  | 0  | 0  | 0  | 0 |
| No Change          | 18   | 10 | 4  | 5  | 6 | 7  | 3  | 18 | 17 | 2 |
| More               | 0    | 2  | 1  | 2  | 1 | 0  | 0  | 0  | 1  | 0 |
| Much More          | 0    | 0  | 0  | 0  | 0 | 0  | 0  | 0  | 0  | 0 |
| No Answer          | 1    | 0  | 2  | 3  | 1 | 0  | 0  | 0  | 0  | 1 |
| <b>Recruitment</b> |      |    |    |    |   |    |    |    |    |   |
| Low                | 2    | 0  | 0  | 1  | 2 | 0  | 1  | 1  | 0  | 0 |
| Moderate           | 6    | 4  | 3  | 4  | 2 | 2  | 0  | 4  | 7  | 0 |
| High               | 3    | 4  | 3  | 3  | 1 | 0  | 0  | 4  | 1  | 0 |
| Don't Know         | 6    | 5  | 3  | 1  | 3 | 3  | 2  | 6  | 9  | 1 |
| No Answer          | 4    | 1  | 1  | 5  | 0 | 2  | 0  | 3  | 2  | 2 |

## *Nephrops*

Of the 177 valid questionnaires received, 54 (31%) provided information on *Nephrops*. The proportion of responses providing information on *Nephrops* was highest in the west (areas 3 & 4) (Figure 42).

No responses were received in 2014 to the supplementary question based on the functional units (FUs) used by ICES in their assessment of the North Sea *Nephrops* stock (see page 12).

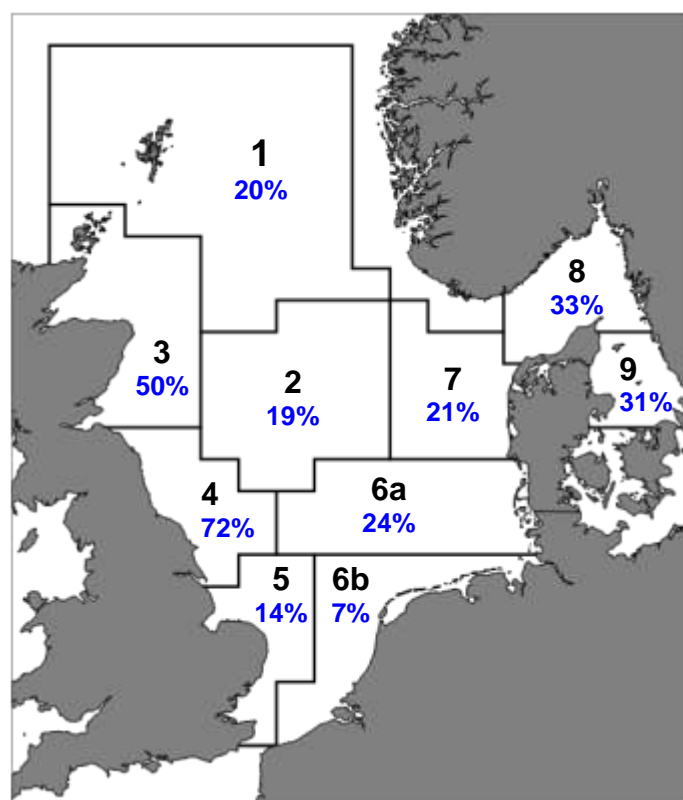


Figure 42 The proportions of responses from each area that provided information on *Nephrops*.

Table 27 shows the responses broken down by fishing gear and vessel size class. Almost half the responses were from medium-sized (15-24m) and one-third from small (<15m) vessels. The majority of responses were from *Nephrops* trawls or otter trawls.

Figure 43 and Figure 44 provide a more detailed breakdown of the responses for *Nephrops* by vessel size and fishing gear.

Table 27 Numbers of responses for *Nephrops* by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |      |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|------|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |      | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL  | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 5      | 8    | 6    | 19             | 29%    | 32%  | 50%  | 35%  |
|              |           | Nephrops Trawl    | 8      | 15   | 1    | 24             | 47%    | 60%  | 8%   | 44%  |
|              |           | Beam Trawl        | 0      | 1    | 3    | 4              | 0%     | 4%   | 25%  | 7%   |
|              |           | Pulse Trawl       | 0      | 0    | 2    | 2              | 0%     | 0%   | 17%  | 4%   |
|              |           | Gill Net          | 4      | 0    | 0    | 4              | 24%    | 0%   | 0%   | 7%   |
|              |           | Seine Net         | 0      | 1    | 0    | 1              | 0%     | 4%   | 0%   | 2%   |
|              |           | ALL               | 17     | 25   | 12   | 54             | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 26%    | 42%  | 32%  | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 33%    | 63%  | 4%   | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 25%  | 75%  | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 0%   | 100% | 100%           |        |      |      |      |
|              |           | Gill Net          | 100%   | 0%   | 0%   | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 100% | 0%   | 100%           |        |      |      |      |
|              |           | ALL               | 31%    | 46%  | 22%  | 100%           |        |      |      |      |

Table 28 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of *Nephrops* this year and last year. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/-  | Fish Size    | 2013 | 2014 | +/-  |
|---------------------|------|------|------|--------------|------|------|------|
| 'Less' <sup>1</sup> | 65%  | 13%  | -52% | Mostly Small | 17%  | 16%  | -1%  |
| No Change           | 23%  | 17%  | -6%  | All Sizes    | 80%  | 69%  | -11% |
| 'More' <sup>2</sup> | 13%  | 70%  | +58% | Mostly Large | 3%   | 15%  | +12% |
| Discards            | 2013 | 2014 | +/-  | Recruitment  | 2013 | 2014 | +/-  |
| 'Less' <sup>1</sup> | 43%  | 20%  | -23% | Low          | 16%  | 2%   | -14% |
| No Change           | 58%  | 62%  | +4%  | Moderate     | 80%  | 80%  | +0%  |
| 'More' <sup>2</sup> | 0%   | 18%  | +18% | High         | 4%   | 17%  | +13% |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

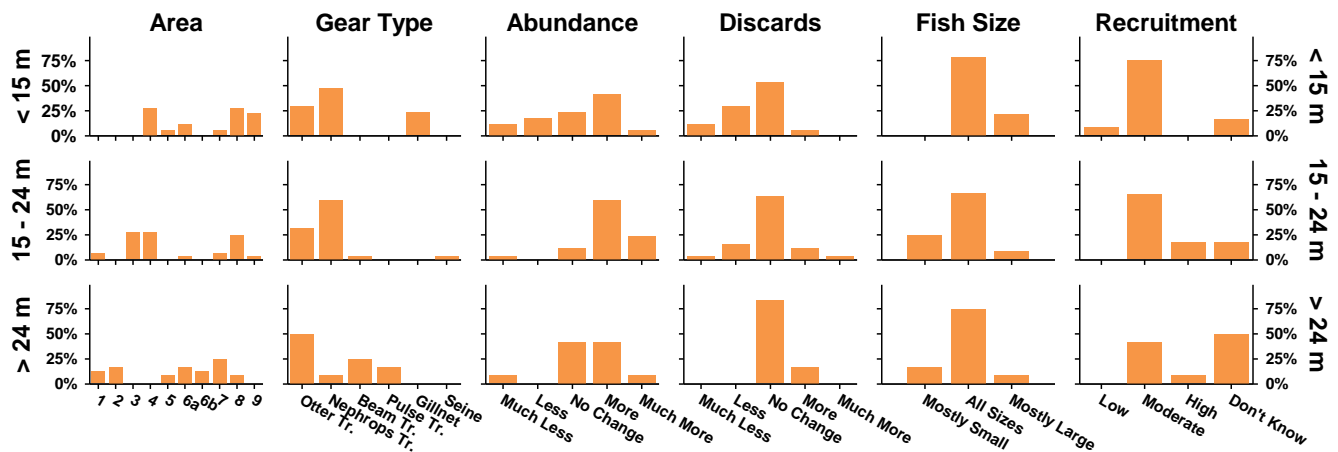


Figure 43 Breakdown of responses for *Nephrops* by fishing vessel size class. Percentage of responses for each size class in each category.

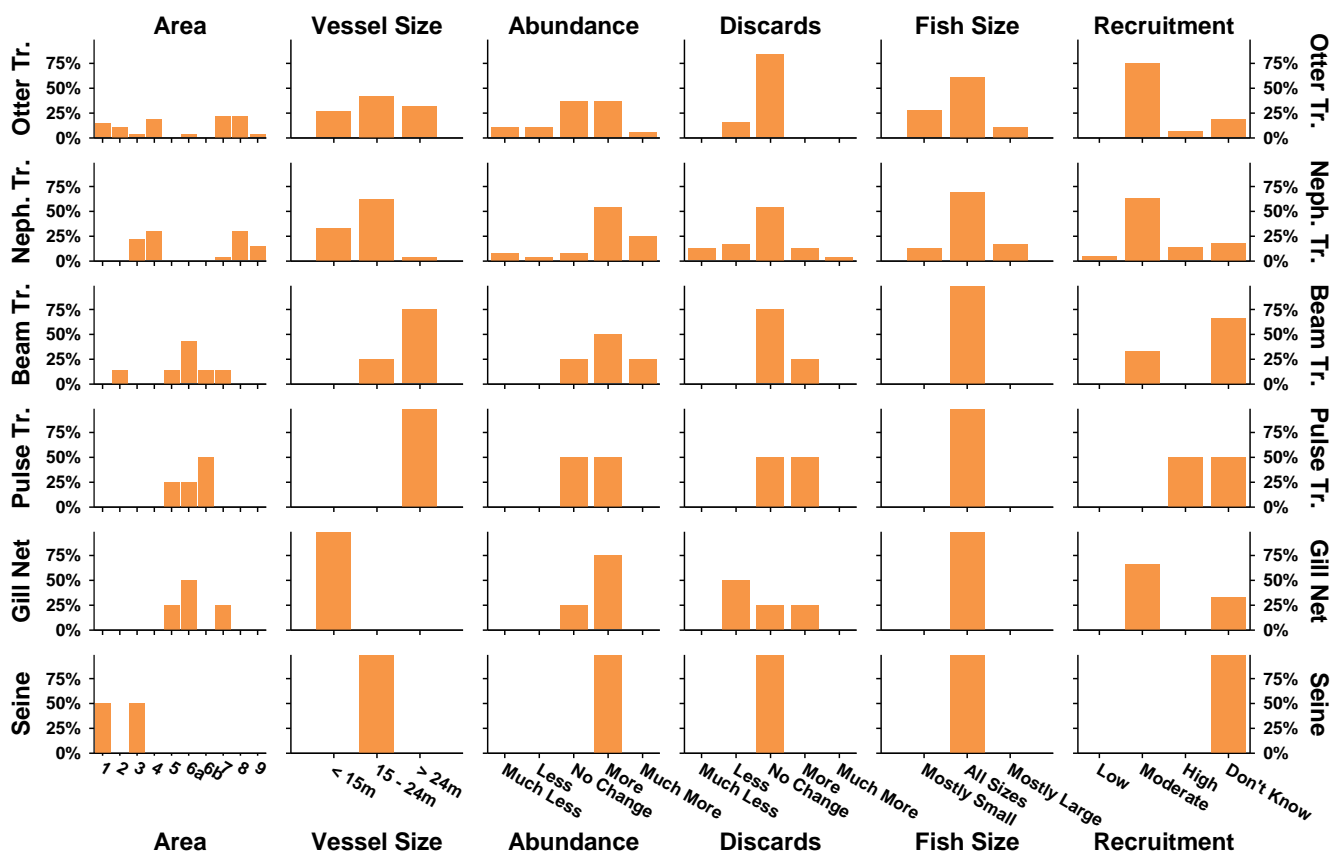


Figure 44 Breakdown of responses for *Nephrops* by fishing gear (Otter Trawl, *Nephrops* Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

## **Abundance**

Almost three-quarters of responses reported a higher abundance of *Nephrops* in 2014 (Table 28), substantially more than in 2013. There was also a substantial fall in the proportion of responses reporting a lower abundance of *Nephrops* in 2014.

The majority of responses reported higher abundances of *Nephrops* in all individual areas (Figure 46). Reports of no change in abundance tended to be most common in the south and east, while reports of lower abundances were more common in the central, northern and western North Sea.

The cumulative index of perceptions of the abundance of *Nephrops* (Figure 47) increased in all areas except the most northern (area 1).

## **Size Range**

More than two-thirds of responses reported catching all sizes of *Nephrops* in 2014 (Table 28), a decrease from 2013. The remaining responses were fairly evenly split between mostly small and mostly large *Nephrops*. The former was almost unchanged from 2013, while the latter had increased.

The majority of responses from all individual areas reported all sizes of *Nephrops* (Figure 46), but no clear pattern was apparent in the remaining responses.

## **Discards**

Almost two-thirds of responses reported no change in the level of discards of *Nephrops* in 2014 (Table 28), slightly more than in 2013. The remaining responses were roughly equally split between reporting lower and higher levels of discards. A fairly large increase in the proportion reporting higher levels of discards in 2014 was matched by a similar fall in the proportion reporting lower levels.

The majority of responses from all individual areas reported no change in levels of discards of *Nephrops* (Figure 46), but no clear pattern was apparent in the remaining responses.

## **Recruitment**

More than three-quarters of responses reported moderate levels of *Nephrops* recruitment in 2014 (Table 28), unchanged from 2013. Most of the remaining responses reported high levels of recruitment, with a fairly large increase from 2013 matched by a fall in the proportion reporting low levels of recruitment.

Across most individual areas the majority of responses reported moderate levels of *Nephrops* recruitment (Figure 46). Reports of high levels of recruitment tended to be most common in the south (areas 5 & 6b).

## Comparison with ICES Stock Assessment

ICES provides advice for nine separate *Nephrops* 'functional units' (sub-stocks) within the North Sea (**Error! Reference source not found.**)<sup>1</sup>, although abundance estimates are only available for four of these: FU6 (Farn Deep), FU7 (Fladen Ground), FU8 (Firth of Forth), and FU9 (Moray Firth). These four units accounted for more than three-quarters (78%) of all the *Nephrops* landings from the North Sea in 2013.

For the purposes of this comparison, the sum of the estimated abundances of *Nephrops* in these four functional units was used.

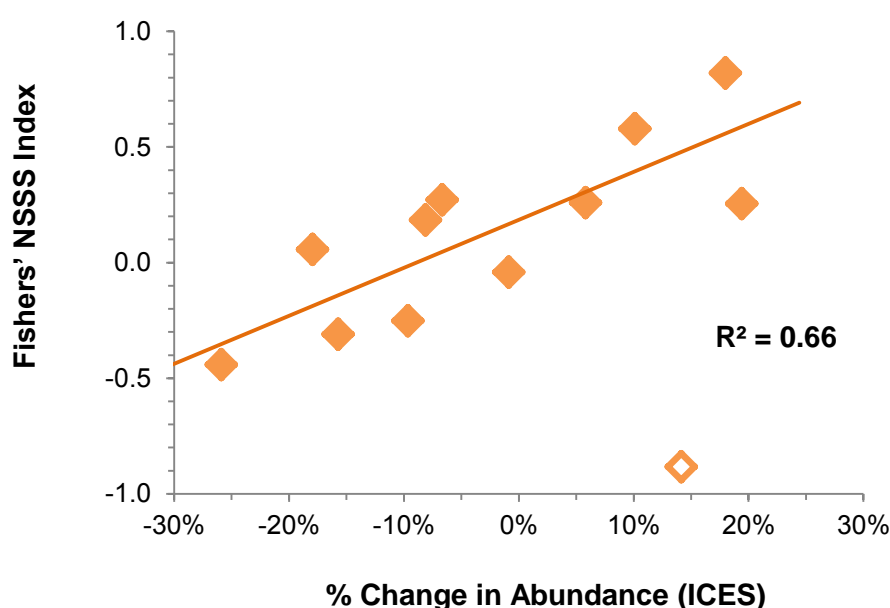


Figure 45 Plot of the annual Fishers' North Sea Stock Survey index against the percentage changes in the total estimated mid-year *Nephrops* abundance for the Farn Deep (Functional Unit 6), Fladen Ground (FU 7), Firth of Forth (FU8) and Moray Firth (FU9) with fitted linear trend line and coefficient of determination for the years to 2012 ( $R^2$ ; values closer to 1 indicate a better agreement.) The unshaded point is for 2013.

A fairly good relationship was apparent between the estimated abundance of *Nephrops* in these four functional units and the Fishers' North Sea Stock Survey index for the whole North Sea (Figure 45) for the years up to 2012. Although the relationship was not particularly strong statistically, it was stronger than those for most other species in this survey. The data point of 2013 clearly did not fit this

<sup>1</sup> For further information see the ICES advice for *Nephrops* in Subarea IV (North Sea), available online at: [www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/Neph-IV.pdf](http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2014/2014/Neph-IV.pdf).

relationship, possibly because of the very small number of responses for *Nephrops* received from the Fishers' North Sea Stock Survey in 2013.



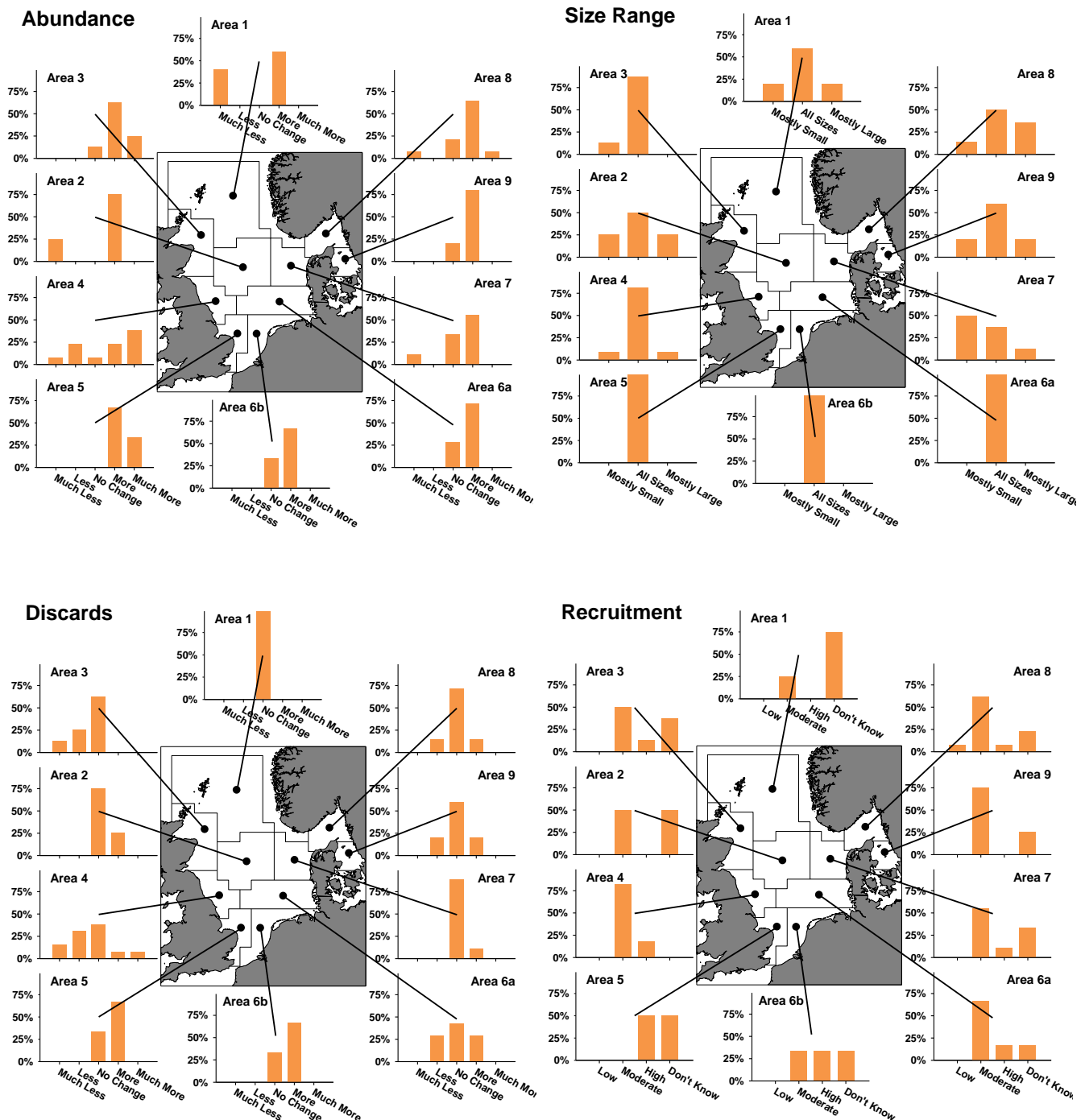


Figure 46 Perceptions of the abundance and size range of *Nephrops*, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category.

## Abundance Index

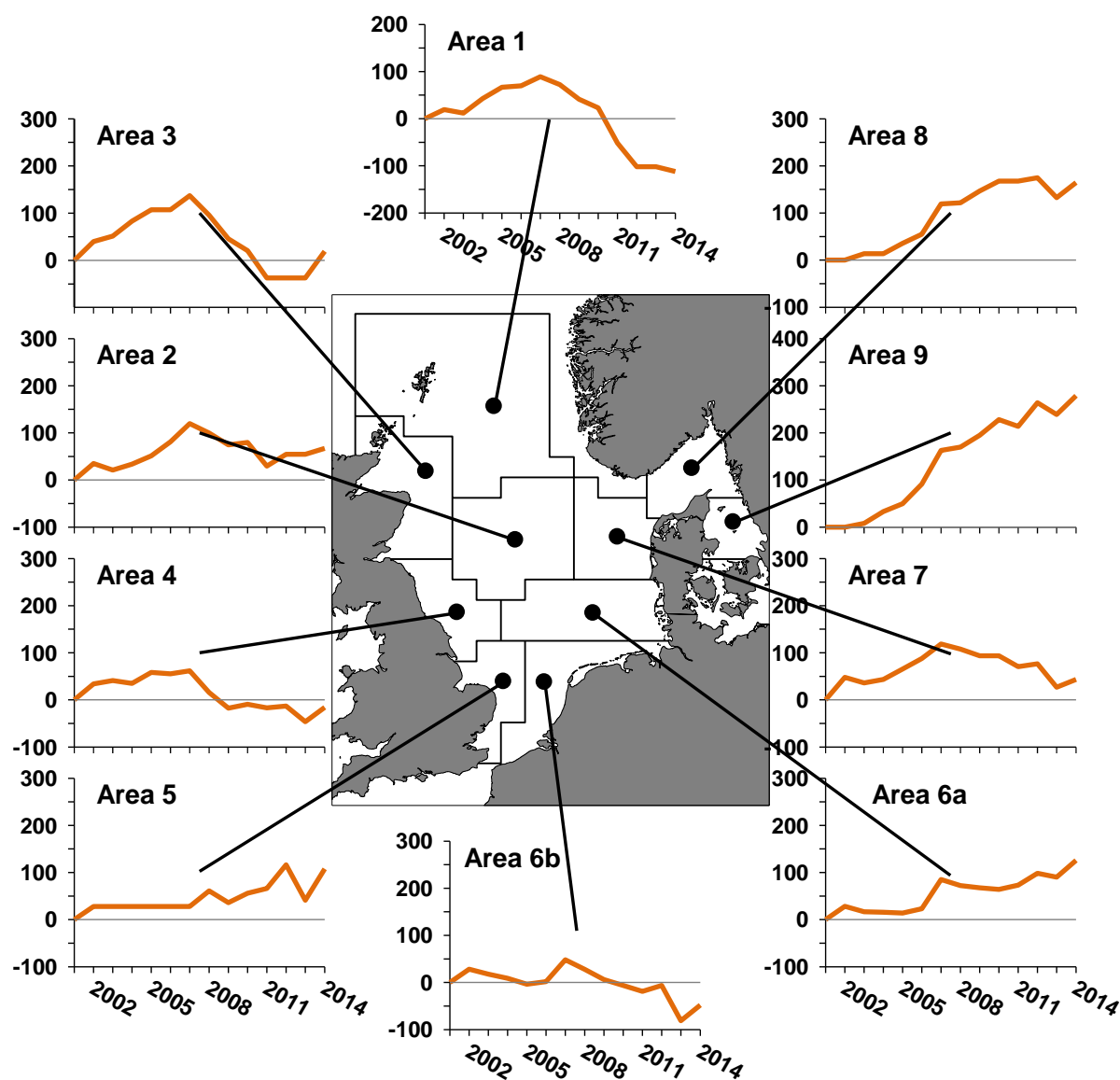


Figure 47 Cumulative time series of index of perceptions of abundance of *Nephrops*, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)

Table 29 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of *Nephrops*.

|                    | Area |   |   |    |   |    |    |   |    |   |
|--------------------|------|---|---|----|---|----|----|---|----|---|
|                    | 1    | 2 | 3 | 4  | 5 | 6a | 6b | 7 | 8  | 9 |
| Number             | 5    | 4 | 8 | 13 | 3 | 7  | 3  | 9 | 14 | 5 |
| <b>Abundance</b>   |      |   |   |    |   |    |    |   |    |   |
| Much Less          | 2    | 1 | 0 | 1  | 0 | 0  | 0  | 1 | 1  | 0 |
| Less               | 0    | 0 | 0 | 3  | 0 | 0  | 0  | 0 | 0  | 0 |
| No Change          | 0    | 0 | 1 | 1  | 0 | 2  | 1  | 3 | 3  | 1 |
| More               | 3    | 3 | 5 | 3  | 2 | 5  | 2  | 5 | 9  | 4 |
| Much More          | 0    | 0 | 2 | 5  | 1 | 0  | 0  | 0 | 1  | 0 |
| No Answer          | 0    | 0 | 0 | 0  | 0 | 0  | 0  | 0 | 0  | 0 |
| <b>Size</b>        |      |   |   |    |   |    |    |   |    |   |
| Mostly Small       | 1    | 1 | 1 | 1  | 0 | 0  | 0  | 4 | 2  | 1 |
| All Sizes          | 3    | 2 | 7 | 9  | 3 | 6  | 3  | 3 | 7  | 3 |
| Mostly Large       | 1    | 1 | 0 | 1  | 0 | 0  | 0  | 1 | 5  | 1 |
| No Answer          | 0    | 0 | 0 | 2  | 0 | 1  | 0  | 1 | 0  | 0 |
| <b>Discards</b>    |      |   |   |    |   |    |    |   |    |   |
| Much Less          | 0    | 0 | 1 | 2  | 0 | 0  | 0  | 0 | 0  | 0 |
| Less               | 0    | 0 | 2 | 4  | 0 | 2  | 0  | 0 | 2  | 1 |
| No Change          | 5    | 3 | 5 | 5  | 1 | 3  | 1  | 8 | 10 | 3 |
| More               | 0    | 1 | 0 | 1  | 2 | 2  | 2  | 1 | 2  | 1 |
| Much More          | 0    | 0 | 0 | 1  | 0 | 0  | 0  | 0 | 0  | 0 |
| No Answer          | 0    | 0 | 0 | 0  | 0 | 0  | 0  | 0 | 0  | 0 |
| <b>Recruitment</b> |      |   |   |    |   |    |    |   |    |   |
| Low                | 0    | 0 | 0 | 0  | 0 | 0  | 0  | 0 | 1  | 0 |
| Moderate           | 1    | 2 | 4 | 9  | 0 | 4  | 1  | 5 | 8  | 3 |
| High               | 0    | 0 | 1 | 2  | 1 | 1  | 1  | 1 | 1  | 0 |
| Don't Know         | 3    | 2 | 3 | 0  | 1 | 1  | 1  | 3 | 3  | 1 |
| No Answer          | 1    | 0 | 0 | 2  | 1 | 1  | 0  | 0 | 1  | 1 |

## Common Sole

Of the 177 valid responses received, 118 (67%) provided information on common (Dover) sole. The proportion of responses providing information on sole was greatest in the southern North Sea (areas 5 & 6b) and the Kattegat (area 9) and lowest in the central and northern North Sea (areas 1 & 2).

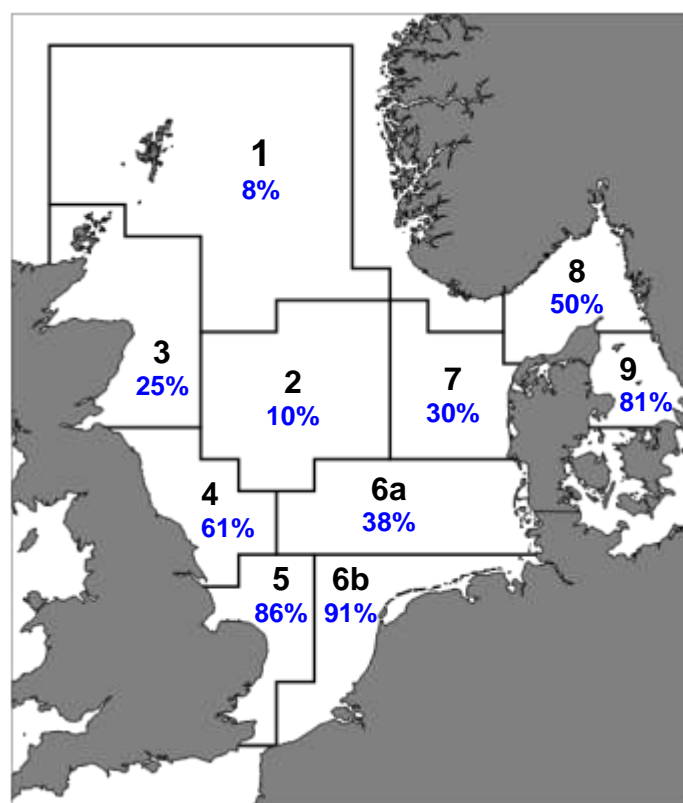


Figure 48 Proportion of responses from each area that provided information on common (Dover) sole.

Table 30 shows the responses broken down by fishing gear and vessel size class. By vessel size, somewhat more responses were received from small (<15 m) vessels, with the remainder equally split between medium-sized (15-24 m) and large (>24 m) vessels. Of the fishing gears, gill nets accounted for the largest proportion of responses, with the remainder roughly equally divided between the other fishing gear types except the seine net.

Figure 49 and Figure 50 provide a more detailed breakdown of the responses for common sole by vessel size and fishing gear.

# NSSS - 2014 Species Accounts: Common Sole

Table 30 Numbers of responses for common sole by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |     |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|-----|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |     | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 8      | 7    | 3   | 18             | 17%    | 21%  | 9%   | 15%  |
|              |           | Nephrops Trawl    | 8      | 13   | 0   | 21             | 17%    | 38%  | 0%   | 18%  |
|              |           | Beam Trawl        | 0      | 6    | 14  | 20             | 0%     | 18%  | 40%  | 17%  |
|              |           | Pulse Trawl       | 0      | 1    | 18  | 19             | 0%     | 3%   | 51%  | 16%  |
|              |           | Gill Net          | 32     | 6    | 0   | 38             | 67%    | 18%  | 0%   | 32%  |
|              |           | Seine Net         | 0      | 1    | 0   | 1              | 0%     | 3%   | 0%   | 1%   |
|              |           | ALL               | 48     | 34   | 35  | 117            | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 44%    | 39%  | 17% | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 38%    | 62%  | 0%  | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 30%  | 70% | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 5%   | 95% | 100%           |        |      |      |      |
|              |           | Gill Net          | 84%    | 16%  | 0%  | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 100% | 0%  | 100%           |        |      |      |      |
|              |           | ALL               | 41%    | 29%  | 30% | 100%           |        |      |      |      |

Table 31 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of common sole this year and last year. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/- | Fish Size    | 2013 | 2014 | +/- |
|---------------------|------|------|-----|--------------|------|------|-----|
| 'Less' <sup>1</sup> | 27%  | 24%  | -3% | Mostly Small | 28%  | 31%  | +3% |
| No Change           | 34%  | 29%  | -5% | All Sizes    | 67%  | 65%  | -1% |
| 'More' <sup>2</sup> | 39%  | 47%  | +8% | Mostly Large | 5%   | 3%   | -2% |
| Discards            | 2013 | 2014 | +/- | Recruitment  | 2013 | 2014 | +/- |
| 'Less' <sup>1</sup> | 20%  | 20%  | +1% | Low          | 16%  | 13%  | -3% |
| No Change           | 52%  | 58%  | +6% | Moderate     | 44%  | 42%  | -2% |
| 'More' <sup>2</sup> | 28%  | 21%  | -7% | High         | 40%  | 45%  | +5% |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

# NSSS - 2014 Species Accounts: Common Sole

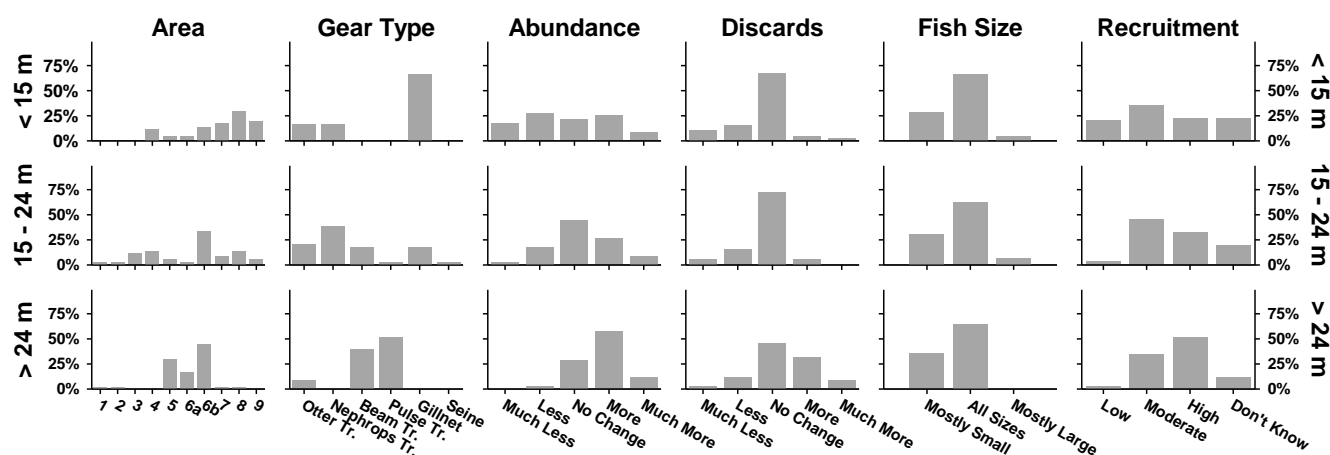


Figure 49 Breakdown of responses for common sole by fishing vessel size class. Percentage of responses for each size class in each category.

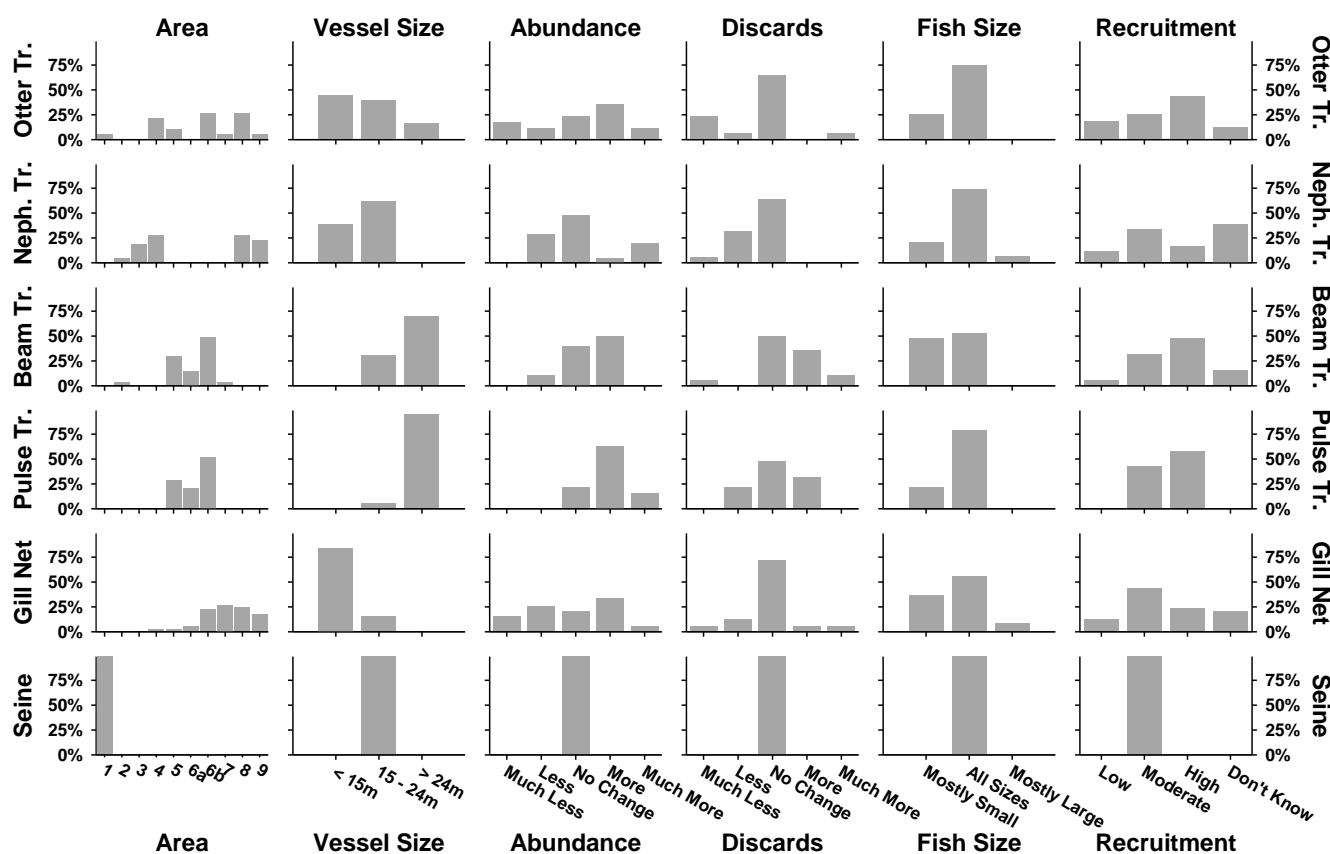


Figure 50 Breakdown of responses for common sole by fishing gear (Otter Trawl, Nephrops Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

# **NSSS - 2014 Species Accounts: Common Sole**

## **Abundance**

Almost half of responses reported a greater abundance of sole in 2014 (Table 31), an increase on 2013. Of the remaining responses, slightly more reported no change in the abundance of sole in 2014, than a lower abundance, with small declines in both.

No clear pattern was apparent in responses across individual areas (Figure 52).

The cumulative index of perceptions of the abundance of common sole (Figure 53) increased in about half of the areas (mainly in the south and east), but declined or remained the same in the others.

## **Size Range**

Two-thirds of responses reported catching all sizes of sole in 2014 (Table 31), almost unchanged from 2013. Most of the remaining responses reported mostly small sole in 2014, slightly more than in 2013.

Across individual areas (Figure 52), all sizes of sole were most commonly reported across most areas. Mostly small sole tended to be most commonly reported in southern and eastern areas.

## **Discards**

More than half of responses reported no change in the level of discards of sole in 2014 (Table 31), somewhat more than in 2013. The remaining responses were equally split between reporting lower and higher levels of discards, with a small fall in the latter.

Across individual areas most responses reported no change in the level of discards (Figure 52). Higher levels of discarding tended to be most commonly reported in the south and east and lower levels in the west.

## **Recruitment**

The majority of responses reported moderate or high levels of recruitment of sole in 2014 (Table 31), with similar proportions of responses in each category. The proportion reporting high levels of recruitment was slightly greater than in 2013, while there were small falls in the other categories.

No clear pattern was apparent in responses across individual areas (Figure 52).

## Comparison with ICES Stock Assessment

There was no evidence of a relationship between the sole abundance index derived from the Fishers' North Sea Stock Survey index and the ICES estimates of the sole spawning stock biomass (Figure 51).

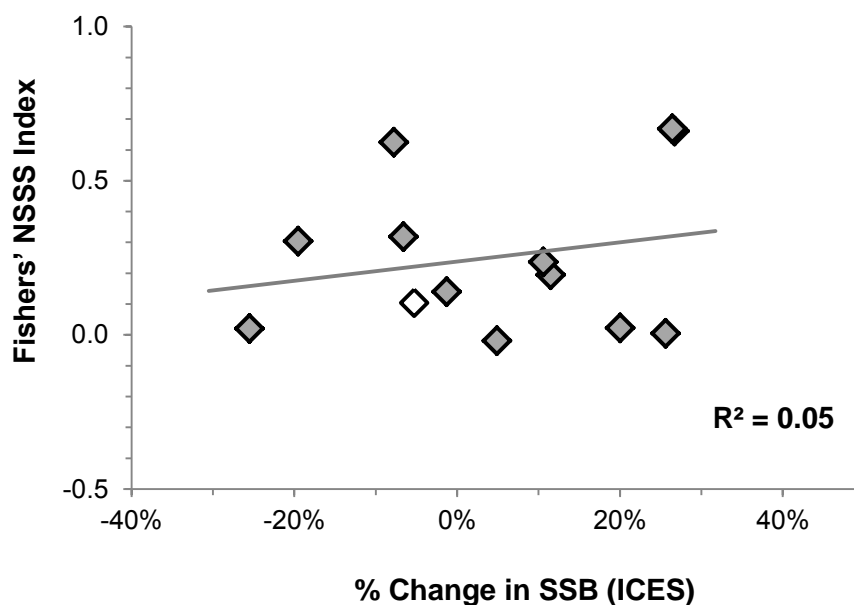


Figure 51 Plots of the annual Fishers' North Sea Stock Survey index against the percentage changes in the estimated mid-year North Sea common sole spawning stock biomass (SSB), with fitted linear trend line and coefficient of determination. Unshaded points are based on the predicted SSB for 2015. ( $R^2$ ; values closer to 1 indicate a better agreement.)



# NSSS - 2014 Species Accounts: Common Sole

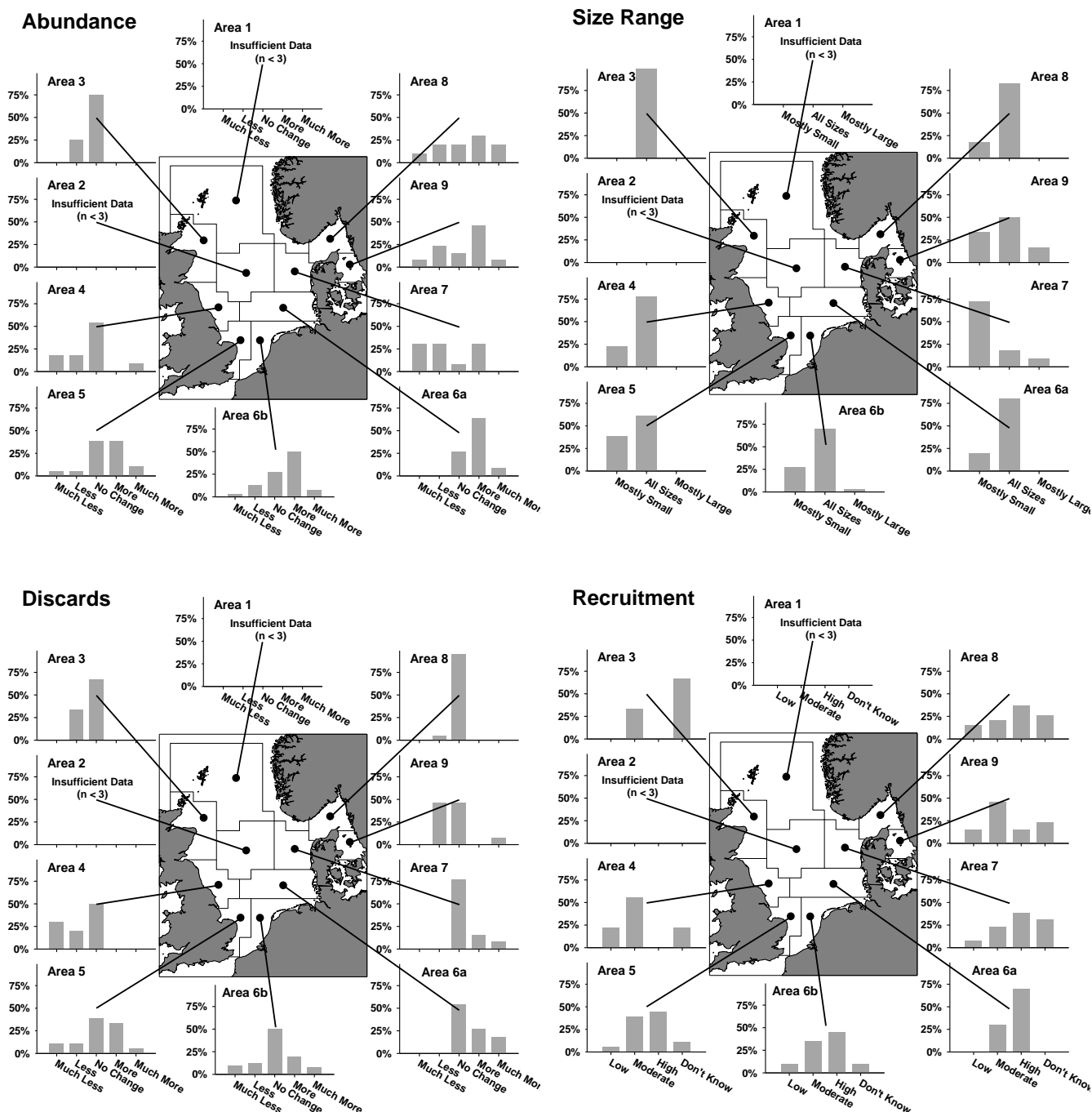


Figure 52 Perceptions of the abundance and size range of common sole, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category. No results are shown for Areas 1 and 2 due to the small number of responses from those areas (see Table 11, p. 28).

## Abundance Index

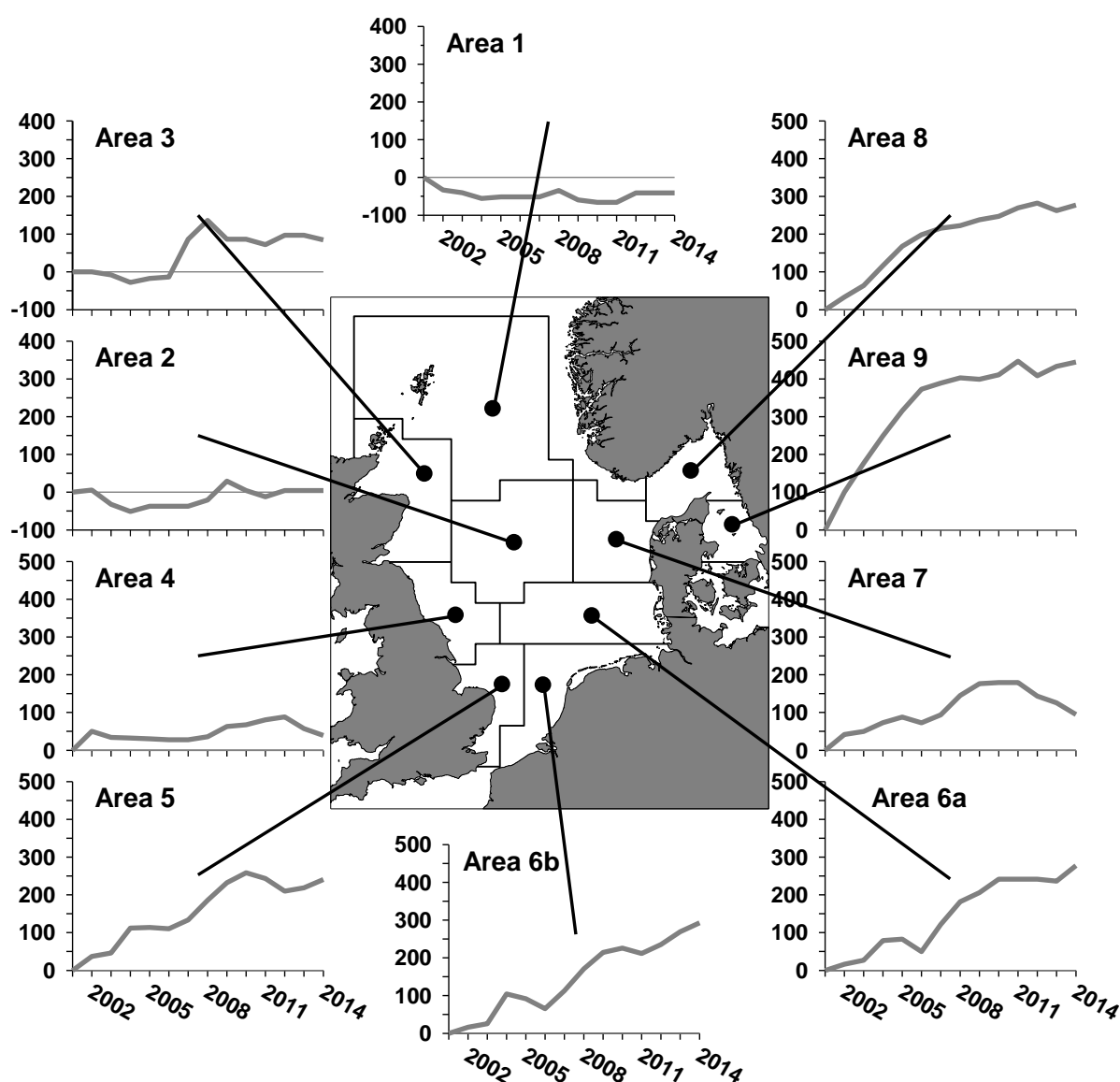


Figure 53 Cumulative time series of index of perceptions of abundance of common sole, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)

# NSSS - 2014 Species Accounts: Common Sole

Table 32 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of common sole in 2011.

|                    | Area |   |   |    |    |    |    |    |    |    |
|--------------------|------|---|---|----|----|----|----|----|----|----|
|                    | 1    | 2 | 3 | 4  | 5  | 6a | 6b | 7  | 8  | 9  |
| Number             | 2    | 2 | 4 | 11 | 18 | 11 | 40 | 13 | 21 | 13 |
| <b>Abundance</b>   |      |   |   |    |    |    |    |    |    |    |
| Much Less          | 0    | 0 | 0 | 2  | 1  | 0  | 1  | 4  | 2  | 1  |
| Less               | 0    | 1 | 1 | 2  | 1  | 0  | 5  | 4  | 4  | 3  |
| No Change          | 2    | 0 | 3 | 6  | 7  | 3  | 11 | 1  | 4  | 2  |
| More               | 0    | 1 | 0 | 0  | 7  | 7  | 20 | 4  | 6  | 6  |
| Much More          | 0    | 0 | 0 | 1  | 2  | 1  | 3  | 0  | 4  | 1  |
| No Answer          | 0    | 0 | 0 | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| <b>Size</b>        |      |   |   |    |    |    |    |    |    |    |
| Mostly Small       | 0    | 1 | 0 | 2  | 7  | 2  | 11 | 8  | 3  | 4  |
| All Sizes          | 1    | 1 | 1 | 7  | 11 | 8  | 28 | 2  | 14 | 6  |
| Mostly Large       | 0    | 0 | 0 | 0  | 0  | 0  | 1  | 1  | 0  | 2  |
| No Answer          | 1    | 0 | 3 | 2  | 0  | 1  | 0  | 2  | 4  | 1  |
| <b>Discards</b>    |      |   |   |    |    |    |    |    |    |    |
| Much Less          | 0    | 0 | 0 | 3  | 2  | 0  | 4  | 0  | 0  | 0  |
| Less               | 0    | 1 | 1 | 2  | 2  | 0  | 5  | 0  | 1  | 6  |
| No Change          | 2    | 0 | 2 | 5  | 7  | 6  | 20 | 10 | 19 | 6  |
| More               | 0    | 0 | 0 | 0  | 6  | 3  | 8  | 2  | 0  | 0  |
| Much More          | 0    | 1 | 0 | 0  | 1  | 2  | 3  | 1  | 0  | 1  |
| No Answer          | 0    | 0 | 1 | 1  | 0  | 0  | 0  | 0  | 1  | 0  |
| <b>Recruitment</b> |      |   |   |    |    |    |    |    |    |    |
| Low                | 0    | 1 | 0 | 2  | 1  | 0  | 4  | 1  | 3  | 2  |
| Moderate           | 1    | 0 | 1 | 5  | 7  | 3  | 14 | 3  | 4  | 6  |
| High               | 0    | 1 | 0 | 0  | 8  | 7  | 18 | 5  | 7  | 2  |
| Don't Know         | 1    | 0 | 2 | 2  | 2  | 0  | 4  | 4  | 5  | 3  |
| No Answer          | 0    | 0 | 1 | 2  | 0  | 1  | 0  | 0  | 2  | 0  |

## Plaice

Of the 177 valid questionnaires received, 157 (89%) provided information on plaice. The proportions of responses providing information on plaice was fairly high in most areas (Figure 54), except area 3.

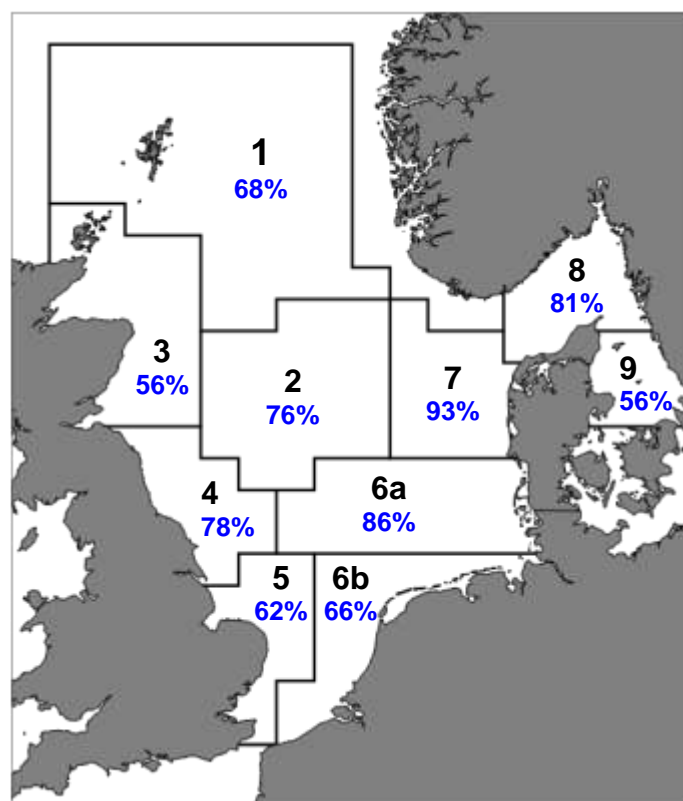


Figure 54 Proportion of responses from each area that provided information on plaice.

Table 33 shows the responses broken down by fishing gear and vessel size class. Responses were fairly evenly divided between the three vessel size classes. Otter trawls accounted for the largest proportion of responses by fishing gear type, followed by gill nets, with most of the remaining responses roughly equally split between the other gear types (except seine nets).

Figure 55 and Figure 56 provide a more detailed breakdown of the responses for plaice by vessel size and fishing gear.

Table 33 Numbers of responses for plaice by fishing gear type and vessel size class. Percentages show % of vessels in each size class using each gear type (at right), and % of vessels using each gear type in each size class (at bottom). (Excludes vessels that did not provide information on fishing gear and/or vessel size class.)

|              |           | VESSEL SIZE CLASS |        |      |     |                |        |      |      |      |
|--------------|-----------|-------------------|--------|------|-----|----------------|--------|------|------|------|
|              |           | Numbers           |        |      |     | % by Gear Type |        |      |      |      |
|              |           | <15m              | 15-24m | >24m | ALL | <15m           | 15-24m | >24m | ALL  |      |
| FISHING GEAR | Numbers   | Otter Trawl       | 11     | 21   | 15  | 47             | 22%    | 39%  | 29%  | 30%  |
|              |           | Nephrops Trawl    | 8      | 16   | 1   | 25             | 16%    | 30%  | 2%   | 16%  |
|              |           | Beam Trawl        | 0      | 6    | 14  | 20             | 0%     | 11%  | 27%  | 13%  |
|              |           | Pulse Trawl       | 0      | 1    | 17  | 18             | 0%     | 2%   | 33%  | 12%  |
|              |           | Gill Net          | 31     | 5    | 0   | 36             | 62%    | 9%   | 0%   | 23%  |
|              |           | Seine Net         | 0      | 5    | 5   | 10             | 0%     | 9%   | 10%  | 6%   |
|              |           | ALL               | 50     | 54   | 52  | 156            | 100%   | 100% | 100% | 100% |
|              | % by Size | Otter Trawl       | 23%    | 45%  | 32% | 100%           |        |      |      |      |
|              |           | Nephrops Trawl    | 32%    | 64%  | 4%  | 100%           |        |      |      |      |
|              |           | Beam Trawl        | 0%     | 30%  | 70% | 100%           |        |      |      |      |
|              |           | Pulse Trawl       | 0%     | 6%   | 94% | 100%           |        |      |      |      |
|              |           | Gill Net          | 86%    | 14%  | 0%  | 100%           |        |      |      |      |
|              |           | Seine Net         | 0%     | 50%  | 50% | 100%           |        |      |      |      |
|              |           | ALL               | 32%    | 35%  | 33% | 100%           |        |      |      |      |

Table 34 Summary of perceptions of the abundance, size, level of discarding and level of recruitment of plaice this year and last year. Proportion of responses in each category for all areas combined this year and last year, and change in proportions (+/-).

| Abundance           | 2013 | 2014 | +/- | Fish Size    | 2013 | 2014 | +/- |
|---------------------|------|------|-----|--------------|------|------|-----|
| 'Less' <sup>1</sup> | 15%  | 14%  | -1% | Mostly Small | 24%  | 27%  | +3% |
| No Change           | 21%  | 27%  | +6% | All Sizes    | 70%  | 65%  | -4% |
| 'More' <sup>2</sup> | 64%  | 59%  | -5% | Mostly Large | 6%   | 7%   | +1% |
| Discards            | 2013 | 2014 | +/- | Recruitment  | 2013 | 2014 | +/- |
| 'Less' <sup>1</sup> | 14%  | 12%  | -2% | Low          | 5%   | 3%   | -2% |
| No Change           | 61%  | 62%  | +1% | Moderate     | 43%  | 42%  | -1% |
| 'More' <sup>2</sup> | 24%  | 26%  | +2% | High         | 52%  | 55%  | +3% |

<sup>1</sup> 'Less' = sum of 'Less' and 'Much Less' responses.

<sup>2</sup> 'More' = sum of 'More' and 'Much More' responses.

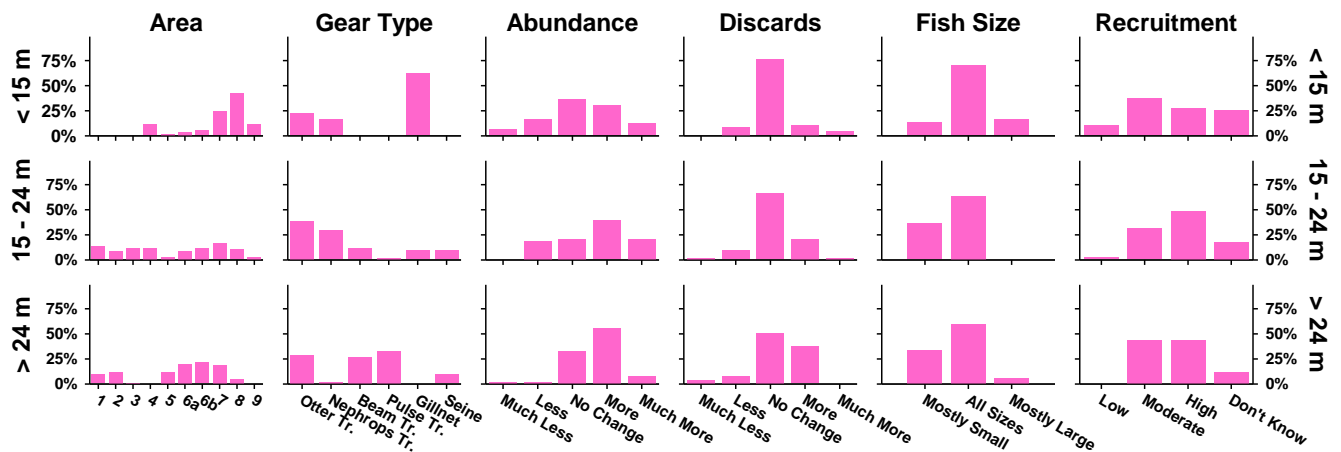


Figure 55 Breakdown of responses for plaice by fishing vessel size class. Percentage of responses for each size class in each category.

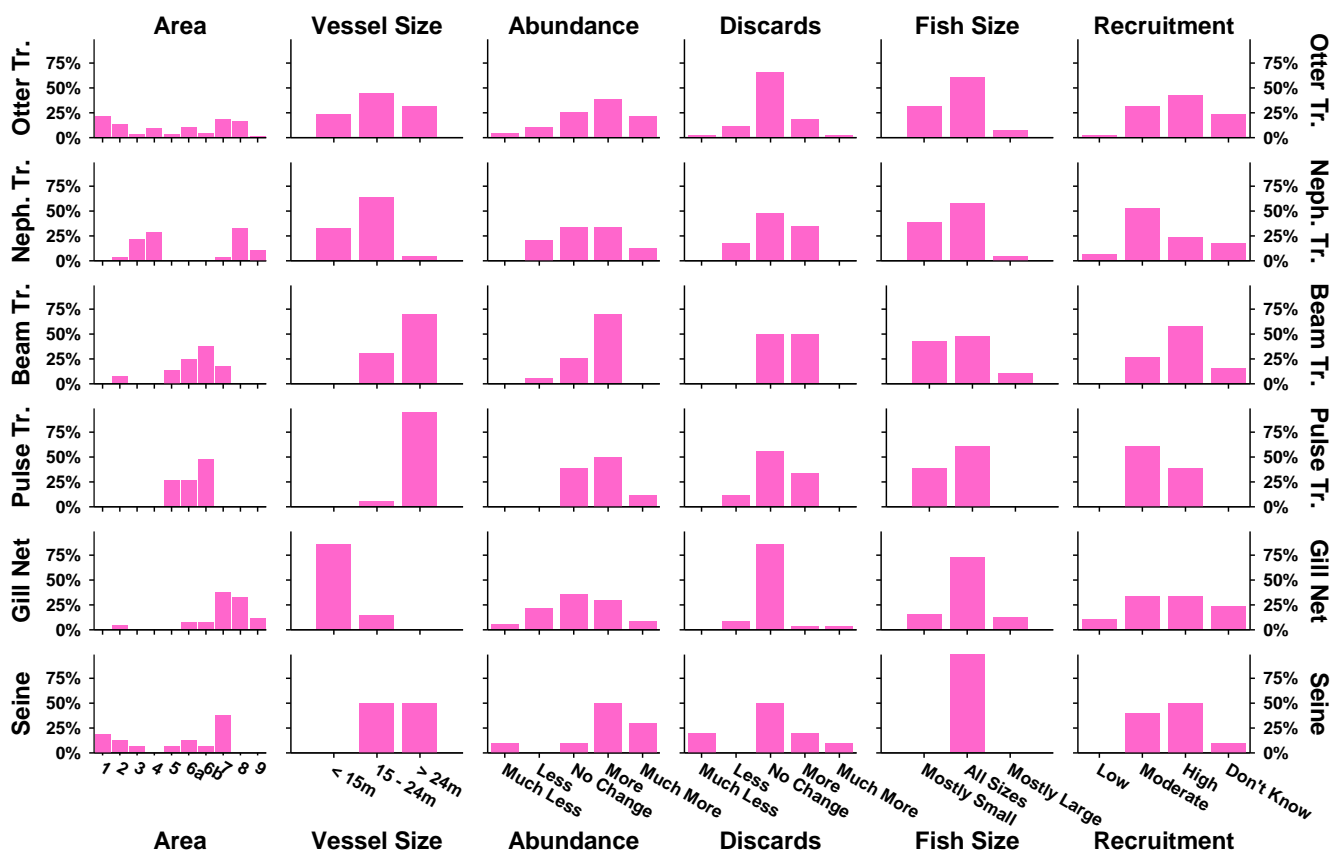


Figure 56 Breakdown of responses for plaice by fishing gear (Otter Trawl, *Nephrops* Trawl, Beam Trawl, Pulse Trawl, Gill Nets and Seine Net). Percentage of responses for each fishing gear in each category.

**Abundance**

More than half of responses reported a higher abundance of plaice in 2014 (Table 34), slightly less than in 2013. There was a similar increase, to about one quarter, in the proportion reporting no change in abundance in 2014, while the proportion reporting fewer plaice was almost unchanged from 2013.

No clear pattern was apparent in the responses across individual areas (Figure 58).

The cumulative index of perceptions of the abundance of plaice (Figure 59) increased in all but one area (area 4).

**Size Range**

Two-thirds of responses reported catching all sizes of plaice in 2014 (Table 34), slightly less than in 2013. One-quarter of responses reported mostly small plaice in 2013, slightly more than in 2014, while the (small) proportion reporting mostly small plaice was almost unchanged.

The pattern of responses was broadly similar across all individual areas (Figure 58), with no clear spatial patterns apparent.

**Discards**

Almost two-thirds of responses reported no change in the level of discarding of plaice in 2014 (Table 34), almost unchanged from 2013. About one-quarter of responses reported higher levels of plaice discarding in 2014, again almost unchanged from 2013, as was the proportion reporting lower levels of discards.

Most responses in most individual areas reported no change in the level of plaice discarding (Figure 58), but no clear pattern was apparent in the other responses.

**Recruitment**

More than half of responses reported high levels of recruitment of plaice in 2014 (Table 34), slightly more than in 2013, with most of the remainder reporting moderate levels.

The picture was mixed across individual areas (Figure 58), with no clear pattern apparent.

### Comparison with ICES Stock Assessment

No real relationship was apparent between the plaice abundance index derived from the Fishers' North Sea Stock Survey and the ICES estimates of the North Sea plaice spawning stock biomass (Figure 57).

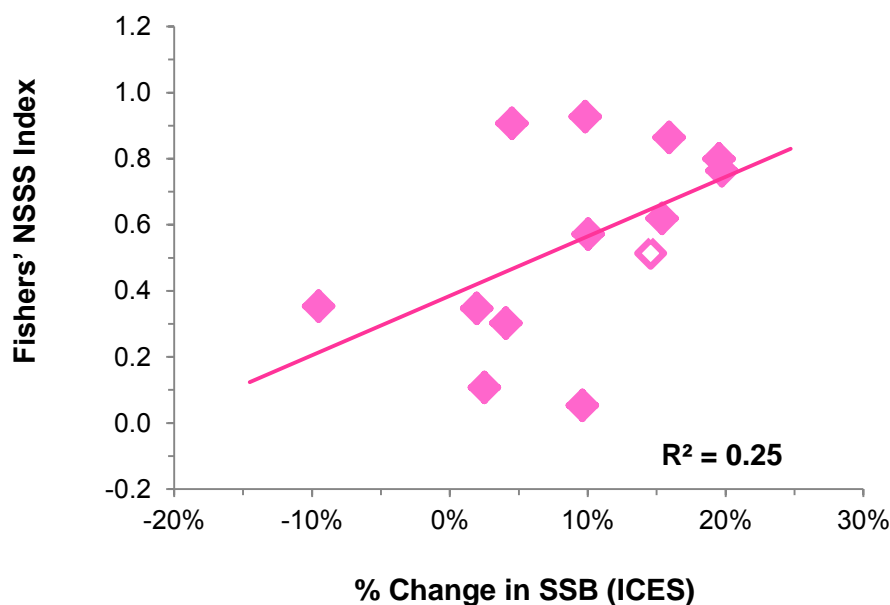


Figure 57 Plot of the annual Fishers' North Sea Stock Survey index against the percentage changes in the estimated mid-year North Sea plaice spawning stock biomass (SSB), with fitted linear trend line and coefficient of determination ( $R^2$ ; values closer to 1 indicate a better agreement). The unshaded point is based on the predicted SSB for 2015.



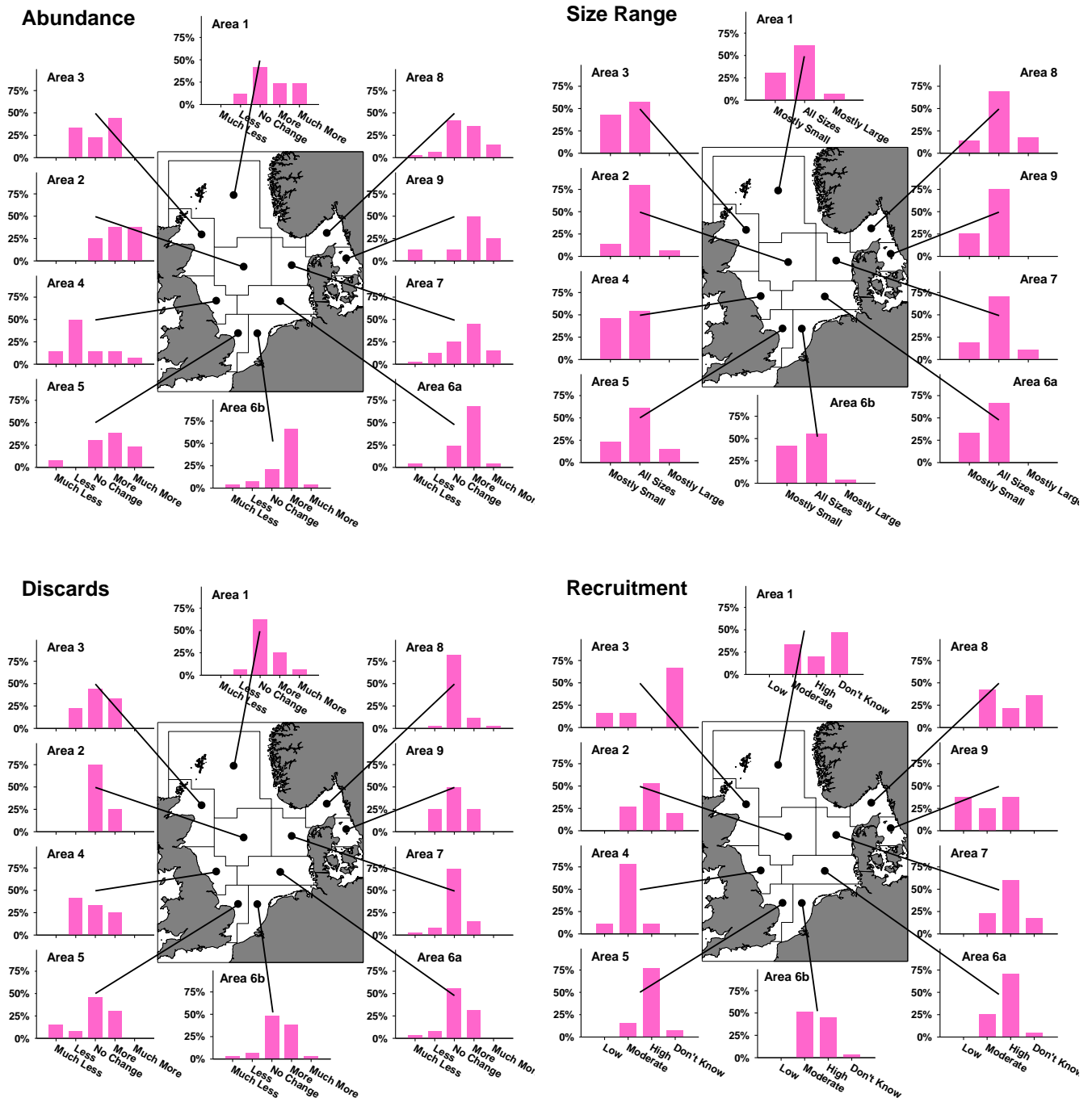


Figure 58 Perceptions of the abundance and size range of plaice, and of the levels of discarding and recruitment this year, compared to last year, by area. Percentage of responses from each area in each category.

## Abundance Index

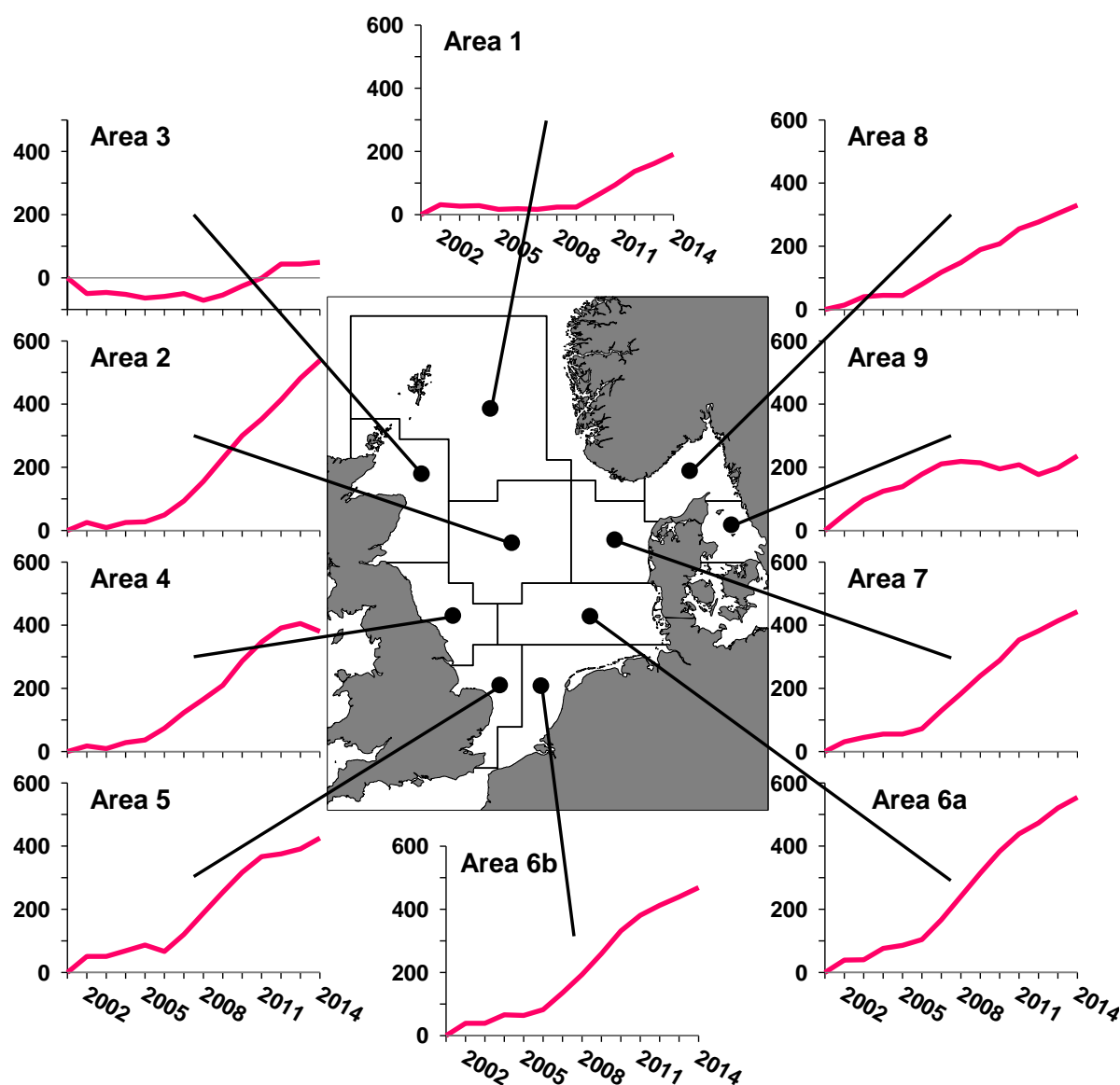


Figure 59 Cumulative time series of index of perceptions of abundance of plaice, by area (see page 14 for explanation of the index). (Note: the cumulative indices have been recalculated for previous years, which may result in some differences from previous reports.)

Table 35 Numbers of responses by area and category for perceptions of the abundance, size, level of discarding and level of recruitment of plaice.

|                    | Area |    |   |    |    |    |    |    |    |   |
|--------------------|------|----|---|----|----|----|----|----|----|---|
|                    | 1    | 2  | 3 | 4  | 5  | 6a | 6b | 7  | 8  | 9 |
| Number             | 17   | 16 | 9 | 14 | 13 | 25 | 29 | 40 | 34 | 9 |
| <b>Abundance</b>   |      |    |   |    |    |    |    |    |    |   |
| Much Less          | 0    | 0  | 0 | 2  | 1  | 1  | 1  | 1  | 1  | 1 |
| Less               | 2    | 0  | 3 | 7  | 0  | 0  | 2  | 5  | 2  | 0 |
| No Change          | 7    | 4  | 2 | 2  | 4  | 6  | 6  | 10 | 14 | 1 |
| More               | 4    | 6  | 4 | 2  | 5  | 17 | 19 | 18 | 12 | 4 |
| Much More          | 4    | 6  | 0 | 1  | 3  | 1  | 1  | 6  | 5  | 2 |
| No Answer          | 0    | 0  | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 1 |
| <b>Size</b>        |      |    |   |    |    |    |    |    |    |   |
| Mostly Small       | 4    | 2  | 3 | 6  | 3  | 8  | 12 | 7  | 4  | 2 |
| All Sizes          | 8    | 12 | 4 | 7  | 8  | 16 | 16 | 26 | 20 | 6 |
| Mostly Large       | 1    | 1  | 0 | 0  | 2  | 0  | 1  | 4  | 5  | 0 |
| No Answer          | 4    | 1  | 2 | 1  | 0  | 1  | 0  | 3  | 5  | 1 |
| <b>Discards</b>    |      |    |   |    |    |    |    |    |    |   |
| Much Less          | 0    | 0  | 0 | 0  | 2  | 1  | 1  | 1  | 0  | 0 |
| Less               | 1    | 0  | 2 | 5  | 1  | 2  | 2  | 3  | 1  | 2 |
| No Change          | 10   | 12 | 4 | 4  | 6  | 14 | 14 | 29 | 27 | 4 |
| More               | 4    | 4  | 3 | 3  | 4  | 8  | 11 | 6  | 4  | 2 |
| Much More          | 1    | 0  | 0 | 0  | 0  | 0  | 1  | 0  | 1  | 0 |
| No Answer          | 1    | 0  | 0 | 2  | 0  | 0  | 0  | 1  | 1  | 1 |
| <b>Recruitment</b> |      |    |   |    |    |    |    |    |    |   |
| Low                | 0    | 0  | 1 | 1  | 0  | 0  | 0  | 0  | 0  | 3 |
| Moderate           | 5    | 4  | 1 | 7  | 2  | 6  | 15 | 8  | 12 | 2 |
| High               | 3    | 8  | 0 | 1  | 10 | 17 | 13 | 21 | 6  | 3 |
| Don't Know         | 7    | 3  | 4 | 0  | 1  | 1  | 1  | 6  | 10 | 0 |
| No Answer          | 2    | 1  | 3 | 5  | 0  | 1  | 0  | 5  | 6  | 1 |

## **Comparison of Areas**

### **Economic Parameters**

The economic parameter index values (Figure 60) were - with the exception of changes in getting or retaining crew - universally negative across all areas. The index values suggest that in general perceptions of economic parameters tended to be most negative in the east (areas 7, 8 & 9) and north west (areas 1 & 3) and least negative in the south (areas 5, 6a & 6b).

### **Species Parameters**

The species-based parameter indices (Figure 61) were more variable between areas, with less evidence of clear spatial patterns. The abundance and recruitment indices tended to be broadly similar across all areas, but the size range and discards indices were more variable.

The overall species parameter index was also broadly similar across all areas.

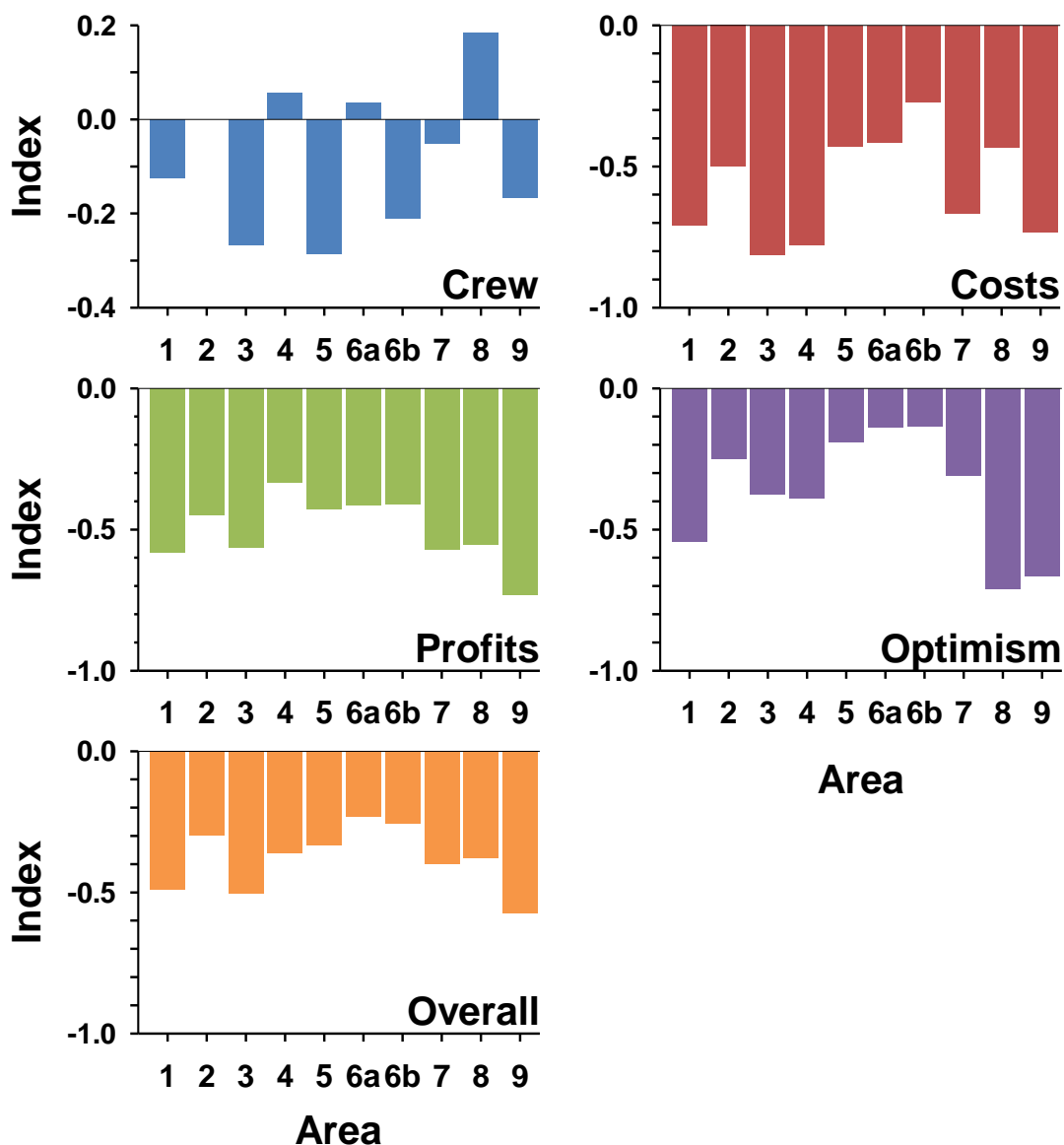


Figure 60 The indices of economic parameters for each area: perceptions of changes in difficulty of getting / retaining crew; costs, profits, optimism, and overall average economic parameter index. Negative index values indicate a more negative perception (e.g. higher costs, lower profits, etc.). See p. 15 for explanation of the indices.

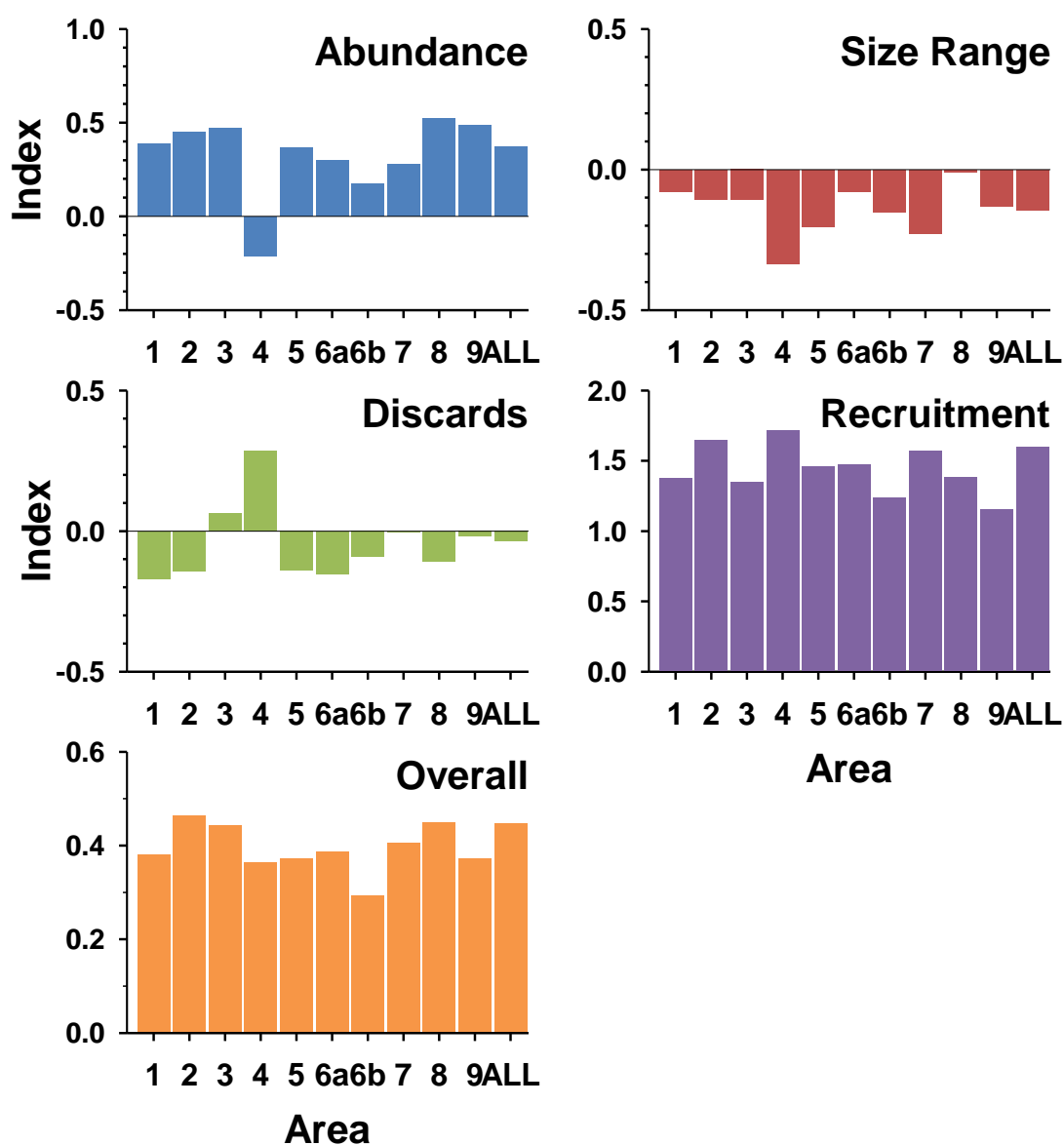


Figure 61 The indices for each area of perceptions of changes in the abundance of fish, the size range of fish caught, the levels of discards and the levels of recruitment. Negative index values indicate a more negative perception (e.g. lower abundance, higher discards, etc.). See p. 15 for explanation of the indices.

## **General Remarks**

This report presents the results of an analysis of the data collected through the Fishers' North Sea Stock Survey in 2014. Given the non-quantitative and subjective nature of this survey these results need to be interpreted and used with caution. Given the constraints of time and resources it has not been possible to fully analyse or explore all of the possible permutations of fish species, areas, fishing gear, vessel sizes and nationalities.

One disadvantage of this form of survey is that it only provides information on perceived changes; it does not tell us anything about absolute levels. For example, it can tell us whether fishermen think their costs this year were higher or lower than last year, but not how high those costs actually are. For this reason, further caution is necessary in interpreting the results; a decline in the proportion of fishermen reporting high costs might look like a positive result, but if their costs remain very high those fishermen may still face economic difficulties.

Overall, the number of (valid) questionnaires returned increased in 2014, almost (but not entirely) reversing the fall seen in 2013. Despite this increase the number of responses received remained the second lowest since the survey was started and remains relatively small in relation to the number of active fishermen in the areas covered by the survey.

Anecdotal evidence in previous years suggests that a factor behind the decline in the number of responses over recent years may be that fishers do not perceive that the results of the survey have any influence on assessments of fish stocks or on management decisions, and thus are losing faith in the value of the survey.

Overall, the results of the 2014 survey appear to be fairly positive in terms of the state of fish stocks. For four of the eight stocks covered by the survey most responses reported higher abundances in 2014 than in 2013, while for the other four most responses reported no change in abundance.

For all species the majority of responses reported catching all sizes of fish, no change in the level of discards and moderate or high levels of recruitment.

Fishermen's perceptions of economic circumstances in 2014 were fairly negative (as is usual), with most responses reporting higher costs, lower profits, less optimism and more difficulty in getting or retaining crew.

The comparison of fishermen's perceptions of changes in the abundance of fish and the scientific assessments of their abundance showed at least some level of agreement in some cases, although the relationship was often weak in statistical

terms. The difficulty of interpreting theses comparisons remains, especially when the two do not agree (which raises the question of which is 'right').



# NEFMC SSC Panel Peer Review of the Fishery Data for Stock Assessment Working Group Report

Patrick J. Sullivan (Chair), Hirotsugu Uchida, John Wiedenmann

November 30, 2018

Hotel Providence, Providence, RI

## Introduction

A panel of three representatives (Sullivan, Uchida, and Wiedenmann) from the Scientific and Statistical Committee of the New England Fisheries Management Council were asked to provide a peer review of the *Fishery Data for Stock Assessment Working Group Report* coauthored by Cadrin (Chair), Frede, Keiley, Linton, Maguire, Rago, Bell, Giacalone, Demarest, Brown and Gibson with contributions by O'Keefe, DeCelles, Wright, Hansell, McGuire and Hennen.

The panel found the Working Group Report to be clear and thorough in its coverage of the strengths and weaknesses of information collected from fishery dependent sources such as might be derived from commercial and recreational landing statistics, logbooks, vessel trip reports, onshore monitoring and observer programs. Particular attention was given to the usefulness and biases associated with Catch Per Unit Effort (CPUE) and Landings Per Unit Effort (LPUE) data as might be employed to assess relative changes in stock abundance to supplement federal or state survey CPUE indices. The quality and usefulness of discard data collected from the fishery, although an important category of fishery dependent data, are not addressed in this review, as these data sources were not included for consideration in the Terms of Reference for the Working Group Report and will be considered elsewhere<sup>1</sup>.

The Working Group Report, through its executive summary, the main body of the report, and adjoining appendices, provides a clear and concise summary of the complex topic of how fishery data is gathered and utilized for the purposes of informing science and management actions. In contrast, federal and state scientific surveys collect information through a proscribed unbiased statistical design to obtain relative abundance indices (e.g. survey CPUE) that are intended to be representative of the population over its entire domain, while gathering other pertinent biological information in an unbiased manner such as age, size and sex composition, growth, maturity and fecundity. Data gathered from fishery dependent sources, while abundant and rich in information, may not be, more specifically, globally representative of the total stock dynamics because of economic incentives for fishermen to maximize harvest and consequently be more likely to “sample” areas that are higher in abundance. Nevertheless, fishery dependent data is

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<sup>1</sup> The Peer Review acknowledges the Council is considering potential improvements to monitoring and collection of discard data in the development of Amendment 23.

an abundant, rich and often underutilized source of information worth careful examination.

### **Responses to the Terms of Reference**

This peer review report will step through each Term of Reference and comment on the completeness of the report and how well it addresses the strengths and weakness of the fishery dependent data.

***TOR1: Explain how fishery dependent and fishery independent data are used in stock assessments, including how different data elements are used and interact in an age-based analytic assessment.***

The report clearly explains how fishery dependent and fishery independent data are used in fishery stock assessments. Both data sources are used in a variety of ways including the estimation of population relative abundance indices that are used to characterize trends in age-based and other analytic assessment methods. In New England, stock assessments often rely on standardized statistically designed surveys using abundant survey information. Other regions, that do not have regular standardized surveys often rely solely on fishery dependent data sources, while still other regions, such as in the North Pacific, often incorporate both. The reasons for this are partly historical, partly philosophical and partly practical. However, the advances now being made in how data are collected and analyzed suggests that further consideration be given to using fishery dependent data not only to supplement existing survey-based relative abundance indices, but also to provide more localized abundance data to inform spatial management, for example, and to usefully characterize how the fleet sees changes in population abundance relative to survey estimates.

A classic example of how fishery dependent data can be susceptible to bias associated with targeting behavior is the CPUE used for assessment that came from the herring purse seine fishery in the North Atlantic. Here, because the fish school, the perceived CPUE did not change as the stock decreased, because the fleet continued to be able to find schools to set on until no more schools were left. The abundances within a school remained the same while the number of schools decreased. Managers were unintentionally misled about stock status and the stock collapsed. This example is not uncommon in occurrence and is often used to justify scientific survey sampling as the gold standard. However, fishery dependent data serves to inform as well.

While fishery dependent data, such as CPUE, can, under the right circumstances, be folded into the more comprehensive designed scientific surveys, as discussed in more detail later, it is useful to consider other information that may come from fishery dependent data sources. For example, greater focus is being given to understanding the social and economic consequences of risk and decision making relative to fishing behavior and responses to management actions. This is because fishermen are guided by

economic incentives. For commercial fisheries this would be primarily the (expected) profit; for recreational fisheries this would be more vaguely captured as “utility” – number of fish kept or caught (kept + release), spending time on water, hanging out with friends, etc. Understanding these incentives and developing the behavioral models could reduce the biases of fishery dependent data and hence enhance the usefulness of CPUE data. However, this requires the collection of socioeconomic information on fisheries, which is typically available through fishery dependent data sources. Note that this type of information not only can be used to help correct for targeting biases, but can be used directly to reduce risk to the fishery and optimize management actions.

Should fishery dependent data be considered for expanded use in New England, data handling and quality assurance procedures already in use in areas outside the northeast might be considered (e.g. SEDAR, STAR) as was noted in the Working Group Report.

Again, to echo observations made in the Working Group Report, technological advances in terms of computational and data gathering hardware and software can greatly improve the acquisition and use of fishery dependent data.

***TOR 2: Summarize the theoretical utility and limitations of using catch per unit effort (CPUE) and landings per unit effort (LPUE) as indexes of abundance for Northeast multispecies (groundfish) stocks, including recent efforts to create a CPUE for any of these stocks and the results of those efforts.***

The Working Group Report provides a thorough consideration of the pros and cons of using fishery independent and fishery dependent catch rates. The summaries provided of examples of where and when CPUE from both sources was used was seen to be valuable.

Consideration of the use of CPUE from any source requires recognition of the potential utility of CPUE and fishery and survey data more generally beyond its specific use as a relative abundance index for tuning assessment models. For example, it is important to recognize that catch by itself is necessary and effort by itself is informative relative to spatial and temporal fishing pressure, and that CPUE can be used to examine local catch rates and reasons why fishers make the choices they make. Furthermore, the quality of information that comes out of CPUE measurements from fishery dependent data includes providing information that can be shared with the assessment community about what the fishermen are seeing in their landings relative to what the scientists might see from their data sources.

In any quest for new or additional information some effort should be spent on examining the costs relative to the benefits of collecting that information. Special attention should be given to examining elements of the fishery that may act as a

greater source of information, for example, sub-fleets representing fishing vessels and captains that have been consistently operating over time.

In thinking beyond relative abundance indices, consideration should be given to whether fishery dependent CPUE might be used to better assess discard species, for example in the groundfish fishery, the non-target bycatches of windowpane flounder and ocean pout, or constraining stocks such as Georges Bank yellowtail flounder.

Fishery dependent CPUE can be used in some instances when fishery independent data is not available, such as for assessing inshore measures of relative abundance. Cooperative surveys are also helpful in this regard.

Model-based statistical estimation methods (e.g. GLM, GLMM, GAM, GAMM) have advanced greatly in recent years and can be used to augment and even merge fishery dependent data with fishery independent data.

***TOR 3: Identify the fishery factors and fishery dependent data needed to create a CPUE that would be a reliable index of abundance for Northeast multispecies stocks – without regard to existing fishing practices, regulations, or monitoring systems.***

As mentioned in the report, ideally one would like to have the fleet be homogenous (uniform) in fishing power, gear used, timing, and location. In many cases, not all of these criteria can be met or even standardized for all fisheries, but in some cases they can.

There is an expected change in efficiency with catch shares that could be taken advantage of, but may also add an extra level of complexity; for example, what impact do catch-share programs and other incentives have on the technical efficiency of the fleet (e.g. sharing captains, or reduced number of vessels fishing)?

While it may be impossible to manage the fleet in such a way as to make it fully homogenous in behavior, other approaches to this problem exist to standardize these indices, including modern methods for statistical modeling, incentives for reporting, and the use of study fleet, for example.

The usefulness of conducting cost/benefit analyses, as mentioned under TOR 1, is applicable here as well. For example, conducting a standardization using GLMM might take time away from conducting an assessment or managing a database, but then again it might be worth it!

Directed research on factors influencing CPUE for both fishery dependent and fishery independent CPUE measures is needed and should be prioritized.

Fine scale spatial and temporal resolution of catch, effort, and behavior information can now be gathered and interwoven with other biophysical

phenomena through, remote sensing and oceanographic modeling, for example. This should be done for data from both fishery independent as well as fishery dependent sources. Often, a greater quantity of data is available from the fishery dependent sources, albeit targeted data, than can be collected from (expensive) surveys. Just this order of magnitude difference in quantity makes considering the utility of using such data sources worthwhile to consider.

We fully endorse the use of action plans as outlined and exemplified in the Working Group Report in the recommendations section to implement efficient mechanisms for gathering data from all sources.

***TOR 4: Compare the desired factors identified with existing conditions and data for the fishery through a gap analysis of factors and data needed, as well as the analytical approaches necessary, to create a CPUE that would be a reliable index of abundance for Northeast multispecies stocks.***

One should recognize that differences in implementation of these recommendations exist when applying these methods to data gathered from the commercial fleet when compared to that available from the recreational fleet, and even within sub components of these fleets there are differences in reporting. Some balance is needed in the quantity and quality of information gathered, especially for those stocks that have significant landings by both fleets (in other words, not to put all your eggs/otoliths/tows in one basket). Other potential sources of uncertainty outside the scope of this review still need to be considered, including monitoring of landings, discards, compliance, enforcement, and environmental conditions.

If monitoring is to be considered for gathering any additional information, percent coverage of the fleet is an important consideration. In the North Pacific, debates continue to exist on whether partial coverage is adequate for observer programs.

We strongly concur with the Working Group Report that gap analysis should be used to identify factors and data needed, including mechanisms for *a priori* identification of targeted fishing, clear effort metrics, use of advanced technologies for monitoring, and finer time and spatial scale standardization. In addition, we might add greater coverage of social and economic indicators. One example of this would be the quantity and quality of the dealer report data.

We note that fishery dependent CPUE data was thoroughly examined several years ago and deemed of limited usefulness, but improvements in technology, statistical methods, and increasing need by management suggests that this analysis should be revisited.

Should fishery dependent CPUE metrics be developed, thought would need to be given to its relationship to other metrics such as those from the survey, as well as other indicators from the past. Any new data set generated should have some

comparability to the past, so that, ideally, a single CPUE index could be generated combining historical data and new information collected.

## **Conclusion**

The Working Group Report provides a clear, thorough and comprehensive analysis of how fishery dependent data can be used, the strengths and weaknesses of such data and how they compare in their characterization of the fishery relative to data gathered from fishery independent sources.

In this report, we expand slightly on the type of information that might be gathered from fishery dependent sources and why reconsideration of these data as input into stock assessment and management should be made.

**Amendment 23**

**To the**

**Northeast Multispecies Fishery Management Plan**

**Appendix III**

**Groundfish Plan Development Team Dockside Monitoring Discussion Paper**

# **Dockside Monitoring Discussion Paper**

**Groundfish Plan Development Team**

Version 2  
December 20, 2018





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## **Overview**

On April 7, 2016, the Groundfish Committee unanimously passed the following motion:

*Move that the Committee task staff and/or PDT, as appropriate, to develop a draft white paper and report to the Council at the June meeting on monitoring strategies (ASM, shoreside, electronic, etc.) that would primarily contribute to accuracy and secondarily precision of groundfish catch reporting.*

*The white paper should include a review of existing shoreside monitoring programs as well as past Council decisions on dockside monitoring with respect to achieving accuracy and precision in reporting of groundfish bycatch and landings as well as funding sources for the programs.*

This discussion document responds to the second component to the motion by considering dockside monitoring and management goals for monitoring in Amendment 16 to the Northeast Multispecies Fishery Management Plan (FMP) as modified by subsequent actions. Amendment 16 implemented at-sea monitoring (ASM) and dockside monitoring (DSM), to “assure that sector ACEs are not exceeded...”<sup>1</sup> The at-sea monitoring program remains in place today, but the groundfish dockside monitoring program has been discontinued through Framework 48. This document provides background information to summarize the development and implementation of the Groundfish Dockside Monitoring Program, including the refinements (Framework 45) and termination of the program (Framework 48). This document also reviews existing shoreside monitoring programs as case studies.

## **Outline**

1. Development of Amendment 16 and the Groundfish Dockside Monitoring Program
2. Overview of Amendment 16’s Proposed Monitoring Measures
3. Amendment 16 and public comments (summary)
4. Overview of Implementation of Amendment 16’s Measures
5. Summary of Modifications to the Groundfish Dockside Monitoring Program (2010-2011)
  - 5.1. Framework 45 and public comments (summary)
  - 5.2. Framework 48 and public comments (summary)
6. Case Studies
  - 6.1 Case Study #1: Groundfish Dockside Monitoring Program (2010-2011)
  - 6.2 Case Study #2: Fisheries and Oceans Canada - Pacific Region Groundfish Dockside Monitoring Program

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<sup>1</sup> New England Fishery Management Council. Oct. 16, 2009. *Amendment 16 to the Northeast Multispecies FMP*. [http://s3.amazonaws.com/nefmc.org/091016\\_Final\\_Amendment\\_16.pdf](http://s3.amazonaws.com/nefmc.org/091016_Final_Amendment_16.pdf)

6.3 Case Study #3: MA DMF Portside Sampling Program

6.4 Case Study #4: Maine DMR Portside Sampling Program

6.5 Case Study #5: Fisheries and Oceans Canada Maritimes Region Groundfish

Dockside Monitoring Program

6.6 Case Study #6: West Coast IFQ Catch Monitor Program

6.7 Case Study #7: North Pacific Observer Program Plant Observer

7. PDT Discussion: Considerations for a Groundfish Dockside Monitoring Program

### **1. Development of Amendment 16 and the Groundfish Dockside Monitoring Program**

During the development of Amendment 16, the Gulf of Maine Research Institute (GMRI) provided research support to inform sector management and policies. In 2008, GMRI hired Archipelago Marine Research, the largest observer service provider for Western Canada, and Pacific Fisheries Management Incorporated to provide feedback on reporting and monitoring needs for the groundfish sector program. Archipelago Marine Research and Pacific Fisheries Management Inc., developed a report for GMRI that suggested several monitoring options for management consideration (McElderry et al., May 2008).<sup>2</sup>

The McElderry et al., (2008) report suggested that if dockside monitoring is used for groundfish monitoring, that these reports should be used to calculate landings, and dealer reports should be used to calculate landings on trips without dockside monitoring coverage. However, the group also point out that: “the proposed system overlaps with monitoring systems that the National Marine Fisheries Service (NMFS) currently runs and, if implemented, ...would create redundancy, as NMFS would need to continue to maintain monitoring systems in a variety of other fisheries.”<sup>3</sup> The McElderry et al., (2008) report did not provide a recommendation to resolve this redundancy.

Archipelago Marine Research and Pacific Fisheries Management Inc. recommended that, for roving monitors, monitoring every offload may not be necessary (e.g., monitoring offloads to trucks then to dealers for same trip is duplicative). Instead, the idea would be to keep the probability of monitoring these offloads sufficiently high to facilitate compliance with regulations.

Archipelago Marine Research and Pacific Fisheries Management Inc. recommended a centralized data management system for consistency in data collection methods for all sectors, particularly when multiple service providers are used. The group also recommended that the

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<sup>2</sup> McElderry, Howard and Turris, Bruce. May 2008. *Evaluation of Monitoring and Reporting Needs for Groundfish Sectors in New England Phase II Report*. Archipelago Marine Research Ltd. and Pacific Fisheries Management Incorporated, <http://walker-foundation.org/Files/walker/2009/GroundfishMonitoringNeedsFinalReportAug1208.pdf>.

<sup>3</sup> Ibid.

centralized data system hold all reporting information from multiple sources (i.e., dockside data, dealer data, Vessel Trip Report (VTR) data).

GMRI held a group meeting on July 2, 2008 to discuss groundfish monitoring and reporting, with sector managers, environmental groups, New England Fishery Management Council (NEFMC) staff and members, NMFS staff, and Northeast Fisheries Science Center staff. Based on the meeting outcome report regarding dockside monitoring, the group of attendees concluded that a monitoring and reporting program should be efficient and transparent and build upon existing monitoring programs administered by NMFS (i.e., avoid redundant monitoring/data collection). In addition, data should be available real-time, and address accountability. The meeting report also concluded that dockside monitoring at 100 percent coverage is necessary for enforcement and stock assessments, with adjustment in coverage levels for less active ports.<sup>4</sup>

Based on the outcome of the meeting, the following issues remained unresolved<sup>5</sup>:

1. *The details of how to do dockside monitoring in smaller, less-used ports.*
2. *Who should do dockside monitoring?*
  - a. *Single contractor for the whole northeast?*
  - b. *Government establishes standards and then sectors select contractors from an approved list?*
  - c. *Local law enforcement officials involved?*
    - i. *Local people certified to do monitoring on behalf of the contractor*
    - ii. *NMFS staff were concerned about legal issues associated with using local law enforcement officials as dockside monitors, including conflicts associated with the potential for industry funding of local, state, or federal enforcement agents*
3. *How to pay for dockside monitoring.*
4. *How monitoring and reporting will mesh with existing efforts.*

## **2. Overview of Amendment 16's Proposed Monitoring Measures**

The current program for monitoring in the groundfish fleet was adopted in Amendment 16, and further modified by Framework 45, Framework 48, and Framework 55 to the Northeast Multispecies Fishery Management Plan (FMP). Amendment 16 required sector operation plans to include detailed strategies for monitoring, reporting, and enforcing catch and landings for all members within the sector. These detailed plans would ensure that sector members:

1. Land all legal-sized fish under FMP management; and
2. Do not exceed the ACE allocations by developing and implementing a dockside monitoring program, used in conjunction with an observer program, to report

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<sup>4</sup> Good Group Decisions. July 2, 2008. *Monitoring and Reporting Discussion: Meeting Report*.

<sup>5</sup> Ibid.

catch information:

- Landings by species, reported by stock, statistical area, and gear type
- Discard estimates applied to landing events by gear type

An observer program would be used in conjunction with a dockside monitoring program to achieve monitoring goals for the sector system. Amendment 16 defines an observer as:

“any person required or authorized to be carried on a vessel for conservation and management purposes by regulations or permits under this Act.”<sup>6</sup>

Amendment 16 stated that: “[t]he primary goal of observers or at-sea monitors for sector monitoring is to verify area fished, catch, and discards by species, by gear type. This data will be reported to the sector managers and to the NMFS. Electronic monitoring may be used in place of actual observers or at-sea monitors if the technology is deemed sufficient for a specific trip based on gear type and area fished. Less than 100% electronic monitoring and at-sea observation will be required.”<sup>7</sup> For trips without an observer onboard, an assumed sector-specific discard rate would apply, unless another monitoring program (deemed adequate by NMFS) is used to accurately report discard rates. An assumed sector-specific discard rate is based on the discard estimates derived from at-sea samplers.

Dockside monitors would certify dealer-reported landings by verifying accuracy of dealer-reported weights by observing offload activity. In 2010, dockside monitoring would cover 50 percent of trips for each sector, and for 20 percent of trips for each sector in subsequent years. Amendment 16 states that sectors should be able to demonstrate to NMFS that an adequate industry-funded monitoring system is in place to monitor a sector’s Annual Catch Entitlement (ACE) by 2012 fishing year.

Amendment 16 stated that the following elements should exist for the sector dockside monitoring program: (1) List of ports that vessels within the sector plan to land fish; and (2) Pre-sail and pre-land hails to inform portside sampler deployment.

### **3. Summary of Public Comments on Amendment 16**

A summary of comments related to Amendment 16 are addressed in this section, including the comments related to the proposed rule. The comments related to the proposed rule are also summarized in the Federal Register notice for the final rule (Refer to Appendix 2). A public hearing document and a Draft Amendment 16 with Draft Environmental Impact Statement was made available to the public. Comments received during the public hearings and

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<sup>6</sup> New England Fishery Management Council. Oct. 16, 2009. Amendment 16 to the Northeast Multispecies FMP. [http://s3.amazonaws.com/nefmc.org/091016\\_Final\\_Amendment\\_16.pdf](http://s3.amazonaws.com/nefmc.org/091016_Final_Amendment_16.pdf)

<sup>7</sup> Ibid.

submitted written comments are also summarized in this section.

Eleven individual commenters, five Congressional representatives (Delahunt, Hodes, and McGovern, Pingree, Michaud), one form letter with over 500 signatures (Jessica Lane et. al), and one form letter with over 8,800 signatures (Diane Luera et. al) supported the establishment of a comprehensive monitoring system. Many commenters, including Congressmen Delahunt, Hodes, and McGovern, the Cape Cod Commercial Hook Fishermen's Association, the Port Clyde Sector, the Island Institute, PEW, and one individual, supported a monitoring program for the sectors and common pool vessels. These commenters noted concerns regarding equity among the groundfish vessels, and the need to account for catch by both sector and common pool vessels.

For dockside monitoring coverage levels, two options were available for public comment, one option for 100 percent DSM coverage, and another option for less than 100 percent DSM coverage. Environmental Defense Fund (EDF), PEW, Conservation Law Foundation (CLF), MA DMF, one form letter with 174 signatures (David Butman et. al.), one individual, Island Institute, Ocean Conservancy, Port Clyde Sector, and Cape Cod Commercial Hook Fishermen's Association and one of its affiliates supported 100 percent dockside monitoring and 100 percent at-sea monitoring of the fishery. The Hook Gear Sector and the Georges Bank Fixed Gear Sector supported relatively high levels of DSM coverage.

The Associated Fisheries of Maine supported less than 100 percent DSM coverage, and suggested that the DSM requirement be waived if the SBRM coverage was able to achieve the Coefficient of Variation (CV) standard. Several commenters opposed the 100 percent DSM coverage, including two individual commenters representing the groundfish fishery. Several commenters expressed concern regarding the high monitoring costs, including thirteen individuals and the Penobscot East Resource Center. The Northeast Coastal Communities Sector supported a threshold for dockside monitoring coverage in ports with relatively low groundfish landings, to reduce dockside monitoring costs. Three commercial fishermen, the Associated Fisheries of Maine, and the Sustainable Harvest Sector proposed a removal of dockside monitoring requirements for trips monitored at sea.

Three commenters supported daily reporting requirements, including one state agency (MA DMF) and two fishing industry groups (Lunds Fisheries and Garden State Seafood Association). Garden State Seafood Association, Penobscot East Resource Center, Hook Gear Sector, Georges Bank Fixed Gear Sector, Cape Cod Commercial Hook Fishermen's Association, Associated Fisheries of Maine, Lunds Fisheries, Ocean Conservancy, CLF, EDF, and MA DMF supported Option 2, area-specific reporting requirements, in which catch data is attributed to the stock area.<sup>8</sup> This option would improve the accuracy of location information

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<sup>8</sup> New England Fishery Management Council. April 15, 2009. Draft Amendment 16 to the Northeast Multispecies FMP.

used to attribute landings by area. The monitoring and reporting system uses location of catch from vessel-trip reports.

During the development of Amendment 16, timely monitoring of the catch by location was difficult because vessel operators were required to submit their reports up to fourteen days following the end of each month. Vessel trip reporting instructions were modified on December 5, 2014, and northeast multispecies permit holders are now required to submit their reports weekly, on the Tuesday following the previous fishing week.<sup>9</sup>

The proposed measures also stated that an assumed discard rate would apply for sectors, unless a sector's operations plan describe how discards would be monitored, reported, and enforced. Options for calculating assumed discard rate includes Option 1, which calculates an assumed discard rate based on the most recent stock assessment to calculate gear-specific discard rates (if available); and Option 2, which calculates an assumed discard rate using observer data from the previous year to calculate gear-specific discard rates. The Cape Cod Commercial Hook Fishermen's Association and the Associated Fisheries of Maine supported Option 2, Area-specific reporting requirements for calculating sectors and common pool assumed discard rates. Several group commenters (EDF and PEW) support Option 1. The Cape Cod Commercial Hook Fishermen's Association supported timely monitoring of discards. The Ocean Conservancy and CLF supported Option 3, which accounts for discards by non-sector vessels.

MA DMF expressed concerns regarding the enforcement of catch limits under the sector system with insufficient incentives for compliance with minimized state and Federal law enforcement. EDF also supported clear enforcement provisions. One groundfish fisherman raised concerns regarding the need to wait for a dockside monitor prior to catch offloading and suggested a six-hour hail is sufficient notice.

#### **4. Overview of Implementation of Amendment 16's Measures**

Amendment 16's final rule revised the dealer reporting and record keeping requirements, to "require dealers to provide a copy of any dealer weigh-out documents or dealer receipts for a particular offloading event to dockside/roving monitors, allow the dockside/roving monitor to sign a copy of the official weigh-out document or dealer receipt retained by the dealer, or sign a dockside monitoring report provided by a dockside/roving monitor."<sup>10</sup>

Accurate catch monitoring is important for fishery managers, and ensures all sectors are held to the same standards regarding catch accounting. Amendment 16's final rule "requires sectors

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<sup>9</sup> National Marine Fisheries Service. December 5, 2014. Fishing Vessel Trip Report (VTR) Reporting Instructions. [http://www.greateratlantic.fisheries.noaa.gov/aps/evtr/vtr\\_inst.pdf](http://www.greateratlantic.fisheries.noaa.gov/aps/evtr/vtr_inst.pdf)

<sup>10</sup> "Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Amendment 16; Final Rule," 68 Federal Register 75 (9 April 2010), pp. 18262-18353. [http://s3.amazonaws.com/nefmc.org/fA16final\\_rule.pdf](http://s3.amazonaws.com/nefmc.org/fA16final_rule.pdf)

to develop mechanisms to adequately monitor catch and discards by participating vessels. One of these mechanisms is an independent third-party dockside/roving monitoring program that observes offloads by sector vessels to ensure that landings are accurately reported. This dockside/ roving monitoring program is required starting in FY 2010, and will be funded by sectors, unless otherwise specified by NMFS. Dockside monitors observe offloadings directly to a dealer, while roving monitors are used to monitor offloads to a truck for later delivery to a dealer.”<sup>11</sup>

At-sea monitoring and/or electronic monitoring would be used “to verify area fished and catch (landings and discards), by species and gear type, for the purposes of monitoring sector ACE utilization.”<sup>12</sup> The manner in which discard estimates are derived may differ annually, and is based on the availability of data to determine a discard rate by fish stock and gear type. The level of coverage necessary would meet the CV standard established under the SBRM. At the time of implementation of Amendment 16, electronic monitoring was not yet approved for use in monitoring catch

The final rule specified the types of monitoring programs that would be used to monitor catch by sectors. There is general consistency between the proposed measures in Amendment 16 and the final rule. However, the language in the final rule is more prescriptive regarding the utility of the dockside monitoring program, compared to the language in the Amendment/Environmental Impact Statement (EIS). Amendment 16 and EIS for the action states that: “[s]ector operations plans will specify how a sector will monitor its catch to assure that sector catch does not exceed the sector allocation. At the end of the fishing year, NMFS will evaluate catch using IVR, VMS, and any other available information to determine whether a sector has exceeded any of its allocations based on the list of participating vessels submitted in the operations plan.”<sup>13</sup>

## **5. Summary of Modifications to the Groundfish Dockside Monitoring Program (2010-2011)**

### **5.1 Framework 45 – Changes to the Sector Dockside Monitoring Program**

Framework 45 removed the requirement for the industry to fund the sector dockside monitoring program for the 2011 and 2012 fishing years. Instead, NMFS would fund the program for up to 100 percent of sector trips, subject to availability of funds. The rationale for removal of the

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<sup>11</sup> “Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Amendment 16; Final Rule,” 68 Federal Register 75 (9 April 2010), pp. 18262-18353. [http://s3.amazonaws.com/nefmc.org/fA16final\\_rule.pdf](http://s3.amazonaws.com/nefmc.org/fA16final_rule.pdf)

<sup>12</sup> Ibid.

<sup>13</sup> New England Fishery Management Council. Oct. 16, 2009. Amendment 16 to the Northeast Multispecies FMP. [http://s3.amazonaws.com/nefmc.org/091016\\_Final\\_Amendment\\_16.pdf](http://s3.amazonaws.com/nefmc.org/091016_Final_Amendment_16.pdf)



requirement for industry to fund DSM is based on the utility of the data, which is minimal when considering other data sources collecting similar information, including vessel trip reports and dealer reports. However, the industry saw benefit in continuing the program with agency support to cover the dockside monitoring program costs.

“Dockside monitoring was adopted by Amendment 16 to verify the accuracy of landings by commercial fishing vessels. The requirement was imposed immediately for vessels fishing in sectors and in FY 2012 for common pool vessels. Because this measure did not replace dealer reporting or VTRs, it did not produce a new data stream that assists the assessment and management of the fishery. Eliminating the requirement will reduce monitoring costs to industry, avoid duplication of effort, and will not reduce the availability of landings information. If the cost is to be covered by NMFS, the industry sees some benefit in continuation of the program.”<sup>14</sup>

The final rule for Framework 45 stated that: “For FY 2011, NMFS estimates that it has sufficient funding to cover approximately 100 percent of sector trips that are not assigned an observer or at-sea monitor. NMFS will specify coverage levels for FY 2012 based upon available NMFS funding.”<sup>15</sup>

Sector vessels were required to submit a trip-end hail that included the following information: “Vessel permit number; vessel trip report serial number, or other applicable trip ID specified by NMFS; landing state; landing port city; dealer name/offload location; estimated arrival date and time; estimated offload date and time; second offload port city and state (if applicable); and total amount of groundfish and non-groundfish species kept.”<sup>16</sup> This end hail reporting requirement was intended to allow enforcement to efficiently ensure compliance with regulations, but was not used by dockside monitors.

Framework 45 altered the 2010 Dockside Monitoring Program by requiring monitors to inspect fish holds: “based on further evaluation of the performance of the dockside monitoring program and consideration of concerns expressed by enforcement personnel, this action now requires that dockside monitors inspect the fish holds for any trip that is assigned a dockside/ roving monitor beginning in FY 2011. This requirement [was intended to] enhance the enforceability of existing provisions and minimize the incentives to underreport/misreport the amount of regulated species landed.” However, prior to developing protocols and training for dockside monitors to board vessels, NMFS responded to safety concerns raised by the NEFMC on samplers inspecting a fish hold, and “determined that retaining the vessel trip-end (pre-landing) hail requirement

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<sup>14</sup> New England Fishery Management Council. Jan. 21, 2011. Framework 45 and EA to the Northeast Multispecies FMP. [http://s3.amazonaws.com/nefmc.org/110120\\_Final\\_FW\\_45\\_Resubmit.pdf](http://s3.amazonaws.com/nefmc.org/110120_Final_FW_45_Resubmit.pdf)

<sup>15</sup> “Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Framework 45; Final Rule,” 79 Federal Register 76 (25 April 2011), pp. 23042-23076. [https://s3.amazonaws.com/nefmc.org/FW45final\\_rule.pdf](https://s3.amazonaws.com/nefmc.org/FW45final_rule.pdf)

<sup>16</sup> New England Fishery Management Council. Jan. 21, 2011. Framework 45 and EA to the Northeast Multispecies FMP. [http://s3.amazonaws.com/nefmc.org/110120\\_Final\\_FW\\_45\\_Resubmit.pdf](http://s3.amazonaws.com/nefmc.org/110120_Final_FW_45_Resubmit.pdf)

currently provides an efficient and effective means for observation and enforcement of vessel landing requirements through unannounced observation of vessel offloads at the discretion of law enforcement, which could include inspection of the hold.”<sup>17</sup>

#### Summary of Public Comments on Framework 45’s Final Rule, Sector Dockside Monitoring Program

A commercial groundfish industry group raised concerns regarding the utility of the DSM program, and suggested ways to improve the program. The group suggested reducing costs by only requiring roving monitors to observe offloads once (rather than observing offloads from vessel to truck and observing that offload from truck to the dealer). The group also suggested that dockside monitoring data should be allowed for use in weekly sector catch reports. NMFS responded that a streamlined and electronic format for data reports collected through dockside monitoring could improve use of the data and noted that dockside monitoring data could not replace the official record of landings collected through dealer reports.

Several group commenters (New England Hook Fisherman’s Association (NEHFA), Penobscot East Resource Center (PERC), PEW Charitable Trusts) and a commercial fisherman suggested an exemption from dockside monitoring requirements for vessels fishing with Handgear A and B permits, or those vessels fishing under the small vessel exemption permit. NMFS responded that the final rule allows for such exemption for common pool vessels, not sector vessels.

Several commenters raised safety concern regarding the requirement for dockside monitors to inspect the fish hold, recommending that this task should be accomplished using NMFS Office of Law Enforcement, rather than a data collector. In addition, these commenters raised concern regarding the need to obtain insurance coverage for liability and harm, in the event that a sampler injured himself/herself while performing fish hold inspections.

Several group commenters (NEHFA, PERC, PEW Charitable Trusts) expressed the need to provide appropriate monitoring to minimize the incentive to misreport and underreport catch. As clarified in the comment response, “the dockside/roving monitoring data are primarily used for enforcement purposes, not catch monitoring.”<sup>18</sup> NMFS planned to provide dockside monitoring coverage (based on available funding) for trips neither covered through SBRM coverage nor ASM coverage. Refer to Appendix 3.

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<sup>17</sup> “Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Framework 45; Interim Final Rule,” 138 Federal Register 76 (19 July 2011). <https://www.govinfo.gov/content/pkg/FR-2011-07-19/pdf/2011-18012.pdf>

<sup>18</sup> “Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Framework 45; Final Rule,” 79 Federal Register 76 (25 April 2011), pp. 23042-23076. [http://s3.amazonaws.com/nefmc.org/FW45final\\_rule.pdf](http://s3.amazonaws.com/nefmc.org/FW45final_rule.pdf)

## 5.2 Framework 48 – Changes to the Sector Dockside Monitoring Program

Framework 48 proposed to discontinue the requirements for the dockside monitoring program:

“In 2011, NMFS made the determination that dockside intercepts by enforcement personnel were sufficient to monitor sector landings and reprioritized financial support for dockside monitoring to alleviate general sector operating costs.”<sup>19</sup>

Framework 48 discontinued the Dockside Monitoring Program starting in the 2013 fishing year. The program was discontinued because the information collected through the dockside monitoring program duplicated information collected by dealers and eliminating the requirement to collect duplicative information would reduce vessel operational costs in the future. To aid its enforcement activity at the docks, NMFS maintained certain sector reporting requirements initially intended to support the dockside monitoring program, namely the requirement for sector vessel operators to submit trip start and end hails.

“Dockside monitoring increases the operating costs of sectors. Landings information is already provided through the dealer reporting system. As long as unreported landings do not occur, the dealer reports can be used to monitor sector landings and there is little advantage to having dockside monitors verify these reports. By eliminating the program, sector operating costs are reduced, and redundant accounting is avoided.”<sup>20</sup>

Framework 48 also clarified that “[t]he primary goal of observers or at-sea monitors for sector monitoring is to verify area fished, catch, and discards by species, [and] by gear type. Electronic monitoring may be used in place of actual observers or at-sea monitors if the technology is deemed sufficient for a specific trip based on gear type and area fished.”<sup>21</sup>

### Public Comments on Framework 48’s Changes to the Sector Dockside Monitoring Program

Sector representatives, one environmental group, and one state agency commented on dockside monitoring program changes in the Framework 48 proposed rule. Some commenters supported retaining trip hail information for enforcement purposes. Sector representatives and one environmental group supported eliminating the dockside monitoring program, due to program inefficiencies (increased monitoring costs with minimal data utility and redundancy in data collection). One state fishery agency questioned whether NMFS believed the current monitoring of landings would be sufficient given the proposed termination of the dockside monitoring program. Refer to Appendix 4.

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<sup>19</sup> “Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Framework 48; Proposed Rule,” 57 Federal Register 78 (25 March 2013), pp. 18188-18219. <https://www.govinfo.gov/content/pkg/FR-2013-03-25/pdf/2013-06774.pdf>

<sup>20</sup> New England Fishery Management Council. (Feb. 26, 2013). Framework 48 and EA to the Northeast Multispecies FMP. [http://s3.amazonaws.com/nefmc.org/130307\\_FW48\\_Figures\\_Repaired.pdf](http://s3.amazonaws.com/nefmc.org/130307_FW48_Figures_Repaired.pdf)

<sup>21</sup> Ibid.

## **6. Case Studies**

The following section identifies a few case studies that summarize past and current dockside monitoring programs. If there is interest in a dockside monitoring program to monitor groundfish fishing activity, these case studies can provide some insight into other information collected from dockside monitoring programs in other fisheries, and the utility of data collected by other dockside monitoring programs. However, the goals for a groundfish dockside monitoring program should be clearly articulated.

### **Case Study #1: Groundfish Dockside Monitoring Program (2010-2011)**

**A. Objective:** The purpose of the DSM Program in 2010 was to verify accurate dealer reporting. Dealer reports are one source of data used to determine a sector's in-season catch relative to the annual catch entitlement, providing the majority of landed weight information. VTRs provide non-dealer landings (e.g., catch retained for bait and home consumption), in addition to dealer landings, as well as statistical areas fished, gear used, and are used to attribute catch, by gear type.<sup>22</sup>

#### **B. Monitoring Tasks:**

- Take copies of all VTRs filled out for the trip, with all information available (no blocked cells).
- Record whether or not the scales are certified by the dealer's state.
- Observe and record whether ice and box weights are tared by the dealer before the catch is added. If the dealer does not tare the box and ice, the dockside monitor must obtain the estimated weight of the ice and box from the dealer and record that weight in his/her report.
- Ask the captain whether all fish have been offloaded, and whether any are being retained for personal use. The dockside monitor must record the captain's estimate of weight of each species being retained for home use or retained on the vessel and record the reason(s).
- Either the dockside monitor or dealer must record the weight of offloaded fish, by species (and market class, if culled), in a report. This report must be signed by the dockside monitor, and the monitor must keep a copy of the signed report.
- Provide accurate and complete data to the sector manager and/or any dockside monitor-designated third party, within 24 hours of the completion of the DSM event.
- Send copies of the VTR(s), the dealer receipt(s) if separate from the dockside

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<sup>22</sup> Labaree, Jonathon. August 2012. *Sector Management in New England's Groundfish Fishery: Dramatic Changes Spurs Innovation*. Gulf of Maine Research Institution.  
[http://www.gmri.org/sites/default/files/resource/sector\\_management\\_in\\_new\\_england.pdf](http://www.gmri.org/sites/default/files/resource/sector_management_in_new_england.pdf)

monitor's report, and the dockside monitor's report to the sector manager or any dockside monitor -designated third party.

- Keep a copy of his/her report, which must be electronically stored by the DSM vendor.
- Inspect fish hold (Modification made in Framework 45 Final Rule, but disallowed shortly thereafter, in Framework 45 Interim Rule). This measure was disallowed, due to safety concerns regarding samplers inspecting the fish hold (Refer to Appendix 8).
- Refer to Appendix 7 for Dockside Monitoring Program Standards.

**C. Summary of Program Logistics for 2010 Groundfish Dockside Monitoring Program:**

- Notification to vessel regarding coverage requirement at end of trip when trip end hail is sent to service provider, and not sooner.
- Hail start and end times reported by vessels, to allow for sampler to arrive at location for sampling. Service providers notify vessels of coverage requirements when sending confirmation in response to trip end hail reported by vessel operator.
- Offloading of fish may not begin until sampler is present, if selected for coverage.
- Fish is sometimes offloaded at different dealers, with a large amount of lag time in between, which may increase costs in some instances (e.g., when sampler must observe offload to truck, and also observe the offload from the truck to the dealer).
  - For example, state regulations affect when fluke can be offloaded
  - Another example is that lobsters are typically offloaded first, and at a different dealer (in order to land live lobsters).

Fish hold inspections likely require additional insurance, which may also increase the costs (in the past, service providers were required to obtain appropriate insurance in case of injury/harm to samplers when inspecting fish holds).

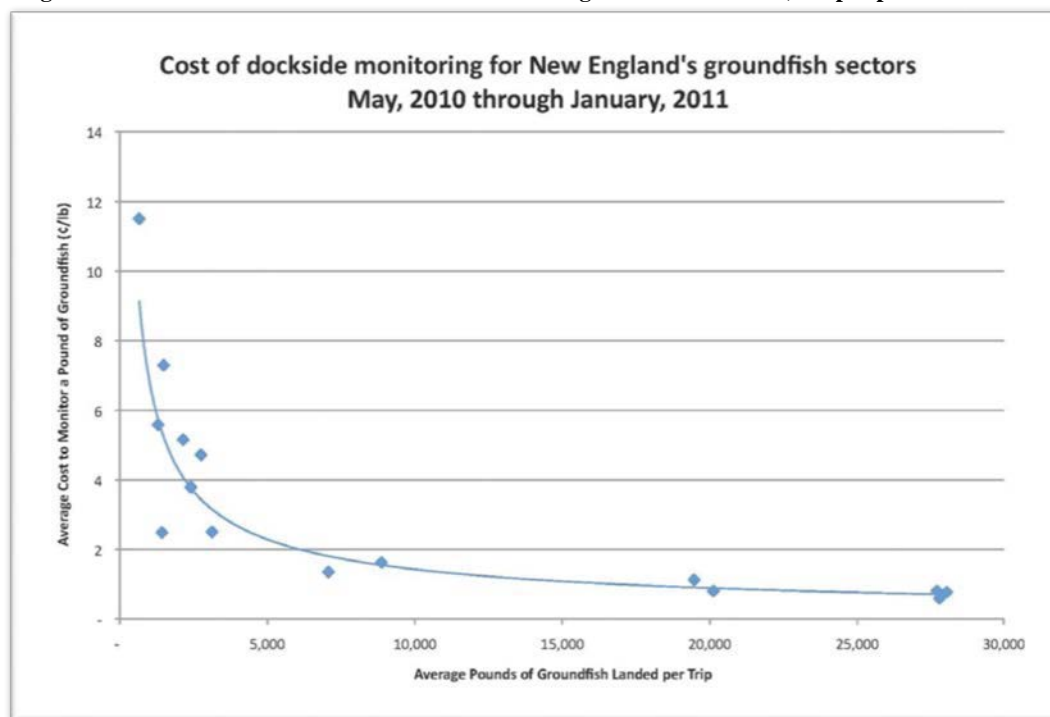
**D. Program Funding (includes cost information):**

Program cost information for the groundfish dockside monitoring program is provided below, based on analysis prepared by GMRI. For the 2010 fishing year, 50 percent of all trips (both trips with and without at-sea observer/monitoring) were monitored. For the 2011 fishing year, the monitoring coverage began at 100 percent of trips without at-sea/observer monitoring and was reduced to 50 percent.

GMRI administered the dockside monitoring program through a grant, which was used to reimburse vessels for dockside monitoring costs.

- Average per pound cost for all sectors ranges from \$0.006/lb. to \$0.12/lb., and was inversely related to volume (i.e., the more fish landed per trip, the lower the cost for DSM on a cost per pound basis; Refer to Figure 1).
- The average cost per trip across ports ranged from \$97 - \$212.
- The 2010 DSM Program was funded by a NMFS grant to GMRI.

Figure 1 - 2010 Groundfish Sector Dockside Monitoring Cost Information (cost per pound of fish landed)



Source: CINAR Report, Funding Sector Operations and Dockside Monitoring in Fishing Year 2011.

**E. Data Utility:** Dockside monitoring activity helped assure accurate dealer and vessel reporting of landings information (real-time monitoring of compliance with accurate dealer reporting). Hail information was used by NOAA Office of Law Enforcement to facilitate enforcement of regulations at the docks.

## Case Study #2: Elements of the Archipelago Dockside Monitoring Services for the Pacific Region's Groundfish Fishery <sup>23</sup>

**A. Objective:** The objectives for the monitoring program include verification procedures and methods to ensure integrity of data, and the ability to correct for deficiencies in the reported data. In British Columbia, Fisheries and Oceans Canada currently utilizes four service providers to fulfill dockside monitoring requirements. Archipelago Marine Research is the approved DSM provider for the Pacific Region's groundfish fishery managed by Fisheries and Oceans Canada. There is no regional annex for the Pacific Region's dockside monitoring program.<sup>24</sup>

### **B. Monitoring Tasks:**

- Species Verification (identify, record weight, record count);

<sup>23</sup> Archipelago Marine Research. 2016. *Dockside monitoring Independent, Third-Party Verification of Landed Catch*. <http://www.archipelago.ca/fisheries-monitoring/dockside-monitoring/>

<sup>24</sup> Based on electronic mail communications with the Pacific Region's monitoring programs coordinator in July 2016.

- For Hook and Line/Trap fishery all fish landed must be separated, piece counted and weighed by individual species and by product type. The only exceptions to the piece count requirement are halibut, lingcod, dogfish and sablefish landed on directed trips;
- Electronic reporting of landings information;
- Retain copies of fish log information, hail information, and other relevant information;
- Obtain fish samples and tag information for use in assessments;
- Monitor compliance with regulations for the fishery, including a fish hold inspection and on-deck inspection for remaining fish after offload is complete;
- Apply fish tags to all retained halibut; and
- Record and track individual quotas in-season for management purposes<sup>25</sup>.

**C. Program Funding (includes cost information):**

Dockside monitoring in the British Columbia groundfish fishery's catch share program is paid for by the industry. In the groundfish fishery, 100 percent dockside monitoring is required. Costs are reported in Canadian dollars, which almost matched US currency during that time period. Based on estimates provided in report by Archipelago Marine Research in 2008, costs range from \$65 to \$500 per trip for groundfish fisheries (includes industry and government support for DSM program). The fishery has mandatory 100% observer or EM coverage. The majority of the groundfish trawl fleet uses onboard observers to observe all fishing events including landings and discards. The hook and line, trap, mid-water trawl for hake, and the small inshore groundfish trawl fishery use an audit-based electronic monitoring system. In British Columbia, the groundfish fleet is comprised of approximately 300 vessels and is valued at approximately \$140 million dollars. The value of landed catch on groundfish vessels is approximately \$40,000 per trip.

**D. Data Utility:** Enhanced regulatory compliance and protection of sustainable commercial fisheries. Dockside monitoring data is considered the primary source of landings data used to inform fisheries management. Biological data is also collected and used in stock assessments. The purpose of tagging all landed halibut is to act as an enforcement tool to decrease the amount of illegally caught halibut entering the market, and to assist in marketing Canadian halibut as a distinct and high-quality product.

**Case Study #3: Massachusetts Department of Marine Fisheries (MA DMF) Portside Sampling Program of the Atlantic herring fishery**

**A. Objective:** Collect information on catch composition, biological information and samples, for the purposes of landings verification and use in stock assessments.<sup>26</sup>

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<sup>25</sup> Fisheries and Oceans Canada. 2010. *Atlantic Region Dockside Monitoring Program Policies and Procedures*.

<sup>26</sup> Massachusetts Division of Marine Fisheries. 2010. *2010 Annual Report*.  
<http://www.mass.gov/eea/docs/dfg/dmf/publications/2010-dmf-annual-report.pdf>



**B. Monitoring Tasks:**<sup>27</sup>

- Collect subsamples of unsorted fish catch (beginning in 2012). Basket subsamples collected every five to seven minutes, on average.
- Record information on species composition and length frequency of fish
- Collect harvester-reported information on fishing effort (laptop, electronic VTR); and
- Refer to sample logs (Appendix #5).

**C. Program Funding:** Portside sampling coverage increased in 2010 due in part to a grant provided by the National Fish and Wildlife Foundation.<sup>28</sup> MA DMF also receives funding from The Nature Conservancy and the Atlantic Herring Research Set-Aside Program. An Atlantic States Marine Fisheries Commission grant was used to support portside sampling efforts on small-mesh bottom trawl vessels in Rhode Island. At this time, the Atlantic Herring Research Set-Aside Program supports the majority of the sampling effort (subcontracted through SMAST, who receives the funding from quota-set aside).

**D. Data Utility:** Information on river herring hotspots are used to inform the voluntary River Herring Bycatch Avoidance Program. All mid-water trawl vessels currently participate in the program, and the majority of small-mesh bottom trawl vessels in Rhode Island also participate in the bycatch avoidance program. Representatives of the state portside sampling program provide advice on feedback based on experience with portside sampling program, to inform management decisions regarding the development of frameworks/amendments related to fishery and bycatch concerns. Samples and length measurements from the Massachusetts and Maine portside sampling programs are used in the herring stock assessments for catch at age information and information on life history parameters. Collected samples also determine maturation stage of fish for spawning closure considerations.

**Case Study #4: Maine Department of Marine Resources (ME DMR) Portside Sampling Program of the Atlantic herring fishery**

**A. Objective:** Compare and analyze sampling results from at-sea monitoring and portside sampling data. Trips covered by observers are sampled portside to compare results due to variations in sampling schemes. Portside sampling effort currently focuses on purse seine vessels, but also include midwater trawl vessels and small-mesh bottom trawl vessels. In the future, portside sampling efforts will focus on catch estimation for the herring and mackerel fisheries to comprehensively monitor these fisheries.

**B. Monitoring Tasks:** Non-targeted fish are sorted and weighed. In some cases, a

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<sup>27</sup> Armstrong, Mike; Hoffman, Bill; and Schondelmeier, Brad. *Portside Sampling and River Herring Bycatch Avoidance*.  
[https://www.greateratlantic.fisheries.noaa.gov/protected/riverherring/tewg/smast\\_madmf\\_portside\\_bycatch\\_program.pdf](https://www.greateratlantic.fisheries.noaa.gov/protected/riverherring/tewg/smast_madmf_portside_bycatch_program.pdf)

<sup>28</sup> NFWF 2016 Request for proposals can be found at (proposals due June 13, 2016):  
<http://www.nfwf.org/fisheriesfund/Pages/2016-Electronic-Mo.aspx>



subsample of catch is weighed. Vessel trip report information is used to attribute landings by area and gear. All weighed fish are then measured for length information, and samples of fish are also taken. Refer to sample logs (Appendix 6).

**C. Program Funding:** Funding is provided by the Atlantic Coastal Cooperative Statistics Program (ACCSP). Beginning in 2016, funding provided by ACCSP was reduced to only cover travel expenses. The state of Maine's general funds support the remainder of the program.

**D. Data Utility:** Samples and length measurements are used in the herring stock assessments for catch at age information and information on life history parameters. Collected samples also determine maturation stage of fish for spawning closure considerations. Samples from portside sampling efforts are processed through the Maine Department of Marine Resources laboratory for catch sampling analysis and ageing.

### **Case Study #5: Elements of the Dockside Monitoring Services for the Maritimes Region's Groundfish Fishery**

**A. Objective:** To provide timely third-party verification of accurate landings information to monitor fishery effort for quota management purposes. To ensure compliance with fishery regulations.

**B. Monitoring Tasks:** Dockside monitoring tasks for the Maritimes Region is based on Department of Fisheries and Oceans Canada National Dockside Monitoring Program Policy and Procedures, and the Maritimes Regional Annex.<sup>29</sup>

- Species Verification (identify, record weight, record count);
- Dockside monitors retain copies of fish log information, hail information, and other relevant information;
- Monitor compliance with regulations for the fishery, including a fish hold inspection and inspection of other areas on vessel where fish is typically stored after offload is complete. Dockside monitors are required to sign harvester logs and certify that there is no additional fish in the fish hold; and
- Certified data entry clerks enter landings information from logs of monitored and unmonitored trips, and submits the information using a landings database.

**C. Program Funding:** There are approximately 1,000 groundfish vessels, and these vessels land fish in remote ports. There is 20% dockside monitoring for catch less than 5,000 pounds, or less than 150 pounds of halibut (there is a small total allowable catch for halibut).

**D. Data Utility:** Enhanced regulatory compliance and protection of sustainable commercial fisheries. Dockside monitoring data is considered the primary source of landings data used to inform fisheries management.

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<sup>29</sup> Fisheries and Oceans Canada. November 2012. *Maritimes Region Dockside Monitoring Annex*.

### Case Study #6: West Coast IFQ Catch Monitor Program

- A. Objective:** Provide accurate, timely, and independent third-party verification of landing reports that are used to manage the fishery. To ensure compliance with fishery regulations.
- B. Monitoring Tasks:**<sup>30</sup> Catch monitors conduct dockside monitoring at first receivers (person or company who receives, purchases, or takes custody, control, or possession of catch onshore from a vessel that harvested fish under the shorebased Individual Fishing Quota (IFQ) Program). They monitor the sorting, weighing and recording of catch as it is received, purchased, taken custody, control, or possession of by first receivers. In general, these activities occur at shorebased processing facilities in the port of landing but may occur at other dockside facilities where catch is offloaded onto trucks that transport it to inland processing facilities.
- Species Verification (identify, record weight, record count);
  - Verify that catch monitoring plans are being followed;
  - Written documentation of the sorting process including all operational issues that may affect the quality of catch sorting; and
  - Monitor compliance with regulations for the fishery, including a fish hold inspection if possible. Monitors record on the data sheet whether or not they were able to inspect the fish hold and confirm that all catch was offloaded, and document the reason why if they were not able to confirm.
- C. Program Funding:** 100% observer and catch monitoring coverage is required for all program participants. Both observers and catch monitors are industry funded.
- D. Data Utility:** Enhanced regulatory compliance and protection of sustainable commercial fisheries.

### Case Study #7: Elements of the North Pacific Observer Program - Plant Observer for the Bering Sea/Gulf of Alaska Pollock Fishery

- A. Objective:** To monitor all Bering Sea pollock offloads for the sorting of salmon. Vessels in the directed pollock fisheries in the Bering Sea and Gulf of Alaska are prohibited from sorting salmon from their catch and must deliver all salmon to the processing plant. To verify Plant/Vessel Offload Form data and delivery weights as time permits.
- B. Monitoring Tasks:**<sup>31</sup> Bering Sea Pollock offload monitoring is a shared duty between the plant observer and vessel observer. Only one observer is required to be present at any given

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<sup>30</sup> NOAA. December 2010. Compliance Guide Pacific Coast Groundfish Trawl Rationalization Program. [http://www.westcoast.fisheries.noaa.gov/publications/fishery\\_management/rawl\\_program/catch-shares-guide-progr.pdf](http://www.westcoast.fisheries.noaa.gov/publications/fishery_management/rawl_program/catch-shares-guide-progr.pdf)

<sup>31</sup> 2017 Observer Sampling Manual North Pacific Observer Program November 1, 2016. Alaska Fisheries Science Center, Fisheries Monitoring and Analysis Division [https://www.afsc.noaa.gov/FMA/Manual\\_pages/MANUAL\\_pdfs/manual2017.pdf](https://www.afsc.noaa.gov/FMA/Manual_pages/MANUAL_pdfs/manual2017.pdf)

time during the offload. The plant and vessel observers are required to be present at the beginning and end of each offload.

- Salmon retention data (identify, record weight, record count, sampling) is the data collection priority;
- Verify Plant/Vessel Offload Form data (species identity, total weight);
- Verify delivery weights as time permits. Either verify based on the weights entered on the fish ticket or by the sum of scale weights.

**C. Program Funding:** 100% monitoring is required for all pollock offloads. The fee is split evenly between the vessel owner/operator and processor or registered buyer.

**E. Data Utility:** Collect information on salmon (weights, biological sampling) retained by the pollock fishery. Enhanced regulatory compliance and protection of sustainable commercial fisheries.

## **7. PDT Discussion: Considerations for a Groundfish Dockside Monitoring Program**

The Groundfish Committee tasked the PDT with investigating the tools used to monitor the groundfish fishery, including the 2010-2011 dockside monitoring program. The DSM program was discontinued in the 2010 fishing year, due to unresolved problems with the program. If the intent is to reconsider a dockside monitoring program for the groundfish fishery in the future, the PDT recommends that the former program be modified, rather than simply reinstated as previously implemented, to achieve the goals of accurate and precise reporting of groundfish bycatch and landings. The following summarizes the PDT's discussion on the topic.

### **Problem Statement**

Accurate landings data are a critical component of total fishery removals for targeted groundfish stocks (those stocks without zero possession limits). They provide the basis for the size structure and magnitude of most of the commercial catch, ensure that sectors are in compliance with their Annual Catch Entitlements, and underpin the quota allocation mechanism. Analytical stock assessment models assume there are no biases in the age structure or with the magnitude of the catch over time. The commercial landings are assumed to be a census of the total landings. It is not an estimate with an associated error distribution similar to the recreational landings estimate. When this assumption is violated--when true catch is biased--it can contribute to problems with model performance, including retrospective errors. The loss of acceptable analytical stock assessment models due to diagnostic issues results in a reliance on overly simple empirical models that do not comprehensively integrate stock dynamics. This exacerbates uncertainty in setting catch limits. Therefore, an accurate time series of landings is a prerequisite for accurate and precise stock assessments, as well as any subsequent projections used to estimate OFLs,

ABCs, and ACLs. Accurate catch reporting is also necessary to ensure that the mechanism for allocating quota between sectors provides a level playing field for all fisherman and ensures that all sector members are subject to the same constraints, thereby ensuring fairness in the governance of the catch share system and improving confidence and trust among participants. Without accurate catch data, the biological and market signals that help inform our understanding of stock conditions are at least muted, if not lost.

In any fishery regulated by output controls with a tradable quota system, where landings are strictly limited, and quota costs vary between species and even between stocks of the same species, incentives to report inaccurately exist. Currently in the groundfish fishery there is no independent verification of landings data at the offload site. Communications with NOAA Office of Law Enforcement (OLE) reveal that only a small percentage of trips are inspected for compliance. For example, in 2017 OLE inspected approximately 300 multispecies trips out of approximately 7,000 (~4%). Based on an initial review, 2% of these 300 may face enforcement actions (either at-sea or dockside). OLE reported that their recent enforcement priorities have shifted away from dockside inspections due to the self-policing construct of the sector management system, and their efforts are now primarily focused on at-sea inspections. OLE expressed concern that current monitoring efforts are insufficient to ensure that groundfish landings are reported accurately. OLE remarked that a dockside inspection, coupled with conformation of the dealer report, is required to ensure accurate landings reports. Fish hold inspections are a routine part of OLE's fishing vessel inspection, although the officer has discretion to forgo the fish hold inspection if there are safety concerns or other relevant circumstances. OLE remarked that fish hold inspections are a critical component of a monitoring program. Further, OLE indicated that they have limited resources to cover the number of trips landed, even with the JEA program as a force multiplier. Rather, OLE focus is based on egregious violations or cases initiated by actionable intelligence. OLE also conveyed that to ensure accurate reporting, a dockside inspection accompanied with confirmation of dealer reporting would be essential.

#### Addressing Unresolved Issues in 2010-2011 DSM Program:

##### *1. The details of how to do dockside monitoring in smaller, less-used ports.*

From 2010 to 2013, 91% of groundfish landings (by value) were offloaded in six New England ports (New Bedford, Gloucester, Boston, Chatham, Point Judith, and Portland). Therefore, the establishment of a dockside monitoring program at these six major ports would enable independent verification of the majority of groundfish landings in New England.

However, monitoring groundfish offloads in other ports where groundfish are landed in lower volumes and with less frequency, is an operational challenge. Canada's Maritimes Regional DSM Program may provide some guidance regarding coverage levels in smaller ports with

lower volumes of groundfish landings. The Canadian Maritimes region uses the volume of groundfish landings at each port to classify a level of coverage. The premise behind this program is that monitoring levels are assigned in proportion to the risk of potential catch misreporting (by volume). Coverage levels are assigned to each port according to a four-tier system. In this case, vessels offloading at ports with low volume landings are subject to intermediate coverage levels (e.g., 25% of trips) through the dockside monitoring program. High volume groundfish vessels, or groundfish vessels offloading at ports with a higher volume of groundfish landings are subject to 100% dockside monitoring.

Under the Canadian Maritimes dockside monitoring program, vessels are required to submit a “hail-in” report at the conclusion of their trip, which details the landed weight (by species) of their catch, the port of landing, the dealer(s), and their anticipated time of arrival. For fleets/ports that don’t have 100% dockside monitoring, the vessel will not know in advance if they will have an assigned dockside monitor for their offload. When a monitor is assigned, the monitor makes sure that the “hail-in” report was reasonably accurate, and if not, they can file an incident report.

A similar tiered dockside monitoring system may work well in this region. Vessels offloading at high volume groundfish ports could be monitored at a relatively high coverage level. Vessels offloading lower quantities of groundfish or offloading at ports with lower volumes of groundfish landings, could be randomly assigned dockside monitors at lower coverage levels. Because vessels already submit hail-in reports as part of their trip level reporting, the dockside monitor can compare the hail in report to the recorded offload weights to incentivize accurate reporting of landings at the species level.

## *2. How to pay for dockside monitoring.*

One of the measures in Framework 48 was disapproved due to legal constraints regarding cost sharing for monitoring in the fishery. Cost sharing responsibilities for industry-funded monitoring programs to address monitoring needs in excess of Federal mandates (i.e., distinct from Standardized Bycatch Reporting Methodology, Marine Mammal Protection Act, and Endangered Species Act requirements) are described in the Draft Environmental Impact Statement to the Industry-Funded Monitoring Amendment (May 2016; Refer to Appendix 1 for specific rationale regarding the disapproval).

“Department of Commerce General Counsel has advised NMFS that monitoring cost responsibilities can be allocated between industry and the government by delineating the sampling and administrative portions of the costs of monitoring. Industry would be responsible for costs directly attributable to the sampling portion of a monitoring program, and NMFS would be responsible for costs directly attributable to the

administrative portion of the monitoring program...”<sup>32</sup>

3. *Does DSM just produce duplicative information?*

Framework 45 removed the requirement that industry pay the costs of dockside monitoring, and it was argued that because dockside monitoring did not replace dealer reporting or VTR’s, dockside monitoring did not produce a new data stream that assisted in the assessment and management of the fishery.

- The data are only duplicative **if** landings are reported accurately by the vessel and dealer.
- The primary goal of DSM is enforcement, whereas dealer reporting and VTRs are used for monitoring.
- Can dockside monitoring data be used to replace dealer data as the official landings record, for trips that are monitored dockside? If so, the information would no longer be duplicative. This is what is done in other monitoring programs (e.g., case studies 2 and 5).

4. *How monitoring and reporting will align with existing efforts.*

1. Objective(s) for dockside monitoring:

The primary objective of dockside monitoring in the groundfish fishery will be to provide independent verification of landings, in order to ensure that landings are accurately reported for all species.

Under A23, dockside monitoring may be used in conjunction with other monitoring initiatives, such as EM. The primary utility of dockside monitoring is to ensure that the landings are recorded accurately for each species. EM or ASM/NEFOP programs can be used to increase the accuracy of discard estimates, and to reduce the magnitude of stock area misreporting. Therefore, dockside monitoring can be used in combination with at-sea monitoring to increase the accuracy of catch estimates (by species and stock area).

Dockside monitoring may also allow some secondary objectives to be fulfilled, for example:

- Dockside monitoring, when used in conjunction with the at-sea monitoring provisions being considered under A23 will allow the magnitude of catch to be known with greater accuracy. This may provide managers will more flexibility

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<sup>32</sup> NEFMC and MAFMC. Draft Environmental Impact Statement for the Industry-Funded Monitoring Omnibus Amendment. August 2018. <https://s3.amazonaws.com/nefmc.org/Draft-EA-for-IFM-Amendment-August-2018.pdf>

to decrease the uncertainty buffer between the Acceptable Biological Catch and Annual Catch Limit. A reduction in the uncertainty buffer would provide additional revenue opportunities to the fishery, particularly if more quota were made available for constraining stocks.

- By providing an independent, third-party verification of landed weights by species, dockside monitoring will reduce the magnitude of misreported landings in the groundfish fishery.
  - Increasing the timeliness and accuracy of in-season quota monitoring for sectors.
  - Dockside monitoring will give all fishery participants greater confidence that landings are being monitored and reported in an equitable manner throughout the fishery, and that all fishery participants are adhering to their quota allocations.
  - Catch and discard weights by species, gear type, mesh size, fishing location, etc. Landings accuracy is not the only objective that can be satisfied by dockside monitors for the groundfish fishery. Monitoring of ACE usage is a broader objective identified in Amendment 16. An expanded dockside monitoring program could provide additional information to inform management. It may be worth exploring additional data collections that dockside monitors may be able to successfully collect, if there is interest in dockside monitoring for the fishery. More importantly, the utility of the data should be clearly articulated by both the NEFMC and NMFS prior to implementation, to ensure that the suite of monitoring options meet the FMP-specific goals.
2. Articulate a clear sampling design to meet monitoring (or enforcement) objectives.
- a. Examples:
- i. Stock-specific hail requirements.

Vessels are currently required to submit a “hail-in” report at the completion of their trip. The “hail-in” report includes the following information:

- Vessel name and permit number
- Intended port of landing and dealer(s)
- Landed weight of all groundfish, by species, and stock area
- Landed weight of all non-groundfish species

As part of their sampling duties, the dockside monitor will compare the “hail-in” weights for each species of fish reported by the captain to the amount of fish that is offloaded at the dealer.

Potential penalty function – for lower volume vessels that are subject to occasional dockside monitoring, their DSM coverage rate could increase if the hail-in reports are inaccurate.

- ii. Inspection of fish hold, if used to monitor and improve catch accuracy.

A major issue with the previous dockside monitoring program was that dockside monitors were not allowed to inspect fish holds, primarily because of liability concerns. The PDT is concerned that fish holds must be inspected at the conclusion of an offload to ensure that all landings have been accounted for and independently verified. The PDT also notes that fish hold inspections are a mandatory component of dockside monitoring programs in other fisheries throughout the world (see case studies). The monitoring amendment should clearly articulate whether the insurance liability associated with having monitors inspect the fish hold of the vessel falls on the vessel owner, or the dockside monitoring service provider.

As an alternative to having dockside monitors physically inspect the fish hold, motion activated cameras could be used to verify that all fish have been removed from the hold at the conclusion of the offload. This option may be particularly well suited for use on vessels with EM systems.

3. Who will pay for non-administrative dockside monitoring costs, if used in the future?
  - Industry
  - Dealer
  - Combination



# **Appendix 1**

## **Text from Greater Atlantic Region disapprovals regarding industry-funded monitoring**

### **Excerpt from the Final Rule for Framework Adjustment 48 to the Northeast Multispecies FMP (78 FR 26118; May 3, 2013)**

#### **2. At-Sea Monitoring Cost-Sharing**

To serve as a more long-term solution to the cost burden of at-sea monitoring to sectors, Framework 48 proposed a mechanism for sharing of at-sea monitoring costs between sectors and NMFS. Framework 48 proposed that the industry would only ever be responsible for paying the direct costs of at-sea monitoring, specifically the daily salary of the at-sea monitor. All other programmatic costs would be the responsibility of NMFS, including, but not limited to: Briefing, debriefing, training and certification costs (salary and non-salary); sampling design development; data storage, management and security; data quality assurance and control; administrative costs; maintenance of monitoring equipment; at-sea monitor recruitment, benefits, insurance and taxes; logistical costs associated with deployment; and at-sea monitor travel and lodging. This measure was intended to reduce the cost burden of at-sea monitoring to sectors and thereby increase their profitability.

NMFS has disapproved this cost-sharing measure because it is not consistent with other applicable laws as developed. Specifically, the Anti-Deficiency Act and other appropriations law prohibits Federal agencies from obligating the Federal government except through appropriations and from sharing the payment of government obligations with private entities. Framework 48 proposed to require NMFS to pay for some portion of the costs of at-sea activities, such as logistical costs generated by deployment, which are outside its statutory obligations under the Magnuson-Stevens Act. As written, this measure would also have required NMFS and sectors to share payment of obligations defined as belonging to one or the other. For example, Framework 48 proposed to require NMFS to pay some costs related to at-sea activities, such as benefits and insurance for at-sea monitors, while sectors would pay other portions of at-sea costs, like the salary for at-sea monitors. Because such action would be prohibited under the law, NMFS has disapproved this measure in Framework 48.

Although this measure was not approvable as developed, NMFS shares the Council and industry's concern about the ability of sectors to bear the full costs of monitoring in future fishing years. NMFS believes this approach to cost sharing, which defines the items that NMFS versus sectors should be responsible for, could be viable if restructured and may be worth pursuing in a future action. NMFS is already working with the New England and Mid-Atlantic Councils' joint Herring/Mackerel Plan Development Team (PDT)/Fishery Management Action Team (FMAT) to pursue cost-sharing options such as this one for those fisheries for FY 2014. The Council could consider including the NE Multispecies FMP in this joint effort to develop a workable and consistent cost-sharing mechanism for the Northeast region.

### **Excerpt from the Final Rule for Amendment 5 to the Atlantic Herring FMP**

## 1. Increased Observer Coverage Requirements

As described previously, the NEFSC determines observer coverage levels in the herring fishery based on the SBRM. Observer coverage in the herring fishery is currently fully funded by NMFS. Amendment 5 proposed increasing observer coverage in the herring fishery by requiring 100-percent observer coverage on Category A and B vessels. Many stakeholders believe this measure is necessary to accurately determine the extent of bycatch and incidental catch in the herring fishery. The Council recommended this measure to gather more information on the herring fishery so that it may better evaluate and, if necessary, implement additional measures to address issues involving catch and discards. The 100-percent observer requirement is coupled with a target maximum industry contribution of \$325 per day. There are two types of costs associated with observer coverage: (1) Observer monitoring costs, such as observer salary and travel costs, and (2) NMFS support and infrastructure costs, such as observer training and data processing. The monitoring costs associated with an observer in the herring fishery are higher than \$325 per day. Cost-sharing of monitoring costs between NMFS and the industry would violate the Anti-Deficiency Act. Therefore, there is no current legal mechanism to allow cost-sharing of monitoring costs between NMFS and the industry.

Throughout the development of Amendment 5, NMFS advised the Council that Amendment 5 must identify a funding source for increased observer coverage because NMFS's annual appropriations for observer coverage are not guaranteed. Some commenters claim that the \$325 per day industry contribution was not a limit, but a target, and that the Council intended the industry to pay whatever was necessary to ensure 100-percent observer coverage. NMFS disagrees, and does not believe the amendment specifies that the industry would pay all the monitoring costs associated with 100-percent observer coverage, nor does it analyze the economic impacts of the industry paying all the monitoring costs. The FEIS for Amendment 5 analyzed alternatives with the industry paying \$325 per day or \$1,200 per day (estimated sum of observer monitoring costs and NMFS support and infrastructure costs), but it did not analyze a range of alternatives that would approximate total monitoring costs. Budget uncertainties prevent NMFS from being able to commit to paying for increased observer coverage in the herring fishery. Requiring NMFS to pay for 100-percent observer coverage would amount to an unfunded mandate. Because Amendment 5 did not identify a funding source to cover the costs of increased observer coverage, the measure is not sufficiently developed to approve at this time. Therefore, NMFS had to disapprove the 100-percent observer coverage requirement. With the disapproval of this measure, this action maintains the existing SBRM observer coverage levels and Federal observer funding for the herring fishery.

Recognizing funding challenges, Amendment 5 specified status quo observer coverage levels and funding for up to 1 year following the implementation of Amendment 5, with the 100-percent observer coverage and partial industry funding requirement to become effective 1 year after the implementation of Amendment 5. During that year, the Council and NMFS, in cooperation with the industry, were to attempt to develop a way to fund 100-percent observer coverage.

During 2013, a working group was formed to identify a workable, legal mechanism to allow for industry-funded observer coverage in the herring fishery; the group includes staff from the New England and

Mid-Atlantic Councils and NMFS. To further explore the legal issues surrounding industry-funded observer coverage, NMFS formed a working group of Northeast Regional Office, NEFSC, General Counsel, and Headquarters staff. The NMFS working group identified an administrative mechanism to allow for industry funding of observer monitoring costs in Northeast Region fisheries, as well as a potential way to help offset funding costs that would be borne by the industry, subject to available funding. This administrative mechanism would be an option to fund observer coverage targets that are higher than SBRM coverage levels. The mechanism to allow for industry-funded observer coverage is a potential tool for all Northeast Region FMPs, but it would need to be added to each FMP through an omnibus amendment to make it an available tool, should the Council want to use it. Additionally, this omnibus amendment could establish the observer coverage targets for Category A and B herring vessels.

In a September 20, 2013, letter to the Council, NMFS offered to be the technical lead on an omnibus amendment to establish the administrative mechanism to allow for industry-funded observer coverage in New England and Mid-Atlantic FMPs. At its September 2013 meeting, the Council considered NMFS's offer and encouraged NMFS to begin development of the omnibus amendment. At this time, NMFS expects to present a preliminary range of alternatives for the omnibus amendment to the New England and Mid-Atlantic Councils in early 2014.

Additionally, other Amendment 5 measures implemented in this action help improve monitoring in the herring fishery. These measures include the requirement for vessels to contact NMFS at least 48 hr in advance of a fishing trip to facilitate the placement of observers, observer sample station and reasonable assistance requirements to improve an observer's ability collect quality data in a safe and efficient manner, and the slippage prohibition and the sampling requirements for midwater trawl vessels fishing in groundfish closed areas to minimize the discarding of unsampled catch.

The same measure that would have required 100-percent observer coverage, coupled with a \$325 contribution by the industry, would have also required that: (1) The 100-percent coverage requirement be re-evaluated by the Council 2 years after implementation; (2) the 100-percent coverage requirement be waived if no observers were available, but not waived for trips that enter the River Herring Monitoring/Avoidance Areas; (3) observer service provider requirements for the Atlantic sea scallop fishery apply to observer service providers for the herring fishery; and (4) states be authorized as observer service providers. NMFS believes these additional measures are inseparable from the 100-percent observer coverage requirement; therefore, NMFS had to disapprove these measures too. With the disapproval of these measures, the existing waiver and observer service provider requirements remain in effect.

**Excerpt from Amendment 14 to the Atlantic Mackerel, Squid, and Butterfish FMP (79 FR 10029; February 24, 2014)**

**1. Increased Observer Coverage Requirements**

Currently, the NMFS Northeast Fisheries Science Center (NEFSC) determines observer coverage levels in the mackerel fishery based on the standardized bycatch reporting methodology (SBRM) and after consultations with the Council. Observer coverage in the mackerel fishery is currently fully funded by

NMFS. In Amendment 14, the Council recommended increases in the observer coverage in the mackerel fishery, specifically 100-percent observer coverage on all limited access mackerel vessels using midwater trawl (i.e., Tiers 1, 2 and 3) and Tier 1 mackerel vessels using small-mesh bottom trawl, 50-percent coverage on Tier 2 mackerel vessels using small-mesh bottom trawl, and 25-percent on Tier 3 mackerel vessels using small-mesh bottom trawl. Many stakeholders believe this measure is necessary to accurately determine the extent of bycatch and incidental catch in the mackerel fishery. The Council recommended this measure to gather more information on the mackerel fishery so that it may better evaluate and, if necessary, implement additional measures to address catch and discards of river herring and shad. The increased observer coverage level recommendations were coupled with a target maximum industry contribution of \$325 per day. There are two types of costs associated with observer coverage: Observer monitoring costs, such as observer salary and travel costs; and NMFS support and infrastructure costs, such as observer training, data processing, and infrastructure. The monitoring costs associated with an observer in the mackerel fishery are higher than \$325 per day. Upon legal analysis of this measure, the cost-sharing of monitoring costs between NMFS and the industry would violate the Anti-Deficiency Act. Therefore, based on this analysis, there is no current legal mechanism to allow cost-sharing of monitoring costs between NMFS and the industry.

Throughout the development of Amendment 14, NMFS advised the Council that Amendment 14 must identify a funding source for increased observer coverage because NMFS's annual appropriations for observer coverage are not guaranteed. Some commenters asserted that the \$325 per day industry contribution was not a limit, but a target, and that the Council intended the industry to pay whatever is necessary to ensure 100-percent observer coverage. NMFS disagrees, and does not believe the amendment specifies that the industry would pay all the monitoring costs associated with 100-percent observer coverage, nor does the amendment analyze the economic impacts of the industry paying all the monitoring costs. The FEIS for Amendment 14 analyzes the industry paying \$325 per day, and the DEIS analyzes the cost of vessels paying \$800 per day (estimated sum of observer monitoring costs), but it does not analyze a range of that would approximate total monitoring costs. Budget uncertainties prevent NMFS from being able to commit to paying for increased observer coverage in the mackerel fishery. Requiring NMFS to pay for 100-percent observer coverage would amount to an unfunded mandate. Because Amendment 14 does not identify a funding source to cover the costs of increased observer coverage, the measure is not sufficiently developed to approve at this time. Therefore, NMFS had to disapprove the 100-percent observer coverage requirement. With the disapproval of this measure, this action maintains the existing observer coverage levels and full Federal funding for observer coverage the mackerel fishery.

In 2013, a working group was formed to identify a workable, legal mechanism to allow for industry-funded observer coverage in the herring fishery, including staff from the New England and Mid-Atlantic Councils and NMFS. To further explore the legal issues surrounding industry-funded observer coverage, NMFS formed a working group of Greater Atlantic Regional Fisheries Office, NEFSC, General Counsel, and Headquarters staff. The NMFS working group is currently exploring possibilities.

In the November 7, 2013, partial approval letter to the Council, NMFS offered to be the technical lead on an omnibus amendment to establish an administrative mechanism to allow for industry-funded

observer coverage in New England and Mid-Atlantic FMPs. At its October 2013 meeting, the Council considered NMFS's offer and encouraged NMFS to begin development of the omnibus amendment. NMFS expects to present a preliminary range of alternatives for the omnibus amendment to the New England and Mid-Atlantic Councils in early 2014.

Additionally, other measures implemented in this action help improve monitoring in the mackerel fishery. These measures include the requirement for vessels to contact NMFS at least 48 hr in advance of a fishing trip to facilitate the placement of observers, observer sample station and reasonable assistance requirements to improve an observer's ability collect quality data in a safe and efficient manner, and the slippage prohibition and the sampling requirements for midwater trawl vessels fishing in groundfish closed areas to minimize the discarding of unsampled catch.

The same measure that would have required increased observer coverage, coupled with a \$325 contribution by the industry, would have also required that: (1) The Council would re-evaluate the increased observer coverage level 2 yr after implementation; and (2) observer service provider requirements for the Atlantic sea scallop fishery would apply to observer service providers for the mackerel fishery. NMFS believes these additional measures are inseparable from the 100-percent observer coverage requirement; therefore, NMFS also disapproved these measures. With the disapproval of these measures, this action maintains the existing SBRM-based observer coverage provisions for the mackerel fishery.

## **Appendix 2**

### **Public Comments on Amendment 16**

#### **Groundfish Dockside Monitoring**

##### **Program**

1. Comment: “The Northeast Coastal Communities Sector also noted that NMFS needs to ensure that the dockside monitoring costs for all sectors are fully covered for FY 2010 and that no individual sector be allowed to carry a balance of funds into 2011 if another sector has insufficient funds to cover their dockside monitoring.”
  - Response: “Amendment 16 anticipated a number of costs associated with sectors, including costs to join a sector and pay for a sector manager, and costs associated with monitoring and reporting provisions. Amendment 16 includes estimates of the costs associated with sector measures. The Council believed that these provisions are necessary to administer and effectively monitor sector operations, and that the benefits of transitioning from the current effort control system to a quota management system under sectors outweigh the costs associated with sector provisions. Under Amendment 16, the Council specified that the fishing industry would pay for the costs associated with sector provisions, and did not provide for alternative funding sources. While many of the administrative and monitoring costs associated with sector operations during FY 2010 will be paid by NMFS through Congressional appropriations dedicated to supporting Sector development, it is unclear whether such funding will remain available to support sector operations in future FYs. Additional funding has been made available from individual states, as well as from several environmental groups, to support individual sector development. If such funding from one or more of these sources is no longer available, the fishing industry will be responsible for paying these costs. Some management measures considered in Amendment 16 were not selected in part because of concerns over the costs and burdens of administering the program. The costs associated with 100- percent at-sea and dockside monitoring coverage were deemed to outweigh the benefits expected from such measures. Therefore, this action minimized costs to the extent practicable, consistent with National Standard 7. As discussed in the response to Comment 41, each individual vessel owner must choose which management regime would provide the most benefits based upon his/her intended operations. Further, if costs to join an already existing sector are considered too high, vessels may form their own sector with similarly situated vessels. The NMFS funding available to help offset costs associated with dockside monitoring during FY 2010 have been awarded by grant to a third party, GMRI, who is working directly with sector representatives to ensure the funds are distributed equitably to each sector relative to their particular monitor needs. Variables affecting dockside monitoring costs include the volume of catch, the number of trips, the need to provide service to remote ports, the need for roving monitors, or any combination of the above. However, these costs are difficult to estimate without full knowledge of how fishing operations will be executed during

FY 2010. The amount of the total grant to be distributed to sectors exceeds the current estimated total cost of dockside monitoring for all of the sectors. If necessary, funds can be shifted to optimize their effectiveness. However, should dockside monitoring costs exceed the amount of the grant, the sectors will be responsible for paying the additional costs, consistent with Amendment 16.”

2. **Comment:** “The Northeast Coastal Communities Sector stated that NMFS should establish a minimum threshold requirement for dockside monitoring to ensure that vessels that land low amounts of fish for each trip are not subject to unnecessarily high dockside monitoring costs, particularly for small ports in eastern Maine where the low availability of regulated species does not result high volumes of fish being landed for each trip.”

- **Response:** “As noted above in the response to Comment 46, the costs associated with dockside monitoring are affected by several variables, including the amount of fish landed, or the amount of time the dockside monitor is required to observe landings. If dockside monitoring costs are based primarily upon these factors, it is possible that the costs will be lower for smaller volumes of fish landed by vessels operating in eastern Maine than for other vessels landing higher volumes of fish. However, Amendment 16 did not propose a minimum threshold of landings that would exempt a trip from the requirements to use a dockside monitor. Instead, Amendment 16 specified that dockside monitoring coverage will be randomly assigned to 50 percent of sector trips. Because Amendment 16 did not include a specific exemption from the dockside monitoring provisions for small volumes of fish landed, NMFS has not revised the dockside monitoring provi by this final rule.”

3. **Comment:** “EDF, PEW, CLF, NAMA, and the CCCHFA indicated that additional observer coverage is necessary to effectively implement sector provisions and increase the accuracy of discard estimates in the fishery. PEW and CLF suggested that at- sea monitoring coverage should be increased to 100 percent, even if that means reducing dockside monitoring coverage. NAMA suggested that such increased coverage should be applied to at least FYs 2010 and 2011 to establish a baseline of sector operations. EDF recommended that if at-sea monitoring cannot be increased to 100 percent without delaying Amendment 16, NMFS should implement more restrictive enforcement measures that require individual vessels to pay for 100 percent observer coverage for the rest of the FY if reported discards are significantly higher or lower compared to observed trips, with positive incentives for sectors that “outperform the fleet average” for reporting quality. Two commercial fishermen, PEW, CLF, and CCCHFA also recommended that NMFS implement 100-percent dockside monitoring coverage. Oceana further claimed that Amendment 16 does not specify the precise level of observer coverage in the FMP, as alleged in a lawsuit brought against NMFS based on the approval of Amendment 13 to the FMP.”

- **Response:** “When the Council adopted Amendment 16, the Council neither selected the option to require 100- percent observer coverage, nor required sectors or the common pool to be subject to an at-sea monitoring program in FY 2010. However,

NMFS agrees with the basic concept advocated by the commenters that higher levels of observer coverage are more effective at collecting the data necessary to monitor groundfish landings and discards under Amendment 16 and reducing the potential of an observer effect that could potentially compromise data collected with less than 100-percent coverage. As stated earlier in the preamble of this final rule, NMFS has funding to provide approximately 38-percent at-sea monitoring coverage for sector vessels, and about 30-percent at-sea monitoring coverage for common pool vessels, in addition to fully funding 50-percent dockside monitoring coverage for FY 2010. Such coverage levels should provide sufficient information to more than meet the minimum requirements of the SBRM, while providing the additional coverage suggested by commenters to monitor sector operations under Amendment 16. Distribution of such funds was intended to accomplish the dual goals of monitoring both at-sea catch and dockside landings to ensure that discards are accurately estimated and landings data are validated. Shifting resources to emphasize one over the other would not be consistent with the objectives of Amendment 16. Additional coverage would provide more data on groundfish catch, but even if available funds were shifted to emphasize at-sea monitoring over dockside monitoring, there may not be sufficient funding to provide 100-percent observer coverage across the entire fishery. Further, there is no guarantee that such funding will be available for future years. Requiring 100-percent coverage would, therefore, cause the fishing industry to bear such costs, absent additional funding for NMFS to pay for such coverage. Individual sectors may establish at-sea monitoring programs through their yearly operations plans that provide for additional observer coverage beyond that provided by NMFS. However, no sector has proposed such additional coverage for FY 2010. Although EDF recommended implementing additional enforcement measures that would increase at-sea monitoring coverage based upon the accuracy of a sector's discard estimates compared to the fleet average, there were insufficient details provided to determine how to implement such a mechanism. Moreover, there is no enforcement authority that would allow the kind of real-time increase of observer coverage suggested by EDF. Further, it is unclear from the description whether it would even be possible for a sector to avoid triggering 100-percent at-sea monitoring coverage, as additional coverage would be required if the sector's reports were either statistically higher or lower than the fleet average. This approach could undermine incentives to accurately report discards and would, instead, create incentives to report discards that reflect the industry average. Because the Council did not include such a mechanism to increase at-sea monitoring coverage in Amendment 16, NMFS does not have the latitude to implement such a provision through this final rule. Finally, the Court's findings in the Amendment 13 lawsuit required that FMPs establish SBRM's, but did not mandate specified levels of observer coverage. Because Amendment 16 is in compliance with the omnibus amendment that implemented SBRMs for all FMPs



managed in the NE in January 2008, Amendment 16 is not at odds with the Court's findings in the lawsuit referred to by the commenters."

4. **Comment:** "Two commercial fishermen, PEW, CLF, and CCCHFA recommended that NMFS utilize electronic monitoring to reduce costs, including deploying electronic monitoring in other fisheries to record NE multispecies bycatch. The APO commented that the standards for approving electronic monitoring technology are not clear and that the public should be involved with any decision to approve such technology."
  - **Response:** "NMFS has not yet determined whether electronic monitoring technology is sufficiently developed to be applied in the NE multispecies fishery. Criteria to evaluate such technology are currently being refined by NMFS based upon existing research and pilot programs. Any electronic monitoring technology to be applied in the NE multispecies fishery will be subject to rulemaking consistent with the Administrative Procedure Act."
5. **Comment:** "Three commercial fishermen, the AFM, and the Sustainable Harvest Sector recommend that dockside monitors should not be required for trips in which either an atsea monitor or fishery observer is deployed. They suggested that such a practice is redundant and a waste of resources."
  - **Response:** "NMFS disagrees. The roles for dockside monitors and at-sea monitors are different; dockside monitors are intended to verify the landings of a vessel and certify that landings weights on the dealer report are accurate, while at-sea monitors are responsible for verifying area fished, catch, and discards by species and gear type. Furthermore, the responsibilities of a fishery observer differ from those of an at-sea monitor, in that observers are also required to collect biological samples and more comprehensive data on the interactions with protected species and marine mammals. Moreover, because both at-sea monitors and observers do not have the capacity to operate 24 hr per day, and are often required to sub-sample portions of the catch, data from at-sea monitors or observers do not represent a complete accounting of every pound of fish that is retained by a vessel, unlike dealer reports, and cannot be used to validate dealer reports. Finally, the Council did not differentiate in Amendment 16 between trips monitored by an at-sea monitor or observer for the purposes of defining dockside monitoring coverage levels. Therefore, because the purposes of dockside monitors and at-sea monitors and observers are different, the associated data for each entity are not directly comparable, and because the Council did not consider the exemption requested by the commenters, NMFS is not implementing such an exemption through this final rule."

## Appendix 3

### Public Comments on Framework 45's Proposed Rule

#### - Changes to the Sector Dockside Monitoring Program

1. **Comment:** “The NSC questioned the utility of dockside/roving monitoring requirements, suggesting that FW 45 should eliminate such requirements completely. The NSC believes the current requirements to be highly inefficient, representing an unsustainable and unjustified cost to the fishing industry. Further, they suggested that NMFS should allow sectors to use dockside monitoring data as a proxy for dealer data in the weekly sector catch reports submitted to NMFS to increase the utility of the dockside/roving monitoring program. Finally, NSC indicated that roving monitors should not have to observe offloads to a truck and also to a dealer, asserting that roving monitors should only be required to observe offloads from the vessel to a truck, to increase the efficiency and reduce costs associated with these provisions.”
  - **Response:** “The Council considered completely eliminating dockside/roving monitoring requirements during the development of FW 45. However, due to lingering concerns over the ability to enforce existing provisions to monitor sector ACE and minimize incentives to misreport catch, the Council retained dockside/roving monitoring requirements in FW 45. NMFS may only approve or disapprove measures proposed in FW 45, and may not change or substitute any measure in a substantive way. Therefore, NMFS cannot eliminate dockside/roving monitoring requirements through this final rule. During the development of Amendment 16, it was anticipated that sectors would rely upon dockside/ roving monitor data to document sector landings immediately following a vessel’s offload until the official dealer reports become available approximately a week later. This practice has been discussed with sector managers through several sector workshops held during 2009 and 2010. NMFS recognizes that dockside/roving monitoring data cannot currently be reported as part of the weekly sector catch reports submitted to NMFS based upon existing guidance and database structures. To date, many dockside/roving monitoring data are not systematically collected in a format that can be easily transferred to a catch monitoring database. Instead, they are often merely scanned images of a dockside/roving monitor report. NMFS has the regulatory authority to accept dockside/roving monitoring data in the future and may reconsider the acceptance of dockside/roving monitoring data if such data become available in an acceptable electronic format. Further, dealer landings, as documented through official dealer reports, have been the standard by which landings are monitored for many years, and were used as the basis for the calculation of potential sector contributions and, therefore, sector ACE. Accordingly, even if dockside/ roving monitor data could be considered as a proxy for dealer landings in weekly sector catch report, dealer landings data would continue to be the official record of species landed by each federally permitted vessel. The Council required sectors to develop

and implement an independent third-party weighmaster system satisfactory to NMFS for monitoring landings and utilization of ACE. The original intent of dockside/roving monitoring coverage was to verify landings of a vessel at the time it is weighed by a dealer to certify the landing weights are accurate as reported on the official dealer report for compliance purposes. Therefore, NMFS implemented regulations under Amendment 16 that require that a roving monitor must observe the offloads from a vessel to a truck and again from the truck to a dealer, unless the vessel offloads directly to a dealer. These regulations were based upon a pilot program and existing dockside/ roving monitoring programs developed in other regions and in Canada. During sector implementation workshops conducted in 2009 and 2010, and ongoing communications with sector managers, NMFS indicated that it would allow a roving monitor to only observe offloads from a vessel to a truck, provided a representative from the dealer ultimately receiving the fish was present at the time of the offload, and that all fish were weighed at the time of the offload. This ensures that the weight of fish offloaded corresponds to the weight of the fish recorded in the official dealer report, consistent with the intent of Amendment 16. Thus, existing regulations and protocols already allow for the behavior requested by the NSC in their comment.”

2. Comment: “The NEHFA, PERC, PEW, and one commercial fisherman supported exempting vessels issued a limited access NE multispecies Handgear A or a Small Vessel Exemption permit or an open access NE multispecies Handgear B permit that is fishing in the common pool from the existing dockside/roving monitoring requirements. They stated that dockside/roving monitoring costs may be more than the value of fish landed on a particular trip and would make the operation of such permits economically unviable. The NEHFA also noted that many handgear vessels are launched and retrieved at public boat ramps, thereby creating logistical difficulties for waiting for the dockside/roving monitor to arrive because a boat may be forced to move off of the dock to accommodate the launching of other boats. This group also contended that the current system of monitoring landings is sufficient for these vessels due to the small amount of fish landed on each trip. Finally, PERC suggested that handgear vessels fishing in sectors should also be exempted from the dockside/roving monitoring requirements.”
  - Response: “NMFS agrees that the costs associated with the existing dockside/ roving monitoring requirements could make fishing with a Handgear A, Handgear B, or Small Vessel Exemption permit uneconomical for the reasons noted above and specified in FW 45. Therefore, NMFS implements the proposed exemption from the common pool dockside/roving monitoring requirements for these permit categories through this final rule. Because the Council did not adopt a provision that would have exempted sector vessels fishing with a handgear permit from the dockside/roving

monitoring requirements as part of FW 45, NMFS cannot implement such a provision through this action.”

3. Comment: “Three commercial fishermen and two commercial fishing industry groups (AFM and NSC) opposed the proposal to require dockside/roving monitors to inspect the fish holds of vessels offloading groundfish. AIS, Inc., a dockside/roving monitoring service provider, also expressed concerns that the proposed requirement for dockside monitors to inspect fish holds presents safety issues. All commenters highlighted the risk of serious injury from having dockside/ roving monitors board vessels, climb down ladders into the fish holds, and inspect the holds or other compartments for fish that have not been offloaded. AIS noted that there are no standards in FW 45 that address potentially dangerous conditions in inspecting holds, or requirements for vessels to provide a standardized safe boarding system. AIS also stated that there is no guidance as to how to inspect fish holds, including whether dockside monitors must inspect piles of ice or look for fish in other compartments, giving the impression that dockside/ roving monitors may be acting as enforcement personnel instead of data collectors. Several commenters suggested that this potential risk will force vessel owners to buy more insurance to ensure that they are adequately covered for any potential liability lawsuits that might result from this provision. In doing so, they contested that this would contradict the FW 45 economic analysis that indicates that this measure should not impact either vessel owners or service providers. They noted that, even if the dockside/roving monitoring service providers had sufficient insurance coverage, vessel owners might still be sued and face financial liability from the injury claims of individual dockside/ roving monitors. Further, they claimed that the proposed rule does not provide any rationale that enhanced enforceability is needed, or that underreporting is occurring. They contested that the existing provisions that require dockside/roving monitors to ask vessel operators if all fish have been offloaded, and classify providing false statements to dockside/roving monitors as a violation, should be sufficient to enforce this provision. They recommended that NMFS Office of Law Enforcement should inspect fish holds, instead of dockside/roving monitors.”
- Response: “As noted throughout the development of Amendment 16 and FW 45 by both fishing industry representatives and NMFS, the transition to expanded sector management and ACLs increases incentives to misreport or under report catch and landings. Dockside/roving monitoring programs established in other regions of the United States and Canada that are managed by harvest quotas are considering, or have required, dockside/roving monitors to inspect fish holds to ensure that all fish are offloaded. The potential for dockside/roving monitors to inspect fish holds was explicitly discussed throughout the development of Amendment 16 as part of both the Council process and parallel meetings to discuss the development of sector measures sponsored by the Gulf of Maine Research Institute. Section 4.2.3.5.4 of the Amendment 16 FEIS documents this discussion and clearly indicates that to be approved as a dockside/roving monitor, a dockside/ roving monitor must meet several

criteria, including: ‘Physical capacity for carrying out the responsibilities of a dockside/roving monitor pursuant to standards established by NMFS such as being certified by a physician to be physically fit to work as a dockside/roving monitor. The physician must understand the monitor’s job and working conditions, including the possibility that a monitor may be required to climb a ladder to inspect fish holds.’’ Therefore, the general public, including both vessel owners and dockside/roving monitoring service providers, were well aware of the potential that dockside/ roving monitors might be required to inspect fish holds and the risks that such activity might incur. However, no comments opposing this practice were raised to NMFS during the public comment period on the Amendment 16 proposed rule. The final rule implementing Amendment 16 measures did not require dockside/roving monitors to inspect the fish holds based, in part, on a pilot dockside/roving monitoring program conducted in the summer of 2009. Similar to comments received on this action, some safety concerns were identified with inspecting fish holds during the pilot program, even though fish holds were actually inspected as part of that pilot program. As a result, in the Amendment 16 proposed (74 FR 69382; December 31, 2009) and final rules, NMFS intentionally included language in the dockside/roving monitoring program operational standards at § 648.87(b)(5)(ii)(B)(1) that allow individual dockside/roving monitors or service providers to inspect fish holds if they elect to do so. Section 311 of the Magnuson-Stevens Act provides the Secretary of Commerce with the general authority to enforce the provisions of the Magnuson-Stevens Act. NMFS acknowledges that existing dockside/roving monitoring provisions make it a violation for a vessel operator to provide false statements to a dockside/roving monitor about whether all catch is offloaded. However, that is just one of many ways to ensure compliance with existing regulations. NMFS does not agree that such measures are completely sufficient to ensure that all catch is offloaded. The only way to validate statements made by a vessel operator is to actually inspect fish holds. NMFS Office of Law Enforcement personnel already have the authority to board and inspect vessels. However, requiring dockside/roving monitors to also inspect fish holds, as anticipated during the development of Amendment 16, provides another means to ensure that vessel operators are complying with existing requirements, and that all fish that are landed are recorded in dealer databases or other data sources such as dockside/roving monitor reports. Dockside/roving monitors are not enforcement personnel, but their observations, including the reports summarizing the offloads of individual trips, are available to law enforcement personnel, as described in Section 4.2.3.5.4 of the Amendment 16 FEIS and the existing regulations at § 648.87(b)(4). The training provided to dockside/roving monitors by NMFS explicitly states that it is the dockside/ roving monitor’s responsibility to account for all catch, whether or not it is properly weighed or recorded by other parties. Monitors must record any species that is not weighed in their incident report to facilitate compliance with existing

requirements. Therefore, based on the need to ensure that NMFS is accurately monitoring the amount of fish landed, NMFS has retained the requirement that dockside/roving monitors must inspect fish holds as part of this final rule. NMFS recognizes that dockside/ roving monitors must proceed with caution when conducting inspections of fish holds. As part of the dockside/ roving monitoring training curriculum and certification process overseen by NMFS, individual dockside/roving monitors are trained and tested for competency in safety procedures, including slips, trips, and falls; electrical safety; climbing stairs and ladders; overhead dangers; unstable items; and fire. In addition, NMFS will likely require all previously certified dockside/roving monitors to attend a refresher safety training session on issues specific to boarding vessels and inspecting fish holds. Based on examples in other U.S. and Canadian fisheries, NMFS is currently developing standardized protocols that outline the major elements that dockside/roving monitors must comply with when inspecting fish holds. These elements include, but are not limited to, requesting permission from the vessel captain to board a vessel, following the instructions of the vessel's captain and crew to safely enter and exit the fish holds, and inspecting only areas of the vessel that would normally be used to store fish. Such standards will be integrated into the dockside/roving monitoring training curriculum developed and conducted by the Northeast Fishery Observer Program. The dockside/roving monitor service provider approval standards adopted in Amendment 16 explicitly included the requirement for service providers to have adequate insurance to cover injury, liability, or accidental death that might befall dockside/roving monitors. NMFS recognizes that despite such coverage, individual dockside/roving monitors still have the capacity to bring a lawsuit against vessel owners for any injuries incurred while inspecting fish holds. NMFS encourages sectors and dockside/ roving monitor service providers to seek agreement on how to best address the issues and problems raised by the comment. As to whether FW 45 sufficiently considers possible increases in cost for liability insurance for inspecting fish holds, NMFS does not have sufficient information to do so. While NMFS has information on the amount and type of insurance dockside/ roving monitoring service providers have purchased, it would be difficult for NMFS to speculate on the costs of additional insurance for individual vessels. However, NMFS is committed to reviewing the requirement to inspect fish holds and the costs associated with it over time as more information becomes available.”

4. Comment: “Two industry groups (AFM and NSC) supported the proposal to delay the industry’s responsibility for dockside and at-sea monitoring costs until FY 2013. They stated that this accurately reflects the fishing industry’s inability to pay for the high costs of such monitoring at this time. However, the NSC cautioned that the economic viability of the fishing industry is not likely to improve sufficiently to enable sectors to cover such monitoring costs in FY 2013. Accordingly, they recommended that the Council and NMFS

should consider further postponing industry responsibility for such costs until the fishing industry is profitable again. In contrast, PEW suggested that sectors should be in a better position to assume monitoring costs in FY 2013. PEW offered that the proposed delay would help ensure the success of the established sector program, arguing that the long-term benefits of fishing under sectors outweigh any potential impacts associated with reduced dockside monitoring in the short term. Oceana opposed delaying industry responsibility for dockside and at-sea monitoring costs, claiming that NMFS does not have the authority to modify sector monitoring provisions in a FW action because such a measure would be a fundamental change in the FMP and that implementing this delay through a FW action would circumvent the public process. Citing a recent court case (*Oceana, Inc. v. Evans*, 384 F. Supp. 2d 203, 255 (D.D.C. 2005)), they contended that such measures can only be modified through an amendment, with an associated NEPA document. They also suggested that the proposed delay would undermine the Magnuson Stevens Act requirements to monitor bycatch and implement measures to ensure accountability for ACLs, especially considering the concerns expressed by NMFS in a November 15, 2010, letter to the Council highlighting concerns about the potential limitation of NMFS funding in 2012 to support dockside and at-sea monitoring. FWW echoed this concern, noting that this might cause a “gap in the necessary enforcement required due to increased incentives for high-grading, misreporting, and underreporting.” They recommended that delaying or removing monitoring costs should be based on vessel size/capacity, or an individual business’s revenue.”

- Response: “NMFS recognizes that the costs of requiring the fishing industry to pay for sufficient at-sea monitoring coverage could reduce profitability. However, a FMP must continue to maintain measures that prevent overfishing and promote the long-term health and stability of the fishery, as required by section 303(a) of the Magnuson-Stevens Act. As noted above, NMFS is concerned that relying exclusively on available NMFS funding for at-sea monitoring coverage during FY 2012 may reduce the amount of at-sea monitoring coverage available during that FY due to the yet uncertain amount of available NMFS funding for FY 2012. NMFS agrees that delaying industry responsibility for paying for at sea monitoring coverage may reduce the amount of at-sea monitoring coverage during FY 2012 and undermine efforts to obtain accurate information regarding catch in the fishery. Therefore, NMFS has disapproved the proposed measure to delay industry responsibility for the costs at-sea monitoring coverage during FY 2012. NMFS expects at least some funding that will offset at least some of the at-sea monitoring coverage costs during FY 2012. Accordingly, the fishing industry would only be responsible for the costs of at-sea monitoring coverage that is not accounted for by available Federal funding. As noted in the FW 45 EA, delaying industry responsibility for funding dockside/roving monitoring coverage in FYs 2011 and 2012 will immediately reduce operational costs to industry, without reducing the availability of landings information. This is because the dockside/roving monitoring data are primarily used for enforcement purposes, not

catch monitoring. The trip-end hail report, in conjunction with the requirement for dockside/roving monitors to inspect fish holds implemented by this final rule, is intended to provide sufficient information to ensure compliance with existing regulations. Moreover, NMFS is expected to have sufficient funding in FY 2011 to continue the levels of observer and at-sea monitoring coverage for both sector and common pool trips implemented in FY 2010, and to augment that with sufficient dockside/ roving monitoring coverage for trips not monitored by observers or at-sea monitors. Even if insufficient funding available to NMFS results in a shortterm reduction in dockside/roving monitoring data, NMFS agrees that such reductions in data would likely be offset by long-term benefits of fishing under sectors. Therefore, NMFS is approving the delay in industry responsibility for dockside/roving monitoring costs through this final rule. Further changes could be considered by the Council through a future management action, but because NMFS does not have the authority to revise measures adopted by the Council in FW 45, NMFS cannot unilaterally postpone industry responsibility for such costs beyond FY 2012 through this action. NMFS disagrees that the proposed postponement of industry responsibility for dockside/roving and at-sea monitoring costs represents a fundamental revision of the FMP and would circumvent the public process. First, the fundamental dockside/roving and at-sea monitoring provisions implemented by Amendment 16 are retained. The only aspect of these provisions that changes through FW 45 is the entity paying for the costs of such monitoring. Although NMFS will pay for at least some of the costs of dockside/ roving and at-sea monitoring coverage for FYs 2011 and 2012, and will endeavor to achieve the coverage requirements specified in Amendment 16 for industry-funded dockside/roving and at-sea monitoring coverage, these changes do not constitute a fundamental change to the FMP requiring an amendment to the FMP. Second, the Council fully anticipated that measures adopted under Amendment 16 could be revised in the future through a FW action. This is documented in the Amendment 16 FEIS's executive summary when it states, "The periodic adjustment process is modified so that all measures adopted can be adjusted on a framework action" (see page 10 of that document) and in Section 4.2.8. This was codified in the regulations at § 648.90(a)(2)(iii) and (c)(1)(i). Both the Amendment 16 FEIS and the proposed regulations to implement Amendment 16 measures were made available for extensive public comment. Therefore, because the fundamental aspects of the Amendment 16 sector and common pool monitoring measures are not affected by the proposed delay in responsibility for monitoring costs, and that the public was afforded substantial opportunity to comment on the ability of the Council and NMFS to revise existing management measures through a FW action as part of the Amendment 16 proposed rule, NMFS has not remanded this provision back to the Council for implementation through an amendment to the FMP."



April 9, 2013

Mr. John K. Bullard, Regional Administrator  
NOAA Fisheries – National Marine Fisheries Service  
55 Great Republic Drive  
Gloucester, MA 01930

RE: Framework 48 to the Northeast Multispecies Fishery Management Plan  
**NOAA-NMFS-2013-0050**

Dear Mr. Bullard:

On behalf of Conservation Law Foundation (CLF), I am writing to provide comments on the rule proposed by NOAA Fisheries for Framework 48 (FW 48) to the Northeast Multispecies Fishery Management Plan.<sup>1</sup> We recently submitted joint comments with the Pew Charitable Trusts to NOAA Fisheries on the related sector operations plans rule.<sup>2</sup> CLF focuses here on our particular concerns with Framework 48, most particularly the proposal to authorize a procedure that would allow sectors to access the year-round groundfish closed areas through their annual sector operations plan approval process.

We would note initially three contextual circumstances that surround the series of framework adjustments and sector ops plan approvals that are being promulgated in such a rushed manner this spring with significantly foreshortened public review and comment periods. First, there is a crisis with a number of groundfish stocks including both cod stocks, GOM haddock, and a number of flounder stocks. Many of the stock assessments exhibit significant retrospective patterns and the assessment scientists have already cautioned that their estimates may be optimistic in terms of predicted the actual condition of those stocks. With cod, age structure is significantly truncated and weights at age are low. Many of these stocks are in crisis as a direct result of the failure to curb overfishing and are now further burdened by worsening environmental factors.

There is no rational reason to place these stocks at any greater risk of further collapse. Although there are a number of significant quota cuts, there are also a number of quota increases in the fishery. Moreover, few, if any, multispecies permit holders are dependent on revenues from the

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<sup>1</sup> Northeast (NE) Multispecies Fishery; Framework Adjustment 48; Federal Register / Vol. 78, No. 57 / Monday, March 25, 2013 / Proposed Rules / pages 18188-219.

<sup>2</sup> Letter to Alison Murphy, NOAA-Fisheries, from Pew Charitable Trusts and the Conservation Law Foundation dated March 28, 2013:  
NOAA\_NMFS\_2013\_0007\_Sector\_Plans\_Pew\_CLF\_0328\_2013 (1jx-84gi-fimp).

stocks with quota cuts, having diversified to a broad range of other species for some time. What is at risk by the measures proposed in Framework 48 as well as several of the other management actions being taken in this period is the long term future of a number of critical stocks and as well as the related fisheries that unavoidably catch these stocks as bycatch, thereby threatening long term risks of substantially greater social and economic harm.

The second overarching circumstance framing the Framework 48 action is the Omnibus EFH Habitat Amendment (Omnibus Amendment). The Omnibus Amendment has been slowly moving through the management process for close to a decade, despite the fact that protection of essential fish habitats from fishing activities was one of the primary legislative purposes of the Sustainable Fisheries Act of 2006. Significant technical analysis has been done in support of the current thinking underlying the Omnibus Amendment but none of that analysis has been presented to the public in a final form and the gaps in that analysis with respect to a consideration of the full range of benefits that EFH provides to species productivity are well known. Much of the work that is currently underway by the Closed Area Technical Team (CATT) is focused on improving that analytical framework and coming to a better understanding of the relationships between essential fish habitats and species productivity and management actions to mitigate or avoid deleterious effects. Each meeting of the CATT produces new information and insights into the multiple ways in which these closed areas are benefitting managed groundfish species, well beyond the mortality reduction benefits.

That analysis, however, is not complete. The documentation, alternatives analysis, and mitigation measures have not been fully reviewed; and the public has had no opportunity yet to understand and respond to the complex set of issues that will be addressed in the Omnibus Amendment. Any material or points of view about the relative contributions of various parts of the existing closed or open areas to improved productivity that are included in those documents are preliminary from a legal point of view. Nevertheless, even the language that is being used in Framework 48 to distinguish “mortality closures” from “habitat closures” reveals that the agency is already making decisions to promote opening existing closed areas on the basis of that preliminary analysis, prejudging the final decision document and environmental analysis. The agency’s action constitutes a classic segmentation of the environmental review process that is fundamentally against the principles and law of the National Environmental Policy Act (“NEPA”).

The negative impacts of the NEPA segmentation are exacerbated by the fact that all these decisions are being made in a foreshortened and confusing public comment period that stretches across four separate regulatory actions: the sector operating plan regulations, Framework 48, Framework 50, and then whatever form the later action takes on approving sector access in some or all of the closed areas later this year. This is the sort of chopped up, incoherent, and disjointed federal environmental review that routinely is found to violate NEPA. The agency here is already on record with the position that if this very same set of questions were to be raised together, there would be no question that an extended and integrated environmental review would be required.

The proposed solution of breaking the decision into smaller pieces is being proposed by the agency for the explicit purpose of avoiding that result. Such an approach is antagonistic to the principles of broad public participation and reasoned, integrated decision making that NEPA is intended to bring to all major federal decisions.

Finally, CLF strenuously objects to the framework process by which the existing closed areas are being made available for access for fishing. This is virtually the same approach that was rejected by the Federal District Court for the District of Columbia in Oceana, Inc. v. Evans, 384 F. Supp. 2d 203, 254, order clarified, 389 F. Supp. 2d 4 (D.D.C. 2005). In Oceana, the court set forth the following standard: “[a] framework adjustment that truly adjusts management measures according to specifications in the FMP might well be lawful, whereas so-called adjustments which in fact undermine or contravene key provisions of an FMP would not.” Oceana, Inc. v. Evans, 384 F. Supp. at 254.

In the instant case, Amendment 16 is the controlling last amendment and it specifically indicated that access to the year-round closed areas was not available to the sectors through their annual operating plans. CLF can find no support in the record of that action that would suggest that opening of any and all of the year-around closures was to be a proper subject of a framework action. Framework 48 directly undermines and contravenes that prohibition in Amendment 16 and is not a proper subject for a framework amendment. To make the situation even more untenable legally, Framework 48 itself does not even frame out or elucidate what the extent and type of access sectors will be allowed. Those sets of decisions are being delegated to yet another action, which seems to not even have the formal status of a framework: a later approval process with unspecified parameters or scope or even timing.

We will now turn to the provisions of Framework 48 itself and provide comments in the order the issues are identified in the document:

#### 1. Status Determination Criteria for SNE/MA Yellowtail

It is difficult to understand a “best-available-science” assessment for SNE/MA yellowtail flounder that the stock could either be fully rebuilt and not overfished and not experiencing overfishing or that it is experiencing overfishing, is overfished, and the productivity of the fish population is so low that it might not ever rebuild even if fishing mortality were held to zero. While the evidentiary split of 60:40 suggests that the assessment scientists certainly considered it was a close call, it nonetheless seems a true Hobson’s choice. Perhaps SNE/MA yellowtail is just another indicator of a heavily disturbed system coupled with inadequate analytical tools for management.

#### 2. SNE/MA Windowpane Flounder sub-ACLs

Given the recent significant exceedance of the total ACL limits for two years, we are pleased to see a new set of reactive and proactive accountability measures for this stock.

### 3. Scallop Fishery sub-ACLs for GB Yellowtail Flounder

These provisions make sense and we think the incentive structure provided by the FY2014 sub-ACL is appropriate.

### 4. Small-Mesh Fisheries sub-ACL for GB Yellowtail Flounder

At 100mt, the small-mesh catch of GB yellowtail flounder is significant and it is important that effective AMs are developed to control mortality in this fishery within prescribed limits. The proposed regulation requires subsequent action to be effecting and the public should know when adequate AMs will be developed in the small-mesh fisheries.

### 5. Recreational Fishery AM

CLF supports the requirement in the law that there should be proactive accountability measures available to the Administrator to ensure that the recreational sub-ACL is not violated.

### 6. Commercial Groundfish Fishery AMs

CLF supports the proposal in this framework to increase the effectiveness of the AMs by accelerating implementation in the fishing season after the overage is believed to have occurred. We also support the promulgation of rules setting area-based AMs for Atlantic Halibut, Atlantic wolffish, and SNE/MA winter flounder. We also support the revised AMs for SNE/MA windowpane flounder, including specifically the area-based AMs.

### 7. Commercial Fishery Minimum Sizes

The goal of these proposals is to reduce regulatory discards and increase revenue from the catch. These proposals are troubling however because they will have a tendency of encouraging fishermen to target small fish that have barely become sexually reproductive. Discards are wasteful and inefficient. However, because discards are counted against the catch but produce no financial return, the current size limits provide a natural disincentive to catching fish just entering the fishery. This action would remove that disincentive and likely still produce large discards of sub-legal fish. The 16" haddock size limit seems designed to promote the targeting of the latest large year class, a year class that might be vital to the future of the fishery if it were allowed another season or two. We have been told and we believe that a number of fishermen also are encouraged to fish illegally with net liners and other devices to prevent the escape of any legal-sized fish, even at the expense of high discards of undersized, sexually immature fish. With continued low levels of observer coverage coupled with the ACL cuts, it is reasonable to expect that such behavior might increase. Lowering sizes will produce more discards, not fewer. This might be less of a problem if full retention were required of all catch; at least then a more accurate picture of the bycatch problem might be documented. But the Council has not elected to do that.

## 8. Sector Monitoring Program

### A. At-Sea Monitoring

Monitoring the New England groundfish fishery has become a troubling flash point and the quality and quantity of the data inputs to the stock assessment models threatens the very foundations of the public's confidence in fishery management. There is an industry perspective that can be seen in Framework 48 that it is the public's responsibility to pay for any monitoring as evidenced by the following sort of statement: "Framework 48 proposes to delay the industry's responsibility for at-sea monitoring costs to FY 2014.... Coverage levels would instead be set at the level that NMFS can fund."<sup>3</sup> The failure of the Council and federal managers to manage these fisheries at sustainable levels has produced the apparent consequence that the scientists and manager are either stuck with inadequate data of the actual catches or fishing businesses that are financially burdened by the low quota levels are forced out of business by the burden of any marginal monitoring costs. We say "apparent" because it remains unclear to CLF what is the broad financial condition of the multispecies permit fleet. Many of the aggregate numbers neither support the notion that there is an economic crisis for vessel owners nor the notion that many multispecies permit holders are currently economically dependent on the stocks that will be experiencing quota cuts in FY2013. The industry has to bear its burden of monitoring if it wants to continue to pursue these fisheries. Raiding the scarce federal funding available for the process of approving electronic monitoring for this fishery in order to cover short-term monitoring costs is one of the worst proposals from a cost-benefit perspective that we can imagine in this area.

This monitoring directly bears on the managers' ability to understand what is actually going on with the various stocks of fish at sea. Monitors provide critical data that supports *increases* in quota as well as *decreases*. The assessment scientists seem to have formed a broad consensus that the persistent retrospective patterns they have seen in many of their groundfish models is a result of missing significant mortality in the fish at sea.

The Council's proposal in Framework 48, like the related provisions in the Sector Operations Plans Proposed Rule (NOAA—NMFS 2013-0007), does not meet applicable legal or regulatory thresholds. They preclude accurate monitoring of sector-level catch and thus undermine the meaningfulness of any of the sector-based accountability measures. These problems have been identified in extensive and thorough detail in the Sector Operations Plan Proposed Rule comments of Oceana. We have attached the Oceana comments to this letter and hereby adopt and incorporate them by reference as if fully set forth herein. The agency should reject the Framework 48 monitoring proposal.

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<sup>3</sup> Northeast (NE) Multispecies Fishery; Framework Adjustment 48, Supplemental Information at 26.

## B. Dockside Monitoring

CLF supports the elimination of the dockside monitoring program as long as the dockside monitoring hail requirements and an effective dockside intercept system are in place, operational, and demonstrably effective.

## C. General Monitoring Comments

With respect to the principle objectives of sector monitoring programs, it is becoming apparent that catch is being misidentified as to the stock area where it is being caught. This is a major problem for assessments and for inshore boats that are disproportionately dependent on particular stocks of fish. Accurate and timely identification of catch by stocks and by place is essential to the fishery and must become a much higher priority for the sector monitoring programs. Of course, without sufficient and appropriate sector/stock monitoring and stratification, all of these principles are meaningless.

We also remain very concerned that the monitoring protocols seem to result in too many monitoring trips on smaller boats that catch a diversity of species but are not responsible for a significant portion of the groundfish species of concern. On the other hand, many of the larger vessels that are targeting these species—and have a greater capacity to support the costs of monitoring—are not being targeted by the monitoring effort. CLF also strongly objects to the qualifying language—“to the extent practicable”—in the rulemaking associated with sector monitoring. Monitoring needs to be adequate to its purpose. Fisheries, or sectors within fisheries, that cannot meet appropriate performance standards should not open.

The rationale for reducing ASM on monkfish DAS trips seems to be sound in a world of constrained monitoring, and the protocols associated with the proposal seem appropriate. There is no reason, however, why electronic monitoring and full retention policies have not been developed and implemented in New England fisheries. These large mesh fisheries are perfect examples of where such programs would be very cost effective, produce valuable catch data, and promote regulatory compliance. Lowering the monitoring requirements works against this goal and is likely a false savings. The program will have to be carefully managed so that significant groundfish discards are not hidden by this loophole from normal coverage requirements.

## 9. GB Yellowtail Flounder Management Measures

The primary problem at this point in time with GB yellowtail management is the recent revelation that potentially wide-scale misreporting of the areas where GB yellowtail are being caught is taking place. This proposal, while understandable on its face, seems likely to create even more misreporting by unobserved boats. Until NMFS develops a better understanding of the extent of catch misreporting and implements measures to reduce the practice, this finer scale tuning of discard rates should not be approved.



## 10. List of Allowable Sector Exemption Requests

This section of the proposed rules eliminates the prohibition set out in Amendment 16 that sectors may not request access to year-around closed areas. The two rationales driving this change are eliminating the redundancy of catch limits and mortality-based closed areas and allowing the multispecies permit fleet access to areas where they could target redfish, pollock and GB haddock. The assumptions underlying these rationales are that the existing closed areas are closed purely to limit fishing mortality and that there are populations of haddock, redfish and pollock in these areas that are otherwise not accessible to the groundfish fleet. Both assumptions are invalid.

With respect to the fishery management functions being served by the existing closed areas, it is apparent from a review of the record that they were all closed for multiple reasons, not just to reduce mortality on groundfish populations. The Framework 48 comment letter submitted by the Pew Charitable Trusts and the appendix attached to that document lay out a detailed history of the closed areas. The Pew comment letter and its appendix are attached to these comments and we adopt and hereby incorporate them by reference as if fully set forth herein. CLF agrees with all the facts and the conclusions in those materials.

With respect to the rationale that access is needed before the Omnibus Amendment is completed in order to provide access to GB haddock, redfish and pollock, the analysis conducted by the CATT completely undercuts that justification. Redfish populations are not significantly identified with any of the existing closed areas and the ACL is fully accessible to the fleet without any opening of closed areas. The only analysis that suggests that additional pollock might be available if a closed area were to be open focuses on the proposed thin box on the eastern side of the Western Gulf of Maine Closed Area. Irrespective of this analysis, the entire pollock ACL appears to be readily accessible within currently open areas, thus obviating the need to reopen area for access to pollock. As for haddock, there already exist SAP programs that are designed to allow access to potential haddock in the Georges Bank closed areas but that issue seems almost academic given the fact that the fleet has caught such a low percentage of its ACL in FY2012. There is no evidence from the trawl surveys or observer data that those haddock are hiding out in CA I or CAII.

Indeed, looking objectively at the situation, the economic analysis of the proposed opening of the existing closed areas concluded that there was a chance of “neutral”—no benefits—to slightly positive benefits associated with allowing access into those areas with significant chances of major long term negative economic consequences. CLF believes that the characterization of the CATT literature search and economic analysis provided in the supplement information associated with Framework 48<sup>4</sup> puts a positive spin, if not an outright exaggeration on the positive side of the presentations CLF observed on this topic at the CATT. In the actual words of

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<sup>4</sup> Northeast (NE) Multispecies Fishery; Framework Adjustment 48 at 40-41.

the economist who conducted the analysis: “there is potential for much greater costs if the exemptions place fishing pressure on critical life stages or greater gear interactions ensue, which would result in a negative net benefit of undetermined magnitude.”<sup>5</sup>

Others have commented on the increased impacts on protected marine mammals if these significant areas were to be re-opened to fishing as well as conflicts between recreational fishermen in the western GOM closure area. All those comments are meritorious and counsel against opening access to these areas.

#### A. Framework 48 Does Not Comply With the National Environmental Policy Act (NEPA)

As a federal agency proposal to modify the terms of an existing FMP, Framework 48 constitutes a major Federal action under NEPA that triggers the requirement to assess the environmental impact of such the proposed changes to the multispecies regulatory regime. 42 U.S.C.A. § 4332(2)(C). *See, e.g., Greenpeace v. Nat'l Marine Fisheries Serv.*, 55 F. Supp. 2d 1248, 1257 (W.D. Wash. 1999). NEPA imposes a requirement that federal agencies “will have available and will carefully consider detailed information concerning significant environmental impacts” before a project is approved. *Winter v. Natural Res. Def. Council, Inc.*, 555 U.S. 7, 23 (2008) (quoting *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989)). *See also City of Alexandria, Va. v. Slater*, 198 F.3d 862, 866 (D.C. Cir. 1999).

An environmental impact statement (EIS) must include a detailed statement of the environmental impact of the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, alternatives to the proposed action, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. 42 U.S.C. § 4332(2)(C)(i)-(v). If it is unclear whether a full EIS is required, an agency must at a minimum prepare an environmental assessment (EA). 40 C.F.R. § 1501.4(b).

While an EA is not as comprehensive as an EIS, an EA must take a “hard look” at potential environmental consequences and consider reasonable alternatives. *See Cape Hatteras Access Pres. Alliance v. U.S. Dept. of Interior*, 731 F. Supp. 2d 15, 34-35 (D.D.C. 2010), and *Flaherty v. Bryson*, 850 F. Supp. 2d 38, 71 (D.D.C. 2012). More specifically, an EA must discuss the need for the proposal, identify alternatives to the proposed action, and describe the environmental impacts of both the proposed action and the alternatives, including direct, indirect and cumulative impacts. *Nat'l Trust for Historic Pres. in the U.S. v. U.S. Dept. of Veterans Affairs*, CIV.A. 09-5460, 2010 WL 1416729 (E.D. La. Mar. 31, 2010). If, following this “hard look” at a proposed action and its potential effects, an agency determines that the action will not result in any significant environmental impacts, the agency may issue a “finding of no significant impact”

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<sup>5</sup> DePiper, October 25, 2012 at 5.



(FONSI) and is excused from preparing an EIS. *Id.* However, if the record does not support a FONSI, the agency must issue an EIS. *Id.*

In this case, the record reflects that the NOAA Fisheries has not previously analyzed the potential environmental consequences of the proposed use of a sector operations plan exemption to re-open areas that are currently closed to fishing for groundfish. Amendment 13 to the Northeast Multispecies Fishery Management Plan, published on April 27, 2004, described the procedure for establishing sectors, identified a list of management measures that may be adjusted through a framework action, and specifically provided that the Regional Administrator may not grant exemptions to year-round closure areas. §648.87(b)(1)(xvi). The prohibition on granting exemptions to NE multispecies year-round closure areas was reiterated in Amendment 16. §648.87(c)(2)(i). Because the re-opening of closed-areas was characterized as a prohibited act, such action was not analyzed in either an EIS or an EA nor, consequently, was a FONSI issued pertaining to such action. In light of this history, the fact that much of the area being proposed for access to sectors has been closed to groundfishing for over a decade and that this federal action authorizing a process to allow access to such areas will have a significant impact on the affected marine environment, NOAA may not re-open the closed-areas without conducting an EIS.

Moreover, the agency's actions are clearly an attempt to "segment" the larger Omnibus Amendment action that is intended to comprehensively address the status of all closed areas in New England. This separation from the Omnibus Amendment of this intended subcomponent of that action is designed to avoid NEPA review requirements. This practice of "segmenting" major Federal actions into smaller units for the purpose of avoiding preparation of an EIS and, thus, consideration of overall environmental impacts violates NEPA. *See Coal. on Sensible Transp., Inc. v. Dole*, 826 F.2d 60, 68 (D.C. Cir. 1987), *Taxpayers Watchdog, Inc. v. Stanley*, 819 F.2d 294, 298 (D.C. Cir. 1987). Courts have identified standards that Federal actions must meet in order to avoid illegal segmentation. These include whether the proposed segment (1) has logical termini; (2) has substantial independent utility; (3) does not foreclose the opportunity to consider alternatives, and (4) does not irretrievably commit federal funds for closely related projects." *Taxpayers Watchdog, Inc. v. Stanley*, 819 F.2d 294, 298-99 (D.C. Cir. 1987) (citing *Piedmont Heights Civic Club, Inc. v. Moreland*, 637 F.2d at 439). The proposed Framework 48 action to establish a process to exempt sectors from the prohibition on fishing in closed-areas would violate at least two of these requirements as it does not have substantial independent utility and it would foreclose opportunities to consider alternatives in the Omnibus Amendment and other future processes.

In 2011, NOAA issued an NOI for the Omnibus Amendment by which it merged into the Amendment a determination as to the functions and values of the groundfish closed areas and as to any future access to those areas. In so doing, NOAA conceded the lack of independent utility of any action to consider re-opening these areas. These are not discrete areas that can be understood or analyzed in isolation; they have interactive effects in the regional marine

ecosystem that have to be approached systemically and in an integrated fashion. The absence of independent utility of these various proposed closed area openings is further emphasized by the economic analysis referenced above that concludes that any benefits of re-opening these areas are highly speculative, if they exist at all.

Additionally, if the areas proposed for new sector access are approved, the opportunity to utilize the Omnibus Amendment to advance alternatives that maintain the existing high quality habitat within the closed areas would obviously be foreclosed as the gear impacts and catch of larger females and other productivity components in the closed areas would be rapidly lost. As noted above, the Omnibus Amendment is designed to fully consider the functions and values of existing and proposed habitat and groundfish closures and to assess the benefits of management measures for alternative areas. Any action that forecloses the very purpose of an ongoing, parallel management effort would be counterproductive and would violate NEPA.

Because NMFS has not prepared an EIS, and because interim consideration of opening areas that are presently closed would constitute improper segmentation under NEPA, NMFS should refrain from implementing any openings outside of the Omnibus Amendment currently underway.

#### B. The Framework 48 Process Must Comply With the Endangered Species Act

The Endangered Species Act makes it unlawful to take a threatened or endangered species. 16 U.S.C.A. § 1538(a)(1). The term “take” means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. 16 U.S.C.A. § 1532(19). Any decision by NOAA to open areas that are presently closed would subject listed endangered species such as right whales and leatherback turtles to ship strikes, entanglement and other forms of takes. NOAA is obligated under the ESA to insure that any action authorized, funded or carried out by the agency is not likely to jeopardize the continued existence of any listed species. 16 U.S.C. § 1536(a)(2). As such, the agency must undertake a detailed consultative process for determining the biological impact of any proposed reopening. *Leatherback Sea Turtle v. Nat'l Marine Fisheries Serv.*, 99-00152 DAE, 1999 WL 33594329 (D. Haw. Oct. 18, 1999). That consultation process must culminate in the issuance of a biological opinion (BiOp) in which the agency states whether it believes that the activity is likely to jeopardize the continued existence of a particular species and, if so, the agency must suggest reasonable and prudent alternatives or devise plans to reduce the risk of a take. *Id.* (citing 16 U.S.C. § 1536(b)(3)(a)). Any action that may authorize groundfishing in the closed areas creates the risk of irreparable harm to endangered species. Consequently, prior to any such action there must first be a full consultative process and the development of a BiOp associated with access to the closed areas.

11. Requirement to Stow Trawl Gear While Transiting Closed Areas

CLF strenuously objects to this proposal that was adopted by the Groundfish Committee against the advice of the Council's VMS/Enforcement Committee, which recommended more modest changes targeted at safety and effectiveness. CLF believes that this fishery continues to have a significant and underreported problem with illegal fishing activity and misreporting of catches.

12. Correction to Eastern U.S./Canada Quota Monitoring

CLF does not think that the agency has the authority to make this change to the regulation without Council action. The fact that a different approach based on the agency's interpretation of Council intent might have been included in the Amendment 16 Preamble does not convert that interpretation into a Council action. Moreover, CLF is concerned that the recent reports and substantiation of misreporting of catch by multispecies permit boats on Georges Bank makes the VTRs inherently unreliable as an allocation mechanism. The current regulation should stay as is and NMFS should begin implementing it according to its terms until and unless the Council decides to change the allocation approach after debate and public comment.

Framework 48 is a step backward for the New England Fishery Management Council. The proposed program compromises data quality by failing to require adequate and appropriate monitoring; it attempts to authorize allowing widespread access to the closed areas despite the Council's awareness that the risks to future productivity are great and the short term benefits are marginal and short-lived at best; it continues a recent pattern of risk-positive management action in the face of great uncertainties about the status of a number of the stocks; and it violates both the spirit and the letter of the National Environmental Policy Act and the Endangered Species Act.

Thank you for this opportunity to offer these comments.

Submitted on behalf of the Conservation Law Foundation.

Sincerely,



Peter Shelley, Esq.  
Senior Counsel



**Paul J. Diodati**  
Director

# *Commonwealth of Massachusetts*

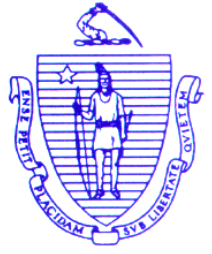
## **Division of Marine Fisheries**

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April 8, 2013

Mr. John K. Bullard  
Regional Administrator  
National Marine Fisheries Service  
55 Great Republic Drive  
Gloucester, MA 01930

Re: FW48 Proposed Rule (NOAA-NMFS-2013-0050)

Dear John:

We offer the following comments on your proposed rule Framework 48 and begin by requesting you to review the GOM cod presentation given by Northeast Fisheries Science Center (NEFSC) scientist, Michael Palmer, (*Gulf of Maine Cod: From Bankers' Hours to Bankruptcy and the Role of Fine-Scale Spatial Dynamics on Stellwagen Bank*).

FW 48 efforts to mitigate for FW 50 "potential negative economic impacts" should consider the frailty of GOM cod in particular. Dr. Palmer's presentation will assist that consideration; i.e., mitigation that ignores the fine-scale spatial distribution of cod will deteriorate stock status and the overall health of the GOM "stock." We highlight this presentation as part of our comments on your proposal to allow sectors to petition NMFS for access (albeit limited) to groundfish "mortality" closures and your dropping the cod minimum size by three inches.

### Minimum fish sizes

The Council has decided to decrease minimum size limits for cod (22 → 19"), haddock (18 → 16"), gray sole (14 → 13"), yellowtail flounder (13 → 12"), plaice (14 → 12"), and redfish (9 → 7"). We opposed this action. Pollock (19"), halibut (41"), and winter flounder (12") are to remain the same. Vessels fishing in sectors will be required to land all allocated groundfish meeting the minimum size requirements. The "logic" for these changes is: *"These changes would be made to reduce regulatory discards and to allow many fish to reach spawning age before being caught, not to facilitate the targeting of smaller fish...The minimum size limits...are based on an analysis of the size of discarded fish in trawl gear in recent years and the length at 50% maturity (our emphasis). The*

*minimum sizes...would be expected to reduce many discards due to minimum size restrictions under the gear requirements in place in 2009-2011...*”

Because the status of many of our groundfish stocks is so poor (e.g., GOM and Georges Bank cod), it is counterintuitive to move away from minimum sizes where percent maturity is greater than 50%. For cod you propose to drop the minimum by 3 inches approaching 50% maturity. With our learning more about cod spawning behavior and the importance of repeat spawners for increased spawning success (not just for cod), targeting 50% maturity is not defensible. DMF research of which you are very aware is very relevant to our arguments.

The Council with NMFS in support has concluded it's acceptable to target cod and other groundfish even when the target size (as a minimum) is about 50% immature. We should be promoting fisheries sustainability through protection of age structure and accounting for spatial distribution with an emphasis on letting far more individuals become first-time, but better yet, second-time spawners.

As a member of the Sanctuary Advisory Council and aware of the contents of the Sanctuary's Management Plan (June 2010), we know the Sanctuary might revise its designation document on or before 2015 (See Executive Summary page iii) to give it authority to set regulations for fisheries within its boundaries. Weakening protection of cod and other Sanctuary resources heavily fished within the Sanctuary is ill-advised. Consider the following Plan conclusion: *“...fishing – especially commercial fishing impacts and pressures every resource state in the sanctuary. On an annual basis, virtually every square kilometer of the sanctuary is physically disturbed by fishing. Fishing has removed almost all of the big old growth individuals among biological important fish populations, and reshaped biological communities and habitats in the process...”* The Sanctuary, of course, would support any measure that reduces discards (such as increased mesh and strategically placed closures), but promoting the targeting of smaller fish with likely increased discarding of even smaller fish will cause justifiable concern.

Will the reduced minimum sizes “facilitate the targeting of smaller fish?” The Council and NMFS assumption that reduced minimum sizes will not change fishermen's behavior is a very risky assumption. After having participated at most of the Council's ABC Risk Policy Workshop designed to develop advice to the SSC about the acceptable probability of overfishing when setting ABCs, we conclude that the likely “severity of consequences” (one aspect of risk) from targeting smaller fish is too high and unacceptable.

By comparison you use the “full retention” approach as the way to conclude you will *“minimize the likelihood that vessels will target smaller fish.”* You compare this option to the minimum size reductions. A far better and legitimate comparison would have been against status quo: “no change in sizes.”

Moreover, by decreasing minimum sizes, NMFS will put sector fishermen at too high a risk. The Commonwealth, and perhaps other states, may not our minimum sizes for the aforementioned reasons, i.e., we are risk averse regarding the negative consequences of lowering the sizes. In our case, the Commonwealth's Marine Fisheries Advisory Commission recently opposed the size reductions, and its approval is needed before any reductions can be adopted.

Consequently, if NMFS lowers the sizes without garnering state support, you do so with the understanding that sector fishermen are held jointly liable for discarding legal-size groundfish. Your rule will force them to discard legal fish according to your definition, but illegal by ours. We appreciate the need to have everything in place for May 1; nevertheless, so far, there have been no important discussions with us about minimum size reductions – just a Federal Register announcement and two weeks to comment. States partner with the federal government on inter-jurisdictional fisheries issues, yet that partnership seems lacking when it comes to this pending groundfish action.

We support status quo. Note your rationale for status quo, i.e., make no changes: “*Since implementation in 1986, the Northeast Multispecies FMP has used minimum size limits in conjunction with gear requirements to reduce catches of sub-adult fish. When adopted the purpose of this measure was to **provide opportunities for fish to spawn before harvest, as well as to reduce the incentive to use illegal mesh to increase catches** (our emphasis).*”

The Council has abandoned this rationale in favor of reducing regulatory discards even though decreasing the minimum size likely will motivate fishermen to use illegal mesh. Witness recent examples given to the Council by Law Enforcement about use of net liners. Regrettably, we seem to be moving away from creating incentives for fishermen to use larger mesh and/or to avoid smaller fish.

We ask you to explain what is meant by a decrease in minimum sizes *allowing many fish to reach spawning age before being caught*. This appears to be a non sequitur. More smaller fish will be caught; therefore, how will many more fish reach spawning age before being caught. A better alternative is larger mesh or required use of square versus diamond mesh depending on the situation.

Also, consider the following FW 48 analysis of impacts of biological impacts: “*...the biological impacts of changing minimum size requirements are a function of whether the change leads to a different selectivity in the fishery. If the catch of small fish as a proportion of the total catch increases, then changes in yield per recruit, status determination criteria, and rebuilding progress could result...there would likely be reductions in yield per recruit, MSY, and slower rebuilding progress.*” GOM cod is provided as an example. “*A shift in selectivity of one year reduces the YPR 9.4% for GOM cod. The value of F40 declines 18.5%.*” The analysis highlights that biological impacts are difficult to predict because impacts will depend on fishermen's behavior.

Understand that we appreciate the subtle and unstated benefit of lowering minimum sizes, ostensibly to reduce regulatory discards; i.e., sectors' ACES effectively increase: less assumed discarding means more to land. We suspect that's why many fishermen, including Council members, especially those involved with sectors, favor the full retention approach that is still "on the table." Full-retention will be very difficult to support without far greater at-sea monitoring and law enforcement. Furthermore, states will have to rescind all minimum sizes, an unlikely scenario. Also, recreational fishermen will find that rescinding for the commercial fishery to be very at odds with their having to live with minimum sizes.

Currently, real or assumed discards caused by that sector reduce each sector's ACE(S). Consequently, a sector fisherman can find his catch portfolio reduced to account for discards even when he doesn't fish, i.e., other sector fishermen's discards count against each member's allocation (PSC, percent sector contribution). By assuming reduced discards with lowered minimum sizes, fewer fish are subtracted from sector ACEs; therefore, more can be landed. If you decide to reduce the minimum sizes, *how will NMFS adjust fishermen's portfolios? This must be clarified now rather than later.*

Finally, consider your own conclusion regarding reducing the minimum sizes: "...*there could potentially be unforeseen consequences from targeting smaller fish that could have long-term negative impacts on future landings and revenue...*" This is an important admission fraught with risk. We counter that the consequences can be and are "foreseen."

#### Mitigating negative impact of FW 50

Preparing as best we can for the severe socioeconomic impact of FW 50 is sensible; however, to properly address mitigation, the Council and NMFS must focus on individuals and not on classes of vessels or gear types. That has not happened. Therefore, NMFS' (Council) claim that fishing opportunities will increase and profitability in the groundfish fishery will improve thereby mitigating negative economic impacts anticipated for groundfish vessels and their communities, is specious.

Consider that you make a very important and risky assumption regarding allowance of exemption requests from sectors to year-round closures and changes to minimum size restrictions. You say: ***"Assuming all impacts to vessels are also applicable to ownership entities, all of the alternatives have the potential to impact a large number of small entities, and while some of the options may significantly alter profitability, none of them would have a disproportionate impact on small entities."*** This is a profound and vital assumption not supported by FW 48 analyses, unless major, untested assumptions are made.

Consider your statement pertaining to sector vessels and operating costs associated with at-sea and dockside monitoring in FY 2013, absent any funding assistance from NMFS: "...*the highest percent reductions in net revenue were expected to occur in the 30-50 ft vessel category.* ***Since profitability of individual vessels is unknown*** (our emphasis), *the effects of this option [sector monitoring] on participation levels could not be*

*estimated, but it is likely that vessels operating close to the margin would be forced to exit the industry or lease their quota...*” NMFS admits the likelihood that small vessels will suffer the greatest impact, contrary to the aforementioned conclusion about no disproportionate impact on small entities. NMFS should explain this seeming contradiction.

We intend to submit comments on FW 50. Those comments will focus on a better way to mitigate. For example, rather than “tweaking rules” in a risky way to give greater operational flexibility to sector fishermen, it will be far better to provide more catch, i.e., extraordinarily precautionary ACLs create extreme adverse socioeconomic impacts affecting sector and common pool fishermen – some far more than others. Caution is important, but layers of precaution cause inordinate sacrifices by vessel owners, fishermen and processors, shore-side infrastructure, etc.

#### Recreational Fishery AMs

NMFS proposes to proactively modify recreational fishery AMs prior to the start of each fishing year. NMFS intends to “*consult with the Council, or the Council’s designee, and would tell the Council, or its designee, what recreational measures are under consideration for the coming year.*”

We emphasize that NMFS should consult with states, not as Council members, but as separate partners having to consider state regulatory changes to support NMFS. The consultation should be more than telling states what NMFS intends to do. Groundfish recreational fisheries occur in state waters as well as in federal waters, perhaps more so in state waters; therefore, with states having saltwater recreational fishing licenses and working closely with NMFS on marine recreational fishery surveys (MRFSS & now MRIP), close coordination and reciprocal cooperation are key.

#### Sector Monitoring Programs

You note that Sectors were required by Amendment 16 to “*implement a dockside monitoring program to validate dealer-reported landings...Dockside monitoring was also set to be implemented for common pool vessels in FY 2012...*” Then you note: “*Through Framework 45, the Council suspended the dockside monitoring requirements until FY 2013 and required dockside monitoring only to the extent NMFS could fund it.*” With these dockside programs now being completely eliminated, we ask for a better description of what exactly convinced NMFS in 2011 that sector landings were “sufficiently monitored.” You indicate, “*dockside intercepts by enforcement personnel were sufficient to monitor those landing.*” Is this still true?

We understood then that reliance on law enforcement was a fallback position because limited funds had to be reprogrammed “to alleviate general sector operating costs.” The central question now becomes: How will sector landings be sufficiently monitored?

Regarding current dockside monitoring hail requirements, you ask whether those requirements should be maintained. We believe they should be kept because, as you state, “*hails have become a useful tool for both NMFS and sector managers to monitor*



*sector vessels' activities, including use of certain sector exemptions, and to facilitate dockside intercepts by enforcement personnel...*” Additionally, we ask if NMFS and Law Enforcement have adequate capability to check hails versus observed landings to monitor sector and common pool landings versus ACEs and quotas.

On a related monitoring issue, you propose to “*revise the regulatory text at §648.87(b)(1)(v)(B) to read that coverage levels must at least meet the CV standard at the overall stock level and be sufficient to monitor sector operations, to the extent practicable, in order to reliably estimate overall catch by sector vessels.*” We ask for more clarification, i.e., what do you mean by “to the extent practicable.”

Furthermore, in the referenced section, you state: “*coverage must be fair and equitable, and distributed in a statistically random manner among all trips such that coverage is representative of fishing activities by all vessels within each sector and by all operations of vessels operating in each sector throughout the year.*” We support your approach, but are concerned that your “to the extent practicable” will result in coverage that isn’t satisfactory especially for statistical purposes and accurate accounts of catch and discard.

Confounding this important issue is the decision to “*delay industry responsibility for at-sea monitoring costs to FY 2014 to mitigate the expected negative economic impacts of lower trip limits in FY 2013. Coverage levels would instead be set at the level that NMFS can fund.*” We support your decision to delay and realize there is no other option to consider, and we understand why. However, by relying on the Council to “*further modify this requirement in the future as more information becomes available on the appropriate monitoring levels, costs of these programs, and implementation of electronic monitoring systems,*” NMFS really means it’s willing to accept a Council likely decision in 2013 to delay that responsibility to 2015 or beyond.

We also support your approach that sectors “*must provide detailed trip-by-trip catch data to NMFS for the purposes of auditing sector catch monitoring data based upon guidance provided by the Regional Administrator.*” However, the “if requested” part of your proposal should be understood as a consistent requirement, not just when requested that could very well be occasionally.

#### Sector Access to Closed Areas

You state, “*...sectors are subject to a hard TAC that limits overall fishing mortality resulting from sector operations, making certain other mortality or effort controls redundant...*” This is a mistake. For example, it doesn’t consider that mortality on aggregations of fish, such as cod, subject to fishing without trip or possession limits (i.e., sector vessels fishing as they will with original allocations enhanced through leasing) can create very high, localized fishing mortality dramatically reducing the size of aggregations and/or interfering with pre-spawning and spawning behavior. Reflect on Dr. Palmer’s analyses of the Stellwagen Bank area and very localized fishing caused by fine-scale distribution of cod.

You state that our concerns will be “evaluated by NMFS in the consideration of any specific sector requests for each fishing year.” We request those evaluations be made available to the Council and public for review before specific exemptions are granted. You indicate a “rigorous analysis” will be necessary, and we agree and ask if the Council’s PDT will be involved. It should be.

We appreciate NMFS is abiding by the Council decisions on access. For example, sectors will not be allowed access in Closed Areas I and II from February 16 through April 30 to protect spawning groundfish. However, we’re uncertain as to whether those are the correct dates, and we ask if the NEFSC will comment on these access dates to be modified by you if access timing is incorrect, e.g., should access be denied during some part of late fall and early winter when cod are also spawning. As you noted, the analyses must be rigorous.

Finally, we appreciate your treatment of the Council’s Closed Area Technical Team analysis of access to the closed areas. The CATT did a fine job and had some important conclusions such as: *“Due to data limitations and the fact that sector fishing effort is driven more by Catch Per Unit of Effort (CPUE) and market conditions than effort controls, the CATT was unable to quantitatively model potential changes in fishing effort.”*

For this and other reasons you’ve decided to *“consider sector requests for exemptions to closed areas in a separate rulemaking from the general approval of sector operation plans for 2013, if the proposed change in FW 48 is approved. The closed area exemption requests would be considered as amendments to the sector operations plans through a proposed and final rule that would be available for public comment with an accompanying National Environmental Policy Act (NEPA) analysis.”* This suggests any access could be no later than this fall. Sector fishermen likely will want access as soon as possible, and we all appreciate the sense of urgency. Nevertheless, this access is very controversial and requires the approach you have selected.

#### Status Determination Criteria GOM & GB Cod and SNE/Mid-Atl Yellowtail Flounder

We always appreciate the hard work of the NEFSC and the effort given to complete the many important stock assessments. However, there are times when we wonder about the outcomes. For example, we have two approved assessment models with one providing a biomass target of 54,743 mt (assumed natural mortality of 0.20). The other target is 80,200 mt (“ramped-up” natural mortality to 0.40 not expected to remain “in perpetuity”). Both models provided a fishing mortality threshold of 0.18. For each GOM cod scenario we are overfishing, and the stock is overfished. You now ask for comments on the two choices.

However, you offer no guidance as to what option is preferred and why, although with the SARC concluding that natural mortality is not expected to remain at 0.40, it seems you’re favoring the 54,743 mt. Considering the fishery failure officially effective on May 1 and a revised rebuilding schedule the Council will develop, it makes sense to choose the lower target.

The key will be to reduce fishing mortality to the 0.18 threshold or below. With that said, we wonder why the SARC did not conclude natural mortality is as high as 0.40, if not



### SPRING GATHERING ON THE CAPE

Gray seals carpeted a beach Thursday at Monomoy National Wildlife Refuge, which has become the most popular area in the region for the mammals to haul themselves out of the ocean and take the sun. The most recent count showed more than 15,000 of the seals off New England.



higher. Consider the photograph in a recent front-page Boston Globe issue. An estimated 15,000 gray seals clustered at a haul-out on Monomoy Island suggests natural mortality has increased and will be much higher than expected for some time to come. This does not bode well for the groundfish fishery and for other stocks on which these seals and other predators (e.g., spiny dogfish) prey.

Finally, for yellowtail once again we wonder. The SARC concluded that the evidence was 60:40 (quite a call) in favor of a “recent recruitment”

scenario assuming that a “*possible change in productivity has reduced the size of incoming year-classes since 1990.*” Therefore, the stock is not overfished and overfishing is not occurring; thus, we are rebuilt, yet the new target is a very low 2,995 mt. The fishing mortality threshold is a modest 0.31, a bit higher than we would have expected.

We ask NMFS to reconcile the conclusion that for yellowtail there has been a “possible change in productivity,” but for cod that doesn’t seem to be case. Furthermore, calling yellowtail “rebuilt,” although technically correct, has a hollow ring to it. If productivity has changed so dramatically as to cause such a dramatic reclassification of yellowtail, why hasn’t GOM and GB cod been affected by changed productivity as well? We consider this to be an unanswered key question pertaining to the direction in which the Council and NMFS are headed, i.e., ecosystem-based fishery management.

### Conclusion

We always appreciate the opportunity to comment on Council decisions and NMFS proposals, especially when those decisions and proposals are not supported by DMF. Of course, there are many we do support and helped develop as a Council member.

The task before us all is how to assist the groundfish fishing industry survive these very difficult times of low ACLs, poor prospects for groundfish rebuilding, and changes in ocean productivity contributing to low to poor year-classes. Our other task is to address industry consolidation and excessive shares – a task made even more difficult due to our fisheries failure.

Mitigation is extremely important, and we will support legitimate mitigation approaches. However, mitigation cannot be allowed that potentially will deteriorate groundfish

resource conditions even further. This is the attitude reflected in all of our  
aforementioned comments and our previous ones on sector operations plans.

Sincerely yours,

A handwritten signature in cursive script that reads "David E. Pierce". The signature is written in dark ink on a white background.

David E. Pierce, Ph.D.  
Deputy Director

cc  
Paul Diodati  
Mary Griffin  
Melanie Griffin  
John Bullard  
Susan Murphy  
Rip Cunningham  
Tom Nies  
William Karp



Post Office Box 112  
Topsham, ME 04086  
Phone: 207.619.1755  
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John Bullard  
Northeast Regional Administrator  
National Oceanic and Atmospheric Administration  
55 Great Republic Drive  
Gloucester, MA 01930

April 9, 2013

Dear Regional Administrator Bullard:

As commercial groundfish fishermen using fixed gear to fish within the Gulf of Maine, we wanted to take this opportunity to directly respond to one aspect of the Framework 48 proposed rule, the Halibut accountability measures (AM), and express our concern regarding the northern location of the fixed gear closures associated with this AM. We understand and support the need for an accountability measure for the Atlantic Halibut fishery in cases where the total allowable catch is exceeded. However, with the current location of the northern area for the fixed gear exclusion area, there is a high likelihood that our summer fishery will be eliminated and that inshore fishermen from Maine will be disproportionately affected.

This past season we observed high numbers of Atlantic Halibut that were just below the minimum size. We are concerned that the total allowable catch has a high likelihood of being exceeded next fishing year, following the trends of the past two fishing seasons of exceeding the TAC by 29% and 57% respectively, and that the accountability measures will go into place for the majority of our 2014 fishing season or in a worst case scenario, 2013.

Additionally, we have significant economic concerns with the impact of eliminating fixed gear in these accountability areas. The justification for the accountability measure in Framework 48 states that approximately \$1 million in estimated revenues come from the fixed gear areas, and that the majority of the effort in that area is from vessels with homeports in Chatham, Massachusetts. Though the economic loss may be largest to these vessels, the Maine Coast Community Sector represents some of the boats with the largest landings at the Portland Fish Exchange, and those boats fish primarily around Platts Bank in the summer when our fishing season is in full swing. Losing access to these grounds would significantly impact fishing businesses within the sector without a corresponding benefit to the Atlantic Halibut resource.

Through observations, we have witnessed higher rates of Atlantic Halibut catch early in the fishing season in this area from targeting monkfish with tie-down gillnets. To better serve and restore the health of the halibut resource installing seasonal closures, or more specific gear restrictions may have a better outcome for the fishing resource while increasing the potential to still target healthy stocks in the area given the added economic pressures next fishing season

with the extremely low allocations. We fear that this accountability measure, as written for the fixed gear area, will have severe unintended consequences without having an adequate benefit for the Atlantic Halibut fishery. Additionally, but putting this AM in place for FY 2013, it does not give our sector the opportunity to develop any exemptions that may allow our fishermen to fish in this area using a specific gear-type. We are currently involved in two projects we feel may help us avoid halibut, one is to develop technology to track bycatch, share with other vessels, and ensure there is limited future catch and the second is a gear modification that allows for large panel mesh in the bottom of the gillnet which we believe would decrease halibut interactions. Without time to continue to test these programs and build a comprehensive exemption our gillnet fishermen will be removed from an important area without having the ability to develop a plan to deal with this AM.

Thank you for the opportunity to provide comments on the fixed gear accountability measure for Atlantic Halibut. We are very concerned with the current placement of the northern fixed gear area, and hope that future discussions can include local fishermen to determine an area, or time of the year to restrict effort, in a constructive manner that will benefit the resource and still provide fishing opportunities to allow MCCA members to continue to fish.

Sincerely,

A handwritten signature in black ink, appearing to read "Ben Martens", with a long horizontal flourish extending to the right.

Ben Martens  
MCCA Sector Manager



April 9, 2013

John K. Bullard  
Regional Administrator  
NOAA Fisheries  
55 Great Republic Drive  
Gloucester, MA 01930

Re: Comments on the Proposed Rule for Framework Adjustment 48 to the Northeast  
Multispecies Fishery Management Plan [Docket No. 120814336-3249-01 RIN 06848-BC27]

Dear John,

The Northeast Seafood Coalition is a non-profit organization representing over 250 commercial fishing entities, which hold over 500 limited access groundfish permits, on political and policy matters affecting their interests in the federal groundfish fishery. Collectively, NSC members represent the full diversity of the groundfish fishery. NSC members fish on small, medium, and large vessels from ports across the northeast and they employ all groundfish gear types. NSC fishing members are enrolled in the Northeast Fishery Sectors (NEFS).

Today, the Northeast Seafood Coalition (NSC) submits the following in response to the request for comments to the regulatory measures for the groundfish fishery proposed under Framework Adjustment 48.

**1) Status Determination Criteria for GOM Cod, GB Cod, SNE/MA Yellowtail  
Flounder and White Hake**

- ***Estimates of Fmsy***

NSC reiterates the specific concerns it expressed in its January 17, 2013, memo to the Council regarding the use and specific choice of Fmsy proxies for groundfish stocks below. As a more general observation, however, the current management process employed by the Council and agency does not provide managers with sufficient information, understanding or opportunity to consider alternative scenarios for directly estimating Fmsy or choosing among proxy alternatives. In many respects, these choices are a matter of policy based on management objectives and acceptable risk and can have profound implications for specific stock management. Such choices should be made by managers, not stock assessment scientists,

through a far more transparent and deliberative process that ultimately provides guidance to such scientists.

The current process for selecting Fmsy proxies is essentially the reverse. As noted below, current policy is based on advice generated more than a decade ago that was itself based on literature published a decade earlier than that. Absent any deliberate process by managers to reconsider this policy, it has simply been carried-forward in each stock assessment and consequent management action – including Framework 48. During this time there have been improvements to both the understanding of such population dynamics as stock-recruitment relationships that may provide for direct estimates of Fmsy, as well as improvements to the relevant analytical and modeling approaches for selecting the appropriate Fmsy proxy.

Thus, notwithstanding statements to the contrary in Framework 48, it is likely that the current use of the Fmsy proxy of F40%msp as the basis for managing nearly every groundfish stock does not meet the statutory standard for using the best scientific information available.

NSC's January 17, 2013 memo to the Council can be found at the conclusion of these comments. NSC urges the Agency under this present rule-making to seriously consider the two recommendations presented at the end of the memo. These recommendations request a more thorough review by the Science and Statistical Committee (SSC) and policy decision by the Council as follows:

*“With these questions in mind, NSC respectfully recommends that the Council submit the following requests to the SSC to be addressed as soon as possible:*

- 1) Where possible, provide direct estimates of Fmsy for all groundfish stocks.***
- 2) Where not possible to provide direct estimates of Fmsy, reevaluate the current Fx%msp proxy taking into consideration of what percentage of MSP is most likely to achieve the specific management goals for each applicable stock. This should include an evaluation of the consequences of this choice on the rebuilding target for each stock, and a comparison to available data.”***

## **2) SNE/MA Windowpane Flounder Sub-ACLs**

NSC supports the proposed action to allocate a sub-ACL of SNE/MA windowpane flounder to the scallop fishery and rename the other sub-component the “other fisheries sub-ACL”.



### **3) Scallop Fishery Sub-ACL for GB Yellowtail Flounder Based on Estimated Catch**

Consistent with NSC's input to the Council during their vote on November 14, 2012, NSC supports the proposed action for two reasons.

1. The TMGC accepted an extremely low TAC for 2013, one that the NSC has great concerns with. At this level and at any level below a 1,000 mt US share, the directed groundfishery is untenable. For this reason, NSC conceded that to destroy both the scallop and groundfish fishery, on paper, in advance of the start of the fishing years, should be avoided if possible. Discussions between groundfish and scallop fishery representatives resolved that the amount of catch estimated for bycatch would represent 40% of the US share of 215 mt in fishing year 2013.
2. NSC cannot overemphasize the need to have each substantial component of a fishery held fully accountable to their catch. Status quo policy does not do this adequately. NSC strongly supports allocating sub ACL's as a percentage of the total ACL in a manner that reflects the historical use and need for the stock by each stakeholder, with the directed fishery afforded the highest priority. Unfortunately, to date, existing policy places the directed fishery, which has suffered the greatest economic loss for the shrinking GB YT ACL, as the lowest priority--essentially receiving the leftovers after all "other" and "more important" fisheries have been receiving between 90 and 100 percent of their need. This policy was overlooked when the US / CA shared TAC was at or about 2,000 mt and the US was receiving at least 75 percent of the TAC. But at such low levels the stock must be allocated according to historical shares.

To be clear, NSC's support for the 40% is limited to 2013 for the reasons mentioned above. The spirit of this temporary 2013 sub-ACL formula was to allow the scallop fishery time to adjust to a sub ACL based on historical shares of 16%. NSC supports 16% in 2014 and beyond and will be strenuously opposed to any disingenuous effort that attempts to modify this critical decision. NSC support for this measure is entirely conditional upon the full three year policy being carried out as prescribed in this proposed rule. (40% 2013, 16% 2014, 16% 2015).

#### **4) Small-Mesh Fisheries Sub-ACL for GB Yellowtail Flounder**

NSC supports the proposed action to allocate a sub-ACL of 2 percent of the U.S. ABC for GB yellowtail to the small-mesh bottom trawl fisheries.

#### **5) Recreational Fishery AM**

NSC strongly supports a healthy and vibrant fishery comprised of both commercial and recreational stakeholders, however, NSC has grave concerns with the approach taken by the Council and Agency regarding recreational fishery accountability measures (AM). To us, there appears to be a stark inconsistency in the manner that MSRA is being implemented by the agency in terms of the approaches applied to deal with enormous cuts in fishery wide ACLs for GOM cod and haddock.

On the one hand, commercial fishermen are not allowed access to the “groundfish closed areas” for the purpose of “protecting groundfish and to promote rebuilding”, while on the other hand, a component of the fishery that argued for and succeeded in receiving 34% and 38% allocation of GOM cod and haddock respectively, is allowed to fish those allocations almost entirely within the “groundfish closed areas”.

The commercial fishery is fishing under an output controlled system with weekly or daily reporting from the sectors. VTR's are submitted within 24hrs of offloading and all VTRs submitted to NMFS every week. Sector vessels have at sea monitors or NEFOP observers on 22% to 38% of all trips. Comparatively, private and “for hire” commercial / recreational fishermen have little or no monitoring, are not under a directly controlled output but are instead managed through effort controls, and their reporting is sparse VTR data coupled with zero quota accounting in-season which leaves the fishery wide opened to a possible overage that would not be detected for months or even years after it occurred.

This double standard of applying AMs is inexcusable and it is questionable whether it is legal under MSRA. The implications to the fish stocks subject to strict rebuilding plans and the economic consequences to commercial fishermen dependent upon these stocks are significant. The recreational component of the fishery has been granted a substantial component of the ACL, a sub- ACL which is harvested largely in closed areas, with limited monitoring and reactive AMs.

But the double standard of management policy continues. Rather than proposing responsible measures for effectively monitoring and controlling fishing in the recreational sector in

response to ACL reductions as large as 77 percent, Framework 48 actually proposes to insert new authority for the RA to “loosen” recreational measures in-season if that sector is “projected” to be unable to achieve their sub ACL. NSC struggles to understand what data would be used that could reliably support such an in-season management response. Would the Agency consider allowing commercial vessels access to the GOM mortality closures if the commercial sub ACL was not being achieved? At least the Agency would know, at any point in time and with great precision, just how much has been harvested and how much is remaining, in stark contrast to what the Agency will have to make the decision to loosen recreational measures for harvests inside the groundfish closed areas.

This approach is tantamount to the Agency being compelled to open the WGOM and eliminate the April rolling closure this year to allow the commercial sector to harvest their GOM cod and GOM haddock that is being under-harvested FY 2012. Instead, the commercial fishery operating under strict hard TAC requirements, real time reporting and monitoring remains constrained by effort controls during a period of low catchability. Recently, the Agency has claimed the under harvest and low catchability has been evidence of low abundance and justification for unthinkable reductions in 2013 ACLs. Contrast that thinking with the proposed action for adjusting measures for the recreational sector and the double standard approach is quite clear to NSC.

## **6) Commercial Groundfish Fishery AMs**

- ***Change to AM Timing for Non- Allocated Stocks***

In general, NSC does not support the proposed action because the data that will be used to make these decisions is known to be unreliable for use in the short term. The subjectivity of the evaluation of “should reliable information be available” is of particular concern since this determination could be made very late in the current fishing which would leave the fishery with little warning that an AM will be triggered at the start of the following year. This can have tremendous negative business effects on the fishery. Although NSC acknowledges the positive aspects of removing the AM if new information determines the AM should not have been implemented in the first place, it is little consolation as compared to the risk that having this policy in place will compel the agency to react when it believes it has “reliable” information when we all know that level of accuracy in the data does not exist in real time for non-allocated stocks. At this point, it is difficult to identify anything that is reliable in groundfish science or management.

Further, NSC notes that the timing of the AM's was not an issue addressed by the Court. Instead, as stated in the proposed rule preamble, NMFS recommends that AM's should be imposed 'as soon as possible' after the overage occurs. The Agency does not explain why and what the biological or management downside is of implementing such AMs in the third year. NSC seriously questions whether that downside would justify the severe impacts on business planning and operations if the agency mistakenly implemented an AM in the second year and had to reverse itself some months later. The potential chaos caused by this scenario argues strongly against putting the Agency in a position to make a subjective judgment as to when data is sufficiently reliable to implement these AMs in the second year. This is just looking for more problems. The groundfish fishery desperately needs reliability and stability—and one small way to achieve that is by continuing to implement these AMs in the third year.

In the event the Agency decides to ignore comments to the contrary and implements this change to the AM timing for non-allocated stocks, NSC supports the Agencies intent to use the start of the fishing year as the trigger point so that the entire fishing year is under one regime unless new information is revealed that could undo an AM if one has been triggered.

- ***Area-Based AMs for Atlantic Halibut, Atlantic Wolffish, and SNE/MA Winter Flounder***

In general, NSC does not support the proposed action because the data that will be used to make these decisions is known to be unreliable for use in the short term.

- ***Revised AM for SNE/MA Windowpane Flounder***

NSC supports SNE / MA Windowpane flounder sub-ACLs and the proposed AM applying to trawl vessels using codend greater than 5"

## 7) Commercial Fishery Minimum Fish Sizes

| Species               | Current Rules | Proposed changes for FW 48 |
|-----------------------|---------------|----------------------------|
| Cod                   | 22            | 19                         |
| Haddock               | 18            | 16                         |
| Pollock               | 19            | No change                  |
| Gray sole             | 14            | 13                         |
| Yellowtail flounder   | 13            | 12                         |
| Dabs                  | 14            | 12                         |
| Redfish               | 9             | 7                          |
| Winter Flounder (BBs) | 12            | No change                  |

NSC strongly supports the proposed action as presented above. One way to help mitigate the huge reductions in ACL is to ensure as little wasted ACL to discards as possible. This measure was carefully analyzed by the PDT with the intent to convert the greatest portion of known discards into landings. Furthermore, these sizes were carefully considered in relation to the maturity and biology of fish stocks. The Council's final vote on the minimum fish sizes presented above is in some cases greater than the sizes originally presented by the PDT.

## **8) Sector Monitoring Programs**

- ***Delay Industry At-Sea Monitoring Cost Responsibility***

NSC supports the Council's request to delay industry At-Sea Monitoring Costs Responsibility. Further, NSC notes that the current FY2013 Continuing Resolution enacted in March reallocates nearly \$120 million in revenues from the Saltonstall-Kennedy fund to cover the agency's costs for several critical functions including "Survey and Monitoring Projects".

- ***At-Sea Monitoring Cost-Sharing***

NSC understands the Agency's concerns and we support including the NE multi-species FMP in the joint effort with FMAT to develop a workable and consistent cost-sharing mechanism for the Northeast Region.

- ***Eliminate Dockside Monitoring***

NSC supports elimination of the dockside monitoring program at this time. NSC has maintained that this program was not well designed or contemplated in a manner that made the data timely or useful. It caused numerous logistics and costs issues without commensurate benefits. NSC has always maintained that Dockside Monitoring should either be 100% or 0% if the program's intent is to ensure equitable enforcement of dealer activities throughout the region. NSC agrees that the trip start and end hails offer vastly improved windows of opportunity for enforcement intercepts and that the requirement should be kept available for the Agency to implement on an "as needed" basis. However, NSC must point out that our experience with handling the traffic coming via VMS and through the various government and third party servers proved completely unreliable for fishermen to receive confirmation of hails returned to the vessels in a timely manner. This problem, unless resolved, will create enforce ability of hail requirements.

Consistent with NSC long record of promoting efforts to reduce redundancy and packaging data inputs to serve multiple purposes, NSC supports NMFS intent to clarify the regulatory text so that hails may be modified in the future to be streamlined with other reporting requirements that collect similar fishery data, such as Vessel Trip Reports (VTRs) and Vessel Monitoring System (VMS) catch reports.

- ***Sector Monitoring Goals and Performance Standard***

NSC supports the agencies proposed regulatory language to more explicitly state Sector Monitoring Goals and Performance Standards.

- ***Reduce At-Sea Monitoring for Monkfish Trips***

NSC supports this proposed action to implement a lower at-sea coverage rate for sector vessels fishing on a monkfish day at sea in the SNE Broad Stock Area with extra-large mesh gillnets.

## **9) GB Yellowtail Flounder Management Measures**

NSC does not support the proposed action. Splitting this area into two strata will do little towards achieving the intended result. The only thing it will do is add complexity without benefit. NSC's comment during the Council deliberations was minimal to none because we struggled to understand how the benefits outweighed the costs or the likelihood of unintended results. NSC favored an approach to consider defining a more discreet area of historical GB YT catches for the purpose of allowing a greater area of GB to be accessed without assumed discard rates constraining access to the vast areas known to be sparse for YT presence. The propose action is far too broad in defining the two areas which we fear will result in no management benefits but will only add administrative burdens to the industry, Sectors and the Agency.

## **10) List of Allowable Sector Exemption Requests**

NSC strongly supports the proposed action to broaden the list of allowable exemption requests. NSC agrees with the Agency's rationale for doing so, sectors are subject to a hard TAC that limits overall fishing mortality resulting from sector operations, making certain other mortality or effort controls redundant. Since hard TAC management was implemented by Amendment 16 in 2010, NSC has commented numerous times on the apparent disregard to remove regulatory artifacts associated with the old input control managed fishery.

## **11) Requirement To Stow Trawl Gear While Transiting**

NSC strongly supports the proposed action to remove the gear towage requirement for trawl vessels while on a groundfish trip. NSC agrees VMS requirements are sufficient to monitor and enforce transiting requirements.

## **12) Correction to Eastern U.S./Canada Quota Monitoring**

NSC supports the agency's proposed removal of the FW42 language inadvertently left in the regulations at § 648.85(b)(8)(v)(C). NSC participated directly in all Amendment 16 development meetings as well as the numerous data and technical workshops held to develop reporting tools and methodologies. If not explicitly, certainly implicitly, this Framework 42 artifact was being entirely replaced with sector level accountability to every distinctly managed stock or stock unit such as eastern and western cod and haddock in the US / CA areas. As the owner and developer of Fishtrax reporting tool, NSC was intimately involved in constantly modifying the software parameters for the automated onboard Fishtrax tool to ensure compliance with the regulatory methodology. NEVER was there an instance, either at a Council meeting or other meeting, where NSC was informed that eastern stocks were going to be required to be MISREPORTED under sector management. Had this ever been questioned or discussed by the Council during the development of Amendment 16, NSC and others would have commented extensively about the inconsistency this requirement poses for reporting and accountability of sector quota.

It is important to NSC that we continue to strive to create offshore opportunities to harvest GB haddock. Canadian haddock TAC utilization has been over 80% to as high as 98% while U.S. is barely harvesting 10%. It would be counterintuitive to artificially constrain U.S. fisherman by essentially requiring them to misreport catch which would result in premature shutdown of access to the very stock the U.S. is already disadvantaged relative to our Canadian counterparts.

Furthermore, since GB cod is one stock, and the eastern / western distinction is purely a management distinction for the benefit of the US / CA resource sharing agreement, there is no real biological issue regarding cod mortality but instead, there is a potential management issue IF misreporting of cod catch occurs on trips that are fishing eastern and western areas. NSC would argue that there would need to be overwhelming and convincing evidence that misreporting is occurring at a level that warrants further dismantling of any chance that the U.S.

can participate on par with the Canadians in the Transboundary Resource Sharing Understanding.

NSC completely agrees with the Agency's interpretation of Amendment 16 intent as this was certainly our understanding as a substantial stakeholder and participant in the Council process.

NSC appreciates the opportunity to provide comments on these important regulatory measures for the groundfish fishery. We will be submitting comments for the Proposed Rule for Framework Adjustment 50 in the coming days.

Sincerely,

A handwritten signature in blue ink that reads "Jackie Odell". The signature is fluid and cursive, with the first name "Jackie" and last name "Odell" clearly distinguishable.

Jackie Odell  
Executive Director



# NORTHEAST SEAFOOD COALITION

DATE: January 17, 2013

TO: New England Fishery Management Council

CC: Science and Statistical Committee

RE: Estimation of Fmsy for Groundfish Stocks

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Implementation of the Magnuson-Stevens Act requirements to end or prevent overfishing according to the National Standard 1 guidelines requires the determination of Fmsy or, if a direct estimate cannot be determined, a proxy thereof.

Efforts to estimate Fmsy in groundfish assessments have typically applied methodologies that rely in part on an adequate understanding of the stock – recruitment relationship for each stock. In practice, stock-recruitment relationships are difficult to determine for many fish stocks. Accordingly, a range of approaches have been developed to estimate Fmsy, including biomass-based production models, theoretical stock-recruitment models, more generalized stock-recruitment models, and empirical stock-recruitment models.

Nevertheless, instead of presenting the results from different methods to the Council, the 2002 *Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish* chose to simply establish a proxy for Fmsy for groundfish stocks. This choice has had a substantially limiting influence on all future groundfish stock assessments and the advice provided to the Council.

<http://www.nefsc.noaa.gov/publications/crd/crd0204/crd0204.pdf>

The default proxy chosen by the 2002 Working Group for Fmsy was the Shepherd model (a combination of stock-and-recruitment theory and yield-per-recruitment theory). The Shepherd model is based on a specification of the ‘maximum spawning potential’ (MSP). Although a

range of MSP values are possible, the Working Group chose only 40% MSP.<sup>1</sup> So, in other words, although a large range of alternatives is possible, the Working Group presented the Council with only one method and only one of the many possible versions of the method.

It should be noted that MSP-based proxies for Fmsy assume the stock is in equilibrium. These stocks are not in equilibrium. Several more realistic alternatives exist for estimating Fmsy using non-equilibrium methods. Indeed, the scientist who performed the simulations in 1992-3 on which the 2002 Working Group based its advice for using F40%msp as a proxy has since raised his own questions about this methodology. Indeed, although those simulations were for west coast fish stocks, managers of those fisheries have since adopted F35%msp as their proxy for Fmsy.

The GARM III Working Group was unable to define stock-recruitment relationships for most groundfish stocks. Instead of using production models or other available methods that do not require any understanding of the stock-recruitment relationship to directly estimate Fmsy, the Working Group chose to apply the F40%msp proxy for Fmsy for all stocks (ignoring F30%, F20%, etc.), except redfish, for which F50%msp was applied. The GARM III report specifically cites the 2002 Working Group report as justification for their choice.

[http://www.nefsc.noaa.gov/saw/qarm/Garm%20III BRPs report 6june2008 finalCorrected.pdf](http://www.nefsc.noaa.gov/saw/qarm/Garm%20III%20BRPs%20report%206june2008%20finalCorrected.pdf)

Further, the choice to adopt the F40%msp proxy for Fmsy by the GARM III Working Group has subsequently been cited as the “best scientific information available” in Amendment 16 and subsequent framework actions adopted by the Council including proposed Framework 48. It is clear that the Council was not fully advised of the implications of this approach or the potentially more desirable and scientifically sound alternatives available when making these

decisions. As can be seen, the limited advice provided in the 2002 Working Group Report cited above has been perpetuated throughout the groundfish stock assessment and management process.

Two serious questions emerge for the Council's consideration—

**1) Was the specific choice of F40%msp as the proxy for Fmsy appropriate for most groundfish stocks and does it represent the best scientific information available?**

<sup>1</sup> The fishing mortality rate associated with 40% of the MSP of the stock. MSP is defined as the 'spawning stock biomass per recruit in the absence of any fishing' —i.e., when  $F=0$ . Thus, the F40%msp proxy means the fishing mortality rate that would reduce spawning stock biomass per recruit to 40% of the unfished level (maximum).

- The choice of 40% of MSP as opposed to some other percentage of MSP in setting a proxy for Fmsy (overfishing) is inherently arbitrary. It also often generates much greater rebuilding targets that may exceed Bmsy, which may be very difficult if not impossible to achieve within arbitrary MSA rebuilding timeframes. Managers need to understand the important implications this choice has for the specific management goals for each stock.

**2) Is any MSP-based proxy for estimating Fmsy appropriate for groundfish stocks and does that represent the best scientific information available? (ie. should we use direct estimates of Fmsy instead)?**

- Overfishing is legally defined according to Fmsy, and technical guidance from NOAA is that Fmsy proxies should only be used when Fmsy is not estimable.
- Since 2002 considerable additional data has been obtained that may support an understanding of the stock-recruitment relationship for some groundfish stocks (including Georges Bank yellowtail flounder) that is adequate to support the direct estimation of Fmsy for specific stocks (but a production model approach does not require assumptions about the stock-recruitment relationship).
- Even when stock-recruitment relationships cannot be determined as is often the case for groundfish stocks, valid production models based on age-aggregated biomass dynamics can be used to provide direct estimates of Fmsy for these stocks.
- MSP-based proxies for Fmsy are not appropriate for groundfish stocks that are not at equilibrium, and alternative non-equilibrium methods are more appropriate.

With these questions in mind, NSC respectfully recommends that the Council submit the following requests to the SSC to be addressed as soon as possible:

- 1) Where possible, provide direct estimates of  $F_{msy}$  for all groundfish stocks.**
- 2) Where not possible to provide direct estimates of  $F_{msy}$ , reevaluate the current  $Fx\%msp$  proxy taking into consideration of what percentage of MSP is most likely to achieve the specific management goals for each applicable stock. This should include an evaluation of the consequences of this choice on the rebuilding target for each stock, and a comparison to available data.**

## Appendix 5

MA DMF 12/2012

## MA DMF Portside Bycatch Study Data Log

|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|-----------------------------------------------------------------------------|--------------|--------------------|--------------------------------------|------------------------------------------------|-----------|-----------|-----------|---------------------|-----------------------------------------------------------------------------------------|
| Land Date: _____                                                            |              |                    |                                      | Scales Used: Large _____ TARE: _____           |           |           |           | DMF TRIP ID: _____  |                                                                                         |
| Vessel Name: _____                                                          |              |                    |                                      | Small _____ TARE: _____                        |           |           |           | Sampler(s): _____   |                                                                                         |
| Vessel Hail: _____ (mts, lbs, trucks)                                       |              |                    |                                      | Subsample Basket scheduled every _____ minutes |           |           |           | Offload Site: _____ |                                                                                         |
| Sub-Sample #                                                                | Time (24 hr) | Basket Weight (kg) | Species 1<br><small>(Target)</small> | Species 2                                      | Species 3 | Species 4 | Species 5 | Species 6           | Notes <small>(Truck #/size, pump/offload notes, LF sample, problems... )</small>        |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
|                                                                             |              |                    |                                      |                                                |           |           |           |                     |                                                                                         |
| <b>Page SUM</b><br><small>(add columns for each page)</small>               |              |                    |                                      |                                                |           |           |           |                     | After adding all columns verify that <b>Basket Weight = SUM of all Species Weights</b>  |
| <b>Trip SUM</b><br><small>(add Page SUMs after last basket of trip)</small> |              |                    |                                      |                                                |           |           |           |                     | <b>Note:</b> If using tube scales add to .1 kgs, if using digital scale add to .01 kgs. |

If **SUM of RH/S** (Alewife, Blueback Herr, Am.Shad) = **1.5% OR MORE** of total **basket weight**, immediately text msg RH% to MA DMF

# Appendix 5

## MA DMF SMALL PELAGIC PORTSIDE BYCATCH SURVEY

| Species _____<br>Tot Wt (kg) _____<br>Sub Wt (kg) _____ |           |             | Species _____<br>Tot Wt (kg) _____<br>Sub Wt (kg) _____ |           |             | Species _____<br>Tot Wt (kg) _____<br>Sub Wt (kg) _____ |           |             | Species _____<br>Tot Wt (kg) _____<br>Sub Wt (kg) _____ |           |             |
|---------------------------------------------------------|-----------|-------------|---------------------------------------------------------|-----------|-------------|---------------------------------------------------------|-----------|-------------|---------------------------------------------------------|-----------|-------------|
| Lt (cm)                                                 | Frequency | Sub Wt (kg) | Lt (cm)                                                 | Frequency | Sub Wt (kg) | Lt (cm)                                                 | Frequency | Sub Wt (kg) | Lt (cm)                                                 | Frequency | Sub Wt (kg) |
| 0                                                       |           |             | 0                                                       |           |             | 0                                                       |           |             | 0                                                       |           |             |
| 1                                                       |           |             | 1                                                       |           |             | 1                                                       |           |             | 1                                                       |           |             |
| 2                                                       |           |             | 2                                                       |           |             | 2                                                       |           |             | 2                                                       |           |             |
| 3                                                       |           |             | 3                                                       |           |             | 3                                                       |           |             | 3                                                       |           |             |
| 4                                                       |           |             | 4                                                       |           |             | 4                                                       |           |             | 4                                                       |           |             |
| 5                                                       |           |             | 5                                                       |           |             | 5                                                       |           |             | 5                                                       |           |             |
| 6                                                       |           |             | 6                                                       |           |             | 6                                                       |           |             | 6                                                       |           |             |
| 7                                                       |           |             | 7                                                       |           |             | 7                                                       |           |             | 7                                                       |           |             |
| 8                                                       |           |             | 8                                                       |           |             | 8                                                       |           |             | 8                                                       |           |             |
| 9                                                       |           |             | 9                                                       |           |             | 9                                                       |           |             | 9                                                       |           |             |
| 0                                                       |           |             | 0                                                       |           |             | 0                                                       |           |             | 0                                                       |           |             |
| 1                                                       |           |             | 1                                                       |           |             | 1                                                       |           |             | 1                                                       |           |             |
| 2                                                       |           |             | 2                                                       |           |             | 2                                                       |           |             | 2                                                       |           |             |
| 3                                                       |           |             | 3                                                       |           |             | 3                                                       |           |             | 3                                                       |           |             |
| 4                                                       |           |             | 4                                                       |           |             | 4                                                       |           |             | 4                                                       |           |             |
| 5                                                       |           |             | 5                                                       |           |             | 5                                                       |           |             | 5                                                       |           |             |
| 6                                                       |           |             | 6                                                       |           |             | 6                                                       |           |             | 6                                                       |           |             |
| 7                                                       |           |             | 7                                                       |           |             | 7                                                       |           |             | 7                                                       |           |             |
| 8                                                       |           |             | 8                                                       |           |             | 8                                                       |           |             | 8                                                       |           |             |
| 9                                                       |           |             | 9                                                       |           |             | 9                                                       |           |             | 9                                                       |           |             |
| 0                                                       |           | Notes       | 0                                                       |           | Notes       | 0                                                       |           | Notes       | 0                                                       |           | Notes       |
| 1                                                       |           |             | 1                                                       |           |             | 1                                                       |           |             | 1                                                       |           |             |
| 2                                                       |           |             | 2                                                       |           |             | 2                                                       |           |             | 2                                                       |           |             |
| 3                                                       |           |             | 3                                                       |           |             | 3                                                       |           |             | 3                                                       |           |             |
| 4                                                       |           |             | 4                                                       |           |             | 4                                                       |           |             | 4                                                       |           |             |
| 5                                                       |           |             | 5                                                       |           |             | 5                                                       |           |             | 5                                                       |           |             |
| 6                                                       |           |             | 6                                                       |           |             | 6                                                       |           |             | 6                                                       |           |             |
| 7                                                       |           |             | 7                                                       |           |             | 7                                                       |           |             | 7                                                       |           |             |
| 8                                                       |           |             | 8                                                       |           |             | 8                                                       |           |             | 8                                                       |           |             |
| 9                                                       |           |             | 9                                                       |           |             | 9                                                       |           |             | 9                                                       |           |             |
|                                                         |           |             |                                                         |           |             |                                                         |           |             |                                                         |           |             |
|                                                         |           |             |                                                         |           |             |                                                         |           |             |                                                         |           |             |
|                                                         |           |             |                                                         |           |             |                                                         |           |             |                                                         |           |             |

# MA DMF SMALL PELAGIC PORTSIDE BYCATCH SURVEY

| Species _____     |           |             | Species _____     |           |             | Species _____     |           |             | Species _____     |           |             |
|-------------------|-----------|-------------|-------------------|-----------|-------------|-------------------|-----------|-------------|-------------------|-----------|-------------|
| Tot Wt (kg) _____ |           |             | Tot Wt (kg) _____ |           |             | Tot Wt (kg) _____ |           |             | Tot Wt (kg) _____ |           |             |
| Sub Wt (kg) _____ |           |             | Sub Wt (kg) _____ |           |             | Sub Wt (kg) _____ |           |             | Sub Wt (kg) _____ |           |             |
| Lt (cm)           | Frequency | Sub Wt (kg) | Lt (cm)           | Frequency | Sub Wt (kg) | Lt (cm)           | Frequency | Sub Wt (kg) | Lt (cm)           | Frequency | Sub Wt (kg) |
| 0                 |           |             | 0                 |           |             | 0                 |           |             | 0                 |           |             |
| 1                 |           |             | 1                 |           |             | 1                 |           |             | 1                 |           |             |
| 2                 |           |             | 2                 |           |             | 2                 |           |             | 2                 |           |             |
| 3                 |           |             | 3                 |           |             | 3                 |           |             | 3                 |           |             |
| 4                 |           |             | 4                 |           |             | 4                 |           |             | 4                 |           |             |
| 5                 |           |             | 5                 |           |             | 5                 |           |             | 5                 |           |             |
| 6                 |           |             | 6                 |           |             | 6                 |           |             | 6                 |           |             |
| 7                 |           |             | 7                 |           |             | 7                 |           |             | 7                 |           |             |
| 8                 |           |             | 8                 |           |             | 8                 |           |             | 8                 |           |             |
| 9                 |           |             | 9                 |           |             | 9                 |           |             | 9                 |           |             |
| 0                 |           |             | 0                 |           |             | 0                 |           |             | 0                 |           |             |
| 1                 |           |             | 1                 |           |             | 1                 |           |             | 1                 |           |             |
| 2                 |           |             | 2                 |           |             | 2                 |           |             | 2                 |           |             |
| 3                 |           |             | 3                 |           |             | 3                 |           |             | 3                 |           |             |
| 4                 |           |             | 4                 |           |             | 4                 |           |             | 4                 |           |             |
| 5                 |           |             | 5                 |           |             | 5                 |           |             | 5                 |           |             |
| 6                 |           |             | 6                 |           |             | 6                 |           |             | 6                 |           |             |
| 7                 |           |             | 7                 |           |             | 7                 |           |             | 7                 |           |             |
| 8                 |           |             | 8                 |           |             | 8                 |           |             | 8                 |           |             |
| 9                 |           |             | 9                 |           |             | 9                 |           |             | 9                 |           |             |
| 0                 |           | Notes       | 0                 |           | Notes       | 0                 |           | Notes       | 0                 |           | Notes       |
| 1                 |           |             | 1                 |           |             | 1                 |           |             | 1                 |           |             |
| 2                 |           |             | 2                 |           |             | 2                 |           |             | 2                 |           |             |
| 3                 |           |             | 3                 |           |             | 3                 |           |             | 3                 |           |             |
| 4                 |           |             | 4                 |           |             | 4                 |           |             | 4                 |           |             |
| 5                 |           |             | 5                 |           |             | 5                 |           |             | 5                 |           |             |
| 6                 |           |             | 6                 |           |             | 6                 |           |             | 6                 |           |             |
| 7                 |           |             | 7                 |           |             | 7                 |           |             | 7                 |           |             |
| 8                 |           |             | 8                 |           |             | 8                 |           |             | 8                 |           |             |
| 9                 |           |             | 9                 |           |             | 9                 |           |             | 9                 |           |             |
|                   |           |             |                   |           |             |                   |           |             |                   |           |             |
|                   |           |             |                   |           |             |                   |           |             |                   |           |             |

## Appendix 6

### DMR PORTSIDE BYCATCH STUDY

Samplers:

|                      |                      |                      |
|----------------------|----------------------|----------------------|
| Basket #    Total Kg | Basket #    Total Kg | Basket #    Total Kg |
| Basket #    Total Kg | Basket #    Total Kg | Basket #    Total Kg |
| Basket #    Total Kg | Basket #    Total Kg | Basket #    Total Kg |
| Basket #    Total Kg | Basket #    Total Kg | Basket #    Total Kg |
| Basket #    Total Kg | Basket #    Total Kg | Basket #    Total Kg |
| Basket #    Total Kg | Basket #    Total Kg | Basket #    Total Kg |
| Basket #    Total Kg | Basket #    Total Kg | Basket #    Total Kg |

Link #  
BCS #  
Date  
Target Species  
Lot Weight

Catch Location  
Gear Code  
Depth Ftm  
VTR #  
Observer

Entered  
Comments



Appendix 7  
**Sector Dockside Monitoring Program Standards**  
May 25, 2009

PURPOSE STATEMENT: *This document reflects a collaborative effort by sector organizers to capture a baseline protocol of a Dockside Monitoring Program for both 100% and less than 100% Dockside Monitoring Program. Acknowledging that individual sectors present unique technical challenges, participants in this process opted to articulate protocols they felt should be met by all sectors at a minimum. However, while it will be the responsibility of individual sectors to design a Dockside Monitoring Program that achieves these protocols, the approach taken by an individual sector will vary based on the unique circumstances of their sector.*

## **I. HAIL**

1. Upon departure, sector vessels will HAIL OUT, meaning notify the Sector Manager (SM) and Dockside Monitoring Vendor that he is departing on a Groundfish (GF) Trip. The HAIL OUT will include basic identifying information. Basic identifying information includes vessel name (or other data that uniquely identifies the vessel) and sector name.
2. Transmission of the HAIL will be either via Vessel Monitoring System (VMS) or some other electronic method as determined by the Sector.
3. At an appropriate time before landing, (determined by sector and Dockside Monitoring Vendor) the sector vessel will HAIL IN, meaning notify the Dockside Monitoring Vendor of his specific offload location, estimated time of arrival, and estimated volume or weight of GF on board. Whether the captain needs to estimate volume of GF on board, broken down by species, will be determined by whether there is 100% or less than 100% Dockside Monitoring for the sector.
  - a. **If there is 100% Dockside Monitoring**, meaning a Dockside Monitor (DM) or Roving Monitor (RM) will be present for the offloading of every sector vessel groundfish trip, then the HAIL IN will include the following:
    - i. Vessel name, Captain's name, permit number, sector name, VTR# and Trip ID #.
    - ii. Specific offloading location, estimated time of arrival, and estimated volume or weight of all species combined on board.
    - iii. The DM vendor will send a confirmation to the vessel that the HAIL was received.
    - iv. If the DM has an emergency and cannot meet the vessel as required, the DM vendor will notify the vessel, the sector manager and the Office of Law Enforcement.
  - b. **If there is less than 100% Dockside Monitoring**, (meaning any specific GF trip may or may not have a DM or RM present to witness offloading), then the vessel will be notified by the DM Vendor (when they send their confirmation) that:
    - i. They will have a DM/RM present, OR
    - ii. They are issued a DM Waiver for the trip, (meaning no DM or RM will be present to witness the offload).

## **Sector Dockside Monitoring Program Standards**

May 25, 2009

- c. **If there is less than 100% Dockside Monitoring:** Regardless of whether the vessel gets a waiver or not, the HAIL IN will include everything required for 100% DM coverage, but will also include an estimated volume of each species on board.

### **II. Responsibilities of the Dockside Monitoring Vendor**

1. The DM Vendor must be able to receive HAILS on a 24/7 basis and must be able to send a confirmation of the HAIL back to the vessel. The confirmation system may be automated, but must indicate completeness of the required information.
2. The DM Vendor may keep a running list of 'open trips' so they are prepared to cover landing events and for other purposes (safety).
3. Upon receiving a HAIL IN, the DM Vendor will respond by sending the vessel and the Sector Manager a confirmation that includes confirming that a DM will be at the unloading station at a time certain; (or be able to communicate with the vessel to coordinate a time for offloading to commence). This can be any time agreeable to the unloading facility, the vessel and the DM.
4. The DM/RM will be required to sign the dealer receipt to document that the offload was observed.
5. The DM Vendor will be required to keep a record of each offload for auditing purposes and for any other reasons that may be stipulated in the private contract between vendor and Sector. This may also be needed to satisfy NMFS compliance concerns.
6. If there is less than 100% DM required, then the DM Vendor will notify the Sector Manager and NMFS Law Enforcement with the complete HAIL IN information (including a breakdown of species to be landed and estimated weight of each species on board) and whether the vessel will have a DM present at offloading or not.
7. The DM/RM must provide accurate and complete data to the SM and/or any third party immediately upon completion of weighing to give the Sector Manager or third party with enough time for the SM to ultimately produce an accurate and complete weekly report to NMFS.
8. The DM Vendor will be responsible for establishing an acceptable randomized methodology for determining allocation of DMs/RMs and waivers if less than 100% coverage level is chosen.
9. The DM Vendor will be responsible for working with Sector Managers to establish an acceptable process for Safe Harbor situations when a sector vessel is unable to follow normal dockside monitoring protocol due to an emergency situation.

### **III. Actual Monitoring of Offload at Dealer**

## Sector Dockside Monitoring Program Standards

May 25, 2009

1. The vessel may enter port and tie at safe berth but no offloading can commence until the DM/RM is present.
  - a. Under limited circumstances vessels may be allowed to land non-allocated stocks for example lobsters or scallops, but will be required to notify NMFS Enforcement with enough notice to enable enforcement to be deployed if desired.
  - b. **If 100% Dockside Monitoring is required:**
    - i. The DM will take copies of the VTR(s) with all information available (no blocked cells).
    - ii. The DM will verify the scales are certified and record the weight of offloaded fish by species or market class.
    - iii. The DM will check the vessel to ensure that all fish have been offloaded.
    - iv. The DM will sign the dealer receipt.
    - v. The DM will collect copies of the VTR(s), and the dealer receipt.
    - vi. The DM will electronically send his copies of the VTR(s), the dealer slip and his report to the sector manager ... if the sector has contracted with a third party to collect and process their data, then the DM will send all three documents to that third party.
    - vii. The DM will keep a copy of his report and it shall be stored by the DM vendor.
  - c. **If less than 100% DM is required and the vessel will get a waiver:**

The DM Vendor, when confirming that they have received the HAIL IN, will notify the vessel that they are receiving a waiver from DM for this trip. It will be the responsibility of each vessel operator to provide electronic copies of the VTR and dealer report to the Sector Manager or if applicable a contracted third party data company.
  - d. **If less than 100% DM is required and the vessel will have a DM or RM,** then the process for 100% DM will be followed.

### IV. Offloading to a Truck / Roving Monitors

1. The vessel will HAIL IN as described for all Dockside Monitoring.
2. It will be the responsibility of each individual sector to specify what remote unloading facilities Sector members will be allowed to offload to trucks at in their operations plans.
3. All trucked fish must be weighed, either at the offload site by a licensed dealer (in which case it is treated as a dockside monitoring event) or at the dealer when the truck offloads.
4. **If 100% DM is required:**
  - a. The DM vendor will be responsible for ensuring a Roving Monitoring will be at the offload site when the vessel arrives to offload. All landing events at remote ports will be required to have a RM present to witness offload activities as well as a DM present at dealer to certify weigh-out.

## **Sector Dockside Monitoring Program Standards**

May 25, 2009

- b. Copies of the VTR(s) need to be available at the truck offload for the DM.

### **5. If less than 100% DM is required:**

- a. The HAIL IN will include the captain's estimate of weight of each species on board.
- b. The vessel will be notified by the Dockside Monitoring Vendor (when they send their confirmation) that
  - i. they will have a RM present OR
  - ii. they are issued a DM Waiver for the trip
  - iii. the DM vendor will notify the Sector Manager and NMFS Law Enforcement with the complete HAIL IN information (including a breakdown of species to be landed and estimated weight of each species on board) and whether the vessel will have a DM present at offloading or not.
- c. Offloading of landings at remote ports and weigh out of landings at dealer facilities will be considered two separate events. DM will be responsible for establishing a selection process that randomly selects remote port offloads that will be monitored by a RM and weigh out of trucked landings at dealer facility by DM.

## **V. Actual Monitoring of Offload at a Remote Port**

- 1. The vessel may enter port and tie at safe berth but no offloading can commence until the RM is present.
  - a. The RM will take copies of the VTR(s) with all information available (no blocked cells).
  - b. If there are scales, then the RM will verify the scales are certified and record the weight of offloaded fish by species.
  - c. If there are no scales at the offload site, then the RM will record the number of totes of each species with the Captain's estimate of weight of each tote.
  - d. The RM will check the vessel to ensure that all fish have been offloaded.
  - e. The RM will ensure that each tote is labeled with the appropriate information including but not limited to:
    - i. Vessel name, Captain's name, permit number, sector name, VTR# and Trip ID #, date of offload, RM name, tote number and species;
  - f. The RM will confirm that the driver's manifest includes an accurate list of all totes, the species they hold, the vessel and permit each tote came from, and the RM's name/contact info.
  - g. The RM will electronically send his copies of the VTR(s) and his Offload Report to the sector manager, and if the sector has contracted with a third party to collect and process their data, then the RM will send both documents to that third party.
  - h. The RM will keep a copy of his report and it shall be stored by the DM vendor.
- 2. Final RM protocols and requirements will be determined by the DM vendor and the individual Sector, detailed in the Sector's Operations Plan, and must be approved by NMFS.



## New England Fishery Management Council

50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116  
John Pappalardo, *Chairman* | Paul J. Howard, *Executive Director*

May 10, 2011

Ms. Patricia A. Kurkul  
Regional Administrator  
National Marine Fisheries Service  
55 Great Republic Drive  
Gloucester, MA 01930

Dear Pat:

The Final Rule implementing Framework Adjustment 45 included a requirement that dockside monitors inspect the fish hold for any trip assigned a dockside or roving monitor. At the April Council meeting, the following motion was passed without an opposing vote (12/0/2):

*"request that the Council write a letter to NMFS expressing our concerns on the requirement to have dockside monitors go down in the fish hold."*

The Council is concerned that this requirement poses an unacceptable safety risk for dockside monitors. There are no generally accepted standards that describe access from an offloading site to a fishing vessel. While at some locations there may be a boarding platform or gangway between the dock and the vessel, it is far more common for access to be by jumping or clambering from one to the other. Given the high tides in some areas of New England there may be a large vertical distance between the pier and the vessel, and as a result access may be via a poorly maintained, slippery, and, in winter, ice-encrusted ladder. There are numerous examples of experienced fishermen falling in the water between the vessel and the pier, often with tragic results. To expose dockside monitors to these risks without a clear benefit is unacceptable.

Once on-board a vessel the number of hazards does not decrease. Dockside monitors are being asked to inspect fish holds; access to a hold can be nearly as hazardous as that between the dock and the vessel. There are also safety concerns with entering fish holds do to the possibility of poor or non-existent ventilation. These personnel operate independently, with no safety observer or backup should they encounter a problem. There is a very real possibility that an accident could be undetected for a considerable length of time.

These safety issues are likely to increase the potential liability for both dealers or dock owners and the fishing vessels. As a result insurance companies may increase premiums. These increased costs will only dissipate the economic benefits of the catch share system.

Even if the safety issues can be resolved, there are other questions concerning the role of the monitors that have not been addressed. Are they to move ice or other gear to ensure all fish has been offloaded?

How do they respond if they do find catch that is not offloaded, since they do not have enforcement authority? Will this requirement delay the offload of multiple vessels at busy offload sites? What will be the response if a vessel captain does not give permission to board their vessel? Can a dealer refuse to allow a monitor to board from its dock because of safety issues?

In sum, the Council believes its concerns warrant revisiting this requirement. We urge you to reconsider this decision in light of the serious safety and practical issues that have been raised. Please contact me if you have any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul", with a stylized flourish extending from the end.

Paul J. Howard  
Executive Director

**Amendment 23**  
**To the**  
**Northeast Multispecies Fishery Management Plan**  
**Appendix IV**  
**Electronic Monitoring Programs in the Northeast Multispecies (Groundfish)**  
**Fishery**

## **Electronic Monitoring Programs in the Northeast Multispecies (Groundfish) Fishery**

The utility of fishery-dependent data for catch monitoring hinges on the collection of accurate information, and electronic monitoring (EM) is a general framework of tools for helping achieve this goal. Amendment 23 to the Northeast multispecies (groundfish) fishery management plan aims to improve monitoring while reducing costs and EM may be one tool to achieve this objective with a properly designed program.

To explore the implementation of EM in the groundfish fishery, the Northeast Fisheries Science Center (NEFSC) and the Greater Atlantic Regional Fisheries Office (GARFO) have coordinated with interested stakeholders on multiple Exempted Fishing Permit (EFP) projects since fishing year (FY) 2016. These EFPs were designed to allow commercial vessels to use EM as part of official catch monitoring protocols, facilitating the development of fleet-wide implementation. At the core of the protocols is a multi-camera video system used to record vessel operations that follow predefined catch handling procedures. The recorded video is then reviewed by trained video reviewers to determine whether the catch handling procedures were followed (e.g., regulatory compliance) and, for audit-model protocols, to annotate the size/weight of groundfish species discarded. Vessel captains are required to report haul-level effort and catch information (including discards) through electronic Vessel Trip Reports (eVTRs), producing fine-scale fishery-dependent data useful for science and management.

The two primary approaches to EM that have been developed for groundfish include:

- 1) Audit model
- 2) Maximized retention

The audit model approach is suited to vessels with small amounts of discards where individual fish can be displayed to a camera for measurement, and documented by the captain on the eVTR. Subsequently, a video reviewer watches the video footage of the trip and independently records all discards. This information is used to verify, or audit, the discards reported by the captain on the eVTR. The maximized retention approach is better suited to larger volume vessels where discards for undersized fish (e.g., haddock) are more easily estimated by retaining the catch and sampling it at the dock as part of a dealer transaction. While the video footage is used to track compliance for both approaches, it is not currently used to estimate discards for vessels participating in maximized retention.

The catch accounting processes used by GARFO have differed both within and between the approaches as each have developed over time. Additionally, modifications to the catch handling, reporting, and reviewing procedures have been made to accommodate various contingencies discovered as participation and the total trip number have increased.



**1) Audit Model (project leads: The Nature Conservancy, Maine Coast Fishermen's Association, and Cape Cod Commercial Fishermen's Alliance)**

- Participants from groundfish sectors use EM to meet at-sea monitoring requirements and account for quota-managed groundfish discards. On a subset of EM trips, vessels also carry federally-funded NEFOP fisheries observers. This project entered its 4<sup>th</sup> year in FY 2019.
- Project collaborators: Gulf of Maine Research Institute (GMRI), Teem Fish (EM service provider), GB Cod Fixed Gear Sector, Maine Coast Community Sector, Northeast Fishery Sectors II, V, and XI, and Sustainable Harvest Sector 1.
- Project Goals: 1) Evaluate third-party video review for catch accounting; 2) Develop audit methodology by using discards seen on video footage to verify fishermen's eVTRs; and 3) Refine catch handling and video review protocols.
- Groundfish Audit Model: EM is running on either ASM-selected trips (5 participating vessels, 27 total trips) or 100% of all declared groundfish trips (17 participating vessels, 369 total trips).
- Video review occurs at the trip level.
  - In FY18, 100% of trips were reviewed.
  - In FY19, we are reviewing less than 100% of trips to test a "true" audit approach.
    - The current audit level for the primary review is 50%.
- Under the audit-model, vessels are assigned one of four discard sources for each trip: NEFOP, eVTR, EM discard report, or a discard rate.
  - Trips with NEFOP observers are assigned the discards reported by the observer, consistent with the fishery as a whole.
  - Trips that are not selected for audit, and do not carry a NEFOP observer, are assigned the discards reported by the vessel on the eVTR.
  - For trips that are selected for audit, NMFS compares the discards reported by the captain on the eVTR to the discards reported by the video reviewer on the EM discard report. If the eVTR and the EM discard report match within a given tolerance, the trip is assigned discards as reported on the eVTR. If they do not match within a given tolerance, the eVTR cannot be verified and the trip is assigned discards based on either the EM discard report or a program-specific discard rate.
- FSB performs a secondary review on a portion of these trips in an effort to develop standards for EM data review and provider performance.
- Groundfish: ~200 active vessels; 25 vessels are operating under the current EFPs (see below for MREM EFP).
- NEFSC/GARFO are developing business practices necessary to support an operational EM program including; data analysis protocols and design for the audit-model (i.e., percentage of video reviewed, pass/fail criteria, development of subsampling and volumetric sampling approaches).

## **2) Maximized Retention (project lead: Gulf of Maine Research Institute)**

- Three participating vessels (96 total trips) from groundfish sectors retain all catch of allocated groundfish in accordance with maximized retention requirements, and use EM to verify compliance. These vessels run cameras on 100% of their groundfish declared trips. The EFP supporting this project was issued for two years and the project is entering its second year.
- Project collaborators: GMRI, Integrated Monitoring (EM service provider), and Sustainable Harvest Sectors 1 and 3.
- Project Goals: 1) Examine feasibility of discard compliance monitoring in a mixed-species fishery; 2) Test maximized retention; 3) Develop a pilot dockside monitoring program to collect catch data and monitor potential changes in size distribution.
- Participants retain 100% of allocated groundfish, while discarding unallocated groundfish and halibut in excess of one fish per trip; EM is used for monitoring catch retention compliance.
  - All allocated groundfish is reported by dealers for catch accounting purposes, including NO SALE catch. Participating vessels receive a discard rate of zero for allocated groundfish on these trips.
- On a subset of EM trips, vessels carry at-sea monitors (ASMs) to collect information on unallocated groundfish and non-groundfish species. All trips are exempted from NEFOP coverage (non-normal sampling).
  - Data collected by ASMs are used to develop program-specific discard rates. These discard rates are used to estimate catch of unallocated groundfish and non-groundfish species on these trips.
- All trips have mandatory dockside monitoring coverage (managed by FSB). Dockside monitors have three primary functions: (1) Inspect fish holds to ensure complete offload of catch; (2) conduct biological sampling on undersized groundfish catch; and (3) verify dealer weights.
- FSB performs a secondary review on a portion of these trips in an effort to develop standards for EM data review and provider performance.
- NEFSC/GARFO are developing business practices necessary to support an EM program including; data analysis protocols and dockside monitoring protocols.

**Amendment 23**

**To the**

**Northeast Multispecies Fishery Management Plan**

**Appendix V**

**Groundfish Plan Development Team Monitoring Analyses and**

**SSC Sub-Panel Peer Review Report**

## Modelling Discard Incentives for Northeast Multispecies (Groundfish) Stocks

4/12/2019

Anna Henry, Chad Demarest, and Melissa Errend

[Introduction](#)

Quantifying total removals is an important data requirement for successful fisheries management. Primarily, total removals are important for determining what future stock sizes will be, and for quota-managed fisheries, to ensure catch is within total catch limits. However, it is easier to measure catch that is retained than catch that is discarded at sea. Catch may be discarded for a variety of reasons, including low market value, regulations prohibit retention, or quota limits have been reached. In some fisheries discarded catch can comprise a significant portion of total removals, so it is important to accurately estimate discards. In U.S. fisheries, this is typically accomplished by deploying human observers on some, or all, fishing trips.

In fisheries with less than 100 percent observer coverage, managers and scientists allocate significant resources to estimate unobserved discards. Often, though, we lack the terminology to communicate precisely what we are estimating. This is particularly problematic in multispecies fisheries where regulations simultaneously require discarding specific species or sizes of fish but also prohibit discarding of other species or sizes of fish. Such is the case in the Northeast Multispecies groundfish fishery.

The fishery includes 17 quota allocated stocks and 5 non-allocated stocks occurring in three distinct ecosystems, delineated by managers into four broad stock areas including: Gulf of Maine (GOM), southern New England/Mid-Atlantic (SNE/MA), and both western and eastern areas of Georges Bank (inshore, and offshore GB). Minimum size limits require discarding undersized fish; yet the fishery as a whole is managed by a quota-based system that requires landing all fish above the minimum size to determine when catch limits are met. Yearly observer coverage ranges from 14% to 32% meaning in some years up to 86% of trips are unobserved (GARFO 2019, Table 1).

Discard rates on observed trips are used to estimate discards on unobserved trips but, importantly, a primary observer duty is to estimate legal discards, i.e., undersized fish and prohibited species. We suggest the term “mandatory discards” to describe this estimate. An ancillary observer duty is to report instances of non-compliance for subsequent NOAA Office of Law Enforcement (OLE) action. Because of this compliance role, illegal discarding of legal-sized fish (termed here “prohibited discards”) is generally assumed not to occur on observed trips, though instances have been reported (NOAA OLE, 2019; see Attachment 1). Without observers onboard, it is very difficult to enforce mandatory landing requirements since sufficient evidence, such as fish length, is rarely acquired before a fish is thrown overboard. Enforcement

cannot always make this determination even if they are on scene (NOAA OLE, 2019). The lack of compliance enforcement leaves unobserved trips vulnerable to an unknown level of voluntary compliance with landing requirements.

Prohibited discarding may severely undermine efforts to estimate total removals and ensure catches stay within limits, but this behavior may be economically rational. This is because in any quota-based fishery there exists some incentive to discard legal sized fish, perhaps to highgrade or avoid constraints imposed by small quota allocations (Arnason 1994). In tradeable quota programs, this incentive is a function of the costs and benefits associated with the retention of each individual fish based largely upon differences in quota prices and expected landing prices. Therefore, the focus on estimating mandatory discards has consequences on the precision and accuracy of total discard and total catch estimates given that the costs and benefits of prohibited discarding on observed trips may not be the same as those on unobserved trips. Theoretically, this stems from the economics of crime that suggests that, among other factors, the willingness to engage in illegal activities is a function of the likelihood of being caught and the severity of punishment (Becker, 1968).

When an observer is not on board, the likelihood that illegal discarding might be detected is thought to be very small, which reduces any potential ‘cost’ of this illegal activity (NOAA OLE, 2019). Therefore, when benefits of discarding are large, catches may be underreported as result. Furthermore, when fishermen are not accountable to their limits and can evade quota constraints by discarding, this undermines the effectiveness of the quota lease market, particularly for those who are less able, or less willing, to discard illegally.

Here, we describe the economic factors that influence a fisherman’s decision to discard illegally by adapting previous theoretical models (Arnason 1994, 2001) to describe the Northeast Multispecies fishery. We then parametrize the model using information from fishing trips 2007-2017 in order to explore how discard incentives change year to year and across stocks. We use results to inform a discussion about what factors influence discard incentives most, and how the discard incentive model might be used retrospectively or prospectively as an indicator of biased catch data.

## Methods

We model the incentive to discard a pound of stock  $i$  on a trip  $k$  ( $Id_{ik}$ ) on unobserved trips as the difference between the costs associated with landing one additional pound of fish ( $q$ , in live pounds) and the costs associated with discarding that unit, standardized by the total ex-vessel value (Equation 1).

$$Id_{ik} = [(Cl_i(q_i) - Cd(q_i))/(pf_i * q_i)]_k. \quad [1]$$

Costs of landing ( $Cl$ , Equation 2) include the cost of leasing quota for that unit of fish<sup>1</sup> ( $pq$ ), sector and landing fees ( $sf$ , and  $lf$ , respectively), and any costs associated with on board handling such as the labor of properly gutting and icing the fish, which all together are per unit costs of labor ( $ClL$ ). In the model, we specify sector fees by sector (sectors 5, 22 and 26 do not have fees, other sectors' fees range between \$.035 and \$.075 per pound) and landing fees are a constant at \$.05 per pound, a typical fee charged dockside by dealers. The cost of labor associated with landing is also modeled as a constant at \$.01 per pound. It is difficult to approximate the true marginal labor cost of landing (which includes all pre-processing, such as gutting, dressing, and putting on ice) realistically this would vary by trip depending on realized crew shares, the total pounds landed, trip duration, and even target species since roundfish and flatfish stocks require different amounts of pre-processing (such as gutting). Murphy et al. (2018) report that between years 2007-2015 the value of the median crew share ranges from \$0 to \$665 per crew member per day depending on vessel size, but the fleetwide median has been relatively stable at \$400 per day. In addition, average groundfish landings per day absent are approximately 2,600 pounds. One groundfish observer estimated that one hour per every twelve hours fishing is spent pre-processing. Combining these pieces of information, our approximation of marginal labor costs appears to be reasonable, since this back-of-the envelope calculation would estimate that if all 2,600 fish were pre-processed in one hour the marginal pre-processing cost could be approximated as \$.013/lb. In 2015, the highest crew shares were observed for the largest vessel size class would yield a marginal labor cost of landing of \$.02/lb.

$$Cl_i(q_i)_k = \{pq_i * q_i + (1 - \delta_k)[(\sum_{j=1}^n pq_j * r_j) * q_i] + ClL(q_i) + sf * q_i + lf * q_i\}_k, \quad [2]$$

In addition, we also include a term that represents the cost of quota for all other stocks associated with landing an additional pound of fish. In New England, on unobserved trips a discard rate is applied based on observed discards within each strata (sector, gear, stock). Therefore, we model this as the proportion of unobserved tows ( $\delta$ , set at 0 for unobserved trips) multiplied by the discard ratio ( $r$ ) which are back calculated by stock and trip using the year end imputed rate as the discards of all stocks within the same broad stock area ( $disc_j$ ) over the quantity kept landings on trip  $k$  ( $q_k$ , Equation 3).

$$r_j = disc_j / q_k. \quad [3]$$

Costs of discarding ( $Cd$ ) include the revenue forgone when not landing one unit of fish (ex-vessel value), as well as the labor costs associated with discarding the fish ( $CdL$ ). As we focus on illegal discarding, we add the probability of detection ( $p(d)$ ) and the magnitude of sanction associated with illegally discarding fish ( $s$ , Equation 4). Labor costs of discarding are assumed to be near zero because there are very few marginal costs associated with discarding outside of sorting, which occurs whether a fish is landed or discarded. We set this at a conservatively high value at \$.005 per pound. The probability of detection and sanction are modeled together as a

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<sup>1</sup> We commonly refer to quota prices and quota costs throughout this work but this only includes the costs of leasing quota. Permanent sale of quota is not allowed except through the sale of the entire fishing permit.

constant, which we set at a combined cost of \$5 for stock landings more than \$20 and \$0 for any landings less than \$20—simply because on trips with low landings this parameter becomes strongly influential. We believe this is conservative granted that the probability of detection for illegally discarding legal sized fish at sea is likely zero or close to zero on unobserved trips, which counteracts even a high possible sanction, noting that here this could represent a sanction of \$20,000 with a 0.25% probability of being detected. King and Sutinen (2010) found that for the NE groundfish fishery in 2006 the average sanction for all violations was \$20,000, but the average settlement fine was around \$10,000. In addition, according to OLE, out of 12 reported incidents of prohibited discarding on both observed trips and unobserved trips (out of which 8 were generated by observers), the strongest action taken has been 1 written warning over the last two years. This supports other information from OLE that even on observed trips it is very difficult to acquire enough evidence to issue violations (NOAA OLE, 2019), and supports our rationale for including a low expected cost for prohibited discarding.

$$Cd_i(q_i)_k = [pf_i * q_i + Cdl(q_i) + p(d) * s]_k \quad [4]$$

Incentives are estimated separately for each allocated groundfish stock and each groundfish trip over fishing years 2007-2017. Trip information is selected for trips from the GARFO DMIS database. Ex-vessel prices are calculated at the NESPP4 (market/grade) level from information of total value and landed pounds for each grade on a given trip. Landed stocks with ex-vessel prices greater than \$10 or less than \$.05 per pound for each of the 17 allocated stocks were removed as outliers from the dataset.

Quota lease prices are estimated with a hedonic price model using methods described in Murphy et al. 2018. For fishing years 2011-2016 quota prices are estimated by stock for each quarter of the fishing year using inter (between) sector and intra (within) sector trades of both fish for fish and fish for cash as reported in sector end of fishing year reports. For quarters with minimal trading volume, the model estimates a quota price of zero. In cases with non-zero prices in adjacent quarters we adjust estimated prices by substituting prices from the surrounding quarters in the same fishing year (Table 2). In other instances, such as where estimated quota prices appear anomalous (e.g., high prices for low utilization stocks), prices were adjusted to the median reported cash trade value. Prices for fishing year 2010 and 2017 are estimated annually due to fewer reported trades and no information on within sector trades<sup>2</sup>. The value of quota for fishing years 2007-2009 (pre sectors) is assumed to be zero.

Sector NEFS IX trips were excluded from results because vessels in this sector were found guilty of strategic misreporting and therefore landings information is known not to be accurate. Strategic misreporting likely affected the quota market as well, but we did not attempt to adjust for this.

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<sup>2</sup> 2017 quota prices will be updated to quarterly modeled prices (including inter sector trade data) after sector year end reports are submitted.

### Model assumptions:

The discard incentive model assumes that:

- landings are representative of underlying discard incentives (e.g. the model will not estimate discard incentives for stocks that are not reported as landed);
- landings data are known without error (e.g. no species substitution or other misreporting);
- modeled quarterly inter- and intra-sector quota prices adequately capture the instantaneous quota cost faced by fishermen during a trip;
- quota price encapsulates the marginal value of quota, where
- the marginal value of leased quota is equal to that of allocated quota (e.g. not incorporating an “endowment” effect);
- expectations of landed fish prices are adequately captured by ex-vessel prices received on each trip.
- quota prices and ex vessel prices are unaffected by illegal discarding or misreporting; (the benefit of discarding includes the marginal value of quota for that stock and the discards associated with landing an additional unit of fish, noting that this does not explicitly include the marginal value of landing any fish accessible in the future and enabled through discarding the fish in question);
- the probability of detection and the associated sanction are perceived by fishermen to be low;
- costs of labor of discarding and labor of landing are constant; and
- there is no shadow value of biomass, i.e., discarded catch cannot be harvested again.<sup>3</sup>

### Results:

Modeled quota prices follow general trends in single stock cash reported trades (Figure 1). Instances where these diverge are due to the influence of fish for fish trades and/or basket trades, where numerous stocks are included with one overall cash price. Price estimates for 2010 may be biased high due to a lack of data on within sector trades. Generally, estimated quota prices increase for stocks and years with higher quota utilization rates (Figure 2) following expectations from general economic theory.

Our model shows that discard incentives for many stocks increased with the implementation of the sector system (fishing year 2010), reflecting the influence of non-zero quota costs (Figure 3). Stocks which have not seen much change in discard incentives include several lower-value or low-utilization stocks such as both GB haddock stocks, pollock, and redfish (see Figure 6 for

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<sup>3</sup> Arnason (1994) believed this was negligible.



trends in ex-vessel prices, Figure 7 for trends in utilization). However, for other stocks trends since have not been consistent, due primarily to the interactions of fluctuating ACLs, quota prices, and ex-vessel prices. The imputed cost of quota for sublegal discards, which for most stocks is somewhere between 0 to 3 cents per pound of landed stock, contributes somewhat less to the incentive to discard legal-sized fish. Other model parameters we estimate as constants likely do not affect changes over time, such as the probability of detection and associated sanction, labor costs, or landing fees because cumulatively these are nearly negligible in contrast to ex-vessel and quota price (all other costs of landing, besides the cost of quota, sum to roughly 10 cents per pound, regardless of stock).

Between 2010 and 2017, almost every year had at least one stock that was landed with a positive discard incentive. In 2010, approximately half of all GB yellowtail flounder landings were modeled to have a positive discard incentive (Figure 4) and the ratio was nearly as high for the SNE/MA yellowtail flounder stock, for which mean quota prices nearly matched mean ex-vessel prices in that year. In 2011, sub-ACLs were increased for all three yellowtail stocks, as well as several other stocks with relatively low allocations, including witch flounder, plaice, and winter flounder. Highly-utilized stocks including GOM cod also saw sub-ACL increases in that year, resulting in very low quantities landed with positive discard incentives (Figure 4) and relatively few trips landing any stock with a positive discard incentive (Figure 8). In 2012, quota prices jumped for the eastern GB cod stock as well as GB yellowtail flounder, resulting in about 20% of landings in that year with a positive discard incentive. From 2013 to 2015, discard incentives are estimated to be highest for yellowtail and cod stocks, with around 20% of landed GOM cod having a positive discard incentive between 2015 and 2017. Starting in 2016, quota for GB cod west was allowed to be converted to GB cod east quota, and in 2014 a similar provision allowed GB haddock west quota to be converted into GB haddock east quota (FW 55 and 51, respectively). The quota conversion for GB cod west is likely reflected in the increase in quota price, and the corresponding increase in discard incentive, in recent years. Other stocks with positive discard incentive landings include witch flounder, plaice, and in some years, GB and GOM winter flounder. GOM haddock also sees higher discard incentives, generally corresponding to years where the difference between ex-vessel price and modeled quota prices are smallest.

Overall, the model suggests that the percentage of trips landing at least one stock with a positive discard incentive has increased since 2010 (Figure 6). This is most true for trips landing GOM cod, noting a particularly strong increase in discard incentives for trips in 2015 (Figure 7). In addition, between 20 to 30 percent of landings between 2014 and 2017 had a positive discard incentive for GOM cod (Figure 4). Comparing quota prices and ex-vessel prices over time, trends seem to match well, with higher proportions of positive discard incentive stocks appearing when average annual quota prices exceed 40 to 50 percent of ex-vessel price (Figure 5, Figure 6).

The discard incentive model may have advantages over other metrics of constraining stocks. When comparing utilization trends with modeled discard incentives, utilization alone does not describe our results, reflecting the imperfect relationship between quota price and utilization. For example, American plaice has been nearly fully utilized since 2012, yet landings and trips with a

positive discard incentive have increased over time. Changing ACLs may also serve as another indicator since highly utilized, low allocation stocks may be inferred as constraining—but we see that for example, in 2013 witch flounder experienced a drop in its ACL and was near fully utilized, but discard incentives did not change much from 2012. This illustrates that while utilization and the total allocation certainly are related to quota prices, the exact nature may be difficult to predict, complicating expectations of how discard incentives might change in a given year.

### Discussion:

Our results show that under sectors, cod and yellowtail flounder stocks have had the highest discard incentives overall, but incentives vary considerably year to year. These stocks are also currently considered to be experiencing overfishing, and are overfished (GARFO, 2019, Table 3). Discard incentives change by stock and fishing year, therefore any bias in catch data resulting from illegal discarding of legal sized fish is unlikely to be consistent in either direction or magnitude over time (Figure 3, Figure 4). Quota prices and ex-vessel prices are primary drivers of discard incentives in any year, therefore an understanding of these two factors are important considerations for the design of management measures seeking to reduce inaccuracies in true catch. Improved tracking on inter- and intra-sector quota prices and individual quota holdings may assist with enforcement as noted by OLE (NOAA OLE 2019).

These findings beg the question: if it was not economically rational to land 20% of all GOM cod in 2016, why were they landed? Assumptions and generalizations in our model may overestimate discard incentives for those who do not lease in much quota or who receive higher ex-vessel prices, and at the margin where labor costs are over or underestimated, but our model also misses other, non-economic reasons that fishermen may choose to comply with regulations even when it is less profitable to do so. Social determinants of compliance include sense of morality, peer perceptions, and judgments about the rules in place (Jagers, Berlin, and Jentoft 2012). However, King and Sutinen (2010) in a 2007 survey found that these normative factors play a weak role in the groundfish fishery; fishermen were found to doubt justifications for management decisions, and believed schedules and rebuilding targets to be arbitrary and unfair. Furthermore, they found that fishing violations, such as fishing illegally, were detected and prosecuted at low enough levels that the economic incentive *not* to comply with regulations was \$4,334 per trip. Therefore, it may be reasonable to assume that our estimates of landings with positive discard incentives represent the lower bound of the total discard-incentivized catch.

Finally, our model may *underestimate* (and rather significantly, at that) the true incentive to illegally discard legal sized fish, for two reasons. First is the endogeneity problem noted in the model assumptions: the very problem the model aims to detect is self-attenuated by discarding all of a given stock, eliminating that trip from our results, and also by the feedback loop created by the fact that illegal discarding reduces demand for quota and consequently impacts quota prices. The second reason is that our model focuses on the marginal incentive for each fish in isolation. In fact, a pound of fish discarded obtains a benefit equal not only the quota value of that pound of fish and the other marginal parameter contributions, but also obtains the benefit of

allowing access to covariate stocks on future tows and trips. The value of this additional fishing opportunity obtained by discarding is difficult to incorporate into a marginal model such as this, but is likely another primary driver of prohibited discarding.

The current model may be a useful indicator of risk, but more work is needed to fully characterize the magnitude of noncompliance in the northeast groundfish fishery. Updating previous work on attitudes about compliance would be helpful to better balance normative motivations against strictly economic incentives, as well as ground truth assumptions in our model about perceptions about probability of detection. Furthermore, predictive models of catch would permit comparisons of catch compositions for at-risk stocks over time in order to estimate underreported catch. This work is needed to accurately estimate the impact of noncompliance on total catch estimates.

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## Groundfish Plan Development Team Document

NOAA Office of Law Enforcement. 2019. Unlawful discarding of Regulated Northeast Multispecies. Report to the Groundfish Plan Development Team. April 9<sup>th</sup> 2019.

## Figures and Tables

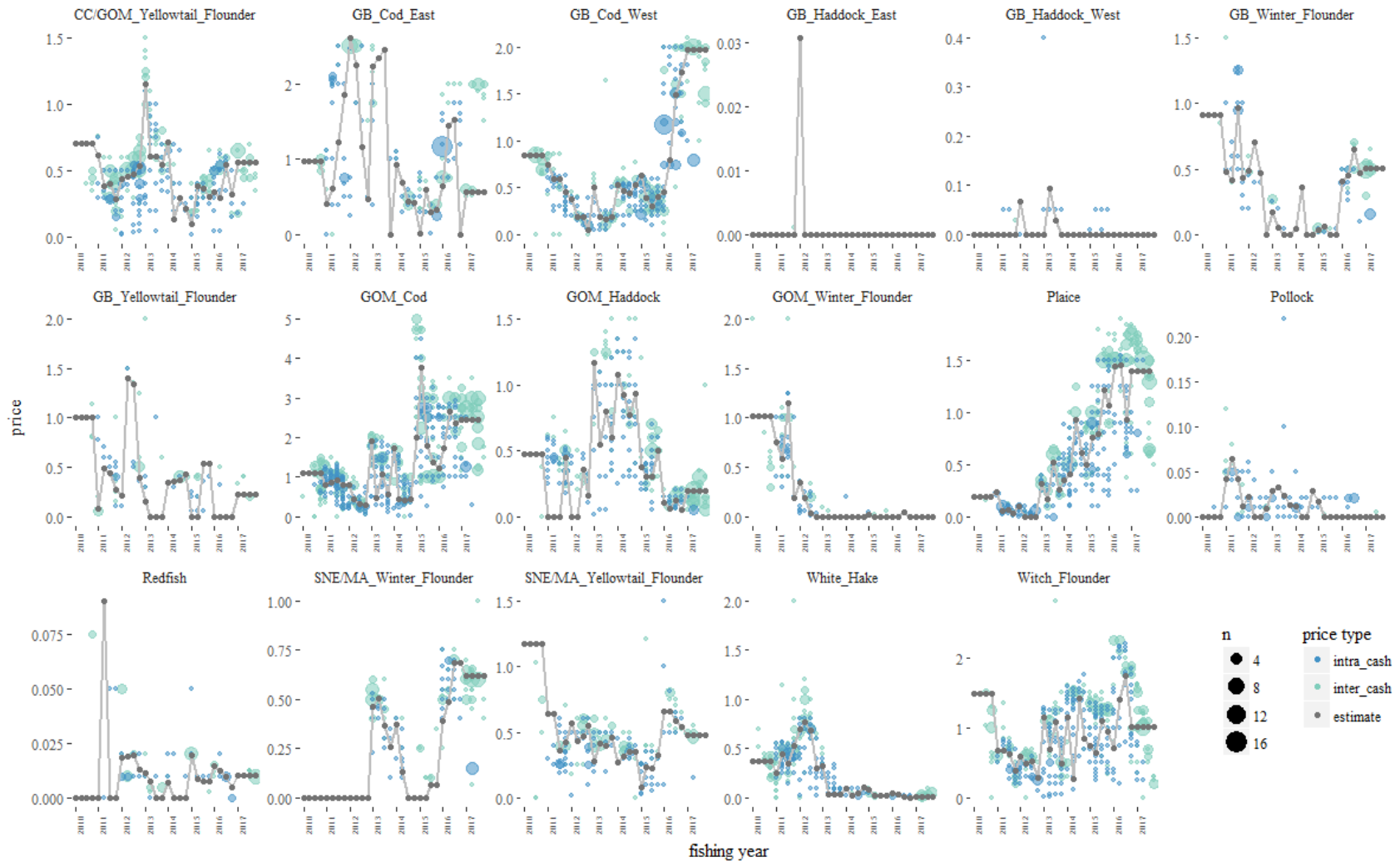


Figure 1. Estimated quota prices and sector reported single stock fish for cash trade prices by fishing year, quarter. Note that the Y-axis values differ for each stock.

## Groundfish Plan Development Team Document

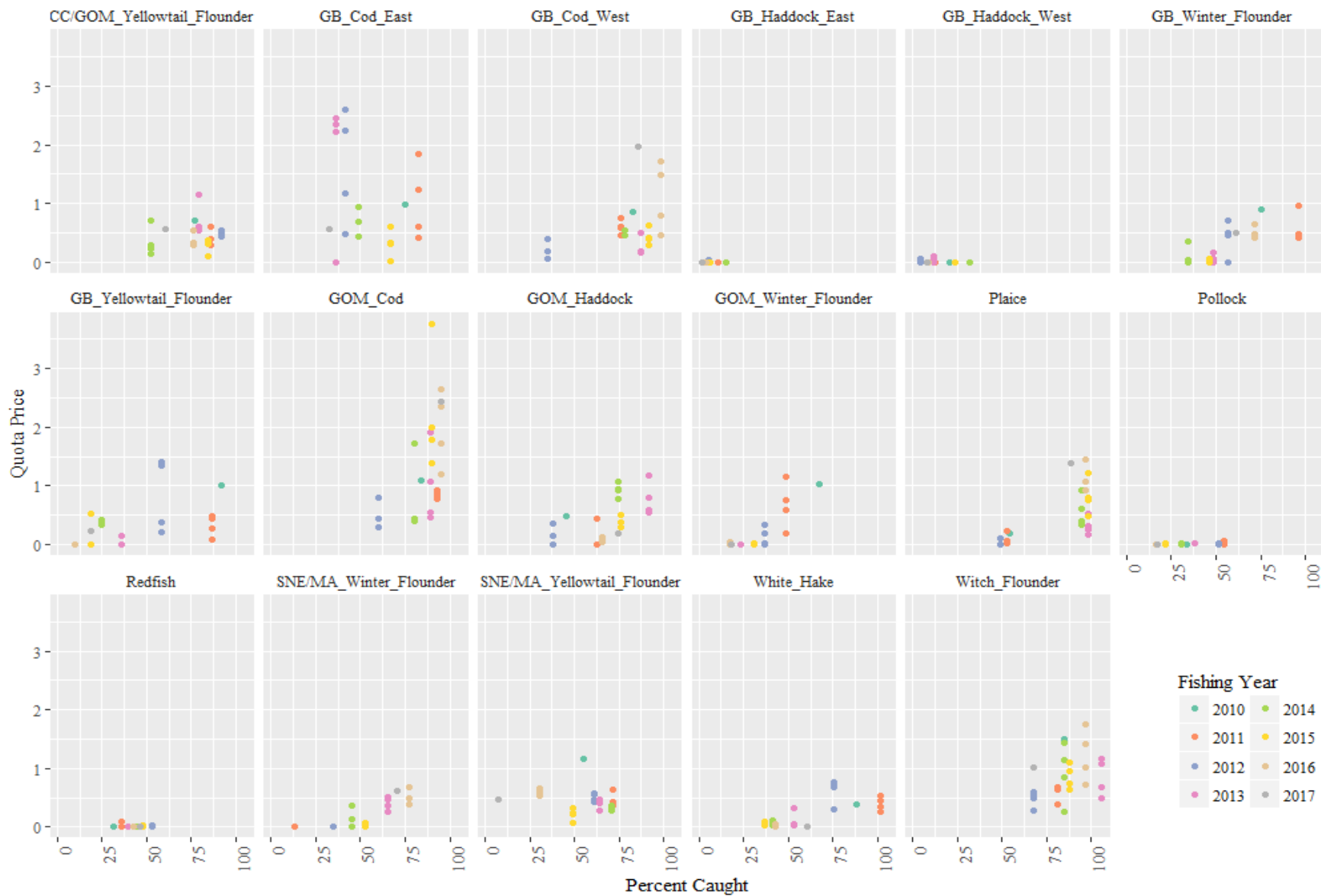


Figure 2. Percent of quota caught and estimated quota prices.

## Groundfish Plan Development Team Document

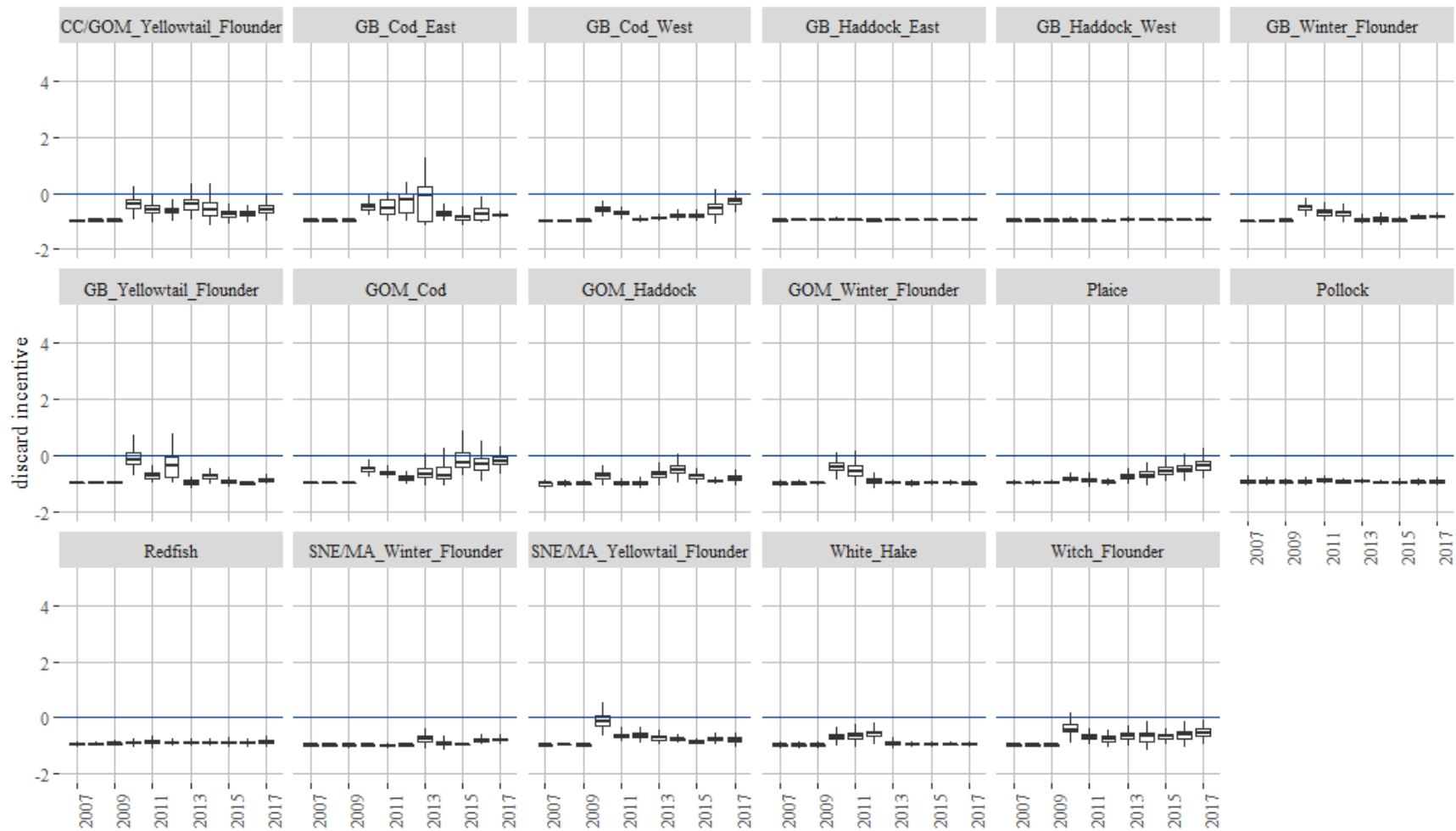


Figure 3. Estimated discard incentives for all unobserved trips fishing years 2007-2017. The boxplot 'box' shows the median, 25th percentile and 75th percentile of the distribution, the whiskers show the "min" and "max" values (defined as 1.5x the upper or lower quartiles), outliers (anything beyond 1.5 times the interquartile range) not shown for clarity.

## Groundfish Plan Development Team Document

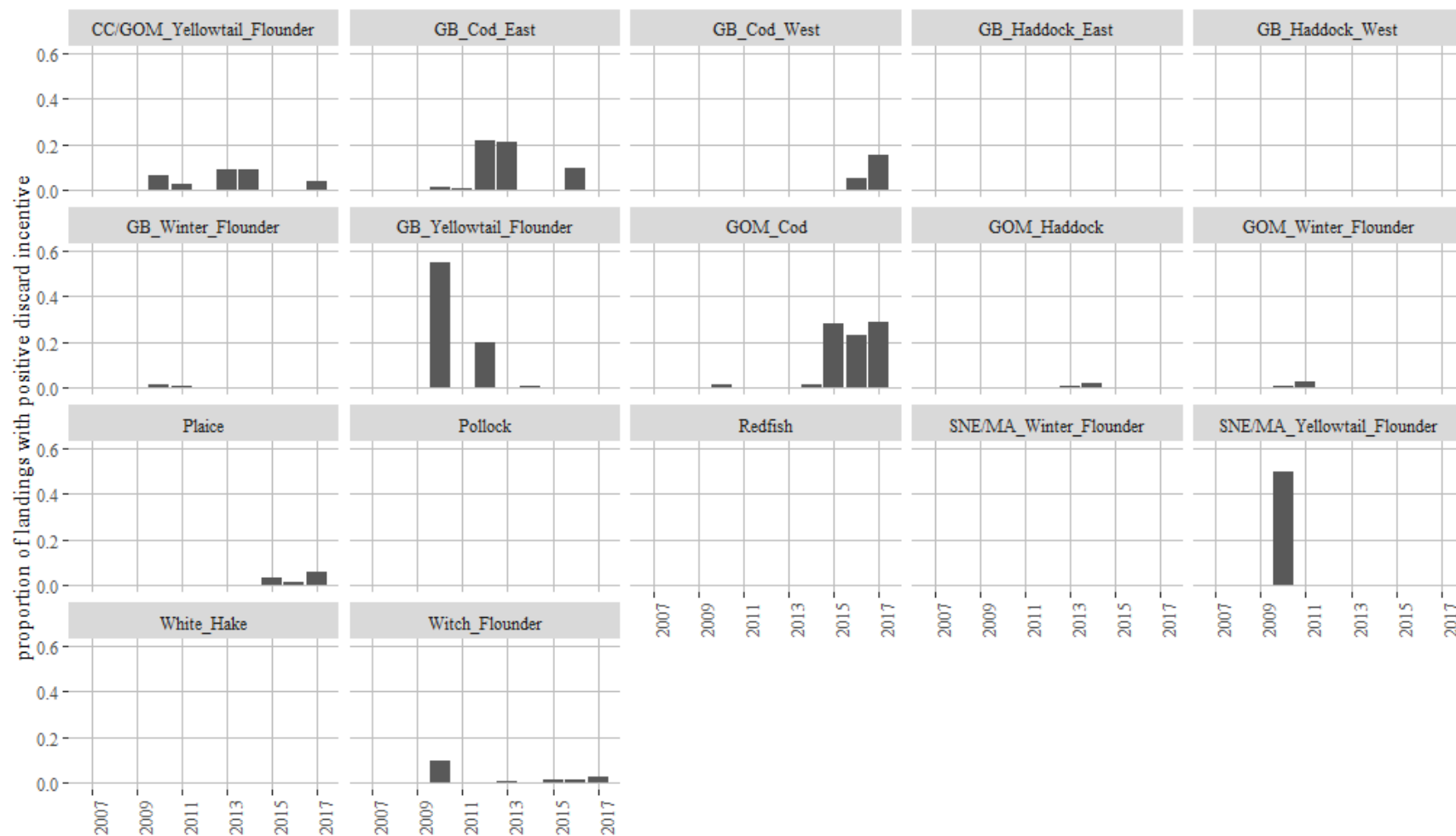


Figure 4: Proportion of landings with a positive discard incentive in each year 2007-2017 and for each allocated stock.



## Groundfish Plan Development Team Document

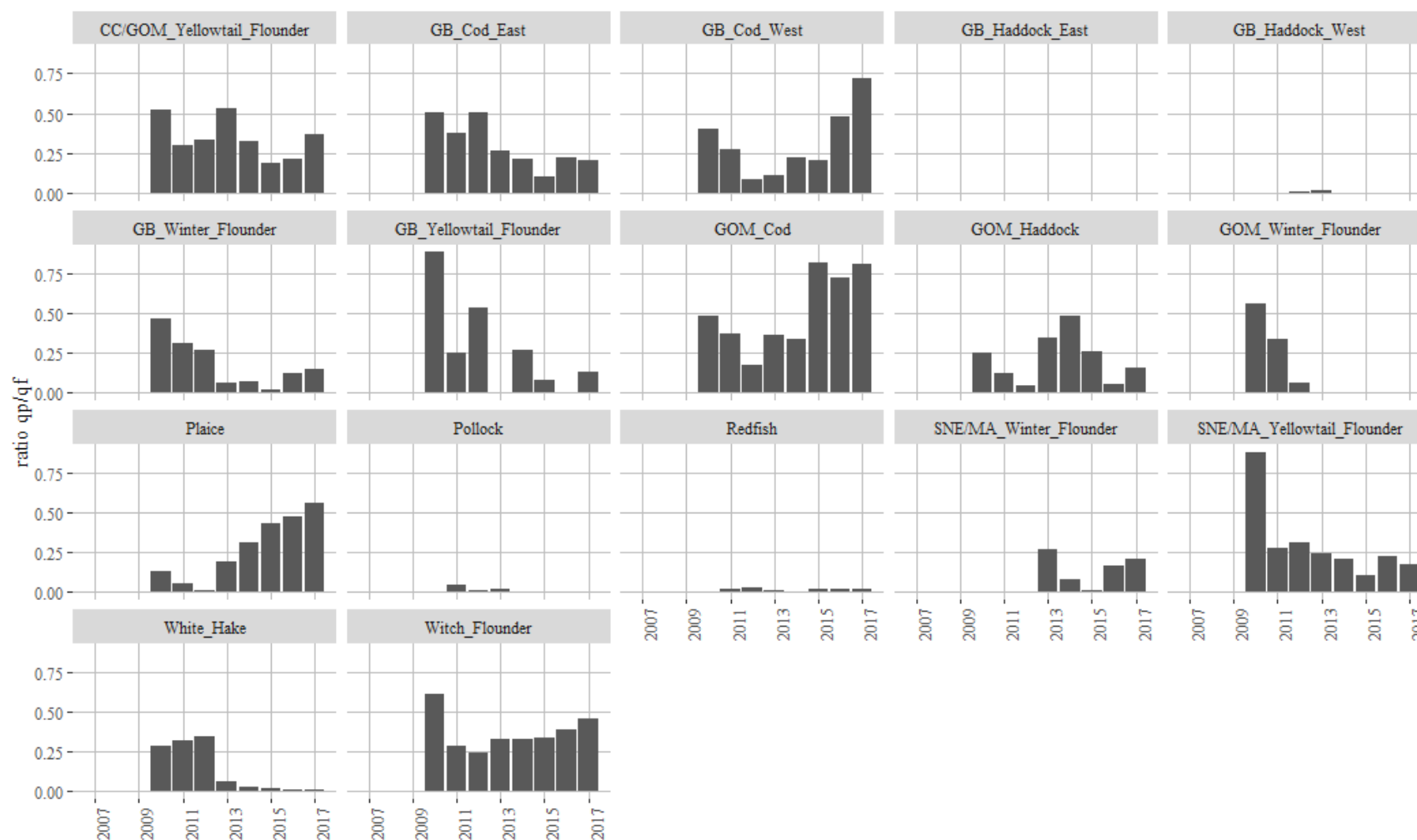


Figure 5: Ratio of modelled average annual quota price to ex-vessel price for each stock and year 2007-2017. \*starting in 2016 quota for GB cod west was allowed to be converted into GB cod east quota, and in 2014 a similar provision allowed GB haddock west quota to be converted into GB haddock east quota (FW 55 and 51, respectively).

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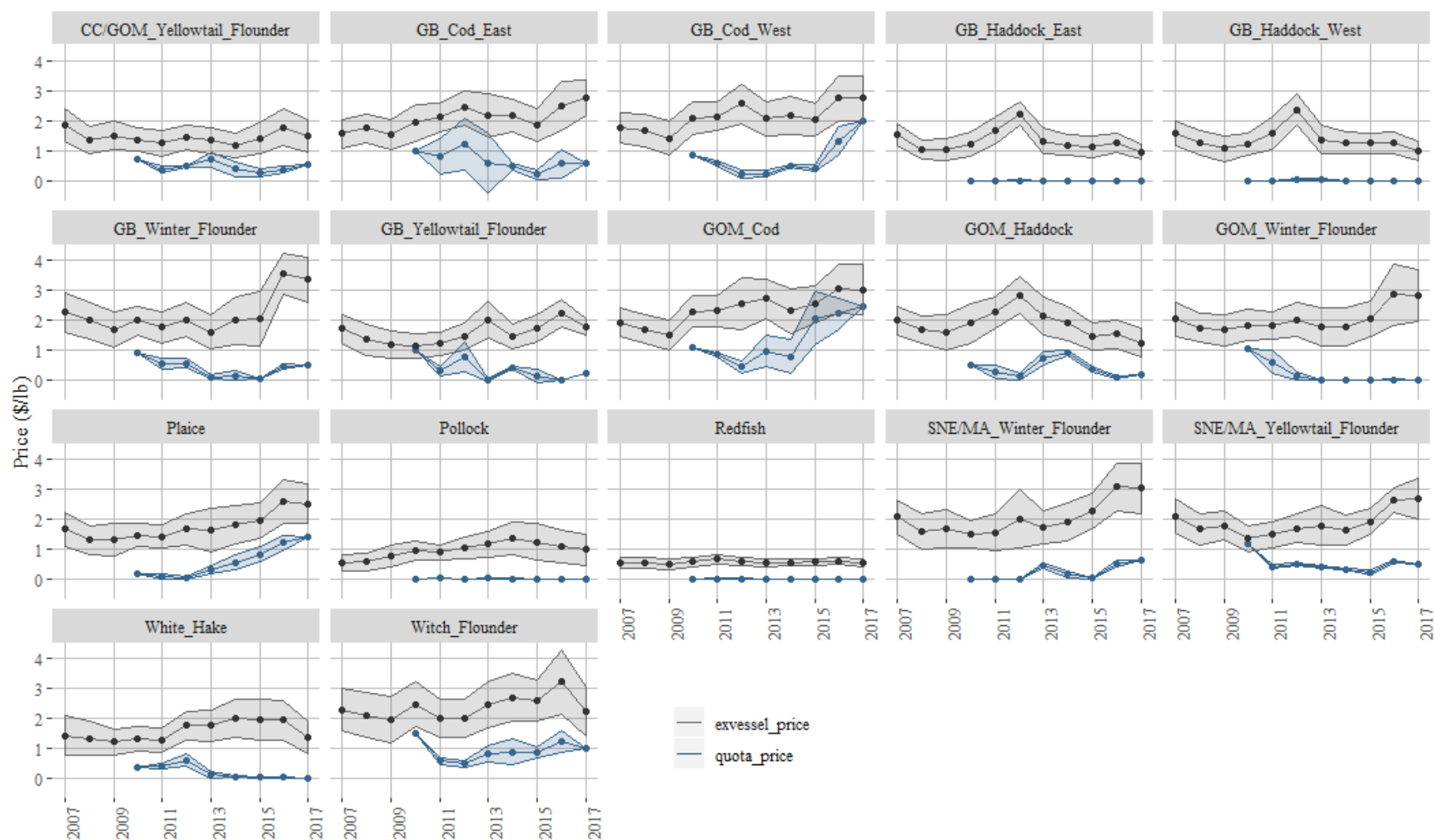


Figure 6: Mean annual ex-vessel price and quota price trends over time 2007-2017.\*starting in 2016 quota for GB cod west was allowed to be converted into GB cod east quota, and in 2014 a similar provision allowed GB haddock west quota to be converted into GB haddock east quota (FW 55 and 51, respectively).

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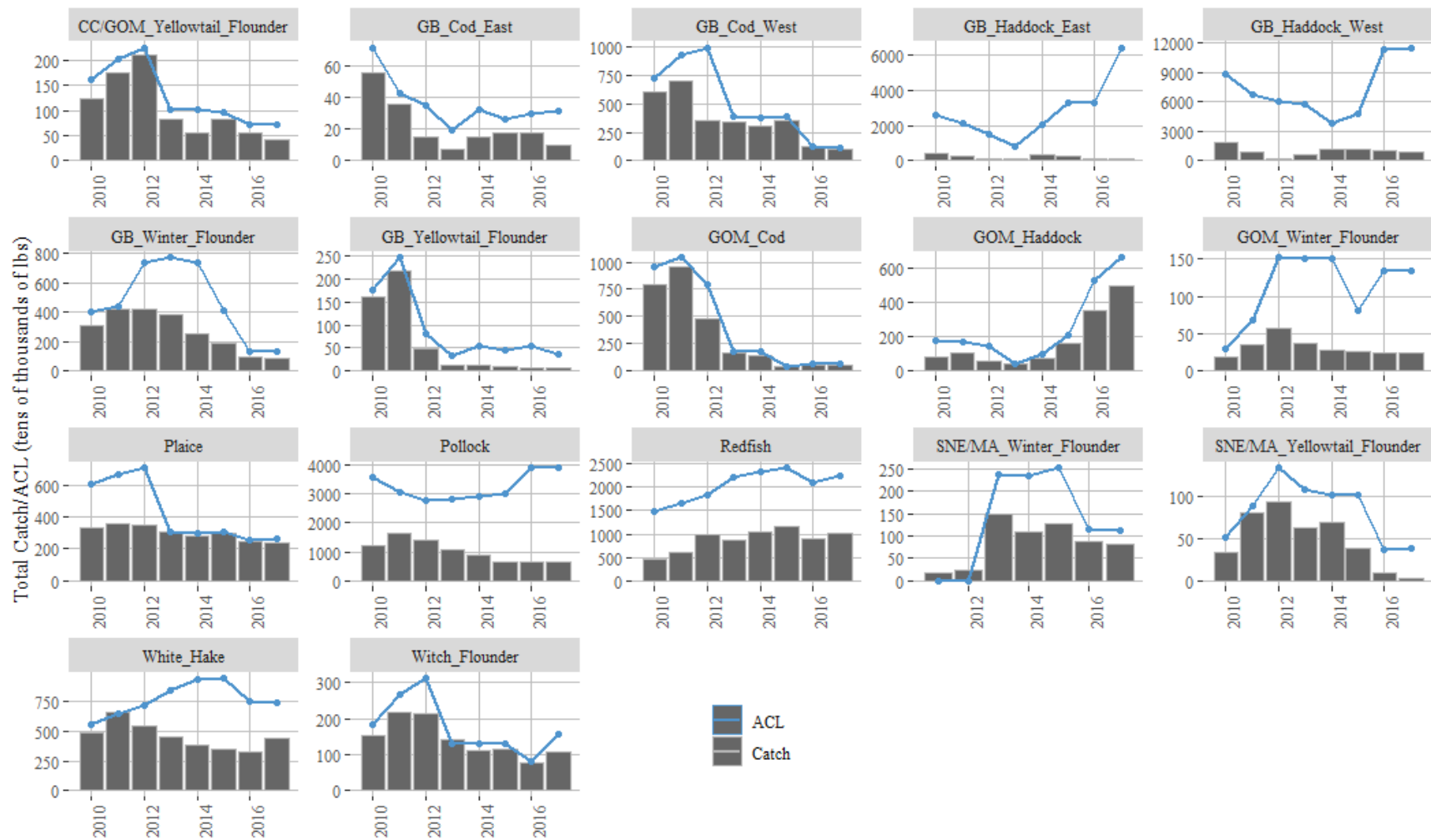


Figure 7: Utilization trends 2010-2017 showing the proportion of the commercial groundfish sub-ACL harvested by the sector program in each year. Note each panel has different y axis.

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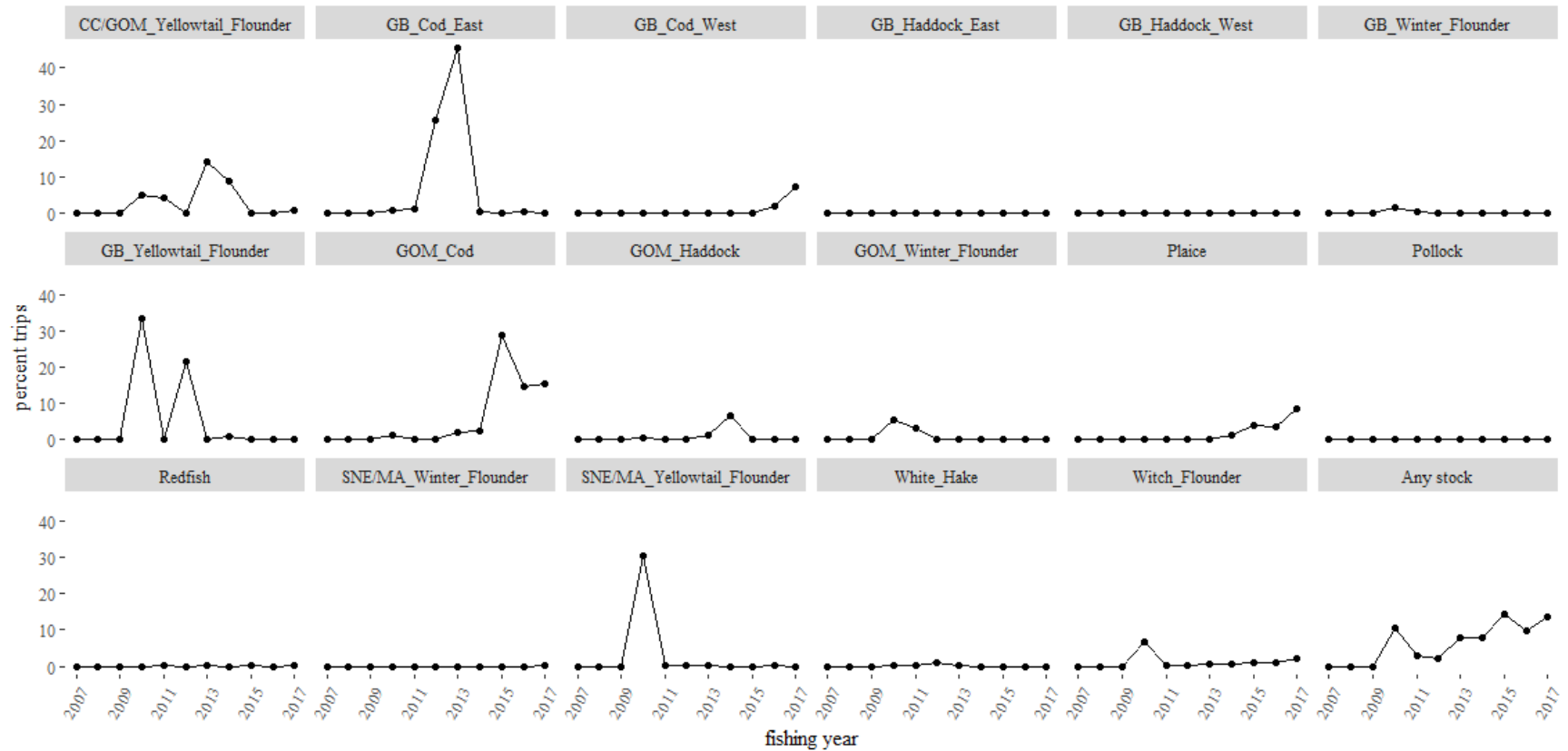


Figure 8. Percent of trips landing listed stock with positive discard incentive on that stock. All stocks plotted on 0-40 Y-axis.

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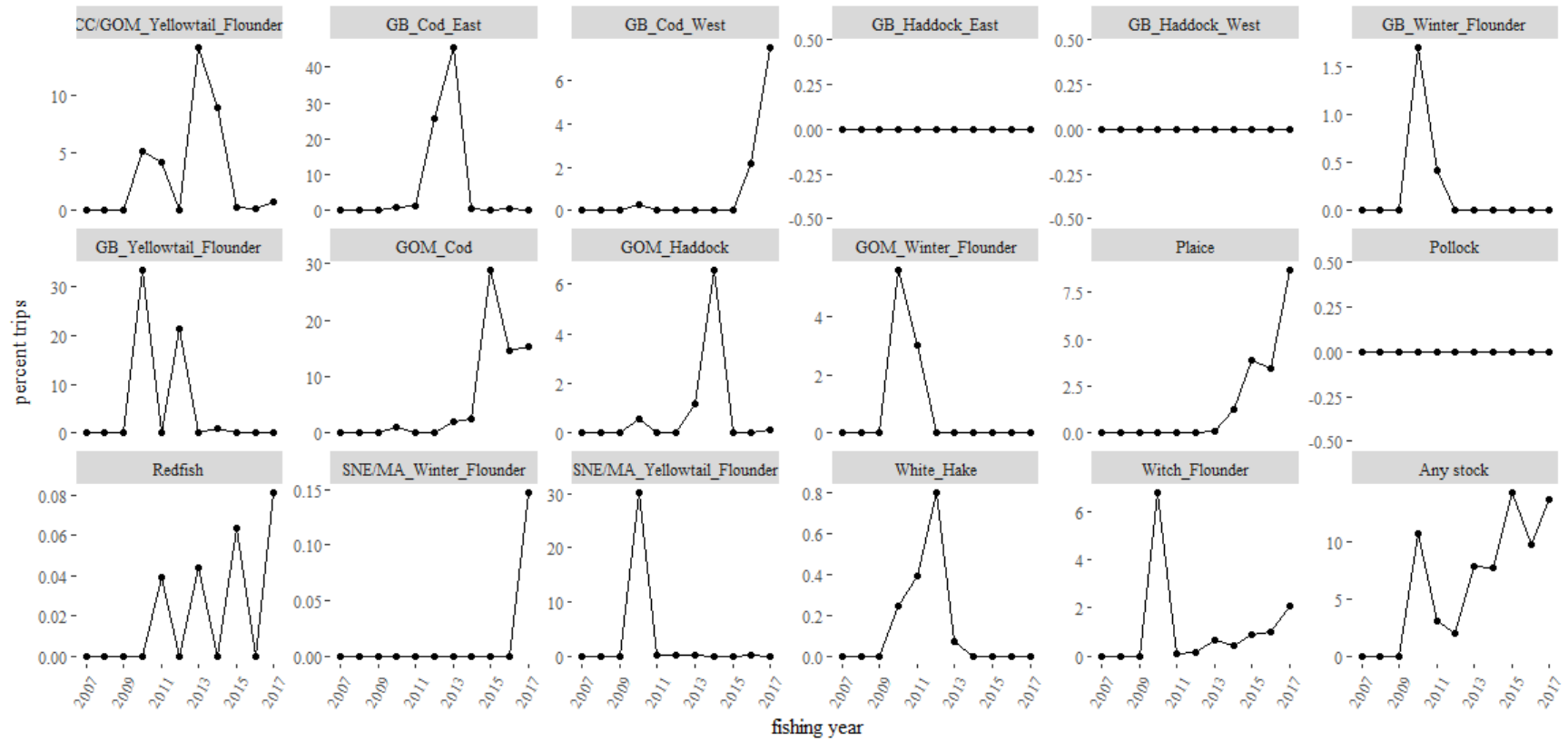


Figure 9. Percent of trips landing listed stock with positive discard incentive on that stock. All stocks plotted with differing Y-axis by stock.

Shapefile: NE\_Multispecies\_Broad\_Stock\_Areas.shp

Posted to Website: 3/15/2015

This shapefile includes the NMFS Regulated Areas in Northeast and Mid-Atlantic Waters depicted below. The dataset can be downloaded from the GARFO GIS website at <http://www.greateratlantic.fisheries.noaa.gov/gis>.

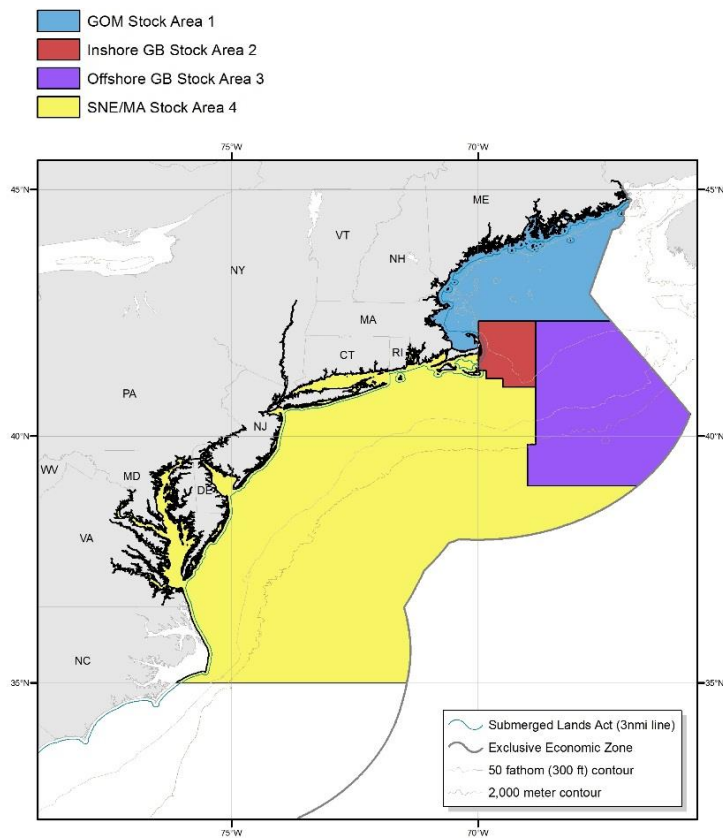


Figure 10. Broad stock areas

([https://www.greateratlantic.fisheries.noaa.gov/educational\\_resources/gis/data/shapefiles/NE\\_Multispecies\\_Broad\\_Stock\\_Areas/NE\\_Multispecies\\_Broad\\_Stock\\_Areas\\_MAP.jpg](https://www.greateratlantic.fisheries.noaa.gov/educational_resources/gis/data/shapefiles/NE_Multispecies_Broad_Stock_Areas/NE_Multispecies_Broad_Stock_Areas_MAP.jpg))

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Table 1: Adapted from GARFO ASM requirements summary FY 2019. \*FY 2018 realized coverage not yet updated

| Fishing year | NEFOP target coverage rate | ASM target coverage level | Total target coverage level | Realized coverage level |
|--------------|----------------------------|---------------------------|-----------------------------|-------------------------|
| FY 2010      | 8%                         | 30%                       | 38%                         | 32%                     |
| FY 2011      | 8%                         | 30%                       | 38%                         | 27%                     |
| FY 2012      | 8%                         | 17%                       | 25%                         | 22%                     |
| FY 2013      | 8%                         | 14%                       | 22%                         | 20%                     |
| FY 2014      | 8%                         | 18%                       | 26%                         | 25.7%                   |
| FY 2015      | 8%                         | 20%                       | 24%                         | 19.8%                   |
| FY 2016      | 8%                         | 10%                       | 14%                         | 14.8%                   |
| FY 2017      | 8%                         | 8%                        | 16%                         | 14.1%                   |
| FY 2018      | 5%                         | 10%                       | 15%                         | n/a*                    |

Table 2. Substitution method for applicable quarters with model estimated zero quota price

| Quarter with estimated zero price | Substituted quarter price (non zero) |
|-----------------------------------|--------------------------------------|
| Q1                                | Q2                                   |
| Q2                                | Average of Q1, Q3                    |
| Q3                                | Average of Q2, Q4                    |
| Q4                                | Q3                                   |

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Table 3. Stock status

| Stock                        | 2017 Assessment |                          |
|------------------------------|-----------------|--------------------------|
|                              | Overfishing?    | Overfished?              |
| GB Cod                       | Unknown         | Yes                      |
| GOM Cod                      | Yes             | Yes                      |
| GB Haddock                   | No              | No                       |
| GOM Haddock                  | No              | No                       |
| GB Yellowtail Flounder       | Yes             | Yes                      |
| SNE/MA Yellowtail Flounder   | Yes             | Yes                      |
| CC/GOM Yellowtail Flounder   | Yes             | Yes                      |
| American Plaice              | No              | No                       |
| Witch Flounder               | Unknown         | Yes                      |
| GB Winter Flounder           | No              | Approaching <sup>2</sup> |
| GOM Winter Flounder          | No              | Unknown                  |
| SNE/MA Winter Flounder       | No              | Yes                      |
| Acadian Redfish              | No              | No                       |
| White Hake                   | No              | No                       |
| Pollock                      | No              | No                       |
| Northern Windowpane Flounder | No              | Yes                      |
| Southern Windowpane Flounder | No              | No                       |
| Ocean Pout                   | No              | Yes                      |
| Atlantic Halibut             | No              | Yes                      |
| Atlantic Wolffish            | No              | Yes                      |

Table 3: Stock Status table from GARFO (2019)



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### Appendix:

Table A-1. Summary information for discard incentive model. Modelled quota costs, ex-vessel value, sublegal discard cost, as well as landing and discarding costs all represent trip-level means.

| Fishing Year | Stock             | Pounds landed | Quota costs (modelled \$) |         | Ex vessel value(\$) |         | Quota cost of sublegal discards (\$/trip) |       | Cost of landing (\$/trip Cl) |         | Cost of discarding (\$/trip Cd) |         | Discard Incentive (per trip) |      |
|--------------|-------------------|---------------|---------------------------|---------|---------------------|---------|-------------------------------------------|-------|------------------------------|---------|---------------------------------|---------|------------------------------|------|
|              |                   |               | MEAN                      | SD      | MEAN                | SD      | MEAN                                      | SD    | MEAN                         | SD      | MEAN                            | SD      | MEAN                         | SD   |
| 2007         | CC/GOM Yellowtail | 140.95        | NA                        | NA      | 262.17              | 460.66  | NA                                        | NA    | 8.46                         | 13.72   | 266.21                          | 462.68  | -0.99                        | 0.05 |
| 2008         | CC/GOM Yellowtail | 126.67        | NA                        | NA      | 171.30              | 331.70  | NA                                        | NA    | 7.60                         | 12.38   | 174.93                          | 333.66  | -0.98                        | 0.06 |
| 2009         | CC/GOM Yellowtail | 130.62        | NA                        | NA      | 196.70              | 290.22  | NA                                        | NA    | 7.84                         | 11.39   | 200.47                          | 292.35  | -0.98                        | 0.05 |
| 2010         | CC/GOM Yellowtail | 304.46        | 215.63                    | 568.52  | 415.05              | 1105.15 | 9.17                                      | 33.62 | 252.99                       | 660.03  | 419.69                          | 1109.75 | -0.38                        | 0.22 |
| 2011         | CC/GOM Yellowtail | 266.04        | 99.03                     | 275.54  | 331.57              | 995.57  | 5.47                                      | 19.80 | 129.19                       | 360.01  | 335.87                          | 1000.10 | -0.53                        | 0.26 |
| 2012         | CC/GOM Yellowtail | 356.98        | 171.54                    | 432.20  | 509.20              | 1298.88 | 6.73                                      | 23.07 | 210.82                       | 519.08  | 514.33                          | 1303.69 | -0.60                        | 0.14 |
| 2013         | CC/GOM Yellowtail | 282.63        | 199.47                    | 360.87  | 377.50              | 754.75  | 3.41                                      | 9.22  | 228.45                       | 415.24  | 382.38                          | 758.22  | -0.33                        | 0.33 |
| 2014         | CC/GOM Yellowtail | 213.78        | 83.46                     | 183.60  | 253.02              | 705.67  | 2.37                                      | 7.16  | 105.46                       | 229.91  | 257.01                          | 708.92  | -0.52                        | 0.38 |
| 2015         | CC/GOM Yellowtail | 443.90        | 118.33                    | 213.15  | 624.51              | 1116.80 | 7.72                                      | 15.61 | 166.86                       | 284.35  | 630.67                          | 1120.50 | -0.73                        | 0.16 |
| 2016         | CC/GOM Yellowtail | 383.98        | 145.54                    | 266.92  | 681.56              | 1270.14 | 8.06                                      | 16.17 | 188.87                       | 338.76  | 687.40                          | 1273.87 | -0.72                        | 0.14 |
| 2017         | CC/GOM Yellowtail | 263.19        | 147.47                    | 261.12  | 396.93              | 754.92  | 6.12                                      | 11.50 | 177.28                       | 309.90  | 402.22                          | 757.63  | -0.54                        | 0.25 |
| 2007         | GB_Cod_East       | 2072.30       | NA                        | NA      | 3240.59             | 2533.27 | NA                                        | NA    | 124.34                       | 111.02  | 3255.91                         | 2541.96 | -0.97                        | 0.01 |
| 2008         | GB_Cod_East       | 1693.99       | NA                        | NA      | 2955.40             | 2817.56 | NA                                        | NA    | 101.64                       | 90.97   | 2968.82                         | 2824.67 | -0.97                        | 0.02 |
| 2009         | GB_Cod_East       | 1967.95       | NA                        | NA      | 3025.11             | 2492.14 | NA                                        | NA    | 118.08                       | 91.55   | 3039.94                         | 2498.85 | -0.97                        | 0.02 |
| 2010         | GB_Cod_East       | 1377.02       | 1348.77                   | 1889.69 | 2668.41             | 3431.85 | 25.34                                     | 47.78 | 1497.42                      | 2108.18 | 2680.29                         | 3440.62 | -0.46                        | 0.16 |
| 2011         | GB_Cod_East       | 579.09        | 466.42                    | 671.53  | 1221.71             | 1989.55 | 9.70                                      | 27.34 | 526.50                       | 757.87  | 1229.55                         | 1994.34 | -0.51                        | 0.26 |
| 2012         | GB_Cod_East       | 187.97        | 230.93                    | 294.96  | 455.79              | 998.24  | 1.24                                      | 2.07  | 246.77                       | 318.43  | 461.63                          | 1000.38 | -0.34                        | 0.37 |

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| Fishing Year | Stock           | Pounds landed | Quota costs (modelled \$) |         | Ex vessel value(\$) |          | Quota cost of sublegal discards (\$/trip) |       | Cost of landing (\$/trip CI) |         | Cost of discarding (\$/trip Cd) |          | Discard Incentive (per trip) |      |
|--------------|-----------------|---------------|---------------------------|---------|---------------------|----------|-------------------------------------------|-------|------------------------------|---------|---------------------------------|----------|------------------------------|------|
|              |                 |               | MEAN                      | SD      | MEAN                | SD       | MEAN                                      | SD    | MEAN                         | SD      | MEAN                            | SD       | MEAN                         | SD   |
| 2013         | GB_Cod_East     | 196.95        | 115.15                    | 152.78  | 429.31              | 929.87   | 0.51                                      | 0.87  | 128.81                       | 151.88  | 435.04                          | 931.86   | -0.24                        | 0.64 |
| 2014         | GB_Cod_East     | 465.14        | 219.39                    | 546.41  | 1013.42             | 2429.84  | 2.28                                      | 12.45 | 257.31                       | 664.85  | 1020.54                         | 2436.19  | -0.71                        | 0.16 |
| 2015         | GB_Cod_East     | 757.05        | 150.53                    | 347.73  | 1400.89             | 2914.41  | 2.67                                      | 6.21  | 204.26                       | 426.96  | 1409.52                         | 2922.09  | -0.84                        | 0.13 |
| 2016         | GB_Cod_East     | 871.03        | 489.54                    | 1138.93 | 2169.36             | 4123.63  | 4.00                                      | 6.83  | 557.74                       | 1244.73 | 2178.60                         | 4130.82  | -0.72                        | 0.28 |
| 2017         | GB_Cod_East     | 752.29        | 430.41                    | 810.70  | 2092.01             | 3973.23  | 2.77                                      | 4.64  | 485.37                       | 903.26  | 2100.72                         | 3980.18  | -0.78                        | 0.07 |
| 2007         | GB_Cod_West     | 1795.79       | NA                        | NA      | 3166.49             | 4147.33  | NA                                        | NA    | 107.75                       | 145.46  | 3180.11                         | 4159.13  | -0.99                        | 0.05 |
| 2008         | GB_Cod_West     | 1470.52       | NA                        | NA      | 2463.16             | 3454.65  | NA                                        | NA    | 88.23                        | 125.51  | 2475.07                         | 3464.76  | -0.99                        | 0.05 |
| 2009         | GB_Cod_West     | 1548.46       | NA                        | NA      | 2202.92             | 3025.46  | NA                                        | NA    | 92.91                        | 127.23  | 2215.37                         | 3035.16  | -0.98                        | 0.04 |
| 2010         | GB_Cod_West     | 1515.17       | 1291.46                   | 2150.03 | 3163.37             | 5187.51  | 17.65                                     | 37.69 | 1440.39                      | 2391.26 | 3175.74                         | 5199.68  | -0.55                        | 0.13 |
| 2011         | GB_Cod_West     | 1972.02       | 1174.99                   | 2281.91 | 4197.91             | 7492.87  | 12.15                                     | 35.37 | 1354.58                      | 2602.06 | 4212.50                         | 7511.34  | -0.70                        | 0.11 |
| 2012         | GB_Cod_West     | 986.78        | 225.03                    | 616.09  | 2525.92             | 5344.23  | 6.12                                      | 23.38 | 311.26                       | 779.46  | 2535.57                         | 5354.97  | -0.92                        | 0.07 |
| 2013         | GB_Cod_West     | 1067.64       | 251.00                    | 604.89  | 2218.23             | 3821.33  | 4.90                                      | 18.90 | 338.88                       | 756.99  | 2228.21                         | 3831.67  | -0.88                        | 0.07 |
| 2014         | GB_Cod_West     | 982.52        | 484.13                    | 861.23  | 2135.20             | 3448.49  | 4.14                                      | 10.79 | 566.02                       | 1004.17 | 2144.64                         | 3456.88  | -0.77                        | 0.10 |
| 2015         | GB_Cod_West     | 1101.03       | 464.98                    | 950.36  | 2250.04             | 3974.98  | 4.69                                      | 12.04 | 556.55                       | 1114.88 | 2260.26                         | 3985.69  | -0.79                        | 0.09 |
| 2016         | GB_Cod_West     | 548.80        | 725.50                    | 1236.12 | 1510.47             | 2155.73  | 4.45                                      | 10.07 | 774.43                       | 1300.77 | 1517.87                         | 2159.79  | -0.55                        | 0.24 |
| 2017         | GB_Cod_West     | 584.73        | 1155.65                   | 1798.43 | 1603.47             | 2266.36  | 4.18                                      | 14.01 | 1207.48                      | 1875.71 | 1611.13                         | 2270.87  | -0.28                        | 0.19 |
| 2007         | GB_Haddock_East | 3136.54       | NA                        | NA      | 4838.95             | 8230.56  | NA                                        | NA    | 188.19                       | 334.26  | 4859.60                         | 8257.77  | -0.98                        | 0.03 |
| 2008         | GB_Haddock_East | 8970.81       | NA                        | NA      | 9188.60             | 13042.11 | NA                                        | NA    | 538.25                       | 806.46  | 9238.41                         | 13105.87 | -0.96                        | 0.03 |
| 2009         | GB_Haddock_East | 14287.19      | NA                        | NA      | 14890.52            | 17902.24 | NA                                        | NA    | 857.23                       | 957.82  | 14966.84                        | 17973.21 | -0.95                        | 0.03 |
| 2010         | GB_Haddock_East | 9714.63       | 0.00                      | 0.00    | 11788.19            | 14170.84 | 86.40                                     | 92.74 | 825.44                       | 880.14  | 11841.74                        | 14223.81 | -0.93                        | 0.03 |
| 2011         | GB_Haddock_East | 5122.47       | 0.00                      | 0.00    | 8571.47             | 13935.17 | 36.40                                     | 66.22 | 403.08                       | 645.10  | 8602.08                         | 13979.36 | -0.96                        | 0.03 |
| 2012         | GB_Haddock_East | 1833.36       | 25.68                     | 58.33   | 4106.34             | 5967.01  | 16.49                                     | 38.98 | 174.02                       | 257.90  | 4120.42                         | 5980.63  | -0.97                        | 0.03 |
| 2013         | GB_Haddock_East | 4967.91       | 0.00                      | 0.00    | 6587.74             | 8131.93  | 19.57                                     | 33.99 | 348.18                       | 456.65  | 6617.48                         | 8162.79  | -0.95                        | 0.04 |
| 2014         | GB_Haddock_East | 8913.79       | 0.00                      | 0.00    | 10634.63            | 13917.27 | 29.33                                     | 40.63 | 688.74                       | 937.17  | 10684.10                        | 13972.92 | -0.95                        | 0.05 |
| 2015         | GB_Haddock_East | 8038.37       | 0.00                      | 0.00    | 8988.77             | 11532.83 | 21.72                                     | 27.33 | 579.17                       | 855.90  | 9033.91                         | 11588.01 | -0.95                        | 0.04 |
| 2016         | GB_Haddock_East | 3992.91       | 0.00                      | 0.00    | 5040.01             | 8964.16  | 16.30                                     | 29.40 | 278.04                       | 456.63  | 5064.80                         | 8999.00  | -0.95                        | 0.03 |
| 2017         | GB_Haddock_East | 4499.52       | 0.00                      | 0.00    | 4278.57             | 9283.22  | 27.97                                     | 66.25 | 327.62                       | 657.73  | 4305.71                         | 9330.93  | -0.93                        | 0.06 |

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| Fishing Year | Stock           | Pounds landed | Quota costs (modelled \$) |         | Ex vessel value(\$) |          | Quota cost of sublegal discards (\$/trip) |        | Cost of landing (\$/trip Cl) |         | Cost of discarding (\$/trip Cd) |          | Discard Incentive (per trip) |      |
|--------------|-----------------|---------------|---------------------------|---------|---------------------|----------|-------------------------------------------|--------|------------------------------|---------|---------------------------------|----------|------------------------------|------|
|              |                 |               | MEAN                      | SD      | MEAN                | SD       | MEAN                                      | SD     | MEAN                         | SD      | MEAN                            | SD       | MEAN                         | SD   |
| 2007         | GB_Haddock_West | 3076.92       | NA                        | NA      | 4826.96             | 9987.44  | NA                                        | NA     | 184.61                       | 389.50  | 4846.67                         | 10018.94 | -0.99                        | 0.05 |
| 2008         | GB_Haddock_West | 3841.95       | NA                        | NA      | 4894.94             | 10698.35 | NA                                        | NA     | 230.52                       | 492.67  | 4918.46                         | 10737.31 | -0.98                        | 0.05 |
| 2009         | GB_Haddock_West | 4554.14       | NA                        | NA      | 4878.71             | 9282.72  | NA                                        | NA     | 273.25                       | 541.57  | 4905.82                         | 9324.13  | -0.98                        | 0.05 |
| 2010         | GB_Haddock_West | 6118.16       | 0.00                      | 0.00    | 7532.12             | 15568.08 | 54.87                                     | 125.43 | 545.12                       | 1078.79 | 7567.38                         | 15629.71 | -0.96                        | 0.06 |
| 2011         | GB_Haddock_West | 3089.06       | 0.00                      | 0.00    | 4929.22             | 12019.77 | 12.67                                     | 49.04  | 262.90                       | 666.49  | 4949.32                         | 12060.00 | -0.98                        | 0.05 |
| 2012         | GB_Haddock_West | 833.62        | 26.95                     | 145.58  | 1968.22             | 5135.25  | 3.76                                      | 13.31  | 96.01                        | 311.70  | 1977.03                         | 5147.02  | -0.99                        | 0.06 |
| 2013         | GB_Haddock_West | 2886.77       | 92.62                     | 294.83  | 3977.76             | 8056.25  | 10.89                                     | 28.47  | 321.73                       | 702.27  | 3996.91                         | 8086.48  | -0.95                        | 0.06 |
| 2014         | GB_Haddock_West | 5306.92       | 0.00                      | 0.00    | 6621.46             | 13203.37 | 15.31                                     | 34.67  | 403.50                       | 778.76  | 6652.51                         | 13255.67 | -0.96                        | 0.06 |
| 2015         | GB_Haddock_West | 4024.85       | 0.00                      | 0.00    | 5009.12             | 11869.04 | 16.04                                     | 39.75  | 316.92                       | 745.48  | 5033.65                         | 11918.10 | -0.96                        | 0.06 |
| 2016         | GB_Haddock_West | 5649.64       | 0.00                      | 0.00    | 7086.81             | 13938.56 | 36.37                                     | 92.17  | 443.13                       | 889.03  | 7119.68                         | 13997.77 | -0.96                        | 0.05 |
| 2017         | GB_Haddock_West | 6589.44       | 0.00                      | 0.00    | 6596.36             | 11681.13 | 48.37                                     | 107.74 | 518.89                       | 858.94  | 6633.98                         | 11738.20 | -0.93                        | 0.06 |
| 2007         | GB_Winter       | 1966.43       | NA                        | NA      | 4430.15             | 4633.98  | NA                                        | NA     | 117.99                       | 121.50  | 4444.78                         | 4643.59  | -0.99                        | 0.04 |
| 2008         | GB_Winter       | 2253.12       | NA                        | NA      | 4482.23             | 4296.58  | NA                                        | NA     | 135.19                       | 123.07  | 4498.26                         | 4306.18  | -0.99                        | 0.04 |
| 2009         | GB_Winter       | 3536.00       | NA                        | NA      | 5861.61             | 6761.45  | NA                                        | NA     | 212.16                       | 264.23  | 5884.09                         | 6781.41  | -0.98                        | 0.04 |
| 2010         | GB_Winter       | 3065.12       | 2786.52                   | 3830.15 | 6048.49             | 8536.59  | 39.03                                     | 70.05  | 3101.52                      | 4268.93 | 6068.59                         | 8556.96  | -0.48                        | 0.17 |
| 2011         | GB_Winter       | 4027.12       | 2176.52                   | 3275.89 | 7073.64             | 9787.83  | 22.82                                     | 38.68  | 2550.75                      | 3787.74 | 7098.56                         | 9815.78  | -0.66                        | 0.16 |
| 2012         | GB_Winter       | 6178.00       | 3350.29                   | 4040.92 | 12447.66            | 13570.66 | 64.78                                     | 149.81 | 3958.44                      | 4722.03 | 12483.39                        | 13601.76 | -0.73                        | 0.15 |
| 2013         | GB_Winter       | 6214.90       | 667.91                    | 1035.20 | 9959.71             | 11251.57 | 36.62                                     | 61.66  | 1231.79                      | 1603.32 | 9995.58                         | 11283.74 | -0.91                        | 0.09 |
| 2014         | GB_Winter       | 3802.68       | 537.50                    | 1246.98 | 7541.70             | 9578.62  | 13.05                                     | 25.05  | 884.04                       | 1600.41 | 7565.46                         | 9601.53  | -0.92                        | 0.11 |
| 2015         | GB_Winter       | 3702.39       | 158.10                    | 257.33  | 7564.28             | 10950.29 | 14.46                                     | 23.84  | 487.94                       | 769.69  | 7587.48                         | 10973.62 | -0.96                        | 0.06 |
| 2016         | GB_Winter       | 2384.96       | 1065.43                   | 1222.87 | 8423.95             | 10286.78 | 16.40                                     | 24.92  | 1290.78                      | 1487.19 | 8440.78                         | 10300.61 | -0.84                        | 0.05 |
| 2017         | GB_Winter       | 2761.07       | 1397.21                   | 1883.20 | 9234.69             | 12481.29 | 11.67                                     | 16.67  | 1655.17                      | 2232.58 | 9253.35                         | 12499.29 | -0.83                        | 0.07 |
| 2007         | GB_Yellowtail   | 2040.42       | NA                        | NA      | 3469.27             | 4805.01  | NA                                        | NA     | 122.43                       | 154.18  | 3484.17                         | 4817.40  | -0.98                        | 0.04 |
| 2008         | GB_Yellowtail   | 2439.25       | NA                        | NA      | 3266.97             | 3039.41  | NA                                        | NA     | 146.36                       | 127.11  | 3283.99                         | 3048.67  | -0.97                        | 0.04 |
| 2009         | GB_Yellowtail   | 2218.85       | NA                        | NA      | 2598.95             | 2113.40  | NA                                        | NA     | 133.13                       | 105.33  | 2614.78                         | 2120.94  | -0.96                        | 0.05 |
| 2010         | GB_Yellowtail   | 1867.60       | 1879.86                   | 2666.41 | 2124.40             | 2660.78  | 24.51                                     | 50.95  | 2076.76                      | 2960.49 | 2138.47                         | 2672.85  | -0.07                        | 0.40 |
| 2011         | GB_Yellowtail   | 2498.72       | 748.25                    | 1395.25 | 2994.36             | 4822.47  | 12.42                                     | 24.40  | 986.50                       | 1749.03 | 3011.58                         | 4841.38  | -0.72                        | 0.15 |

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| Fishing Year | Stock         | Pounds landed | Quota costs (modelled \$) |         | Ex vessel value(\$) |         | Quota cost of sublegal discards (\$/trip) |       | Cost of landing (\$/trip Cl) |         | Cost of discarding (\$/trip Cd) |         | Discard Incentive (per trip) |      |
|--------------|---------------|---------------|---------------------------|---------|---------------------|---------|-------------------------------------------|-------|------------------------------|---------|---------------------------------|---------|------------------------------|------|
|              |               |               | MEAN                      | SD      | MEAN                | SD      | MEAN                                      | SD    | MEAN                         | SD      | MEAN                            | SD      | MEAN                         | SD   |
| 2012         | GB_Yellowtail | 1148.81       | 885.95                    | 1920.96 | 1669.02             | 3414.49 | 6.76                                      | 21.70 | 998.84                       | 2135.60 | 1679.39                         | 3426.83 | -0.37                        | 0.43 |
| 2013         | GB_Yellowtail | 532.67        | 7.72                      | 18.40   | 1069.29             | 4591.71 | 1.51                                      | 4.62  | 57.13                        | 217.98  | 1076.30                         | 4602.99 | -0.96                        | 0.10 |
| 2014         | GB_Yellowtail | 477.40        | 184.31                    | 685.26  | 690.77              | 1964.62 | 3.04                                      | 13.58 | 230.79                       | 849.73  | 697.69                          | 1972.64 | -0.73                        | 0.17 |
| 2015         | GB_Yellowtail | 353.64        | 51.08                     | 300.36  | 607.42              | 1334.57 | 1.49                                      | 3.64  | 82.62                        | 337.41  | 613.77                          | 1338.32 | -0.92                        | 0.16 |
| 2016         | GB_Yellowtail | 449.60        | 0.00                      | 0.00    | 994.33              | 2930.20 | 1.61                                      | 3.96  | 43.49                        | 128.85  | 1000.95                         | 2936.94 | -1.00                        | 0.05 |
| 2017         | GB_Yellowtail | 898.44        | 205.09                    | 575.97  | 1571.93             | 4368.20 | 3.37                                      | 9.20  | 292.33                       | 824.76  | 1580.47                         | 4381.10 | -0.87                        | 0.09 |
| 2007         | GOM_Cod       | 594.72        | NA                        | NA      | 1143.67             | 906.66  | NA                                        | NA    | 35.68                        | 26.75   | 1151.57                         | 908.80  | -0.98                        | 0.03 |
| 2008         | GOM_Cod       | 671.40        | NA                        | NA      | 1133.51             | 942.86  | NA                                        | NA    | 40.28                        | 30.85   | 1141.80                         | 945.27  | -0.98                        | 0.03 |
| 2009         | GOM_Cod       | 766.90        | NA                        | NA      | 1137.70             | 988.57  | NA                                        | NA    | 46.01                        | 33.96   | 1146.49                         | 991.09  | -0.97                        | 0.02 |
| 2010         | GOM_Cod       | 995.35        | 1082.01                   | 1430.06 | 2258.39             | 3043.27 | 17.93                                     | 50.27 | 1188.67                      | 1563.39 | 2268.27                         | 3049.62 | -0.46                        | 0.18 |
| 2011         | GOM_Cod       | 876.70        | 738.93                    | 1144.86 | 2012.16             | 2963.79 | 13.82                                     | 29.28 | 830.96                       | 1275.87 | 2021.49                         | 2970.34 | -0.60                        | 0.10 |
| 2012         | GOM_Cod       | 482.78        | 212.04                    | 380.40  | 1225.72             | 2178.23 | 5.57                                      | 19.61 | 260.41                       | 463.95  | 1233.03                         | 2182.71 | -0.80                        | 0.10 |
| 2013         | GOM_Cod       | 280.99        | 271.50                    | 632.48  | 758.02              | 1507.99 | 2.91                                      | 9.36  | 298.37                       | 676.17  | 764.18                          | 1510.75 | -0.58                        | 0.44 |
| 2014         | GOM_Cod       | 293.09        | 228.45                    | 400.90  | 673.33              | 1121.03 | 2.20                                      | 6.57  | 255.71                       | 452.40  | 679.60                          | 1124.27 | -0.61                        | 0.28 |
| 2015         | GOM_Cod       | 121.77        | 249.88                    | 400.49  | 306.57              | 478.37  | 1.55                                      | 3.55  | 261.90                       | 417.81  | 311.83                          | 479.55  | -0.08                        | 0.46 |
| 2016         | GOM_Cod       | 190.06        | 417.64                    | 745.39  | 577.37              | 1037.63 | 2.85                                      | 9.64  | 437.01                       | 777.34  | 583.16                          | 1039.22 | -0.29                        | 0.27 |
| 2017         | GOM_Cod       | 174.56        | 425.37                    | 704.75  | 525.83              | 868.82  | 2.88                                      | 7.47  | 443.30                       | 733.05  | 531.53                          | 870.28  | -0.16                        | 0.24 |
| 2007         | GOM_Haddock   | 121.38        | NA                        | NA      | 240.73              | 899.42  | NA                                        | NA    | 7.28                         | 30.50   | 244.59                          | 902.33  | -1.02                        | 0.07 |
| 2008         | GOM_Haddock   | 145.28        | NA                        | NA      | 242.67              | 949.14  | NA                                        | NA    | 8.72                         | 41.71   | 246.26                          | 952.96  | -1.01                        | 0.07 |
| 2009         | GOM_Haddock   | 182.44        | NA                        | NA      | 288.51              | 1596.12 | NA                                        | NA    | 10.95                        | 69.60   | 291.90                          | 1601.60 | -1.00                        | 0.07 |
| 2010         | GOM_Haddock   | 221.18        | 105.14                    | 533.74  | 415.82              | 1937.80 | 4.92                                      | 34.05 | 128.62                       | 649.29  | 420.03                          | 1943.60 | -0.71                        | 0.16 |
| 2011         | GOM_Haddock   | 200.63        | 55.76                     | 535.18  | 451.44              | 2379.47 | 3.57                                      | 17.10 | 76.91                        | 657.61  | 455.87                          | 2385.74 | -0.97                        | 0.11 |
| 2012         | GOM_Haddock   | 101.61        | 12.69                     | 45.89   | 287.19              | 745.98  | 1.55                                      | 9.29  | 22.44                        | 67.05   | 291.29                          | 747.84  | -0.99                        | 0.09 |
| 2013         | GOM_Haddock   | 119.22        | 86.79                     | 229.27  | 254.24              | 676.88  | 1.31                                      | 7.76  | 97.13                        | 259.88  | 258.12                          | 679.12  | -0.65                        | 0.19 |
| 2014         | GOM_Haddock   | 201.17        | 180.65                    | 560.45  | 378.36              | 1271.97 | 1.71                                      | 6.64  | 196.79                       | 608.71  | 382.66                          | 1275.56 | -0.45                        | 0.28 |
| 2015         | GOM_Haddock   | 521.09        | 195.13                    | 793.99  | 756.06              | 2292.53 | 4.67                                      | 33.53 | 237.36                       | 977.12  | 762.05                          | 2302.14 | -0.74                        | 0.13 |
| 2016         | GOM_Haddock   | 1172.75       | 98.77                     | 259.70  | 1779.72             | 3977.37 | 12.01                                     | 30.40 | 197.48                       | 477.79  | 1789.47                         | 3990.84 | -0.92                        | 0.08 |

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| Fishing Year | Stock       | Pounds landed | Quota costs (modelled \$) |         | Ex vessel value(\$) |         | Quota cost of sublegal discards (\$/trip) |       | Cost of landing (\$/trip CI) |         | Cost of discarding (\$/trip Cd) |         | Discard Incentive (per trip) |      |
|--------------|-------------|---------------|---------------------------|---------|---------------------|---------|-------------------------------------------|-------|------------------------------|---------|---------------------------------|---------|------------------------------|------|
|              |             |               | MEAN                      | SD      | MEAN                | SD      | MEAN                                      | SD    | MEAN                         | SD      | MEAN                            | SD      | MEAN                         | SD   |
| 2017         | GOM_Haddock | 1509.36       | 286.36                    | 638.49  | 1873.86             | 3864.05 | 15.69                                     | 39.42 | 419.21                       | 922.72  | 1885.38                         | 3880.27 | -0.79                        | 0.13 |
| 2007         | GOM_Winter  | 59.77         | NA                        | NA      | 121.05              | 318.07  | NA                                        | NA    | 3.59                         | 10.20   | 124.06                          | 319.70  | -1.01                        | 0.07 |
| 2008         | GOM_Winter  | 58.28         | NA                        | NA      | 101.08              | 338.79  | NA                                        | NA    | 3.50                         | 11.56   | 103.52                          | 340.52  | -1.00                        | 0.06 |
| 2009         | GOM_Winter  | 54.77         | NA                        | NA      | 90.50               | 337.70  | NA                                        | NA    | 3.29                         | 12.53   | 92.58                           | 339.50  | -1.00                        | 0.07 |
| 2010         | GOM_Winter  | 52.01         | 53.17                     | 133.30  | 94.83               | 233.55  | 1.58                                      | 6.03  | 59.61                        | 149.05  | 97.34                           | 235.22  | -0.39                        | 0.22 |
| 2011         | GOM_Winter  | 67.69         | 40.80                     | 118.12  | 122.72              | 327.68  | 1.70                                      | 6.40  | 48.84                        | 136.35  | 125.76                          | 329.36  | -0.56                        | 0.26 |
| 2012         | GOM_Winter  | 105.57        | 13.74                     | 45.72   | 211.84              | 564.98  | 2.29                                      | 8.86  | 25.85                        | 73.72   | 215.53                          | 566.95  | -0.90                        | 0.12 |
| 2013         | GOM_Winter  | 128.20        | 0.00                      | 0.00    | 227.64              | 541.60  | 2.09                                      | 8.86  | 14.03                        | 34.55   | 231.25                          | 543.89  | -0.97                        | 0.07 |
| 2014         | GOM_Winter  | 115.35        | 0.00                      | 0.00    | 204.16              | 851.11  | 1.34                                      | 6.08  | 12.25                        | 59.76   | 207.41                          | 854.42  | -0.99                        | 0.08 |
| 2015         | GOM_Winter  | 144.31        | 0.60                      | 2.60    | 296.02              | 598.15  | 2.69                                      | 7.37  | 16.93                        | 34.36   | 299.97                          | 600.38  | -0.98                        | 0.07 |
| 2016         | GOM_Winter  | 162.09        | 1.14                      | 8.04    | 460.17              | 954.26  | 3.84                                      | 8.86  | 20.28                        | 41.34   | 464.74                          | 956.30  | -0.99                        | 0.06 |
| 2017         | GOM_Winter  | 161.23        | 0.00                      | 0.00    | 451.48              | 1288.64 | 4.12                                      | 14.90 | 19.30                        | 59.06   | 456.28                          | 1291.31 | -1.00                        | 0.06 |
| 2007         | Plaice      | 298.41        | NA                        | NA      | 494.65              | 1387.79 | NA                                        | NA    | 17.90                        | 52.64   | 498.90                          | 1392.74 | -1.00                        | 0.06 |
| 2008         | Plaice      | 361.21        | NA                        | NA      | 468.91              | 1401.44 | NA                                        | NA    | 21.67                        | 68.50   | 473.39                          | 1407.53 | -0.99                        | 0.06 |
| 2009         | Plaice      | 426.79        | NA                        | NA      | 559.07              | 1645.68 | NA                                        | NA    | 25.61                        | 75.92   | 563.79                          | 1652.24 | -0.98                        | 0.06 |
| 2010         | Plaice      | 603.97        | 116.65                    | 300.40  | 881.79              | 2215.41 | 6.01                                      | 15.84 | 167.02                       | 420.66  | 887.76                          | 2223.75 | -0.82                        | 0.21 |
| 2011         | Plaice      | 459.92        | 38.39                     | 130.26  | 654.45              | 1931.54 | 2.64                                      | 7.38  | 74.99                        | 217.28  | 659.46                          | 1938.89 | -0.87                        | 0.12 |
| 2012         | Plaice      | 444.60        | 10.71                     | 58.66   | 737.65              | 2009.06 | 2.64                                      | 7.58  | 46.54                        | 134.69  | 743.01                          | 2015.77 | -0.94                        | 0.07 |
| 2013         | Plaice      | 590.14        | 182.89                    | 441.12  | 961.71              | 2225.85 | 3.78                                      | 9.36  | 229.66                       | 532.22  | 967.78                          | 2232.68 | -0.76                        | 0.13 |
| 2014         | Plaice      | 645.11        | 363.21                    | 809.23  | 1166.14             | 2336.86 | 4.50                                      | 10.49 | 416.02                       | 899.53  | 1172.78                         | 2343.58 | -0.65                        | 0.19 |
| 2015         | Plaice      | 858.66        | 718.03                    | 1268.40 | 1670.32             | 2902.99 | 7.17                                      | 17.38 | 789.51                       | 1378.24 | 1678.56                         | 2910.44 | -0.50                        | 0.24 |
| 2016         | Plaice      | 847.23        | 1030.65                   | 1766.55 | 2186.16             | 3724.51 | 10.52                                     | 21.12 | 1105.56                      | 1879.42 | 2194.58                         | 3731.61 | -0.44                        | 0.22 |
| 2017         | Plaice      | 769.64        | 1076.26                   | 1934.54 | 1927.93             | 3665.14 | 8.02                                      | 21.85 | 1144.73                      | 2056.18 | 1936.04                         | 3672.22 | -0.30                        | 0.32 |
| 2007         | Pollock     | 1755.41       | NA                        | NA      | 936.33              | 2853.56 | NA                                        | NA    | 105.32                       | 312.99  | 948.86                          | 2877.33 | -0.92                        | 0.08 |
| 2008         | Pollock     | 1905.41       | NA                        | NA      | 1093.42             | 2980.84 | NA                                        | NA    | 114.32                       | 324.86  | 1106.87                         | 3005.15 | -0.93                        | 0.07 |
| 2009         | Pollock     | 1409.66       | NA                        | NA      | 1091.96             | 3095.75 | NA                                        | NA    | 84.58                        | 243.81  | 1102.88                         | 3114.79 | -0.95                        | 0.06 |
| 2010         | Pollock     | 1713.70       | 0.00                      | 0.00    | 1602.16             | 3818.97 | 12.91                                     | 36.66 | 148.97                       | 356.02  | 1614.78                         | 3839.07 | -0.93                        | 0.08 |

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| Fishing Year | Stock         | Pounds landed | Quota costs (modelled \$) |         | Ex vessel value(\$) |         | Quota cost of sublegal discards (\$/trip) |       | Cost of landing (\$/trip Cl) |         | Cost of discarding (\$/trip Cd) |         | Discard Incentive (per trip) |      |
|--------------|---------------|---------------|---------------------------|---------|---------------------|---------|-------------------------------------------|-------|------------------------------|---------|---------------------------------|---------|------------------------------|------|
|              |               |               | MEAN                      | SD      | MEAN                | SD      | MEAN                                      | SD    | MEAN                         | SD      | MEAN                            | SD      | MEAN                         | SD   |
| 2011         | Pollock       | 1755.86       | 70.74                     | 195.30  | 1571.04             | 3954.91 | 10.47                                     | 32.40 | 224.31                       | 578.37  | 1583.97                         | 3977.72 | -0.87                        | 0.07 |
| 2012         | Pollock       | 1927.05       | 18.48                     | 87.60   | 1995.13             | 4774.86 | 11.61                                     | 44.31 | 183.67                       | 530.26  | 2008.96                         | 4799.89 | -0.94                        | 0.07 |
| 2013         | Pollock       | 2065.49       | 47.88                     | 101.88  | 2384.32             | 4834.29 | 10.65                                     | 32.63 | 220.11                       | 471.92  | 2399.07                         | 4856.20 | -0.93                        | 0.06 |
| 2014         | Pollock       | 1850.59       | 17.53                     | 63.62   | 2498.70             | 4850.40 | 9.34                                      | 30.54 | 170.44                       | 357.67  | 2512.50                         | 4868.37 | -0.96                        | 0.06 |
| 2015         | Pollock       | 1820.88       | 4.98                      | 26.05   | 2252.31             | 4379.77 | 12.02                                     | 38.01 | 163.78                       | 344.10  | 2265.83                         | 4397.73 | -0.96                        | 0.06 |
| 2016         | Pollock       | 2321.83       | 0.00                      | 0.00    | 2543.88             | 4944.76 | 17.12                                     | 48.66 | 196.40                       | 429.97  | 2559.79                         | 4968.58 | -0.96                        | 0.07 |
| 2017         | Pollock       | 2247.22       | 0.00                      | 0.00    | 2191.42             | 4488.22 | 17.82                                     | 66.25 | 200.66                       | 453.50  | 2206.81                         | 4511.57 | -0.94                        | 0.08 |
| 2007         | Redfish       | 552.48        | NA                        | NA      | 304.05              | 1021.91 | NA                                        | NA    | 33.15                        | 123.29  | 309.37                          | 1032.36 | -0.95                        | 0.07 |
| 2008         | Redfish       | 638.53        | NA                        | NA      | 337.69              | 1304.68 | NA                                        | NA    | 38.31                        | 174.00  | 343.32                          | 1319.56 | -0.95                        | 0.07 |
| 2009         | Redfish       | 696.12        | NA                        | NA      | 336.56              | 1283.39 | NA                                        | NA    | 41.77                        | 186.19  | 342.27                          | 1299.15 | -0.94                        | 0.07 |
| 2010         | Redfish       | 1432.36       | 0.00                      | 0.00    | 820.28              | 2892.84 | 9.79                                      | 40.59 | 117.91                       | 453.91  | 830.07                          | 2922.34 | -0.90                        | 0.08 |
| 2011         | Redfish       | 1394.36       | 18.23                     | 141.31  | 920.16              | 4083.95 | 5.90                                      | 26.12 | 125.91                       | 503.38  | 929.53                          | 4115.14 | -0.88                        | 0.10 |
| 2012         | Redfish       | 2137.75       | 37.46                     | 155.51  | 1281.73             | 5133.88 | 11.77                                     | 92.34 | 210.93                       | 864.62  | 1294.92                         | 5176.61 | -0.89                        | 0.08 |
| 2013         | Redfish       | 2240.06       | 11.16                     | 55.00   | 1180.57             | 3861.41 | 10.67                                     | 44.05 | 193.84                       | 692.46  | 1194.54                         | 3899.91 | -0.90                        | 0.09 |
| 2014         | Redfish       | 3176.08       | 7.51                      | 52.98   | 1777.57             | 5640.82 | 15.69                                     | 56.23 | 263.63                       | 827.52  | 1796.40                         | 5690.80 | -0.90                        | 0.07 |
| 2015         | Redfish       | 4919.05       | 57.66                     | 192.21  | 2832.19             | 8439.65 | 20.99                                     | 67.97 | 457.37                       | 1273.17 | 2860.24                         | 8510.88 | -0.88                        | 0.09 |
| 2016         | Redfish       | 4915.88       | 49.99                     | 171.44  | 2940.39             | 8829.78 | 26.30                                     | 98.28 | 468.67                       | 1374.88 | 2968.65                         | 8904.09 | -0.89                        | 0.08 |
| 2017         | Redfish       | 5506.34       | 56.02                     | 155.01  | 2981.12             | 8486.35 | 27.29                                     | 70.99 | 539.82                       | 1434.37 | 3012.26                         | 8561.32 | -0.87                        | 0.11 |
| 2007         | SNE/MA_Winter | 658.31        | NA                        | NA      | 1366.02             | 3250.22 | NA                                        | NA    | 39.50                        | 98.43   | 1373.82                         | 3258.28 | -1.00                        | 0.05 |
| 2008         | SNE/MA_Winter | 547.79        | NA                        | NA      | 877.62              | 2633.26 | NA                                        | NA    | 32.87                        | 115.00  | 884.63                          | 2642.38 | -1.00                        | 0.05 |
| 2009         | SNE/MA_Winter | 449.62        | NA                        | NA      | 753.60              | 2265.55 | NA                                        | NA    | 26.98                        | 89.10   | 759.24                          | 2272.87 | -1.01                        | 0.06 |
| 2010         | SNE/MA_Winter | 83.72         | 0.00                      | 0.00    | 126.43              | 513.08  | 0.21                                      | 0.51  | 7.93                         | 39.22   | 128.85                          | 515.84  | -0.99                        | 0.08 |
| 2011         | SNE/MA_Winter | 44.89         | 0.00                      | 0.00    | 69.84               | 124.67  | 0.29                                      | 0.63  | 4.49                         | 8.32    | 73.37                           | 125.94  | -1.00                        | 0.08 |
| 2012         | SNE/MA_Winter | 30.36         | 0.00                      | 0.00    | 61.05               | 130.48  | 0.20                                      | 0.48  | 2.97                         | 5.64    | 63.32                           | 131.99  | -0.98                        | 0.07 |
| 2013         | SNE/MA_Winter | 841.86        | 383.87                    | 1313.67 | 1452.60             | 4341.69 | 4.16                                      | 24.22 | 457.67                       | 1519.37 | 1461.25                         | 4354.44 | -0.74                        | 0.13 |
| 2014         | SNE/MA_Winter | 653.33        | 102.45                    | 347.97  | 1245.46             | 4149.07 | 1.50                                      | 5.53  | 158.63                       | 508.51  | 1252.96                         | 4160.89 | -0.91                        | 0.12 |
| 2015         | SNE/MA_Winter | 700.40        | 14.51                     | 67.55   | 1587.43             | 5392.54 | 2.22                                      | 12.15 | 75.55                        | 210.68  | 1595.47                         | 5403.46 | -0.97                        | 0.05 |

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| Fishing Year | Stock             | Pounds landed | Quota costs (modelled \$) |         | Ex vessel value(\$) |         | Quota cost of sublegal discards (\$/trip) |       | Cost of landing (\$/trip CI) |         | Cost of discarding (\$/trip Cd) |         | Discard Incentive (per trip) |      |
|--------------|-------------------|---------------|---------------------------|---------|---------------------|---------|-------------------------------------------|-------|------------------------------|---------|---------------------------------|---------|------------------------------|------|
|              |                   |               | MEAN                      | SD      | MEAN                | SD      | MEAN                                      | SD    | MEAN                         | SD      | MEAN                            | SD      | MEAN                         | SD   |
| 2016         | SNE/MA_Winter     | 719.59        | 364.99                    | 987.06  | 2203.60             | 6443.31 | 6.27                                      | 28.27 | 429.21                       | 1159.73 | 2211.78                         | 6453.05 | -0.78                        | 0.08 |
| 2017         | SNE/MA_Winter     | 710.58        | 439.33                    | 1296.99 | 2146.25             | 6513.79 | 4.79                                      | 21.14 | 499.83                       | 1458.13 | 2154.27                         | 6523.86 | -0.76                        | 0.10 |
| 2007         | SNE/MA_Yellowtail | 285.81        | NA                        | NA      | 599.78              | 667.88  | NA                                        | NA    | 17.15                        | 22.12   | 605.85                          | 669.92  | -0.99                        | 0.04 |
| 2008         | SNE/MA_Yellowtail | 301.70        | NA                        | NA      | 504.95              | 501.71  | NA                                        | NA    | 18.10                        | 19.20   | 510.99                          | 503.59  | -0.98                        | 0.04 |
| 2009         | SNE/MA_Yellowtail | 268.06        | NA                        | NA      | 478.04              | 451.71  | NA                                        | NA    | 16.08                        | 18.13   | 484.14                          | 453.32  | -0.99                        | 0.02 |
| 2010         | SNE/MA_Yellowtail | 727.93        | 850.84                    | 1185.25 | 973.52              | 1169.87 | 9.86                                      | 21.38 | 927.93                       | 1289.13 | 982.01                          | 1174.59 | -0.09                        | 0.27 |
| 2011         | SNE/MA_Yellowtail | 1123.82       | 465.49                    | 518.48  | 1657.96             | 1829.74 | 6.37                                      | 13.94 | 575.17                       | 629.79  | 1668.31                         | 1835.58 | -0.64                        | 0.13 |
| 2012         | SNE/MA_Yellowtail | 951.14        | 491.82                    | 454.65  | 1603.80             | 1558.65 | 11.84                                     | 20.74 | 592.31                       | 545.44  | 1613.39                         | 1562.78 | -0.61                        | 0.13 |
| 2013         | SNE/MA_Yellowtail | 693.44        | 294.24                    | 434.64  | 1230.63             | 1581.30 | 3.46                                      | 15.25 | 361.69                       | 531.20  | 1238.72                         | 1586.13 | -0.72                        | 0.11 |
| 2014         | SNE/MA_Yellowtail | 903.30        | 304.13                    | 526.86  | 1480.15             | 2336.56 | 2.66                                      | 6.65  | 391.75                       | 687.99  | 1489.27                         | 2344.73 | -0.77                        | 0.08 |
| 2015         | SNE/MA_Yellowtail | 528.37        | 109.91                    | 172.70  | 1016.65             | 1570.00 | 0.81                                      | 2.65  | 160.27                       | 250.06  | 1023.80                         | 1574.63 | -0.86                        | 0.07 |
| 2016         | SNE/MA_Yellowtail | 178.33        | 105.44                    | 167.61  | 471.67              | 746.43  | 1.34                                      | 4.60  | 122.47                       | 193.01  | 476.56                          | 748.44  | -0.75                        | 0.11 |
| 2017         | SNE/MA_Yellowtail | 54.93         | 26.13                     | 57.09   | 147.18              | 330.64  | 0.35                                      | 1.43  | 31.37                        | 67.89   | 150.83                          | 331.92  | -0.80                        | 0.11 |
| 2007         | White_Hake        | 409.37        | NA                        | NA      | 578.15              | 1432.52 | NA                                        | NA    | 24.56                        | 59.35   | 583.47                          | 1437.62 | -0.99                        | 0.07 |
| 2008         | White_Hake        | 388.37        | NA                        | NA      | 514.98              | 1370.73 | NA                                        | NA    | 23.30                        | 60.13   | 520.34                          | 1375.82 | -0.99                        | 0.07 |
| 2009         | White_Hake        | 464.79        | NA                        | NA      | 561.02              | 1496.68 | NA                                        | NA    | 27.89                        | 71.95   | 566.73                          | 1502.92 | -0.98                        | 0.07 |
| 2010         | White_Hake        | 796.79        | 299.71                    | 736.52  | 1059.67             | 2604.55 | 6.10                                      | 17.11 | 361.78                       | 874.93  | 1067.34                         | 2614.31 | -0.66                        | 0.17 |
| 2011         | White_Hake        | 801.36        | 329.36                    | 842.77  | 1026.44             | 2558.43 | 4.01                                      | 9.76  | 392.67                       | 975.44  | 1034.40                         | 2567.90 | -0.64                        | 0.16 |
| 2012         | White_Hake        | 726.57        | 443.60                    | 899.18  | 1270.77             | 2623.79 | 4.03                                      | 9.64  | 502.86                       | 1005.64 | 1278.62                         | 2631.28 | -0.56                        | 0.20 |
| 2013         | White_Hake        | 890.68        | 103.73                    | 357.82  | 1567.88             | 3019.42 | 4.63                                      | 12.45 | 173.18                       | 452.99  | 1576.70                         | 3027.94 | -0.90                        | 0.12 |
| 2014         | White_Hake        | 792.12        | 52.14                     | 138.68  | 1571.72             | 3360.62 | 4.26                                      | 13.87 | 112.64                       | 268.24  | 1579.87                         | 3369.69 | -0.95                        | 0.07 |
| 2015         | White_Hake        | 970.09        | 38.07                     | 116.74  | 1876.73             | 3815.01 | 6.36                                      | 24.63 | 112.33                       | 256.06  | 1885.75                         | 3825.34 | -0.96                        | 0.06 |
| 2016         | White_Hake        | 1053.07       | 25.32                     | 65.24   | 2030.67             | 3351.17 | 9.14                                      | 19.81 | 110.06                       | 200.20  | 2040.19                         | 3360.67 | -0.96                        | 0.06 |
| 2017         | White_Hake        | 1485.73       | 17.27                     | 33.48   | 2020.09             | 3672.25 | 12.70                                     | 29.23 | 141.21                       | 261.26  | 2031.55                         | 3686.12 | -0.94                        | 0.06 |
| 2007         | Witch_Flounder    | 302.77        | NA                        | NA      | 690.68              | 1721.14 | NA                                        | NA    | 18.17                        | 47.93   | 695.44                          | 1725.62 | -1.00                        | 0.05 |
| 2008         | Witch_Flounder    | 292.95        | NA                        | NA      | 614.52              | 1433.77 | NA                                        | NA    | 17.58                        | 43.64   | 619.14                          | 1437.96 | -1.00                        | 0.05 |
| 2009         | Witch_Flounder    | 305.05        | NA                        | NA      | 592.81              | 1302.22 | NA                                        | NA    | 18.30                        | 41.24   | 597.42                          | 1306.23 | -0.99                        | 0.05 |

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| Fishing Year                                       | Stock          | Pounds landed | Quota costs (modelled \$) |        | Ex vessel value(\$) |         | Quota cost of sublegal discards (\$/trip) |       | Cost of landing (\$/trip Cl) |        | Cost of discarding (\$/trip Cd) |         | Discard Incentive (per trip) |      |
|----------------------------------------------------|----------------|---------------|---------------------------|--------|---------------------|---------|-------------------------------------------|-------|------------------------------|--------|---------------------------------|---------|------------------------------|------|
|                                                    |                |               | MEAN                      | SD     | MEAN                | SD      | MEAN                                      | SD    | MEAN                         | SD     | MEAN                            | SD      | MEAN                         | SD   |
| 2010                                               | Witch_Flounder | 296.67        | 441.61                    | 913.92 | 727.89              | 1439.37 | 3.84                                      | 9.42  | 468.91                       | 967.57 | 732.66                          | 1443.14 | -0.37                        | 0.28 |
| 2011                                               | Witch_Flounder | 298.45        | 172.55                    | 423.61 | 597.11              | 1355.27 | 2.49                                      | 7.40  | 199.22                       | 484.74 | 601.60                          | 1359.64 | -0.70                        | 0.13 |
| 2012                                               | Witch_Flounder | 289.98        | 140.92                    | 337.03 | 581.40              | 1273.01 | 2.41                                      | 5.57  | 166.74                       | 394.57 | 586.19                          | 1276.98 | -0.74                        | 0.14 |
| 2013                                               | Witch_Flounder | 292.68        | 238.27                    | 447.56 | 719.95              | 1311.18 | 2.11                                      | 4.91  | 263.48                       | 491.46 | 724.89                          | 1314.69 | -0.64                        | 0.16 |
| 2014                                               | Witch_Flounder | 269.73        | 236.61                    | 480.89 | 725.69              | 1266.29 | 2.13                                      | 5.24  | 260.06                       | 518.40 | 730.45                          | 1269.56 | -0.66                        | 0.20 |
| 2015                                               | Witch_Flounder | 326.27        | 280.30                    | 466.71 | 837.57              | 1248.49 | 3.19                                      | 7.54  | 309.42                       | 509.32 | 843.04                          | 1251.70 | -0.66                        | 0.20 |
| 2016                                               | Witch_Flounder | 257.20        | 319.54                    | 539.21 | 826.50              | 1295.02 | 3.51                                      | 7.38  | 343.81                       | 574.60 | 831.64                          | 1297.67 | -0.61                        | 0.20 |
| 2017                                               | Witch_Flounder | 384.17        | 391.06                    | 641.86 | 854.80              | 1240.87 | 4.62                                      | 11.59 | 426.92                       | 698.41 | 860.79                          | 1244.40 | -0.51                        | 0.23 |
| ** all values have not been adjusted for inflation |                |               |                           |        |                     |         |                                           |       |                              |        |                                 |         |                              |      |

Table A-2: Annualized marginal discarding incentive and marginal parameter values by stock. Ex-vessel price and quota price represent weighted means. Prices have not been adjusted for inflation.

| Fishing year | stock             | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-------------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2007         | CC/GOM Yellowtail | 1.86                        | NA                      | NA                                      | 0.06                    | 1.89                       | -1.83                     |
| 2008         | CC/GOM Yellowtail | 1.35                        | NA                      | NA                                      | 0.06                    | 1.38                       | -1.32                     |
| 2009         | CC/GOM Yellowtail | 1.51                        | NA                      | NA                                      | 0.06                    | 1.53                       | -1.47                     |
| 2010         | CC/GOM Yellowtail | 1.36                        | 0.71                    | 0.03                                    | 0.83                    | 1.38                       | -0.55                     |
| 2011         | CC/GOM Yellowtail | 1.25                        | 0.37                    | 0.02                                    | 0.49                    | 1.26                       | -0.78                     |
| 2012         | CC/GOM Yellowtail | 1.43                        | 0.48                    | 0.02                                    | 0.59                    | 1.44                       | -0.85                     |



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| Fishing year | stock             | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-------------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2013         | CC/GOM Yellowtail | 1.34                        | 0.71                    | 0.01                                    | 0.81                    | 1.35                       | -0.54                     |
| 2014         | CC/GOM Yellowtail | 1.18                        | 0.39                    | 0.01                                    | 0.49                    | 1.20                       | -0.71                     |
| 2015         | CC/GOM Yellowtail | 1.41                        | 0.27                    | 0.02                                    | 0.38                    | 1.42                       | -1.04                     |
| 2016         | CC/GOM Yellowtail | 1.77                        | 0.38                    | 0.02                                    | 0.49                    | 1.79                       | -1.30                     |
| 2017         | CC/GOM Yellowtail | 1.51                        | 0.56                    | 0.02                                    | 0.67                    | 1.53                       | -0.85                     |
| 2007         | GB Cod East       | 1.56                        | NA                      | NA                                      | 0.06                    | 1.57                       | -1.51                     |
| 2008         | GB Cod East       | 1.74                        | NA                      | NA                                      | 0.06                    | 1.75                       | -1.69                     |
| 2009         | GB Cod East       | 1.54                        | NA                      | NA                                      | 0.06                    | 1.54                       | -1.48                     |
| 2010         | GB Cod East       | 1.94                        | 0.98                    | 0.02                                    | 1.09                    | 1.95                       | -0.86                     |
| 2011         | GB Cod East       | 2.11                        | 0.81                    | 0.02                                    | 0.91                    | 2.12                       | -1.21                     |
| 2012         | GB Cod East       | 2.42                        | 1.23                    | 0.01                                    | 1.31                    | 2.46                       | -1.14                     |
| 2013         | GB Cod East       | 2.18                        | 0.58                    | 0.00                                    | 0.65                    | 2.21                       | -1.55                     |
| 2014         | GB Cod East       | 2.18                        | 0.47                    | 0.00                                    | 0.55                    | 2.19                       | -1.64                     |
| 2015         | GB Cod East       | 1.85                        | 0.20                    | 0.00                                    | 0.27                    | 1.86                       | -1.59                     |
| 2016         | GB Cod East       | 2.49                        | 0.56                    | 0.00                                    | 0.64                    | 2.50                       | -1.86                     |
| 2017         | GB Cod East       | 2.78                        | 0.57                    | 0.00                                    | 0.65                    | 2.79                       | -2.15                     |
| 2007         | GB Cod West       | 1.76                        | NA                      | NA                                      | 0.06                    | 1.77                       | -1.71                     |
| 2008         | GB Cod West       | 1.68                        | NA                      | NA                                      | 0.06                    | 1.68                       | -1.62                     |
| 2009         | GB Cod West       | 1.42                        | NA                      | NA                                      | 0.06                    | 1.43                       | -1.37                     |
| 2010         | GB Cod West       | 2.09                        | 0.85                    | 0.01                                    | 0.95                    | 2.10                       | -1.15                     |
| 2011         | GB Cod West       | 2.13                        | 0.60                    | 0.01                                    | 0.69                    | 2.14                       | -1.45                     |
| 2012         | GB Cod West       | 2.56                        | 0.23                    | 0.01                                    | 0.32                    | 2.57                       | -2.25                     |
| 2013         | GB Cod West       | 2.08                        | 0.24                    | 0.00                                    | 0.32                    | 2.09                       | -1.77                     |
| 2014         | GB Cod West       | 2.17                        | 0.49                    | 0.00                                    | 0.58                    | 2.18                       | -1.61                     |
| 2015         | GB Cod West       | 2.04                        | 0.42                    | 0.00                                    | 0.51                    | 2.05                       | -1.55                     |
| 2016         | GB Cod West       | 2.75                        | 1.32                    | 0.01                                    | 1.41                    | 2.77                       | -1.35                     |

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| Fishing year | stock           | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-----------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2017         | GB Cod West     | 2.74                        | 1.98                    | 0.01                                    | 2.07                    | 2.76                       | -0.69                     |
| 2007         | GB Haddock East | 1.54                        | NA                      | NA                                      | 0.06                    | 1.55                       | -1.49                     |
| 2008         | GB Haddock East | 1.02                        | NA                      | NA                                      | 0.06                    | 1.03                       | -0.97                     |
| 2009         | GB Haddock East | 1.04                        | NA                      | NA                                      | 0.06                    | 1.05                       | -0.99                     |
| 2010         | GB Haddock East | 1.21                        | 0.00                    | 0.01                                    | 0.08                    | 1.22                       | -1.13                     |
| 2011         | GB Haddock East | 1.67                        | 0.00                    | 0.01                                    | 0.08                    | 1.68                       | -1.60                     |
| 2012         | GB Haddock East | 2.24                        | 0.01                    | 0.01                                    | 0.09                    | 2.25                       | -2.15                     |
| 2013         | GB Haddock East | 1.33                        | 0.00                    | 0.00                                    | 0.07                    | 1.33                       | -1.26                     |
| 2014         | GB Haddock East | 1.19                        | 0.00                    | 0.00                                    | 0.08                    | 1.20                       | -1.12                     |
| 2015         | GB Haddock East | 1.12                        | 0.00                    | 0.00                                    | 0.07                    | 1.12                       | -1.05                     |
| 2016         | GB Haddock East | 1.26                        | 0.00                    | 0.00                                    | 0.07                    | 1.27                       | -1.20                     |
| 2017         | GB Haddock East | 0.95                        | 0.00                    | 0.01                                    | 0.07                    | 0.96                       | -0.88                     |
| 2007         | GB Haddock West | 1.57                        | NA                      | NA                                      | 0.06                    | 1.58                       | -1.52                     |
| 2008         | GB Haddock West | 1.27                        | NA                      | NA                                      | 0.06                    | 1.28                       | -1.22                     |
| 2009         | GB Haddock West | 1.07                        | NA                      | NA                                      | 0.06                    | 1.08                       | -1.02                     |
| 2010         | GB Haddock West | 1.23                        | 0.00                    | 0.01                                    | 0.09                    | 1.24                       | -1.15                     |
| 2011         | GB Haddock West | 1.60                        | 0.00                    | 0.00                                    | 0.09                    | 1.60                       | -1.52                     |
| 2012         | GB Haddock West | 2.36                        | 0.03                    | 0.00                                    | 0.12                    | 2.37                       | -2.26                     |
| 2013         | GB Haddock West | 1.38                        | 0.03                    | 0.00                                    | 0.11                    | 1.38                       | -1.27                     |

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| Fishing year | stock           | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-----------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2014         | GB Haddock West | 1.25                        | 0.00                    | 0.00                                    | 0.08                    | 1.25                       | -1.18                     |
| 2015         | GB Haddock West | 1.24                        | 0.00                    | 0.00                                    | 0.08                    | 1.25                       | -1.17                     |
| 2016         | GB Haddock West | 1.25                        | 0.00                    | 0.01                                    | 0.08                    | 1.26                       | -1.18                     |
| 2017         | GB Haddock West | 1.00                        | 0.00                    | 0.01                                    | 0.08                    | 1.01                       | -0.93                     |
| 2007         | GB Winter       | 2.25                        | NA                      | NA                                      | 0.06                    | 2.26                       | -2.20                     |
| 2008         | GB Winter       | 1.99                        | NA                      | NA                                      | 0.06                    | 2.00                       | -1.94                     |
| 2009         | GB Winter       | 1.66                        | NA                      | NA                                      | 0.06                    | 1.66                       | -1.60                     |
| 2010         | GB Winter       | 1.97                        | 0.91                    | 0.01                                    | 1.01                    | 1.98                       | -0.97                     |
| 2011         | GB Winter       | 1.76                        | 0.54                    | 0.01                                    | 0.63                    | 1.76                       | -1.13                     |
| 2012         | GB Winter       | 2.01                        | 0.54                    | 0.01                                    | 0.64                    | 2.02                       | -1.38                     |
| 2013         | GB Winter       | 1.60                        | 0.11                    | 0.01                                    | 0.20                    | 1.61                       | -1.41                     |
| 2014         | GB Winter       | 1.98                        | 0.14                    | 0.00                                    | 0.23                    | 1.99                       | -1.76                     |
| 2015         | GB Winter       | 2.04                        | 0.04                    | 0.00                                    | 0.13                    | 2.05                       | -1.92                     |
| 2016         | GB Winter       | 3.53                        | 0.45                    | 0.01                                    | 0.54                    | 3.54                       | -3.00                     |
| 2017         | GB Winter       | 3.34                        | 0.51                    | 0.00                                    | 0.60                    | 3.35                       | -2.75                     |
| 2007         | GB Yellowtail   | 1.70                        | NA                      | NA                                      | 0.06                    | 1.71                       | -1.65                     |
| 2008         | GB Yellowtail   | 1.34                        | NA                      | NA                                      | 0.06                    | 1.35                       | -1.29                     |
| 2009         | GB Yellowtail   | 1.17                        | NA                      | NA                                      | 0.06                    | 1.18                       | -1.12                     |
| 2010         | GB Yellowtail   | 1.14                        | 1.01                    | 0.01                                    | 1.11                    | 1.15                       | -0.03                     |
| 2011         | GB Yellowtail   | 1.20                        | 0.30                    | 0.00                                    | 0.39                    | 1.21                       | -0.81                     |
| 2012         | GB Yellowtail   | 1.45                        | 0.77                    | 0.01                                    | 0.87                    | 1.46                       | -0.59                     |
| 2013         | GB Yellowtail   | 2.01                        | 0.01                    | 0.00                                    | 0.11                    | 2.02                       | -1.91                     |
| 2014         | GB Yellowtail   | 1.45                        | 0.39                    | 0.01                                    | 0.48                    | 1.46                       | -0.98                     |
| 2015         | GB Yellowtail   | 1.72                        | 0.14                    | 0.00                                    | 0.23                    | 1.74                       | -1.50                     |
| 2016         | GB Yellowtail   | 2.21                        | 0.00                    | 0.00                                    | 0.10                    | 2.23                       | -2.13                     |
| 2017         | GB Yellowtail   | 1.75                        | 0.23                    | 0.00                                    | 0.33                    | 1.76                       | -1.43                     |

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| Fishing year | stock       | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2007         | GOM Cod     | 1.92                        | NA                      | NA                                      | 0.06                    | 1.94                       | -1.88                     |
| 2008         | GOM Cod     | 1.69                        | NA                      | NA                                      | 0.06                    | 1.70                       | -1.64                     |
| 2009         | GOM Cod     | 1.48                        | NA                      | NA                                      | 0.06                    | 1.49                       | -1.43                     |
| 2010         | GOM Cod     | 2.27                        | 1.09                    | 0.02                                    | 1.19                    | 2.28                       | -1.08                     |
| 2011         | GOM Cod     | 2.30                        | 0.84                    | 0.02                                    | 0.95                    | 2.31                       | -1.36                     |
| 2012         | GOM Cod     | 2.54                        | 0.44                    | 0.01                                    | 0.54                    | 2.55                       | -2.01                     |
| 2013         | GOM Cod     | 2.70                        | 0.97                    | 0.01                                    | 1.06                    | 2.72                       | -1.66                     |
| 2014         | GOM Cod     | 2.30                        | 0.78                    | 0.01                                    | 0.87                    | 2.32                       | -1.45                     |
| 2015         | GOM Cod     | 2.52                        | 2.05                    | 0.01                                    | 2.15                    | 2.56                       | -0.41                     |
| 2016         | GOM Cod     | 3.04                        | 2.20                    | 0.02                                    | 2.30                    | 3.07                       | -0.77                     |
| 2017         | GOM Cod     | 3.01                        | 2.44                    | 0.02                                    | 2.54                    | 3.04                       | -0.51                     |
| 2007         | GOM Haddock | 1.98                        | NA                      | NA                                      | 0.06                    | 2.02                       | -1.96                     |
| 2008         | GOM Haddock | 1.67                        | NA                      | NA                                      | 0.06                    | 1.70                       | -1.64                     |
| 2009         | GOM Haddock | 1.58                        | NA                      | NA                                      | 0.06                    | 1.60                       | -1.54                     |
| 2010         | GOM Haddock | 1.88                        | 0.48                    | 0.02                                    | 0.58                    | 1.90                       | -1.32                     |
| 2011         | GOM Haddock | 2.25                        | 0.28                    | 0.02                                    | 0.38                    | 2.27                       | -1.89                     |
| 2012         | GOM Haddock | 2.83                        | 0.12                    | 0.02                                    | 0.22                    | 2.87                       | -2.65                     |
| 2013         | GOM Haddock | 2.13                        | 0.73                    | 0.01                                    | 0.81                    | 2.17                       | -1.35                     |
| 2014         | GOM Haddock | 1.88                        | 0.90                    | 0.01                                    | 0.98                    | 1.90                       | -0.92                     |
| 2015         | GOM Haddock | 1.45                        | 0.37                    | 0.01                                    | 0.46                    | 1.46                       | -1.01                     |
| 2016         | GOM Haddock | 1.52                        | 0.08                    | 0.01                                    | 0.17                    | 1.53                       | -1.36                     |
| 2017         | GOM Haddock | 1.24                        | 0.19                    | 0.01                                    | 0.28                    | 1.25                       | -0.97                     |
| 2007         | GOM Winter  | 2.03                        | NA                      | NA                                      | 0.06                    | 2.08                       | -2.02                     |
| 2008         | GOM Winter  | 1.73                        | NA                      | NA                                      | 0.06                    | 1.78                       | -1.72                     |
| 2009         | GOM Winter  | 1.65                        | NA                      | NA                                      | 0.06                    | 1.69                       | -1.63                     |
| 2010         | GOM Winter  | 1.82                        | 1.02                    | 0.03                                    | 1.15                    | 1.87                       | -0.73                     |
| 2011         | GOM Winter  | 1.81                        | 0.60                    | 0.03                                    | 0.72                    | 1.86                       | -1.14                     |
| 2012         | GOM Winter  | 2.01                        | 0.13                    | 0.02                                    | 0.24                    | 2.04                       | -1.80                     |

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| Fishing year | stock      | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2013         | GOM Winter | 1.78                        | 0.00                    | 0.02                                    | 0.11                    | 1.80                       | -1.69                     |
| 2014         | GOM Winter | 1.77                        | 0.00                    | 0.01                                    | 0.11                    | 1.80                       | -1.69                     |
| 2015         | GOM Winter | 2.05                        | 0.00                    | 0.02                                    | 0.12                    | 2.08                       | -1.96                     |
| 2016         | GOM Winter | 2.84                        | 0.01                    | 0.02                                    | 0.13                    | 2.87                       | -2.74                     |
| 2017         | GOM Winter | 2.80                        | 0.00                    | 0.03                                    | 0.12                    | 2.83                       | -2.71                     |
| 2007         | Plaice     | 1.66                        | NA                      | NA                                      | 0.06                    | 1.67                       | -1.61                     |
| 2008         | Plaice     | 1.30                        | NA                      | NA                                      | 0.06                    | 1.31                       | -1.25                     |
| 2009         | Plaice     | 1.31                        | NA                      | NA                                      | 0.06                    | 1.32                       | -1.26                     |
| 2010         | Plaice     | 1.46                        | 0.19                    | 0.01                                    | 0.28                    | 1.47                       | -1.19                     |
| 2011         | Plaice     | 1.42                        | 0.08                    | 0.01                                    | 0.16                    | 1.43                       | -1.27                     |
| 2012         | Plaice     | 1.66                        | 0.02                    | 0.01                                    | 0.10                    | 1.67                       | -1.57                     |
| 2013         | Plaice     | 1.63                        | 0.31                    | 0.01                                    | 0.39                    | 1.64                       | -1.25                     |
| 2014         | Plaice     | 1.81                        | 0.56                    | 0.01                                    | 0.64                    | 1.82                       | -1.17                     |
| 2015         | Plaice     | 1.95                        | 0.84                    | 0.01                                    | 0.92                    | 1.95                       | -1.04                     |
| 2016         | Plaice     | 2.58                        | 1.22                    | 0.01                                    | 1.30                    | 2.59                       | -1.29                     |
| 2017         | Plaice     | 2.50                        | 1.40                    | 0.01                                    | 1.49                    | 2.52                       | -1.03                     |
| 2007         | Pollock    | 0.53                        | NA                      | NA                                      | 0.06                    | 0.54                       | -0.48                     |
| 2008         | Pollock    | 0.57                        | NA                      | NA                                      | 0.06                    | 0.58                       | -0.52                     |
| 2009         | Pollock    | 0.77                        | NA                      | NA                                      | 0.06                    | 0.78                       | -0.72                     |
| 2010         | Pollock    | 0.93                        | 0.00                    | 0.01                                    | 0.09                    | 0.94                       | -0.86                     |
| 2011         | Pollock    | 0.89                        | 0.04                    | 0.01                                    | 0.13                    | 0.90                       | -0.77                     |
| 2012         | Pollock    | 1.04                        | 0.01                    | 0.01                                    | 0.10                    | 1.04                       | -0.95                     |
| 2013         | Pollock    | 1.15                        | 0.02                    | 0.01                                    | 0.11                    | 1.16                       | -1.05                     |
| 2014         | Pollock    | 1.35                        | 0.01                    | 0.01                                    | 0.09                    | 1.36                       | -1.27                     |
| 2015         | Pollock    | 1.24                        | 0.00                    | 0.01                                    | 0.09                    | 1.24                       | -1.15                     |
| 2016         | Pollock    | 1.10                        | 0.00                    | 0.01                                    | 0.08                    | 1.10                       | -1.02                     |
| 2017         | Pollock    | 0.98                        | 0.00                    | 0.01                                    | 0.09                    | 0.98                       | -0.89                     |
| 2007         | Redfish    | 0.55                        | NA                      | NA                                      | 0.06                    | 0.56                       | -0.50                     |

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| Fishing year | stock             | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-------------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2008         | Redfish           | 0.53                        | NA                      | NA                                      | 0.06                    | 0.54                       | -0.48                     |
| 2009         | Redfish           | 0.48                        | NA                      | NA                                      | 0.06                    | 0.49                       | -0.43                     |
| 2010         | Redfish           | 0.57                        | 0.00                    | 0.01                                    | 0.08                    | 0.58                       | -0.50                     |
| 2011         | Redfish           | 0.66                        | 0.01                    | 0.00                                    | 0.09                    | 0.67                       | -0.58                     |
| 2012         | Redfish           | 0.60                        | 0.02                    | 0.01                                    | 0.10                    | 0.61                       | -0.51                     |
| 2013         | Redfish           | 0.53                        | 0.00                    | 0.00                                    | 0.09                    | 0.53                       | -0.45                     |
| 2014         | Redfish           | 0.56                        | 0.00                    | 0.00                                    | 0.08                    | 0.57                       | -0.48                     |
| 2015         | Redfish           | 0.58                        | 0.01                    | 0.00                                    | 0.09                    | 0.58                       | -0.49                     |
| 2016         | Redfish           | 0.60                        | 0.01                    | 0.01                                    | 0.10                    | 0.60                       | -0.51                     |
| 2017         | Redfish           | 0.54                        | 0.01                    | 0.00                                    | 0.10                    | 0.55                       | -0.45                     |
| 2007         | SNE/MA Winter     | 2.08                        | NA                      | NA                                      | 0.06                    | 2.09                       | -2.03                     |
| 2008         | SNE/MA Winter     | 1.60                        | NA                      | NA                                      | 0.06                    | 1.61                       | -1.55                     |
| 2009         | SNE/MA Winter     | 1.68                        | NA                      | NA                                      | 0.06                    | 1.69                       | -1.63                     |
| 2010         | SNE/MA Winter     | 1.51                        | 0.00                    | 0.00                                    | 0.09                    | 1.54                       | -1.44                     |
| 2011         | SNE/MA Winter     | 1.56                        | 0.00                    | 0.01                                    | 0.10                    | 1.63                       | -1.53                     |
| 2012         | SNE/MA Winter     | 2.01                        | 0.00                    | 0.01                                    | 0.10                    | 2.09                       | -1.99                     |
| 2013         | SNE/MA Winter     | 1.73                        | 0.46                    | 0.00                                    | 0.54                    | 1.74                       | -1.19                     |
| 2014         | SNE/MA Winter     | 1.91                        | 0.16                    | 0.00                                    | 0.24                    | 1.92                       | -1.67                     |
| 2015         | SNE/MA Winter     | 2.27                        | 0.02                    | 0.00                                    | 0.11                    | 2.28                       | -2.17                     |
| 2016         | SNE/MA Winter     | 3.06                        | 0.51                    | 0.01                                    | 0.60                    | 3.07                       | -2.48                     |
| 2017         | SNE/MA Winter     | 3.02                        | 0.62                    | 0.01                                    | 0.70                    | 3.03                       | -2.33                     |
| 2007         | SNE/MA Yellowtail | 2.10                        | NA                      | NA                                      | 0.06                    | 2.12                       | -2.06                     |

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| Fishing year | stock             | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-------------------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2008         | SNE/MA Yellowtail | 1.67                        | NA                      | NA                                      | 0.06                    | 1.69                       | -1.63                     |
| 2009         | SNE/MA Yellowtail | 1.78                        | NA                      | NA                                      | 0.06                    | 1.81                       | -1.75                     |
| 2010         | SNE/MA Yellowtail | 1.34                        | 1.17                    | 0.01                                    | 1.27                    | 1.35                       | -0.07                     |
| 2011         | SNE/MA Yellowtail | 1.48                        | 0.41                    | 0.01                                    | 0.51                    | 1.48                       | -0.97                     |
| 2012         | SNE/MA Yellowtail | 1.69                        | 0.52                    | 0.01                                    | 0.62                    | 1.70                       | -1.07                     |
| 2013         | SNE/MA Yellowtail | 1.77                        | 0.42                    | 0.00                                    | 0.52                    | 1.79                       | -1.26                     |
| 2014         | SNE/MA Yellowtail | 1.64                        | 0.34                    | 0.00                                    | 0.43                    | 1.65                       | -1.22                     |
| 2015         | SNE/MA Yellowtail | 1.92                        | 0.21                    | 0.00                                    | 0.30                    | 1.94                       | -1.63                     |
| 2016         | SNE/MA Yellowtail | 2.64                        | 0.59                    | 0.01                                    | 0.69                    | 2.67                       | -1.99                     |
| 2017         | SNE/MA Yellowtail | 2.68                        | 0.48                    | 0.01                                    | 0.57                    | 2.75                       | -2.17                     |
| 2007         | White Hake        | 1.41                        | NA                      | NA                                      | 0.06                    | 1.43                       | -1.37                     |
| 2008         | White Hake        | 1.33                        | NA                      | NA                                      | 0.06                    | 1.34                       | -1.28                     |
| 2009         | White Hake        | 1.21                        | NA                      | NA                                      | 0.06                    | 1.22                       | -1.16                     |
| 2010         | White Hake        | 1.33                        | 0.38                    | 0.01                                    | 0.45                    | 1.34                       | -0.89                     |
| 2011         | White Hake        | 1.28                        | 0.41                    | 0.01                                    | 0.49                    | 1.29                       | -0.80                     |
| 2012         | White Hake        | 1.75                        | 0.61                    | 0.01                                    | 0.69                    | 1.76                       | -1.07                     |
| 2013         | White Hake        | 1.76                        | 0.12                    | 0.01                                    | 0.19                    | 1.77                       | -1.58                     |
| 2014         | White Hake        | 1.98                        | 0.07                    | 0.01                                    | 0.14                    | 1.99                       | -1.85                     |
| 2015         | White Hake        | 1.93                        | 0.04                    | 0.01                                    | 0.12                    | 1.94                       | -1.83                     |
| 2016         | White Hake        | 1.93                        | 0.02                    | 0.01                                    | 0.10                    | 1.94                       | -1.83                     |
| 2017         | White Hake        | 1.36                        | 0.01                    | 0.01                                    | 0.10                    | 1.37                       | -1.27                     |
| 2007         | Witch             | 2.28                        | NA                      | NA                                      | 0.06                    | 2.30                       | -2.24                     |
| 2008         | Witch             | 2.10                        | NA                      | NA                                      | 0.06                    | 2.11                       | -2.05                     |

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| Fishing year | stock | Ex-vessel price (\$/lb, pf) | Quota price (\$/lb, pq) | Quota cost of sublegal discards (\$/lb) | Cost of Landing (\$/lb) | Cost of Discarding (\$/lb) | Discard Incentive (\$/lb) |
|--------------|-------|-----------------------------|-------------------------|-----------------------------------------|-------------------------|----------------------------|---------------------------|
| 2009         | Witch | 1.94                        | NA                      | NA                                      | 0.06                    | 1.96                       | -1.90                     |
| 2010         | Witch | 2.45                        | 1.49                    | 0.01                                    | 1.58                    | 2.47                       | -0.89                     |
| 2011         | Witch | 2.00                        | 0.58                    | 0.01                                    | 0.67                    | 2.02                       | -1.35                     |
| 2012         | Witch | 2.00                        | 0.49                    | 0.01                                    | 0.57                    | 2.02                       | -1.45                     |
| 2013         | Witch | 2.46                        | 0.81                    | 0.01                                    | 0.90                    | 2.48                       | -1.58                     |
| 2014         | Witch | 2.69                        | 0.88                    | 0.01                                    | 0.96                    | 2.71                       | -1.74                     |
| 2015         | Witch | 2.57                        | 0.86                    | 0.01                                    | 0.95                    | 2.58                       | -1.64                     |
| 2016         | Witch | 3.21                        | 1.24                    | 0.01                                    | 1.34                    | 3.23                       | -1.90                     |
| 2017         | Witch | 2.23                        | 1.02                    | 0.01                                    | 1.11                    | 2.24                       | -1.13                     |



## **Unlawful discarding of Regulated Northeast Multispecies**

Enforcing unlawful discarding of regulated Northeast multispecies is extremely challenging. Most investigations are reactive in nature, responding to complaints from the fishing industry or the observer program. Proactive enforcement focused on discarding can only be done at sea which adds to the complexity and presents other limitations.

The act of discarding fish can happen relatively quickly. It is easy for violators to actively look for enforcement while discarding fish at sea. NOAA's Office of Law Enforcement (OLE) receives and handles a number of discarding investigations, however, OLE is often unable to conclude investigations due to a lack of evidence. Even in instances where enforcement is on scene to witness a discarding violation, it can still be difficult to make a case. For example, the fish being discarded could be unmarketable or undersized which would otherwise be legal to discard. Enforcement cannot always make this determination on scene as fish are being actively discarded. To support an unlawful discard case, it would almost be necessary to either measure the fish before they are discarded or recover the fish being discarded to determine their size or disposition. Recovering discarded fish at sea would be difficult and could pose safety issues. Consequently, even if an unlawful discarding event is witnessed by enforcement, it can be difficult to make a case for these reasons.

In cases where we have been able to take some investigatory steps, there typically has to be some supporting information, such as information from crew, observer, or member of the industry. It is rare that we can initiate an investigation based on witnessing this behavior, even when conducting a patrol focused on targeting discarding violations. Most discarding incidents reported to OLE are generated from observer referrals. Most of these lack sufficient evidence for many of the reasons listed above and the data collection process utilized by the observer program.

The sector quota and leasing system does not provide enforcement with the ability to track quotas in real time. This limits enforcement's ability to use quotas as a reliable indicator of potential discarding violations. The annual quota calculations used in the sector system enables unscrupulous operators to strategically plan to discard when they believe a low probability of detection exists. This contrasts with other fisheries such as the common pool system where an overage landed on a single trip, cannot be offset by leasing additional quota.

### **Unlawful Discarding Incident Dispositions (Fishing years 2017 and 2018)**

|                                   |    |
|-----------------------------------|----|
| Total incidents –                 | 12 |
| Closed due to lack of evidence –  | 8  |
| Ongoing investigations –          | 2  |
| Written warnings –                | 1  |
| Closed due to lack of resources - | 1  |

**Unlawful Discarding Incidents Reporting Source (Fishing years 2017 and 2018)**

|                         |   |
|-------------------------|---|
| Observer generated –    | 8 |
| Industry complaint -    | 3 |
| Enforcement generated – | 1 |

**Unlawful Discarding Violations Penalties**

Unlawful discarding investigations that result in enforcement action can be handled with either Compliance Assistance, a Written Warning, or a Notice of Violation and Assessment (NOVA). Summary settlements are another method of addressing a violation, but unlawful discarding is not included in the summary settlement schedule and therefore cannot not be applied for this offense. However, offenses associated with a discarding violations may be included in the summary settlement schedule. For example, a \$500 summary settlement could be issued for a failure to maintain, keep, or submit accurate reports.

A NOVA may be issued for an unlawful discard violation in accordance with General Counsel's Penalty Policy Schedule, which utilizes a complex matrix to determine NOVA penalty amounts. Unlawful discarding is generally considered a Level II offense, with penalties ranging from \$2,000 to \$20,000. Factors considered in assessing a civil penalty may include the nature, circumstances, extent, and gravity of the alleged violation; the respondent's degree of culpability, any history of prior violations, and ability to pay; and such other matters as justice may require.

# Evaluating the Observer Effect for the Northeast U.S. Groundfish Fishery

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*updated April 18, 2019*

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– DRAFT –

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## Introduction

The commercial component of the Northeast U.S. Multispecies fishery comprises 20 individual fish stocks and 2 management units<sup>1</sup>. Of these, commercial fisherman are allocated quota for 15 stocks, leaving 5 for which retention is prohibited. Fishing quota is allocated to approximately 1,000 permits and actively fished by around 200 participating commercial vessels (NEFMC 2017). The majority of the commercial fishery for groundfish (~98% of landings) is managed under the sector system whereby individual vessel owners pool stock-level quota into any one of 21 sectors, each operating as a collective, pooling the quota and allocating it to individual member fisherman. Quota for allocated stocks may be traded between sectors. Trades are remunerated in three ways: single stock trades for a given amount of money (fish-for-cash), pounds of multiple stocks traded for a single value (basket trades), and pounds of quota for one stock traded for pounds of quota of another stock with no money exchanged (swaps). All regulated groundfish species have a prescribed minimum fish size and regulations prohibit retaining fish below that size, and discarding fish above it.

Observers are deployed on participating vessels to estimate discarded catch for each of the 20 fish stocks on each trip. Observer coverage levels vary but in general observers have been onboard trips accounting for between 10-35% of all trips taken in any given fishing year. Discards on observed trips are calculated by dividing the sum of observed stock-level discards on observed tows by the total amount of retained catch on these tows. For trips with no observer coverage, discards are estimated by applying the annualized observed discard rate (stock-level discards divided by the sum of kept catch), stratified by broad stock area, sector and fishing gear. Discards count against a sector's quota after adjusting for gear and stock-based discard mortality rates. Vessels are assessed estimated discards on unobserved trips based on their strata, regardless of whether or not an individual species was reported on that trip. Sectors must have adequate quota reserves for all species in a given stock area prior to any member vessels fishing in that area. Observers have also been the primary source of enforcement for mandatory retention regulations.

As observer coverage only represents a fraction of the total fishing activity in the sector component of the commercial groundfish fishery, obvious questions arise: Does data generated on observed fishing trips reflect the activities of the whole fleet? Are estimates generated from these data unbiased? Bias may be induced by either a deployment effect, where the assignment of observers to vessels is non-random, or an observer effect, where the fishing activities on observed trips vary in detectable ways from those on unobserved trips (Benoit and Allard 2009). These two effects, deployment and observer, may act separately or in combination

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<sup>1</sup>George's Bank is divided into a "west" component for which haddock and cod stocks are assessed exclusively by NOAA fisheries, and an "east" component for which these stocks together with yellowtail flounder are jointly assessed with the Canadian Department of Fisheries and Oceans under a trans-boundary management agreement.

to render data collected by on board observers biased. This paper focuses specifically on one component of the the latter effect: do individual vessels alter their behavior in response to the presence of an observer?

Fisherman may alter their fishing behavior when carrying an observer for any one of at least five reasons: (1) people may act differently as a response to simply being watched, an established phenomena referred to as the Hawthorne Effect (McCambridge et al. 2018); (2) fisherman may not want to impart their individual discarding preferences on the other members of their sector, an effect driven primarily by within-strata fishing practice heterogeneity; (3) observers incur costs associated with slower fish processing and handling times, carrying extra food, and general inconvenience, all of which may incentivize fisherman to make shorter trips when observers are on board; (4) catch of undersized fish varies across space and fishing in areas and at times where undersized fish are relatively less abundant may minimize discard rates, though at the cost of reduced revenues; and (5) binding quota constraints impart strong economic incentives to discard legal-sized fish when an observer is not on board and to avoid these stocks in the presence of an observer, again presumably at a cost in terms of reduced trip revenues.

## Methods

This paper uses an exact matching method to determine if vessel performance along several metrics vary in a detectable way when an observer is on board, and when one is not. Following a procedure laid out by Benoit and Allard (2009), same-vessel trip sequences are analyzed to test for differences among various metrics. These trip sequences take the form of either: (1) three unobserved trips in a row (UUU), or (2) one observed trip between unobserved trips (UOU). To attenuate the possibility of interpreting seasonal effects as behavioral effects, only trips occurring within 45 days of each other are included. Trips are not repeated in multiple sequences. Vessels with less than two sequences are excluded from the analysis.

Triplet sequences are winnowed to pairs by taking the difference of either the leading or lagging trip with respect to the middle trip. The variable  $U$  in equation (1) and  $U^1$  in equation (2), below, are selected randomly as either the leading or trailing trip in the triplet sequence, while the middle trip in the sequence is always the reference trip ( $O$  or  $U^1$ , below). To mitigate against regulatory changes affecting fishing behavior within sequences while maximizing the number of OU pairs, sequences overlapping the start of a new fishing year (May 1 of each year) select only the lead or lag pair that occurs in the same FY as the reference trip.

Differences are calculated as

$$\Delta O_{yfv} = (O - U/U)_{yfv} * 100$$

(Equation 1)

$$\Delta U_{yfv} = (U^1 - U^2/U)_{yfv} * 100$$

(Equation 2)

where  $y$  is a fishing year,  $f$  is fishing vessel and  $v$  is any one of the metrics evaluated.  $U$  is the mean unobserved value for each year, vessel and metric combination.

Metrics evaluated,  $v$ , are:

1. Trip duration
2. Kept catch
3. Total revenue
4. Kept groundfish
5. Kept non-groundfish
6. Groundfish average price
7. Opportunity cost of quota

## 8. Number of groundfish market categories included in kept catch

The difference between the median values for  $\Delta U$ 's and  $O$ 's is calculated as

$$(M_{\Delta U - \Delta O})_{yfv} = \text{median}(\Delta U)_{yfv} - \text{median}(\Delta O)_{yfv}$$

(Equation 3)

Differences between observed and unobserved trips are tested in three ways: (1) location differences are observed in  $M_{\Delta U - \Delta O}$ , with 95% confidence intervals estimated using bootstrap sampling (1,000 replicates) from the  $U_{yfv}$  and  $O_{yfv}$  values, where a lack of overlap with zero implies a 95% probability that the true median values for each population are significantly different<sup>2</sup>; (2) the Kolmogorov-Smirnov statistic is used to test for general differences in shape of the  $U_{yfv}$  and  $O_{yfv}$  distributions; and (3) the Kuiper statistic is used to test for differences in the extremities of the distributions (Conover 1980).

Multiple hypothesis tests are performed with the Kolmogorov-Smirnov (KSA) and Kuiper (KA) statistics. For these, a p-value of 0.005 is considered to be significant. As always, statistical significance should be considered in light of the data and research question. All p-values are reported.

## Data

Vessel Trip Report (VTR) and Commercial Fishery Dealer (CFDBS) data are combined to construct trip-level data using the Data Matching and Imputation System (DMIS) database [cite needed]. Trips with an Allocation Management System (AMS) declaration code of "NMS" are included in the initial dataset<sup>3</sup>. Only vessels fishing with trawl or gillnet gears are retained. Observer trips are matched by a step-wise algorithm, focusing on permit number, VTR serial number, days-at-sea (DAS) identification number, date and time sailed. For the sector years, both Northeast Fishery Observer Program (NEFOP) and at-sea monitoring (ASM) data are matched.

$U$  and  $O$  values are extracted from these data, and annual fishing year (May 1 – April 30) data sets are built with same-vessel two-trip sequences.

Trips in the United States-Canada Resource Sharing Agreement Area (USCA area) are removed from the pre-sector (FY 2007-2009) dataset, as these trips were subject to observer coverage at higher rates than trips outside the area. All trips fishing with extra large mesh (ELM) and targeting non-groundfish are excluded for all years, as are all trips by vessels enrolled in the Common Pool from 2010-2017<sup>4</sup>. All excluded trips and their corresponding triplets are retained and, to better understand the potential drivers of observer effects, are analyzed separately in the future.

## Results

Results are reported at two levels of aggregation:

- regulatory regime, as
  - pre-sector years (FY's 2007-2009),

<sup>2</sup>"Location" refers to the central tendency of the data, in this case the median values, and has no geographic connotation here.

<sup>3</sup>"NMS" is the code denoting trips made under the Northeast Multispecies Fishery Management Plan.

<sup>4</sup>In 2015 the New England Fishery Management Council exempt gillnet vessels fishing with mesh larger than 10 inches in certain areas near the coast from ASM coverage, as these trips had a documented history of catch very little groundfish. These trips are subject to NEFOP coverage, however.

- initial sector years (FY’s 2010-2012),
- intermediate sector years (FY’s 2013-2015),
- contemporary sector years (FY’s 2016-2018)<sup>5</sup>; and
- gear type, distinguishing between trawl and gillnet gears<sup>6</sup>.

Results at the fishing year (FY) level, further disaggregated by gillnet and trawl, are estimated for context. Separate analyses have also been completed for single-day and multi-day trips, as well as a stock-level analysis of kept catch for 15 individual groundfish stocks.

## Tests for differences in central tendency

Equations (1) and (2) are scaled by each vessel’s mean annual values and median value differences are represented as percentages. For example, a median value of -0.04 for the kept catch variable implies that vessels catch roughly 4% less fish on an observed trip, relative to a neighboring unobserved trip by that same vessel, as measured across all vessels in the dataset. If the bootstrapped 95% confidence intervals fail to overlap with zero, the value is interpreted as significant using the confidence interval test. With eight metrics evaluated over four time stanzas, there are 32 units evaluated for observer effects. However, in the first stanza, before the sector system, there were no tradeable quota allocations.

### Trawl vessels

For trawl vessels, 18 bootstrapped 95% confidence intervals failed to overlap zero. In the pre-sector years, three of seven metrics are significant under this test. In the three sector stanzas, 15 metrics are significant and nine are not.

Trawl vessels catch less fish when an observer is onboard. In the stanzas after 2009, they fish for less time and land less groundfish. Statistical significance is obtained for kept catch in all four stanzas, and for trip duration, groundfish kept catch and total revenues in the three post-2009 stanzas. Groundfish average prices are statically higher for three of the four stanzas, the exception being the period from 2010-2012. Composition of groundfish catch on observed and unobserved trips appears to be different. In the second and third time stanzas, groundfish vessels landed less high quota value stocks on observed trips, while in the final stanza the median differential is zero. Based on the reductions in catch and fishing time on observed trips after 2009, the changes in response to observer presense appear to be related to incentives embedded in catch accountability and quota constraints.

<sup>5</sup>FY 2018 data are complete through February 28 and inclusive of the first 10 full months of the fishing year.

<sup>6</sup>Trawl gears include the Vessel Trip Report (VTR) codes ‘OHS’, ‘OTB’, ‘OTC’, ‘OTF’, ‘OTM’, ‘OTO’, ‘OTR’, ‘OTS’, and ‘OTT’. Gillnet gears include the codes ‘GNR’, ‘GNS’, and ‘GNT’.

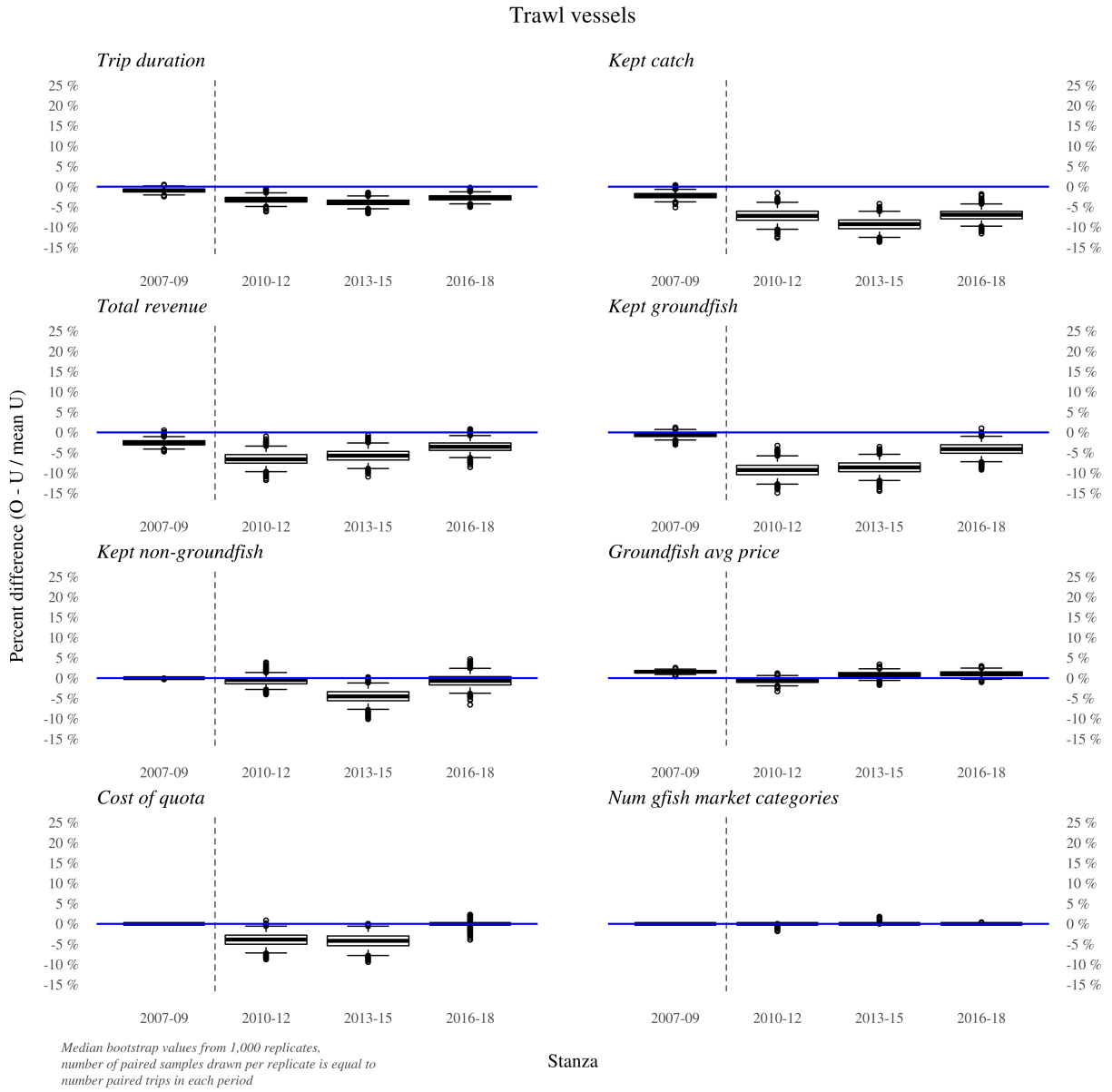


Figure 1: Results of bootstrap analysis, observed and unobserved same-vessel paired trips by stanza

Table 1: Stanza 1, 2007-2009

| Gear  | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|-------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Trawl | Kept groundfish                     |          | -1.9 %        | -0.6 % | 0.5 %         | 10,844       | 726        |
| Trawl | Number groundfish market categories |          | 0 %           | 0 %    | 0 %           | 10,844       | 726        |
| Trawl | Groundfish avg price                | *        | 0.9 %         | 1.6 %  | 2.3 %         | 10,845       | 726        |
| Trawl | Kept catch                          | *        | -3.7 %        | -2.2 % | -0.7 %        | 10,845       | 726        |
| Trawl | Kept non-groundfish                 |          | 0 %           | 0 %    | 0 %           | 10,845       | 726        |
| Trawl | Opportunity cost of quota           |          | 0 %           | 0 %    | 0 %           | 10,845       | 726        |
| Trawl | Total revenue                       | *        | -4.1 %        | -2.6 % | -1.1 %        | 10,845       | 726        |
| Trawl | Trip duration                       |          | -2 %          | -0.9 % | 0 %           | 10,845       | 726        |

Table 2: Stanza 2, 2010-2012

| Gear  | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|-------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Trawl | Kept groundfish                     | *        | -12.6 %       | -9.3 % | -5.9 %        | 2,787        | 1,413      |
| Trawl | Number groundfish market categories |          | -0.4 %        | 0 %    | 0 %           | 2,787        | 1,413      |
| Trawl | Groundfish avg price                |          | -1.9 %        | -0.6 % | 0.6 %         | 2,787        | 1,413      |
| Trawl | Kept catch                          | *        | -10.2 %       | -7.2 % | -4.1 %        | 2,787        | 1,413      |
| Trawl | Kept non-groundfish                 |          | -3.3 %        | -0.4 % | 1.7 %         | 2,787        | 1,413      |
| Trawl | Opportunity cost of quota           | *        | -7.3 %        | -3.9 % | -0.8 %        | 2,787        | 1,411      |
| Trawl | Total revenue                       | *        | -9.4 %        | -6.6 % | -3.4 %        | 2,787        | 1,413      |
| Trawl | Trip duration                       | *        | -4.9 %        | -3.2 % | -1.6 %        | 2,787        | 1,413      |



Table 3: Stanza 3, 2013-2015

| Gear  | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|-------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Trawl | Kept groundfish                     | *        | -12 %         | -8.6 % | -5.4 %        | 2,920        | 954        |
| Trawl | Number groundfish market categories |          | 0 %           | 0 %    | 0.1 %         | 2,920        | 954        |
| Trawl | Groundfish avg price                |          | -0.5 %        | 0.8 %  | 2.3 %         | 2,920        | 954        |
| Trawl | Kept catch                          | *        | -12.3 %       | -9.2 % | -6.1 %        | 2,920        | 954        |
| Trawl | Kept non-groundfish                 | *        | -7.9 %        | -4.5 % | -1.4 %        | 2,920        | 954        |
| Trawl | Opportunity cost of quota           | *        | -8 %          | -4.2 % | -0.6 %        | 2,920        | 954        |
| Trawl | Total revenue                       | *        | -8.8 %        | -5.7 % | -2.8 %        | 2,920        | 954        |
| Trawl | Trip duration                       | *        | -5.5 %        | -3.8 % | -2.3 %        | 2,920        | 954        |

Table 4: Stanza 4, 2016-2018

| Gear  | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|-------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Trawl | Kept groundfish                     | *        | -7 %          | -4.1 % | -1.2 %        | 2,805        | 799        |
| Trawl | Number groundfish market categories |          | 0 %           | 0 %    | 0 %           | 2,805        | 799        |
| Trawl | Groundfish avg price                |          | -0.2 %        | 1.1 %  | 2.4 %         | 2,805        | 799        |
| Trawl | Kept catch                          | *        | -9.9 %        | -6.9 % | -4.3 %        | 2,805        | 799        |
| Trawl | Kept non-groundfish                 |          | -3.5 %        | -0.7 % | 2.5 %         | 2,805        | 799        |
| Trawl | Opportunity cost of quota           |          | -1.7 %        | 0 %    | 1 %           | 2,805        | 799        |
| Trawl | Total revenue                       | *        | -6.3 %        | -3.5 % | -0.7 %        | 2,805        | 799        |
| Trawl | Trip duration                       | *        | -4.2 %        | -2.7 % | -1.3 %        | 2,805        | 799        |

### Gillnet vessels

For gillnet vessels the picture is less clear-cut. 13 units in total have 95% confidence intervals that fail to overlap with zero. Pre-sector, from 2007-2009, four metrics were significant and three were not. Under sector management, the three stanzas from 2010-2018, nine are significant and thirteen are not. However, in the most recent stanza (FY 2016-2018), six of the eight metrics yeild significant differences in bootstrapped confidence intervals, and a seventh (number of groundfish market categories), while statistically insignificant, shows a trend toward more market categories landed on observed trips.

Gillnet vessels consistently make shorter trips, generate less revenue and appear to retain slightly less catch overall in the presence of an observer. There is a trend in later stanzas toward more groundfish and less non-groundfish on observed trips for these vessels, indicating that observers affect the mix of species landed. More groundfish market categories in the last stanza may indicate differential groundfish targeting, or perhaps high-grading of specific species. The most striking result is that, in the last stanza, with an observer on board the same gillnet vessels have a 17% higher opportunity cost of quota than when they do not. Statistically different behavior in response to an observer is nearly equally prevalent for gillnet and trawl vessels, though the nature of the response does differ between the two. This may be an artifact of smaller sample sizes (fewer number of paired trips, particularly in the later stanzas) which attenuate the model's power to discern effects. The distinction in response before and after the implementation of sectors is less clear cut for gillnetters than for trawlers, noting that gillnet vessels demonstrated a stronger behavioral response than trawlers before sectors. Finally, during the contemporary sector years (fourth stanza) a trend of less non-groundfish landed, more groundfish and, in particular, more high quota value species landed is noteworthy.

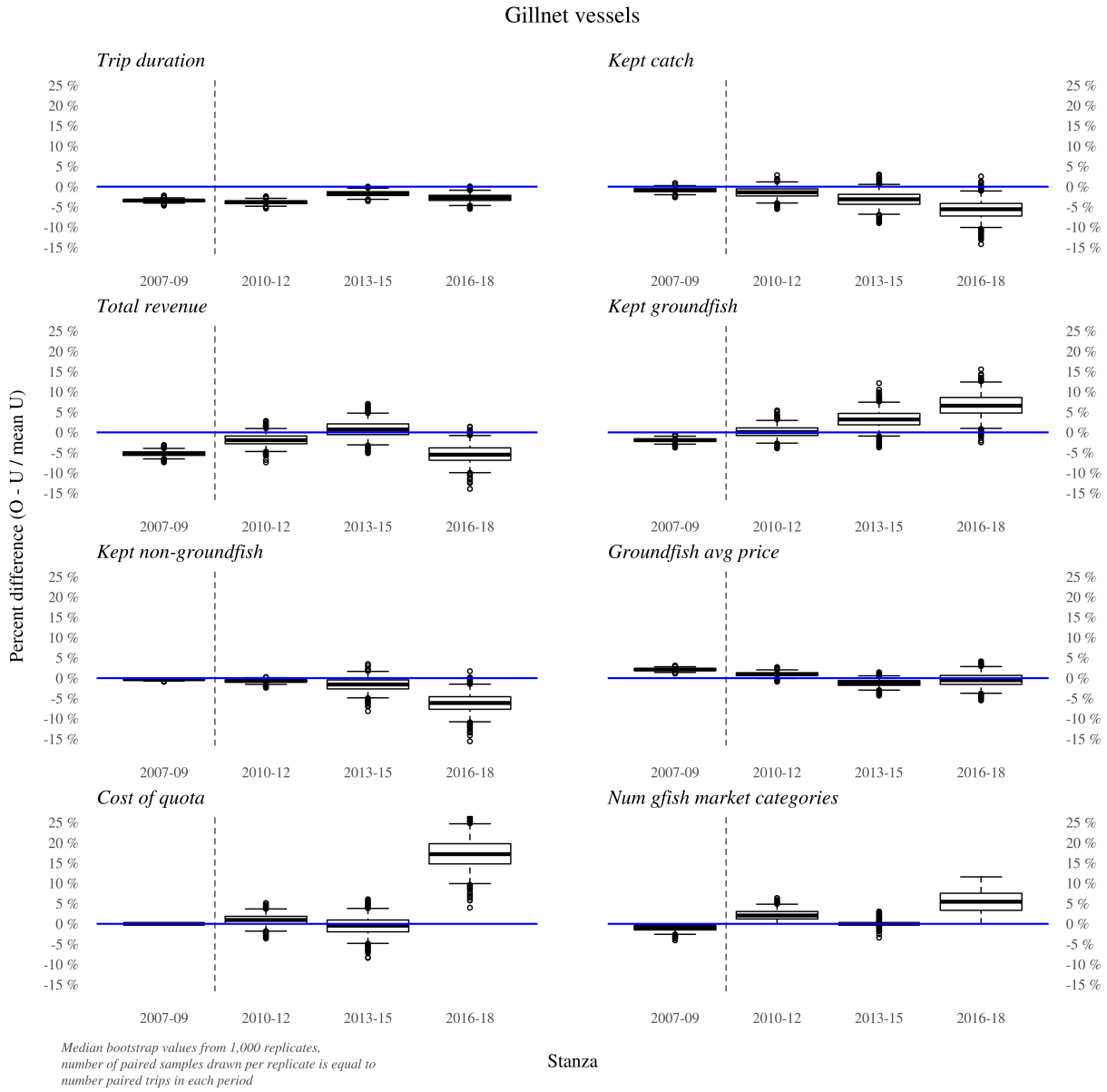


Figure 2: Results of bootstrap analysis, observed and unobserved same-vessel paired trips by stanza

Table 5: Stanza 1, 2007-2009

| Gear    | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|---------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Gillnet | Kept groundfish                     | *        | -2.9 %        | -1.9 % | -1 %          | 10,782       | 531        |
| Gillnet | Number groundfish market categories |          | -2.8 %        | -1 %   | 0 %           | 10,782       | 531        |
| Gillnet | Groundfish avg price                | *        | 1.5 %         | 2.1 %  | 2.8 %         | 10,782       | 531        |
| Gillnet | Kept catch                          |          | -1.9 %        | -0.8 % | 0.1 %         | 10,782       | 531        |
| Gillnet | Kept non-groundfish                 |          | -0.6 %        | -0.3 % | 0 %           | 10,782       | 531        |
| Gillnet | Opportunity cost of quota           |          | 0 %           | 0 %    | 0 %           | 10,782       | 531        |
| Gillnet | Total revenue                       | *        | -6.5 %        | -5.2 % | -4 %          | 10,782       | 531        |
| Gillnet | Trip duration                       | *        | -4.2 %        | -3.4 % | -2.7 %        | 10,782       | 531        |

Table 6: Stanza 2, 2010-2012

| Gear    | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|---------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Gillnet | Kept groundfish                     |          | -2.4 %        | 0.1 %  | 3.2 %         | 2,609        | 1,330      |
| Gillnet | Number groundfish market categories |          | 0 %           | 2.1 %  | 4.9 %         | 2,609        | 1,330      |
| Gillnet | Groundfish avg price                |          | -0.2 %        | 1 %    | 2 %           | 2,609        | 1,330      |
| Gillnet | Kept catch                          |          | -4.1 %        | -1.4 % | 1 %           | 2,609        | 1,330      |
| Gillnet | Kept non-groundfish                 |          | -1.6 %        | -0.7 % | 0 %           | 2,609        | 1,330      |
| Gillnet | Opportunity cost of quota           |          | -1.8 %        | 0.9 %  | 3.8 %         | 2,609        | 1,330      |
| Gillnet | Total revenue                       |          | -4.7 %        | -1.9 % | 1.1 %         | 2,609        | 1,330      |
| Gillnet | Trip duration                       | *        | -4.8 %        | -3.8 % | -2.8 %        | 2,609        | 1,330      |

Table 7: Stanza 3, 2013-2015

| Gear    | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|---------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Gillnet | Kept groundfish                     |          | -0.9 %        | 3.2 %  | 7.6 %         | 1,622        | 434        |
| Gillnet | Number groundfish market categories |          | -0.9 %        | 0 %    | 1.4 %         | 1,622        | 434        |
| Gillnet | Groundfish avg price                |          | -2.9 %        | -1.2 % | 0.4 %         | 1,622        | 434        |
| Gillnet | Kept catch                          |          | -6.5 %        | -3.1 % | 0.4 %         | 1,622        | 434        |
| Gillnet | Kept non-groundfish                 |          | -5.1 %        | -1.6 % | 1.2 %         | 1,622        | 434        |
| Gillnet | Opportunity cost of quota           |          | -5 %          | -0.5 % | 4.2 %         | 1,622        | 434        |
| Gillnet | Total revenue                       |          | -3 %          | 0.7 %  | 4.9 %         | 1,622        | 434        |
| Gillnet | Trip duration                       | *        | -3 %          | -1.7 % | -0.4 %        | 1,622        | 434        |

Table 8: Stanza 4, 2016-2018

| Gear    | Variable                            | CIs <> 0 | 95% CI, lower | Median | 95% CI, upper | n Unobserved | n Observed |
|---------|-------------------------------------|----------|---------------|--------|---------------|--------------|------------|
| Gillnet | Kept groundfish                     | *        | 1.1 %         | 6.6 %  | 12.2 %        | 833          | 277        |
| Gillnet | Number groundfish market categories |          | 0 %           | 5.5 %  | 10.3 %        | 833          | 277        |
| Gillnet | Groundfish avg price                |          | -3.4 %        | -0.5 % | 2.7 %         | 833          | 277        |
| Gillnet | Kept catch                          | *        | -10.6 %       | -5.6 % | -1 %          | 833          | 277        |
| Gillnet | Kept non-groundfish                 | *        | -10.8 %       | -6.1 % | -1.5 %        | 833          | 277        |
| Gillnet | Opportunity cost of quota           | *        | 10.2 %        | 17.2 % | 24.7 %        | 833          | 277        |
| Gillnet | Total revenue                       | *        | -9.6 %        | -5.5 % | -1.1 %        | 833          | 277        |
| Gillnet | Trip duration                       | *        | -4.5 %        | -2.7 % | -1 %          | 833          | 277        |

## Tests for differences in distribution shape

The Kolmogorov-Smirnov (K-S) test, a nonparametric test evaluating the difference between cumulative distribution functions of two independent samples,  $U$  and  $O$ , is sensitive to differences in location and shape. Generally, at a 0.005 significance level this test finds fewer significant differences in distribution shapes than the bootstrap confidence interval method for changes in location.

The Kuiper (K) test, another nonparametric test, is similar to the K-S but evaluates in an additive way both positive and negative differences in the cumulative distribution functions of the  $U$  and  $O$  values. It is more sensitive, therefore, to changes in the tails of the distributions in question.

### Trawl vessels

Of the 31 evaluated units, 12 are significant under the Kolmogorov-Smirnov test and 22 under the Kuiper test. In the pre-sector stanza, three of seven units have statistically significant differences in distribution shape (K-S) and, for all seven units, the tails of the  $U$  and  $O$  distributions are significantly different under the Kuiper test. In the three sector stanzas, nine units exhibit significantly different distributions under the K-S test, with 16 significantly different distributions under the Kuiper test.

The K-S test highlights similar units to the bootstrapped confidence intervals, namely kept catch, trip duration and kept groundfish. The Kuiper test, however, reveals differences in  $U$  and  $O$  distribution shapes for opportunity cost of quota (three sector stanzas) and number of groundfish market categories (all four stanzas).

Table 9: Stanza 1, 2007-2009

| Gear  | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|-------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Trawl | Kept groundfish                     |                 | 0.179 | *              | 0.002 | 10,844       | 726        |
| Trawl | Number groundfish market categories | *               | 0.001 | *              | 0.000 | 10,844       | 726        |
| Trawl | Groundfish avg price                | *               | 0.002 | *              | 0.000 | 10,845       | 726        |
| Trawl | Kept catch                          | *               | 0.002 | *              | 0.000 | 10,845       | 726        |
| Trawl | Kept non-groundfish                 |                 | 0.102 | *              | 0.000 | 10,845       | 726        |
| Trawl | Total revenue                       |                 | 0.169 |                | 0.031 | 10,845       | 726        |
| Trawl | Trip duration                       |                 | 0.066 | *              | 0.005 | 10,845       | 726        |

Table 10: Stanza 2, 2010-2012

| Gear  | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|-------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Trawl | Kept groundfish                     | *               | 0.000 | *              | 0.000 | 2,787        | 1,413      |
| Trawl | Number groundfish market categories |                 | 0.149 | *              | 0.000 | 2,787        | 1,413      |
| Trawl | Groundfish avg price                |                 | 0.272 |                | 0.029 | 2,787        | 1,413      |
| Trawl | Kept catch                          | *               | 0.000 | *              | 0.004 | 2,787        | 1,413      |
| Trawl | Kept non-groundfish                 |                 | 0.625 | *              | 0.002 | 2,787        | 1,413      |
| Trawl | Opportunity cost of quota           |                 | 0.101 | *              | 0.000 | 2,787        | 1,411      |
| Trawl | Total revenue                       | *               | 0.003 |                | 0.021 | 2,787        | 1,413      |
| Trawl | Trip duration                       |                 | 0.007 | *              | 0.001 | 2,787        | 1,413      |

Table 11: Stanza 3, 2013-2015

| Gear  | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|-------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Trawl | Kept groundfish                     | *               | 0.000 | *              | 0.002 | 2,920        | 954        |
| Trawl | Number groundfish market categories |                 | 0.426 | *              | 0.000 | 2,920        | 954        |
| Trawl | Groundfish avg price                |                 | 0.251 |                | 0.059 | 2,920        | 954        |
| Trawl | Kept catch                          | *               | 0.001 | *              | 0.004 | 2,920        | 954        |
| Trawl | Kept non-groundfish                 |                 | 0.128 |                | 0.448 | 2,920        | 954        |
| Trawl | Opportunity cost of quota           |                 | 0.013 | *              | 0.000 | 2,920        | 954        |
| Trawl | Total revenue                       |                 | 0.016 |                | 0.077 | 2,920        | 954        |
| Trawl | Trip duration                       | *               | 0.000 | *              | 0.000 | 2,920        | 954        |

Table 12: Stanza 4, 2016-2018

| Gear  | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|-------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Trawl | Kept groundfish                     | *               | 0.002 | *              | 0.002 | 2,805        | 799        |
| Trawl | Number groundfish market categories |                 | 0.127 | *              | 0.000 | 2,805        | 799        |
| Trawl | Groundfish avg price                |                 | 0.180 |                | 0.346 | 2,805        | 799        |
| Trawl | Kept catch                          | *               | 0.000 | *              | 0.001 | 2,805        | 799        |
| Trawl | Kept non-groundfish                 |                 | 0.649 |                | 0.443 | 2,805        | 799        |
| Trawl | Opportunity cost of quota           |                 | 0.178 | *              | 0.000 | 2,805        | 799        |
| Trawl | Total revenue                       |                 | 0.032 |                | 0.073 | 2,805        | 799        |
| Trawl | Trip duration                       | *               | 0.000 | *              | 0.000 | 2,805        | 799        |



**Gillnet vessels**

Only six of 31 units are significant under the Kolmogorov-Smirnov test and 9 under the Kuiper test for gillnet vessels. In the pre-sector stanza, three of seven units have statistically significant differences in distribution shape for both the K-S and Kuiper tests. In the three sector stanzas, three of 24 possible units exhibit significantly different  $U$  and  $O$  distributions under the K-S test, and 6 under the Kuiper test.

As with trawl vessels, the K-S test here highlights, when significant, difference similar to the bootstrapped confidence intervals. And also like with trawl vessels, the Kuiper test reveals differences in  $U$  and  $O$  distribution shapes for the number of groundfish market categories in all four stanzas.

Table 13: Stanza 1, 2007-2009

| Gear    | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|---------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Gillnet | Kept groundfish                     |                 | 0.104 |                | 0.179 | 10,782       | 531        |
| Gillnet | Number groundfish market categories |                 | 0.111 | *              | 0.000 | 10,782       | 531        |
| Gillnet | Groundfish avg price                |                 | 0.012 |                | 0.027 | 10,782       | 531        |
| Gillnet | Kept catch                          |                 | 0.722 |                | 0.456 | 10,782       | 531        |
| Gillnet | Kept non-groundfish                 | *               | 0.001 | *              | 0.000 | 10,782       | 531        |
| Gillnet | Total revenue                       | *               | 0.002 |                | 0.007 | 10,782       | 531        |
| Gillnet | Trip duration                       | *               | 0.002 | *              | 0.001 | 10,782       | 531        |

Table 14: Stanza 2, 2010-2012

| Gear    | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|---------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Gillnet | Kept groundfish                     |                 | 0.594 |                | 0.070 | 2,609        | 1,330      |
| Gillnet | Number groundfish market categories | *               | 0.001 | *              | 0.000 | 2,609        | 1,330      |
| Gillnet | Groundfish avg price                |                 | 0.161 |                | 0.645 | 2,609        | 1,330      |
| Gillnet | Kept catch                          |                 | 0.182 |                | 0.108 | 2,609        | 1,330      |
| Gillnet | Kept non-groundfish                 |                 | 0.006 | *              | 0.000 | 2,609        | 1,330      |
| Gillnet | Opportunity cost of quota           |                 | 0.239 |                | 0.025 | 2,609        | 1,330      |
| Gillnet | Total revenue                       |                 | 0.612 |                | 0.917 | 2,609        | 1,330      |
| Gillnet | Trip duration                       | *               | 0.000 | *              | 0.000 | 2,609        | 1,330      |

Table 15: Stanza 3, 2013-2015

| Gear    | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|---------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Gillnet | Kept groundfish                     |                 | 0.137 |                | 0.018 | 1,622        | 434        |
| Gillnet | Number groundfish market categories |                 | 0.942 | *              | 0.000 | 1,622        | 434        |
| Gillnet | Groundfish avg price                |                 | 0.314 |                | 0.210 | 1,622        | 434        |
| Gillnet | Kept catch                          |                 | 0.228 |                | 0.222 | 1,622        | 434        |
| Gillnet | Kept non-groundfish                 |                 | 0.223 |                | 0.043 | 1,622        | 434        |
| Gillnet | Opportunity cost of quota           |                 | 0.167 |                | 0.028 | 1,622        | 434        |
| Gillnet | Total revenue                       |                 | 0.110 |                | 0.010 | 1,622        | 434        |
| Gillnet | Trip duration                       |                 | 0.034 | *              | 0.004 | 1,622        | 434        |

Table 16: Stanza 4, 2016-2018

| Gear    | Variable                            | KS $\leq$ 0.005 | p(KS) | K $\leq$ 0.005 | p(K)  | n Unobserved | n Observed |
|---------|-------------------------------------|-----------------|-------|----------------|-------|--------------|------------|
| Gillnet | Kept groundfish                     |                 | 0.144 |                | 0.101 | 833          | 277        |
| Gillnet | Number groundfish market categories |                 | 0.077 | *              | 0.000 | 833          | 277        |
| Gillnet | Groundfish avg price                |                 | 0.702 |                | 0.486 | 833          | 277        |
| Gillnet | Kept catch                          |                 | 0.040 |                | 0.033 | 833          | 277        |
| Gillnet | Kept non-groundfish                 |                 | 0.041 |                | 0.100 | 833          | 277        |
| Gillnet | Opportunity cost of quota           | *               | 0.004 |                | 0.013 | 833          | 277        |
| Gillnet | Total revenue                       |                 | 0.032 |                | 0.053 | 833          | 277        |
| Gillnet | Trip duration                       |                 | 0.092 |                | 0.019 | 833          | 277        |

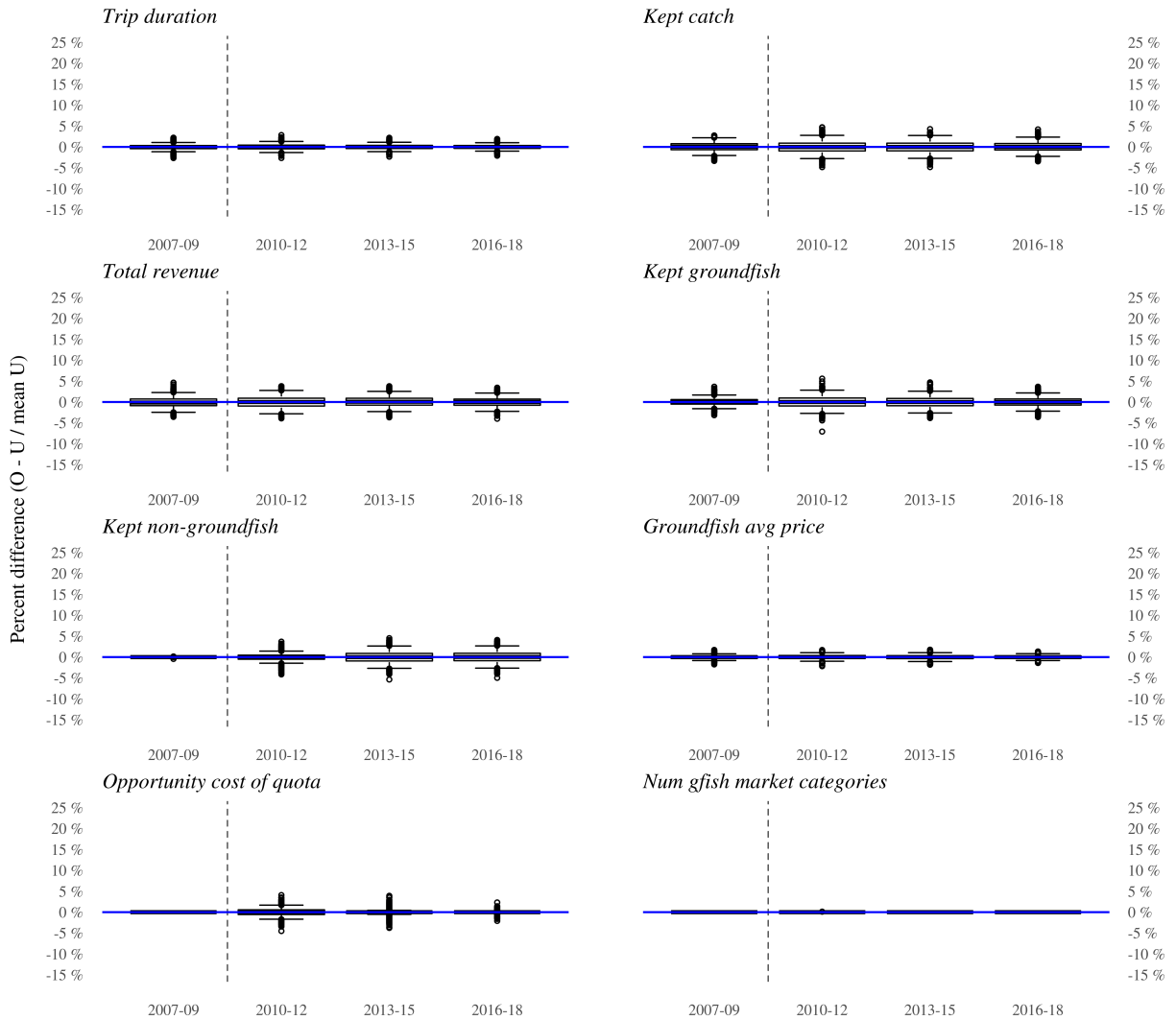
## Discussion

It is clear that fishing vessels engaged in the groundfish fishery alter their behavior in response to observers. Estimated confidence intervals for  $U$  and  $O$  values overlap with zero for only a handful of the metrics evaluated across stanzas or fishing years. Generally, the most pronounced effects are seen across trip duration, kept catch, kept groundfish, trip revenue and opportunity cost of quota. Observer presence has the smallest affect on the number of groundfish market categories and non-groundfish average prices, but, particularly in the former, even here we see differences in the tails of the distributions.

### No treatment model

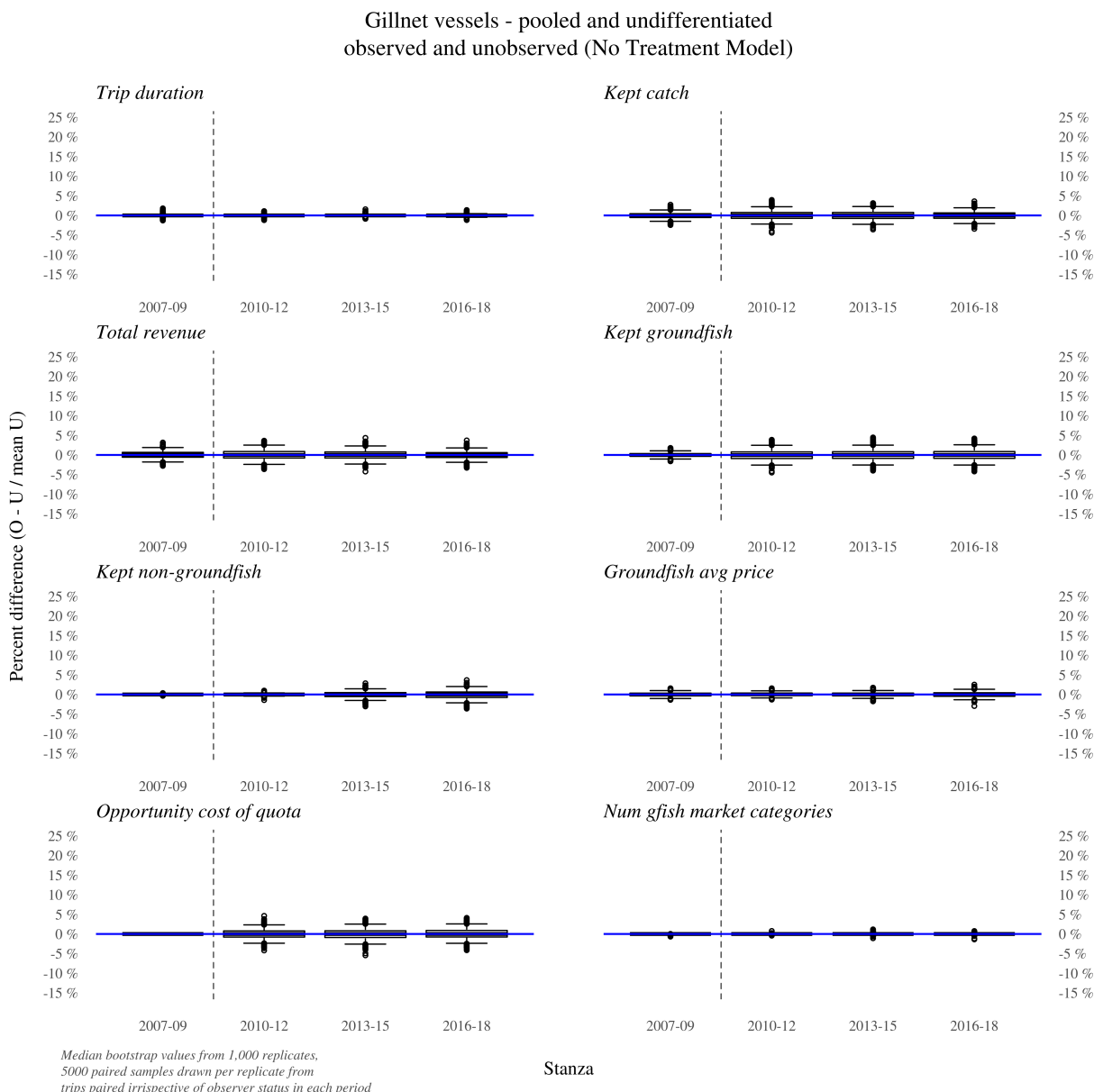
In an effort to demonstrate that the effects estimated here are, in fact, the result of observer presence and not driven by underlying variability in trip-level data driven by unobserved factors, the model was run as previously described, but with assignment to triplets ( $U$  and  $O$ ) made irrespective of actual observer status. As one would expect, the No Treatment estimates across all metrics and stanzas are median-centered on zero with little variance in the two distributions. This demonstrates that the observed variation between  $U$  and  $O$  triplets in the primary (treatment) model is almost certainly a function of observer presence. See Appendix (forthcoming) for details.

Trawl vessels - pooled and undifferentiated  
observed and unobserved (No Treatment Model)



Median bootstrap values from 1,000 replicates,  
5000 paired samples drawn per replicate from  
trips paired irrespective of observer status in each period

Stanza



## Differences across time

Incentives to alter fishing behavior have varied across time. Prior to sector implementation discards had no direct cost to fisherman and trip limits required discarding certain species. These factors may have reduced the incentive to alter fishing practices in response to an observer, noting that gillnet vessels did demonstrate a significant behavioral response prior to sectors. Gillnet vessels, however, are also more likely to have encounters with marine mammals and have other gear-specific requirements (i.e. pingers) that may further affect responses to observers independent of quota-based management and associated regulations.

After full sector implementation, the accountability of discards and the application of sector/gear specific discard rates to unobserved trips, together with the potential catch of constraining stocks and the high opportunity cost of quota associated with landing such stocks, increased the incentive to change behavior. We see this most dramatically in the contemporary sector stanza for gillnet vessels, but the trend from lower quota costs on observed trip toward zero difference on trawl vessels may reflect a similar response.

## The two-sided problem

Incentives to alter behavior in response to an observer may induce less effort, catch, etc...or more, as some vessels fish longer (or shorter) trips or otherwise alter their fishing practices due to quota allocations, fishing preferences, or other factors. One vessel may attempt to minimize observed discarding of flatfish at the expense of cod, while another vessel may take the exact opposite approach. Such offsetting behavior could change the central tendency of the  $M_{\Delta U - \Delta O}$  distribution very little, but affect its shape, particularly at the tails. Number of market categories for groundfish and opportunity cost of quota differ at the tails for both gillnet and trawl vessels. These distribution differences may point toward highgrading and/or circumventing mandatory fish retention regulations.

More broadly, the two-sided nature of the problem is important to understand because directionally opposite responses to observer presence attenuates the central tendency test and some may view location differences on the order of 5-10% as trivial when, taken in context, they represent large and statistically significant differences between observed and unobserved populations.

To better understand the influence of positive and negative observer responses, we estimated median annual (FY) values across each of the eight metrics for all vessels represented in the matched pair data, subtracting each vessel's annual median  $U$  value from its median  $O$  to get a median difference in observed behavior. An example of the distribution of vessel-level observer effects by FY, in this case for opportunity cost of quota, can be seen below.

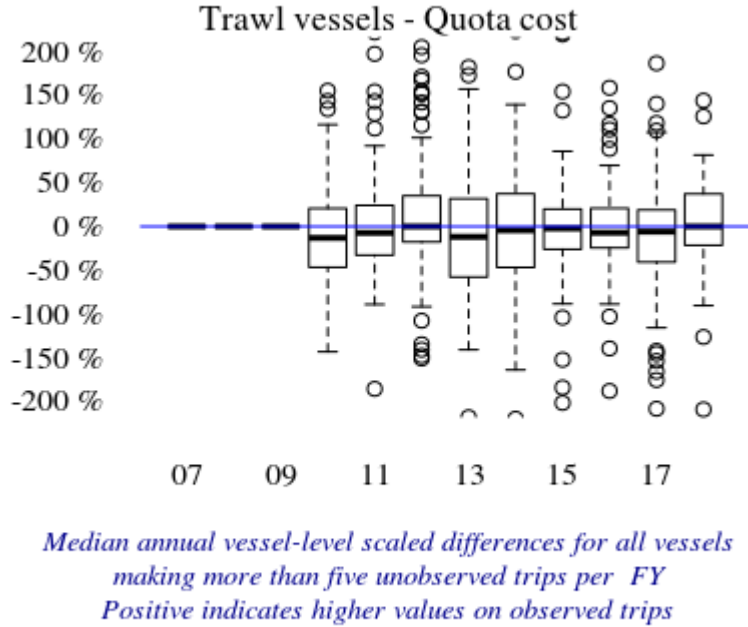


Figure 3: Distribution of vessel-level median annual observer effects, trawl)

These plots make clear the point that over the course of a year, some vessels persistently shift their behavior in response to observer in a positive direction, others the opposite.

The effect of these off-setting behaviors may be that a large amount of catch can be taken by vessels that persistently alter behavior in one direction or the other. To test this, and to better understand how much fishing activity may be affected, we take two sub-sets of vessels—those that exhibit a  $\pm 15\%$  median annual

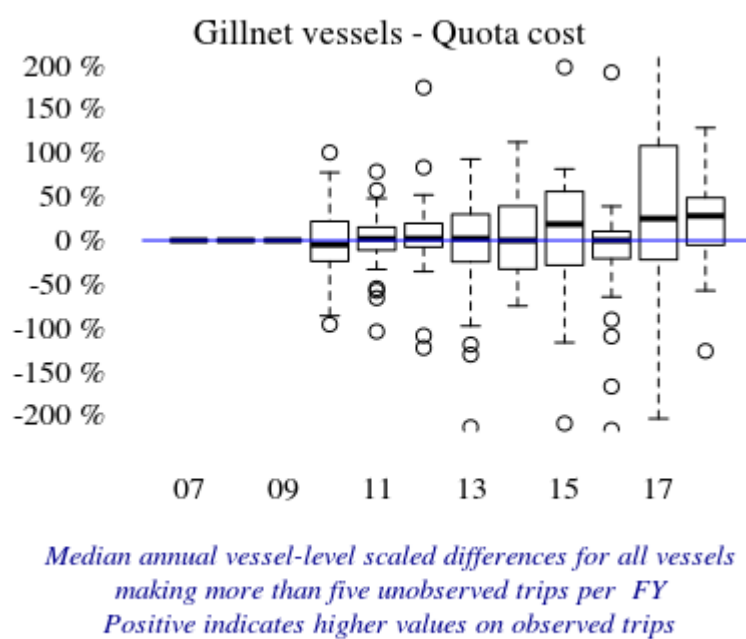


Figure 4: Distribution of vessel-level median annual observer effects, gillnet)



difference in behavior (observer effect) for each metric, and those with a  $\pm 30\%$  difference—and estimate the proportion of vessels and groundfish catch accounted for annually by these sets. We find that across a range of metrics, vessels with an annual observer effect response of  $\pm 15\%$  or more account for roughly 20-30% of the groundfish vessels, and roughly 50-60% of the groundfish catch. Vessels with a  $\pm 30\%$  response account for 10-20% of the vessels and 30-40% of the catch. Vessels exhibiting these levels of observer effect for the opportunity cost of quota metric, in particular, represent the largest share of groundfish catch, from 40-80% depending on threshold and year. It is important to note that, even in the case of no observer effect, the nature of fishing and its underlying variability would likely result in some vessels fitting into one or both of these threshold categories. Further analysis of, for example, the extra-large mesh fishery, which has no quota-based incentives that may benefit from observer effects, may shed more light on the question of underlying variability versus strategic behavioral responses.

## Last word

These analyses point toward a consistent pattern of different fishing behaviors when an observer is on board. The Benoit and Allard method isolates vessel effects by focusing on the differences in behavior in response to an observer *for the same vessel*. The data show a clear trend for three key metrics—in almost all circumstances vessels appear to retain less fish, fish for less time and obtain lower revenues when an observer is on board. Gillnet vessels retain substantially more groundfish, at a higher opportunity cost of quota, in the most recent time stanza. The distributions of  $U$  and  $O$  pairs is substantially different at the tails for the number of groundfish market categories landed, pointing toward highgrading by a subset of the fleet. Persistent differences such as higher average groundfish prices with an observer on board (trawl vessels) and emerging differences like a greater number of market categories retained with an observer (gillnet vessels) indicate that the composition of catch on observed trips is different. This suggests that data collected by observers are not merely a compressed representation of unobserved fishing practices but, rather, they are non-representative along critical dimensions such as proportions and quantities of discarded fish, legally and perhaps illegally, and fish retained.

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\begin{table}[t]

\caption{Vessel median observer effects  $> \pm 15\%$  and  $30\%$ , proportion of total and proportion of groundfish landed}

| FY   | Variable      | N vsls | Vsls, $> \pm 15\%$ | % gfish caught $\pm 15$ | Vsls, $> \pm 30\%$ | % gfish caught $\pm 30$ |
|------|---------------|--------|--------------------|-------------------------|--------------------|-------------------------|
| 2007 | gfish_lbs     | 564    | 125                | 0.35                    | 90                 | 0.27                    |
| 2007 | gfish_mcat    | 564    | 91                 | 0.22                    | 53                 | 0.11                    |
| 2007 | gfish_price   | 564    | 77                 | 0.29                    | 32                 | 0.13                    |
| 2007 | k_all         | 564    | 114                | 0.38                    | 86                 | 0.28                    |
| 2007 | non_gfish_lbs | 564    | 92                 | 0.26                    | 75                 | 0.23                    |
| 2007 | total_value   | 564    | 124                | 0.39                    | 91                 | 0.28                    |
| 2007 | trip_dur      | 564    | 89                 | 0.30                    | 57                 | 0.17                    |
| 2008 | gfish_lbs     | 527    | 129                | 0.31                    | 91                 | 0.23                    |
| 2008 | gfish_mcat    | 527    | 117                | 0.27                    | 61                 | 0.12                    |
| 2008 | gfish_price   | 527    | 81                 | 0.25                    | 54                 | 0.17                    |
| 2008 | k_all         | 527    | 137                | 0.35                    | 95                 | 0.26                    |
| 2008 | non_gfish_lbs | 527    | 113                | 0.38                    | 80                 | 0.28                    |
| 2008 | total_value   | 527    | 134                | 0.38                    | 90                 | 0.25                    |
| 2008 | trip_dur      | 527    | 101                | 0.30                    | 59                 | 0.15                    |
| 2009 | gfish_lbs     | 476    | 114                | 0.51                    | 79                 | 0.35                    |
| 2009 | gfish_mcat    | 476    | 107                | 0.33                    | 60                 | 0.18                    |
| 2009 | gfish_price   | 476    | 88                 | 0.36                    | 48                 | 0.24                    |
| 2009 | k_all         | 476    | 120                | 0.51                    | 86                 | 0.33                    |
| 2009 | non_gfish_lbs | 476    | 118                | 0.48                    | 93                 | 0.33                    |
| 2009 | total_value   | 476    | 124                | 0.46                    | 86                 | 0.30                    |
| 2009 | trip_dur      | 476    | 102                | 0.40                    | 63                 | 0.25                    |
| 2010 | gfish_lbs     | 377    | 96                 | 0.55                    | 56                 | 0.26                    |
| 2010 | gfish_mcat    | 377    | 72                 | 0.27                    | 33                 | 0.14                    |
| 2010 | gfish_price   | 377    | 56                 | 0.36                    | 22                 | 0.18                    |
| 2010 | k_all         | 377    | 95                 | 0.48                    | 66                 | 0.33                    |
| 2010 | non_gfish_lbs | 377    | 82                 | 0.49                    | 64                 | 0.37                    |
| 2010 | quota_cost    | 377    | 103                | 0.53                    | 76                 | 0.43                    |
| 2010 | total_value   | 377    | 99                 | 0.49                    | 63                 | 0.32                    |
| 2010 | trip_dur      | 377    | 64                 | 0.43                    | 31                 | 0.22                    |
| 2011 | gfish_lbs     | 362    | 113                | 0.54                    | 80                 | 0.43                    |
| 2011 | gfish_mcat    | 362    | 61                 | 0.23                    | 22                 | 0.09                    |
| 2011 | gfish_price   | 362    | 49                 | 0.29                    | 18                 | 0.08                    |
| 2011 | k_all         | 362    | 98                 | 0.41                    | 58                 | 0.30                    |
| 2011 | non_gfish_lbs | 362    | 79                 | 0.41                    | 55                 | 0.29                    |
| 2011 | quota_cost    | 362    | 99                 | 0.45                    | 61                 | 0.30                    |
| 2011 | total_value   | 362    | 108                | 0.48                    | 68                 | 0.28                    |
| 2011 | trip_dur      | 362    | 64                 | 0.35                    | 32                 | 0.22                    |

\end{table}

\begin{table}[t]  
\caption{Vessel median observer effects > +/- 15% and 30%, proportion of total and proportion of  
groundfish landed}

| FY   | Variable      | N vsls | Vsls, > +/-15% | % gfish caught +/-15 | Vsls, > +/-30% | % gfish caught +/-30 |
|------|---------------|--------|----------------|----------------------|----------------|----------------------|
| 2012 | gfish_lbs     | 352    | 131            | 0.67                 | 87             | 0.44                 |
| 2012 | gfish_mcat    | 352    | 75             | 0.27                 | 29             | 0.09                 |
| 2012 | gfish_price   | 352    | 77             | 0.44                 | 41             | 0.20                 |
| 2012 | k_all         | 352    | 122            | 0.62                 | 75             | 0.45                 |
| 2012 | non_gfish_lbs | 352    | 115            | 0.59                 | 91             | 0.48                 |
| 2012 | quota_cost    | 352    | 113            | 0.61                 | 79             | 0.43                 |
| 2012 | total_value   | 352    | 125            | 0.65                 | 72             | 0.37                 |
| 2012 | trip_dur      | 352    | 90             | 0.53                 | 52             | 0.34                 |
| 2013 | gfish_lbs     | 305    | 102            | 0.62                 | 67             | 0.43                 |
| 2013 | gfish_mcat    | 305    | 62             | 0.26                 | 31             | 0.10                 |
| 2013 | gfish_price   | 305    | 65             | 0.49                 | 27             | 0.25                 |
| 2013 | k_all         | 305    | 100            | 0.63                 | 72             | 0.49                 |
| 2013 | non_gfish_lbs | 305    | 95             | 0.66                 | 62             | 0.36                 |
| 2013 | quota_cost    | 305    | 105            | 0.73                 | 84             | 0.60                 |
| 2013 | total_value   | 305    | 92             | 0.61                 | 52             | 0.35                 |
| 2013 | trip_dur      | 305    | 64             | 0.55                 | 36             | 0.31                 |
| 2014 | gfish_lbs     | 280    | 85             | 0.70                 | 60             | 0.45                 |
| 2014 | gfish_mcat    | 280    | 52             | 0.32                 | 26             | 0.14                 |
| 2014 | gfish_price   | 280    | 57             | 0.51                 | 32             | 0.24                 |
| 2014 | k_all         | 280    | 80             | 0.64                 | 48             | 0.39                 |
| 2014 | non_gfish_lbs | 280    | 71             | 0.53                 | 55             | 0.41                 |
| 2014 | quota_cost    | 280    | 95             | 0.71                 | 72             | 0.49                 |
| 2014 | total_value   | 280    | 90             | 0.67                 | 56             | 0.39                 |
| 2014 | trip_dur      | 280    | 66             | 0.54                 | 31             | 0.21                 |
| 2015 | gfish_lbs     | 250    | 75             | 0.55                 | 56             | 0.37                 |
| 2015 | gfish_mcat    | 250    | 50             | 0.18                 | 27             | 0.11                 |
| 2015 | gfish_price   | 250    | 46             | 0.42                 | 24             | 0.19                 |
| 2015 | k_all         | 250    | 76             | 0.52                 | 63             | 0.41                 |
| 2015 | non_gfish_lbs | 250    | 82             | 0.63                 | 63             | 0.45                 |
| 2015 | quota_cost    | 250    | 80             | 0.46                 | 59             | 0.36                 |
| 2015 | total_value   | 250    | 76             | 0.47                 | 51             | 0.28                 |
| 2015 | trip_dur      | 250    | 63             | 0.52                 | 41             | 0.35                 |
| 2016 | gfish_lbs     | 230    | 67             | 0.56                 | 46             | 0.29                 |
| 2016 | gfish_mcat    | 230    | 39             | 0.14                 | 19             | 0.05                 |
| 2016 | gfish_price   | 230    | 46             | 0.42                 | 20             | 0.16                 |
| 2016 | k_all         | 230    | 82             | 0.70                 | 51             | 0.40                 |
| 2016 | non_gfish_lbs | 230    | 69             | 0.56                 | 53             | 0.32                 |
| 2016 | quota_cost    | 230    | 78             | 0.74                 | 44             | 0.41                 |
| 2016 | total_value   | 230    | 73             | 0.54                 | 41             | 0.35                 |
| 2016 | trip_dur      | 230    | 50             | 0.66                 | 20             | 0.12                 |

\end{table}

\begin{table}[t]  
\caption{Vessel median observer effects > +/- 15% and 30%, proportion of total and proportion of  
groundfish landed}

| FY   | Variable      | N vsls | Vsls, > +/-15% | % gfish caught +/-15 | Vsls, > +/-30% | % gfish caught +/-30 |
|------|---------------|--------|----------------|----------------------|----------------|----------------------|
| 2017 | gfish_lbs     | 213    | 73             | 0.63                 | 50             | 0.35                 |
| 2017 | gfish_mcat    | 213    | 42             | 0.17                 | 14             | 0.06                 |
| 2017 | gfish_price   | 213    | 48             | 0.43                 | 24             | 0.12                 |
| 2017 | k_all         | 213    | 67             | 0.59                 | 43             | 0.28                 |
| 2017 | non_gfish_lbs | 213    | 73             | 0.63                 | 48             | 0.44                 |
| 2017 | quota_cost    | 213    | 76             | 0.60                 | 54             | 0.43                 |
| 2017 | total_value   | 213    | 72             | 0.61                 | 49             | 0.44                 |
| 2017 | trip_dur      | 213    | 52             | 0.66                 | 25             | 0.46                 |
| 2018 | gfish_lbs     | 198    | 50             | 0.31                 | 39             | 0.25                 |
| 2018 | gfish_mcat    | 198    | 45             | 0.20                 | 13             | 0.05                 |
| 2018 | gfish_price   | 198    | 37             | 0.25                 | 15             | 0.09                 |
| 2018 | k_all         | 198    | 58             | 0.51                 | 28             | 0.34                 |
| 2018 | non_gfish_lbs | 198    | 51             | 0.64                 | 27             | 0.39                 |
| 2018 | quota_cost    | 198    | 58             | 0.69                 | 39             | 0.44                 |
| 2018 | total_value   | 198    | 51             | 0.46                 | 33             | 0.20                 |
| 2018 | trip_dur      | 198    | 36             | 0.42                 | 18             | 0.22                 |

\end{table}

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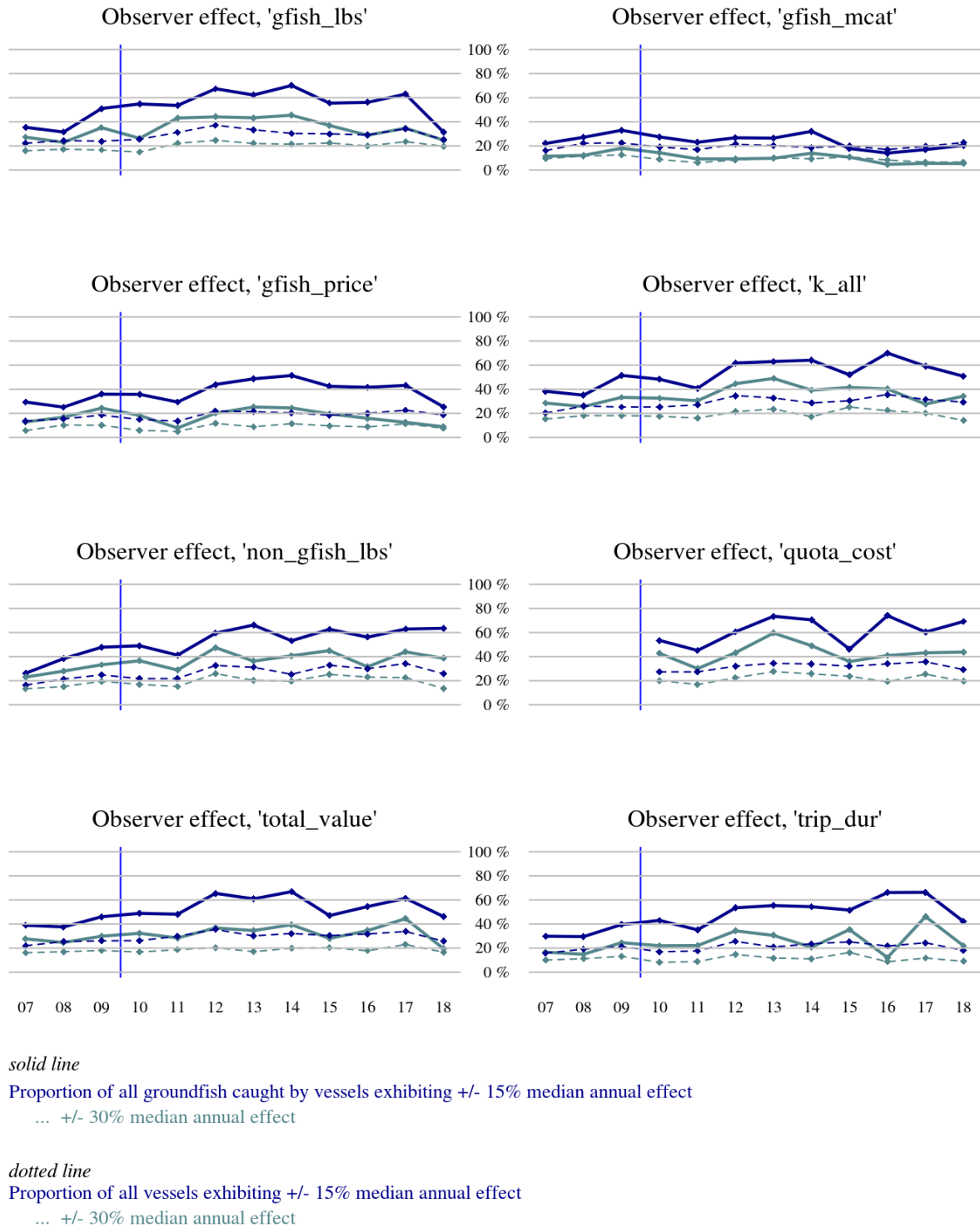


Figure 5: Proportion of vessels and catch accounted for by vessels with median annual observer effect greater than +/- 15 and 30%

# Predicting Gulf of Maine (GOM) cod catch on Northeast Multispecies (groundfish) sector trips: implications for observer bias and fishery catch accounting

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**–DRAFT–**

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The National Marine Fisheries Service (NMFS) estimates total groundfish catch across 20 stocks for the Northeast multispecies (groundfish) sector fleet by integrating several sources of information on landings and discards. Landings are reported by dealers for all trips, while discards are known only for ~15–30% of trips in a given year that are selected to carry a fisheries observer from the Northeast Fisheries Observer Program (NEFOP) or the At-Sea Monitoring Program (ASM). Under the assumption that trips can be randomly selected for observation and that the observed fishing activity and harvest outcomes are representative of behavior across the fleet (within defined strata), rates of discarding are calculated and applied to unobserved trips to obtain estimates of the unobserved discards in the fishery. Total catch for a given stock is then the summation of reported landings, observed discards, and the estimated discards on unobserved trips.

Evidence that observed trips are *not* representative of the effort across the fleet has been presented by the Groundfish Plan Development Team (PDT), calling into question the accuracy of the catch estimation methods used by NMFS to monitor the fishery. An increase in the amount of landed groundfish catch on unobserved trips, for example, suggests differences in catch rates that cannot be easily assessed given that total catches (landings + discards) are not known with certainty for unobserved trips (discards are estimated). Other Groundfish PDT work has quantified the incentives to modify fishing behavior in the presence of constraining stocks (e.g., Atlantic cod), which could result in spatial/temporal avoidance on observed trips and illegal discarding of legal-sized fish on unobserved trips. While both empirical and anecdotal evidence suggests that observed trips are not representative, the resulting implications of observer bias on total catch estimation have not been quantified.

Here, we used observed trips in the Gulf of Maine (GOM) stock area to model cod catch while accounting for typical effort attributes (e.g., total kept catch, vessel size, trip length) in addition to spatial and temporal covariance in catch. Using this predictive model, we then predicted total catch (kept + discarded) on unobserved trips and compared the summed predictions across a fishing season to the catch estimates for sectors reported by NMFS. Discrepancies suggest the potential for unreported catch.

## Methods

### *Data*

The catch data came from the Greater Atlantic Regional Fisheries Office (GARFO) database known as the Data Matching & Identification System (DMIS) which integrates multiple sources of information including dealer records, Vessel Trip Reports (VTRs), and NEFOP/ASM observer records for all commercial fisheries trips. The data were limited to groundfish trips (or subtrips) taken by sector vessels in fishing years (FY)

2011, 2013, 2015, and 2017 using otter trawls (OTF) or gillnets (GNS) in the GOM stock area (as defined by the VTR). These years were chosen as a reasonable representation of the sector management program (implemented in 2010). Subtrips are defined as fishing effort in a single NMFS statistical area (and gear), allowing for a focus exclusively on GOM effort, and landings from OTF and GNS vessels comprise >95% of cod catch for sector vessels. Records were also limited to those trips with a VTR-recorded latitude and longitude location, which included >99% of available trips. Finally, we further limited the data to those trips with reported landings of >0 lbs for cod. This last choice reflected a desire to simplify the modeling by removing the encounter process (i.e., whether a trip encountered cod), recognizing that any trips with unreported cod would be missed.

For each fishing year and gear type, the data were split between observed and unobserved trips. Total cod catch on an observed trip included the landings (i.e., kept catch) reported by the dealer and the discards recorded by the observer. Unobserved trips had discards assigned by DMIS according to a rate as calculated by observed trips within the same stratum (i.e., gear, stock area), consistent with the Standardized Bycatch Reporting Methodology (Wigley et al. 2007).

### ***Model fitting: observed trips***

The predictive model of cod catch was built using the observed trips for each gear and fishing year combination. The model included fixed effects representing attributes of fishing effort and random effects for variation according to vessel permit, space, and time. The spatial and temporal effects were modeled with predictive processes (PPs) to estimate covariances in space and time and partition variation that could be attributed to either dimension (Viana et al. (2013); Finley et al. (2009)).

Total cod catch (discards + landings),  $y_i$ , for each trip  $i$  was modeled as a Poisson random variable such that:

$$y_i \sim \text{Poisson}(\mu_i)$$

$$\log(\mu_i) = \mathbf{X}\boldsymbol{\beta} + \nu_j + \omega_1(s_i) + \omega_2(t_i) + \epsilon_i$$

where  $\mathbf{X}$  is a vector of predictors for trip  $i$  taken by vessel  $j$ , and  $\boldsymbol{\beta}$  is the vector of fixed effects on the log scale. The model also included a random effect for vessel,  $\nu_j$ ; the spatial PP for residual variation due to space,  $\omega_1(s_i)$ ; and the temporal PP for residual variation due to the date of the trip,  $\omega_2(t_i)$ . Random error not attributed to vessel, space, or time was estimated by  $\epsilon_i$ , which was modeled by a mean-zero normal distribution with variance  $\sigma_\epsilon^2$ . We used a Poisson distribution for expected catch,  $E[y_i]$ , to accommodate increased variance at larger quantities.

The fixed effects in  $\mathbf{X}$  included: 1) intercept; 2) total kept catch; 3) pollock, 4) haddock, 5) winter flounder, and 6) yellowtail flounder landings; 7) trip length and 8) squared trip length; 9) vessel tonnage and 10) squared vessel tonnage. Both trip length and vessel tonnage included squared terms to accommodate non-linear relationships. These covariates were chosen to represent attributes of fishing effort that might correlate with cod catch. The covariates representing catch/landings were log10-transformed (after adding 1). All covariates for the fixed effects were standardized to have mean of 0 and unit variance.

The random effects for space and time relied on spatial and temporal PPs, respectively, that were estimated at a reduced resolution in comparison to the observed data (Viana et al. 2013). The spatial PP was defined at 224 knots spaced on a 15-km grid restricted to where active fishing was recorded (e.g., Fig. 1). The temporal PP was defined at 25 knots spaced every 2 weeks throughout the fishing year. We specified Gaussian processes on the spatial and temporal knots with covariances that were a function of distance (in space or time). Following Viana et al. (2013), one can define a generic covariance function between 2 locations:

$$C(x_a, x_b | \phi) = \sigma^2 \rho(x_a, x_b | \phi)$$

where  $\rho(x_a, x_b | \phi) = \exp[-|d_{ab}|/\phi]$  is the correlation between locations  $x_a$  and  $x_b$ , and  $d_{ab}$  is the distance between the locations;  $\sigma^2$  is the random effect variance; and  $\phi$  is a scale parameter controlling the rate

of decay in correlation between points as distance increases. By using coarse-scale spatial/temporal knots on which to define the Gaussian processes, the computational burden of the modeling procedure is greatly reduced. The Gaussian processes were therefore defined as:

$$\begin{aligned}\omega_1(s^*) &\sim GP(0, \sigma_s^2 \rho(s_a, s_b | \phi_s)) \\ \omega_2(t^*) &\sim GP(0, \sigma_t^2 \rho(t_a, t_b | \phi_t))\end{aligned}$$

Further details for how the Gaussian processes estimated on the knots relate to the random effects  $\omega_1(s)$  and  $\omega_2(t)$  estimated for the observed data can be found in Viana et al. (2013) and Finley et al. (2009).

We fit the models using a Bayesian approach and estimated the posterior distributions of parameters via Markov chain Monte Carlo (MCMC) methods with JAGS (Plummer 2003) and R (R Core Team 2018). We used standard vague priors for most parameters, with slightly-informative priors for the scale parameters,  $\phi_s \sim Ga(3, 0.066)$ , and  $\phi_t \sim Ga(3, 0.033)$ ; and for the spatial and temporal random variances,  $\sigma_s \equiv \sigma_t \propto T(\mu = 0, \tau = 1, \nu = 5) [\sigma > 0]$ . The latter specification indicates a scaled Half Student-T distribution, which can be useful for constraining variance parameters (Rankin et al. 2016). We also used a highly informative prior for the residual variance (i.e., standard deviation for  $\epsilon_i$ ) such that  $\sigma_\epsilon \sim N(0.7, \sigma^2 = 0.0225)$ ; this prior was chosen after some initial model fitting to stabilize the residual variance estimate. The models were run for 6,000 iterations over 3 chains after an adaption phase of 6,000, resulting in posterior distributions of 18,000 values. Convergence was achieved by examining trace plots and ensuring that the potential scale reduction factor was  $< 1.1$  for all parameters (Gelman and Rubin 1992).

### ***Model predictions: unobserved trips***

We used the parameter estimates from each model to predict the cod catch on unobserved trips. The linear functions of expected catch were straightforward for the 10  $\hat{\beta}$  estimates (9 covariates with intercept) and vessel-specific random effects,  $\hat{\nu}_j$ . For vessels with no observed trips (and, hence, no estimated random effect), the vessel-specific random effect was set to 0. For the spatial and temporal random effects, distance matrices were calculated between all unobserved trips and the spatial and temporal knot locations so that expected values of  $\hat{\omega}_1(s_i)$  and  $\hat{\omega}_2(t_i)$  for each trip  $i$  could be calculated. Random error as estimated by  $\hat{\sigma}_\epsilon$  was also added to the predictions to capture the full uncertainty in the model. The predictions for all individual trips were summed to estimate a total predicted cod catch for each gear and year, across the full posterior distribution of parameter estimates.

We also made predictions for the observed trips to illustrate how well the models could predict total cod catch without the observation-specific deviations,  $\hat{\epsilon}_i$ . All other fixed- and random-effect parameter estimates across the full posterior distributions were used as with the unobserved trips. Random error was re-inserted according to estimates of  $\hat{\sigma}_\epsilon$  to account for over-dispersion.

Finally, the entire model fitting and prediction process was replicated for pollock to help contextualize the patterns observed for cod. Pollock is an abundant species that is not overfished and has not had a constraining quota during the period of analysis. The only differences in model structure were the species landings included as predictors (haddock, white hake, winter flounder, redfish). The full modeling results for pollock are not presented here, aside from the final predictions of total catch for observed and unobserved trips.

## **Results**

Decreases in the observed catch (discards + landings) of cod between 2011 and 2017 are apparent for vessels using otter trawls and gillnets (Figs. S1–S8 in Supplement 1). The number of observed and unobserved trips also decreased over time (Table 1). Sample sizes for the predictive models ranged from a high of 1,489 trawl trips in 2011 to a low of 183 gillnet trips in 2017.



Table 1: Number of observed and unobserved sector trips taken in the Gulf of Maine with cod landings >0 lbs.

| Gear | FY   | Observed | Unobserved |
|------|------|----------|------------|
| OTF  | 2011 | 1193     | 2735       |
|      | 2013 | 561      | 1768       |
|      | 2015 | 437      | 1311       |
|      | 2017 | 384      | 1353       |
| GNS  | 2011 | 1489     | 3416       |
|      | 2013 | 555      | 2059       |
|      | 2015 | 295      | 839        |
|      | 2017 | 183      | 763        |

Full model results are presented in Supplement 2. The fixed effects estimates varied by gear type and year (Figs. 2–3). Some species had a strong positive relationship with expected cod catch each year (e.g., pollock ( $\beta_3$ ) for gillnets), while others had variable relationships (e.g., yellowtail ( $\beta_6$ ) in 2017 was negative for gillnets and positive for otter trawls). Kept all ( $\beta_2$ ) was a relatively strong predictor of cod catch for otter trawls across all years but decreased gradually for gillnets from 2011 to 2017. Trip length and vessel tonnage were not strongly associated with cod catch, likely due to the effect of kept all.

The amount of random variation explained by spatial location ( $\sigma_s$ ) decreased over time for both otter trawl and gillnet vessels (Figs. 4–5). Vessel-specific variation ( $\sigma_\nu$ ) was as large as temporal variation ( $\sigma_t$ ) for most years across both gear types. The patterns in residual spatial variation in observed cod catch (conditional on total kept catch, trip length, etc.) were stronger in the earlier years for both gear types (Figs. 6–7). The spatial patterns also changed between the gear types in later years. For example, in 2017 there appeared to be greater relative catch for inshore otter trawl trips while for gillnet trips, higher relative catches occurred farther offshore. Temporal variation exhibited different patterns between the gear types, and often across years within a gear type (Fig. 8).

The predictions of total cod catch for observed trips were fairly accurate even after removing the trip-specific random effects ( $\epsilon_i$ ) and re-inserting random error (Table 2, Fig. 9). The percentage differences between the reported catch and the posterior mode of predictions was <5% for 6 of the 8 models. The highest difference was in 2013 for otter trawls, where the model under-predicted total catch by 13%.

Table 2: Reported vs. model-predicted cod catch (mt) for **observed** trips, with percentage of reported by which posterior mode differs.

| Gear | FY   | Reported catch | Posterior distribution |        |        |        | % Diff. |
|------|------|----------------|------------------------|--------|--------|--------|---------|
|      |      |                | Mode                   | 2.5%   | 50%    | 97.5%  |         |
| OTF  | 2011 | 819.70         | 852.25                 | 743.23 | 849.64 | 967.96 | 4       |
|      | 2013 | 102.64         | 89.57                  | 75.59  | 92.57  | 114.11 | -13     |
|      | 2015 | 23.26          | 21.61                  | 17.73  | 21.77  | 26.31  | -7      |
|      | 2017 | 34.95          | 36.53                  | 28.93  | 37.51  | 48.29  | 5       |
| GNS  | 2011 | 391.03         | 378.55                 | 339.36 | 378.47 | 422.27 | -3      |
|      | 2013 | 54.72          | 52.78                  | 45.78  | 53.87  | 62.96  | -4      |
|      | 2015 | 18.16          | 17.53                  | 14.61  | 18.16  | 22.14  | -3      |
|      | 2017 | 18.79          | 18.36                  | 13.91  | 18.76  | 25.67  | -2      |

The predictions of total cod catch for unobserved trips exhibited a trend across time for gillnets with no apparent pattern for otter trawls (Table 3, Fig. 10). The discrepancy for gillnets increased over the years, with model predictions suggesting greater estimates of cod catch than that which was reported. In 2017, the posterior mode of total catch was 68% larger than the reported catch. For otter trawls, the differences between modes and reported catches were never >15% and varied in direction across the years.

Table 3: Reported vs. model-predicted cod catch (mt) for **unobserved** trips, with percentage of reported by which posterior mode differs.

| Gear | FY   | Reported catch | Posterior distribution |         |         |         | % Diff. |
|------|------|----------------|------------------------|---------|---------|---------|---------|
|      |      |                | Mode                   | 2.5%    | 50%     | 97.5%   |         |
| OTF  | 2011 | 1786.65        | 2063.37                | 1829.05 | 2076.19 | 2322.05 | 15      |
|      | 2013 | 365.44         | 333.12                 | 276.58  | 339.97  | 416.49  | -9      |
|      | 2015 | 81.01          | 78.74                  | 65.61   | 80.63   | 97.20   | -3      |
|      | 2017 | 123.72         | 140.08                 | 114.71  | 144.61  | 177.96  | 13      |
| GNS  | 2011 | 989.78         | 985.43                 | 888.04  | 990.10  | 1110.04 | 0       |
|      | 2013 | 189.80         | 207.54                 | 174.06  | 211.30  | 259.75  | 9       |
|      | 2015 | 50.81          | 71.45                  | 57.63   | 74.80   | 97.14   | 41      |
|      | 2017 | 54.39          | 91.11                  | 66.66   | 96.77   | 143.19  | 68      |

The predictions for pollock suggested that our regression models were not as accurate at predicting catch for this species Supplement 3. For observed trips, model predictions were typically higher than reported catch (*always* for gillnets), suggesting a positive bias that was unaccounted for by the fixed effects and structured random effects. As a result, the predictions for unobserved trips are difficult to assess. It should be noted that the relative relationships between the reported catch and the predicted catch were similar between observed and unobserved trips.

## Discussion

The predictive models leveraged information from observer data to estimate relationships between cod catch (landings + discards) and measures of effort, other species landings, and random variation attributed to space, time, and vessel. The models fit the observed data well, suggesting that predictions of total cod catch (across a fleet) using structured information might be useful for understanding discrepancies in expected and reported catch.

It appears that discrepancies for gillnet vessels could be indicative of unreported catch, which has increased over time. This assumes that observed trips can adequately represent unobserved trips with regards to “pre-catch” behavior – the manner in which gear is fished and effort expended. We modeled pre-catch behavior using several attributes of effort (e.g., kept all, location) that were expected and shown to influence catch outcomes. If other important attributes of effort were not modeled explicitly, then catch per unit effort (CPUE) of cod estimated by the observed trips may not accurately predict expected catch on unobserved trips. Under the assumption that estimated CPUE is representative, the predicted discrepancies indicate the potential unreported catch that may be attributed to differences in “post-catch” behavior (e.g., non-compliance with discarding regulations mandating retainment of legal-sized fish).

For otter trawls, the erratic pattern of predicted vs. reported cod catch is difficult to explain. It is possible that important pre-catch behavior specific to mobile gear was missing from the model structure (e.g., tow speed, tow length), which would invalidate the transfer of inferences on CPUE from observed trips to unobserved trips. This uncertainty illustrates the general difficulty of measuring fishing effort using limited information at coarse scales, compared to detailed haul-level reporting.

Additional caveats of the modeling process necessitate tempered conclusions. Other statistical distributions for expected catch on a trip (e.g., quasi-Poisson, negative binomial) may provide a better fit to the catch data, though the random error should have been useful at capturing over-dispersion and helping adjust predictions. The scales of the spatial and temporal knots were not explored and other choices may have been better able to estimate the covariances in each dimension. In particular, the majority of fishing effort is expended in a small proportion of the GOM relatively close to shore (e.g., Fig. S1), suggesting that a finer spatial resolution might pick up more nuanced variation in space. This caveat also highlights the limitations of using a single, self-reported latitude and longitude for each subtrip of effort, which likely prevents fine-scale spatial inferences and induces additional uncertainties.

The reduction in effort and observer coverage across time also increases uncertainty for models from later years. For example, the sample size of observed trips for gillnets was almost an order of magnitude smaller in 2017 ( $n=183$ ) compared to 2011 ( $n=1,489$ ) (Table 1). A larger model that combines multiple years of data and leverages parameter pooling across years might yield more accurate parameter estimation. Nevertheless, the added complexity of statistical modeling would not overcome any deficiencies in the sampling design or violations regarding the validity of inferences from observed trips to unobserved trips.

The predicted cod catch was 40% and 68% greater than the reported catch in 2015 and 2017, respectively, for unobserved gillnet trips. The time period coincides with highly constraining quotas for the species. These numbers overwhelm the potential error attributed to sub-legal discard estimation that otherwise serves as the target for observer coverage in the fishery. While the modeling effort presented here cannot prove the existence of unreported catch on unobserved trips, it provides an approximation to the scale of the problem.

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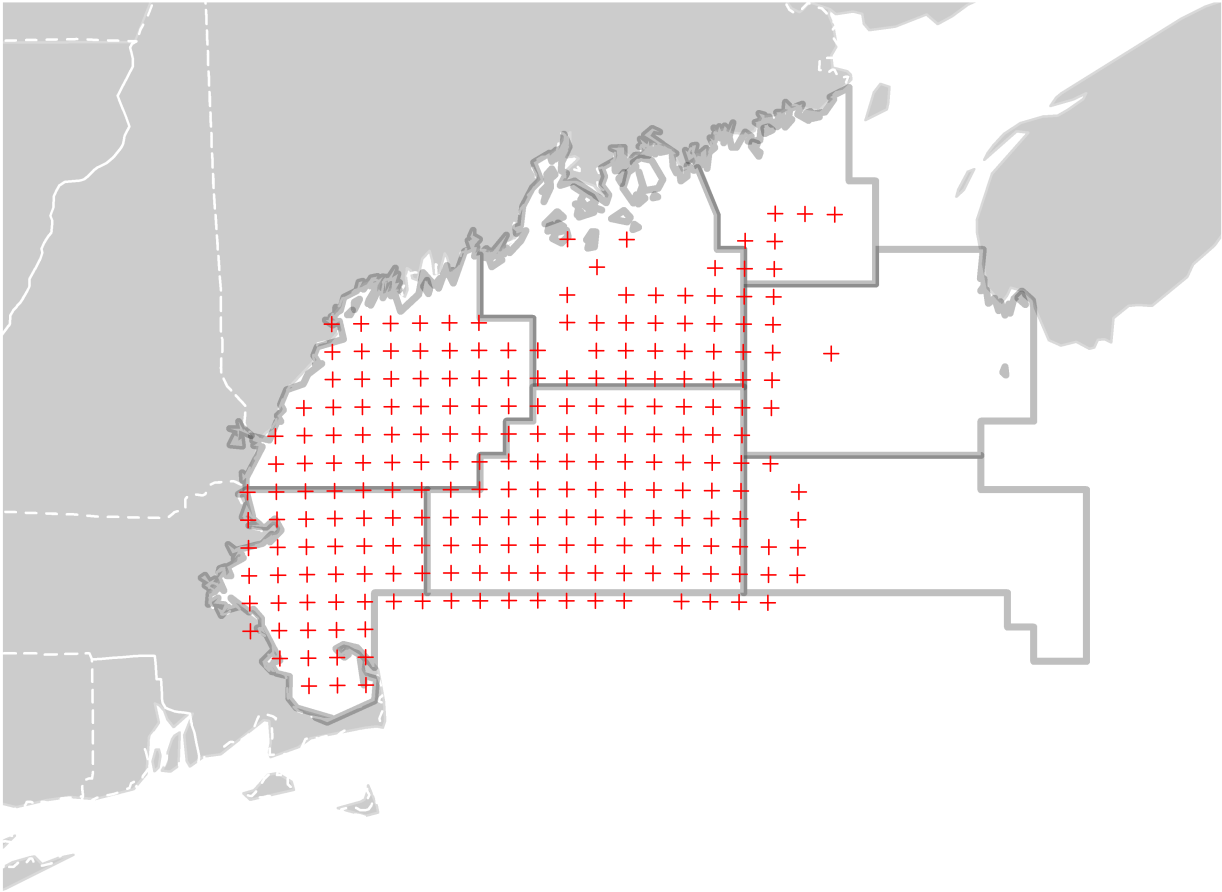


Figure 1: Gulf of Maine broad stock area with NMFS statistical areas for reference and location of the  $n=224$  spatial knots spaced at 15 km used for modeling spatial covariance.

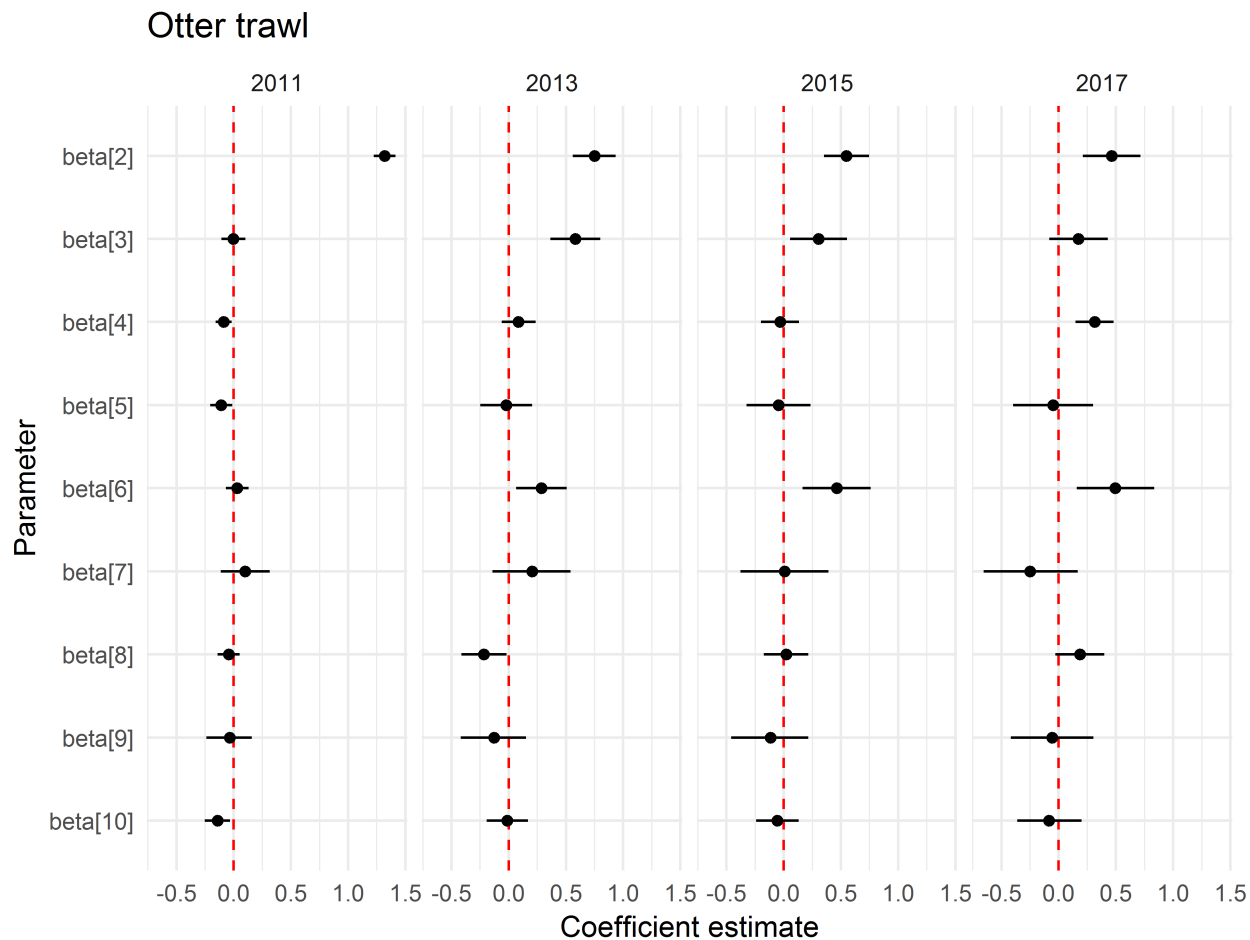


Figure 2: Parameter estimates for log-scale models of GOM cod catch on otter trawl vessels. The fixed effects ( $\beta$ ) correspond to the following (absent the intercept): 2) kept all; 3) pollock; 4) haddock; 5) winter flounder; 6) yellowtail flounder; 7) trip length; 8) squared trip length; 9) vessel tonnage; 10) squared vessel tonnage.

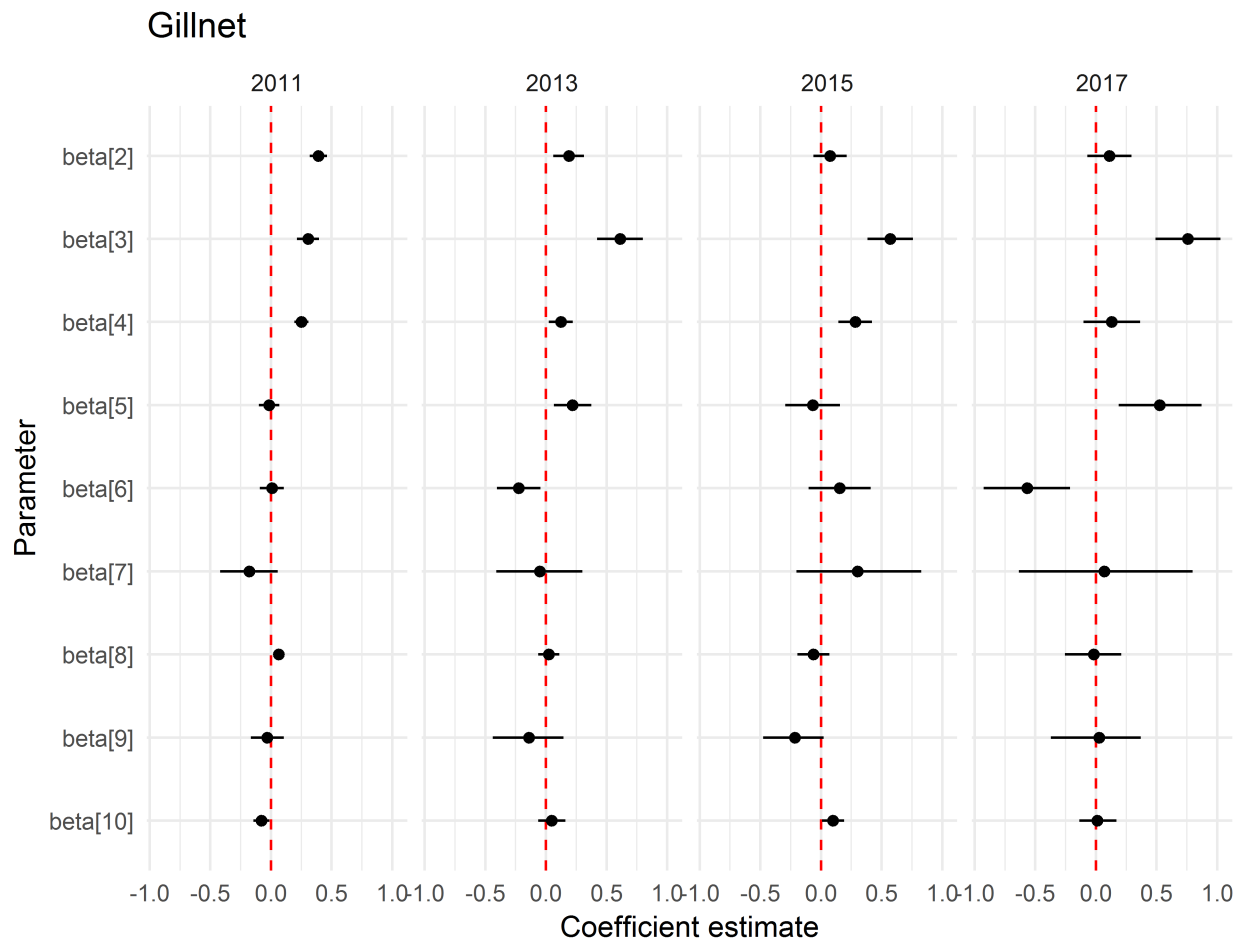


Figure 3: Parameter estimates for log-scale models of GOM cod catch on gillnet vessels. The fixed effects ( $\beta$ ) correspond to the following (absent the intercept): 2) kept all; 3) pollock; 4) haddock; 5) winter flounder; 6) yellowtail flounder; 7) trip length; 8) squared trip length; 9) vessel tonnage; 10) squared vessel tonnage.

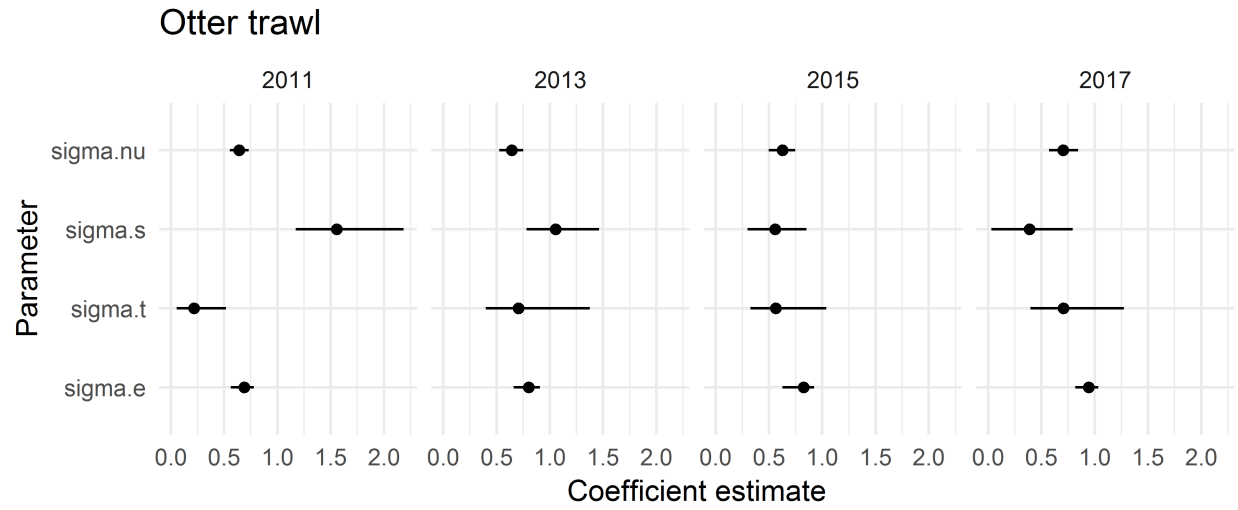


Figure 4: Parameter estimates for log-scale models of GOM cod catch on otter trawl vessels. The variance (standard deviation) estimates correspond to random effects for vessel ( $\sigma_\nu$ ), space ( $\sigma_s$ ), time ( $\sigma_t$ ), and residual ( $\sigma_\epsilon$ ).



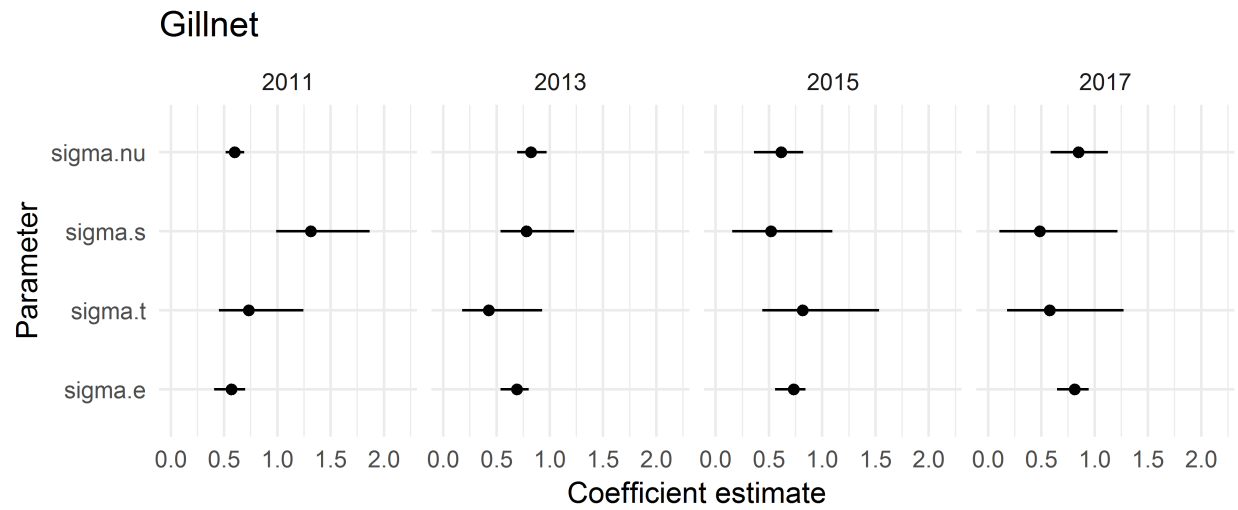


Figure 5: Parameter estimates for log-scale models of GOM cod catch on gillnet vessels. The variance (standard deviation) estimates correspond to random effects for vessel ( $\sigma_\nu$ ), space ( $\sigma_s$ ), time ( $\sigma_t$ ), and residual ( $\sigma_\epsilon$ ).

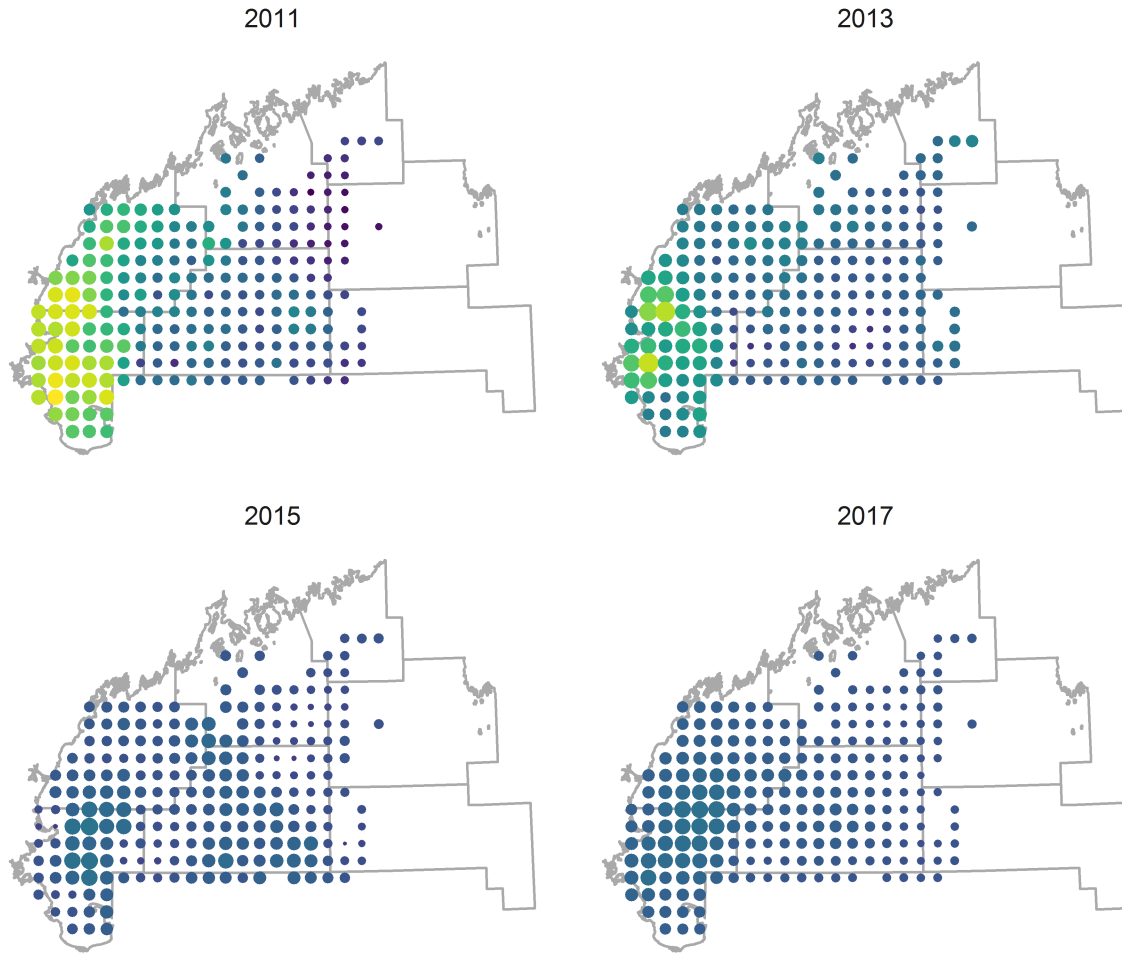


Figure 6: Relative spatial variation in cod catch unexplained by predictors of effort on observed trips taken by sector vessels using otter trawls in the Gulf of Maine during fishing years 2011, 2013, 2015, and 2017. Circle color represents relative variation across years (lighter = higher catch) while circle size represents variation within a year (larger = higher catch).

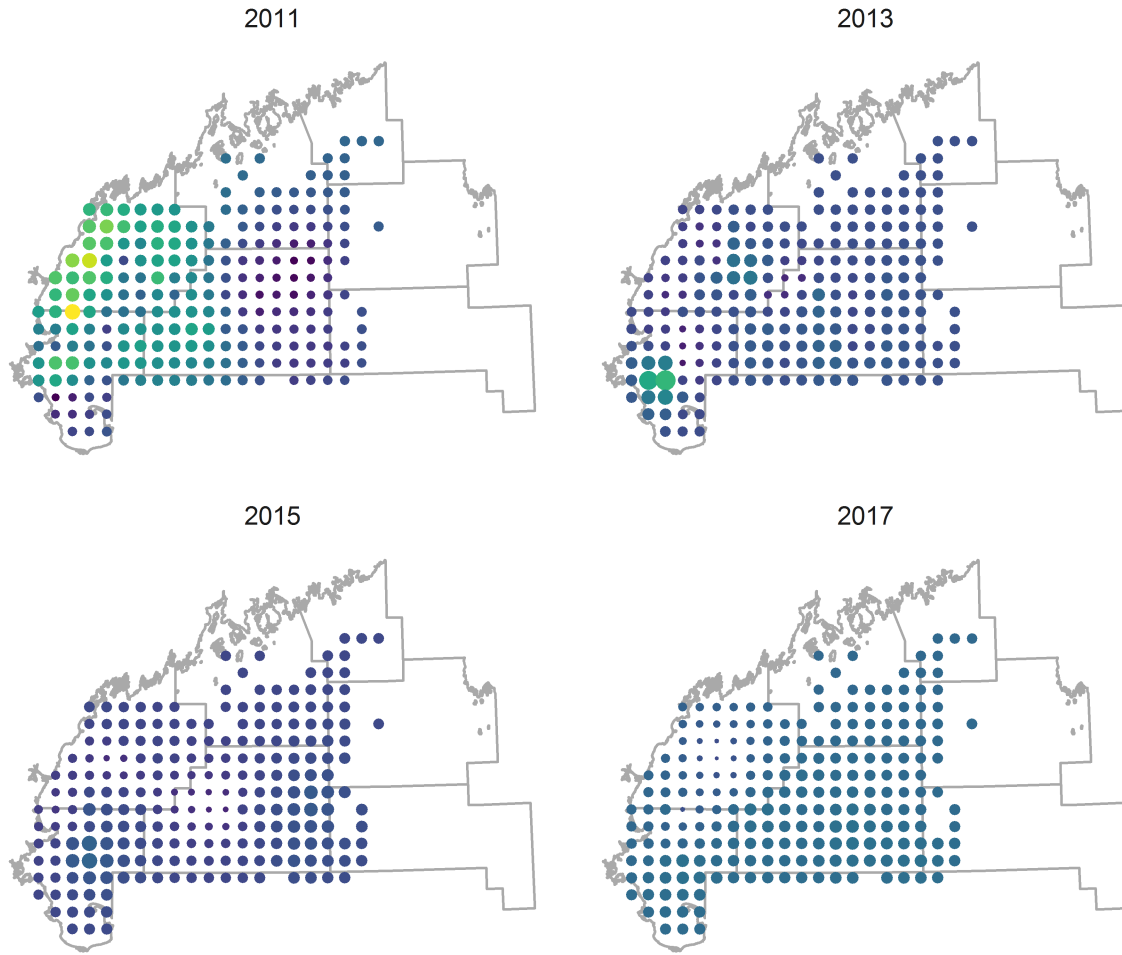


Figure 7: Relative spatial variation in cod catch unexplained by predictors of effort on observed trips taken by sector vessels using gillnets in the Gulf of Maine during fishing years 2011, 2013, 2015, and 2017. Circle color represents relative variation across years (lighter = higher catch) while circle size represents variation within a year (larger = higher catch).

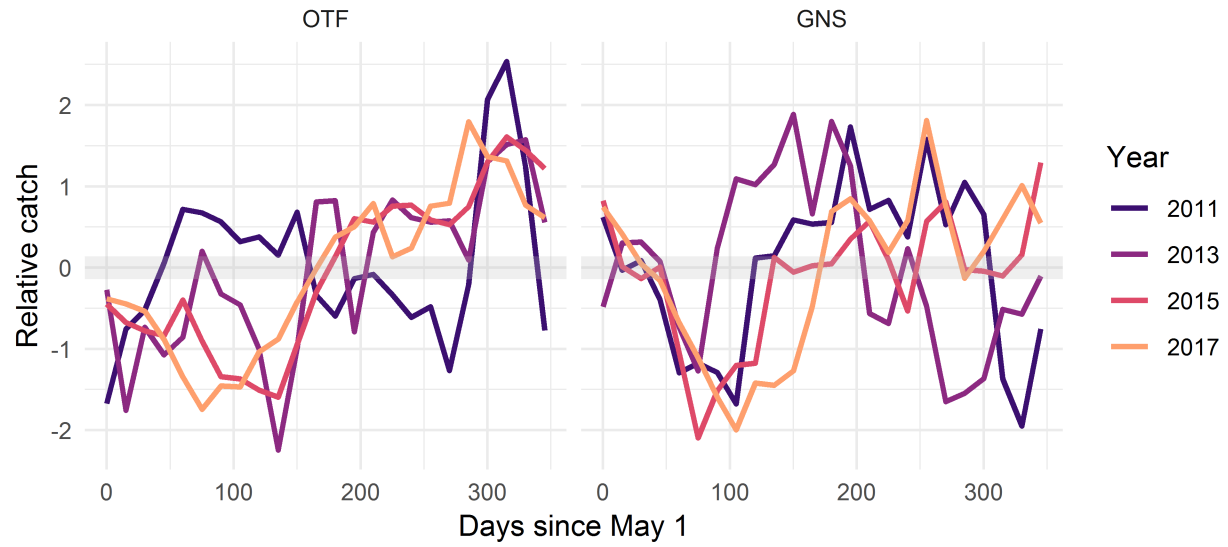


Figure 8: Relative temporal variation in cod catch unexplained by predictors of effort on observed trips taken by sector vessels using otter trawls and gillnets in the Gulf of Maine during fishing years 2011, 2013, 2015, and 2017.

# GOM Cod catch on observed trips

Model predictions (gray) vs. GARFO estimate (red)

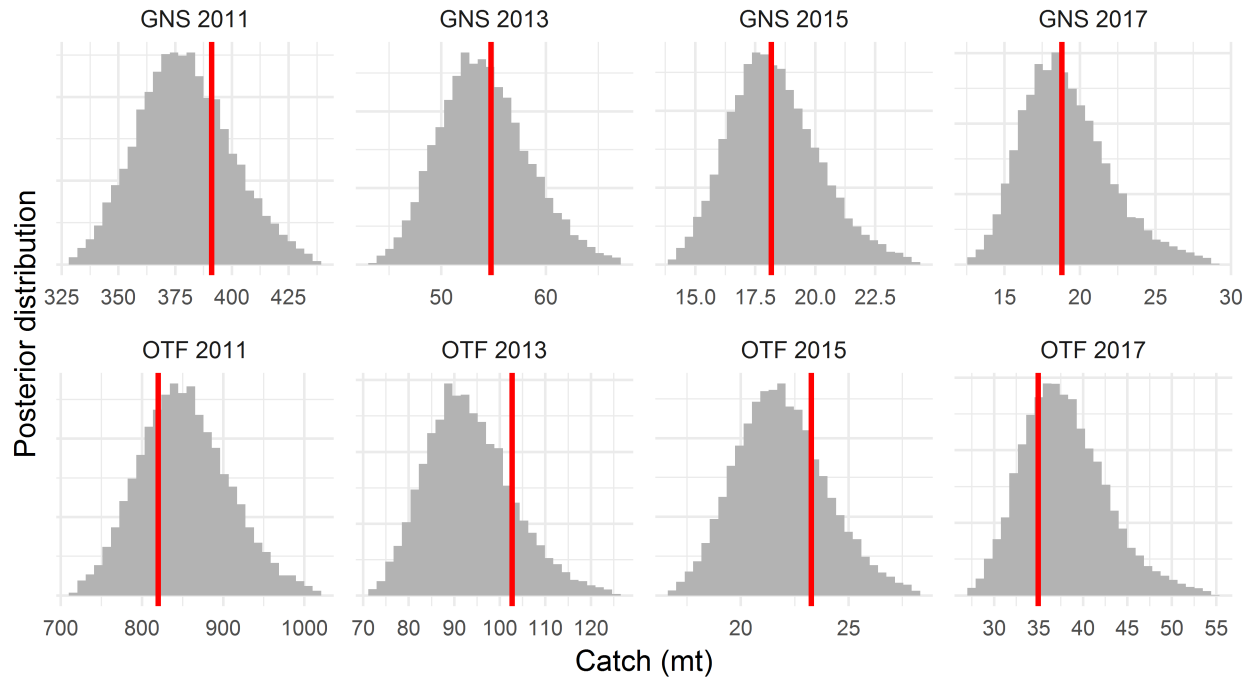


Figure 9: Model predictions of total cod catch (landed + discarded) compared to reported catch (red) on **observed** trips. While observed trips were used to fit the models, estimates of  $\epsilon_i$  (residual variation) were not used to make predictions. Gear types included otter trawls (OTF) and gillnets (GNS).

# GOM Cod catch on unobserved trips

Model predictions (gray) vs. GARFO estimate (red)

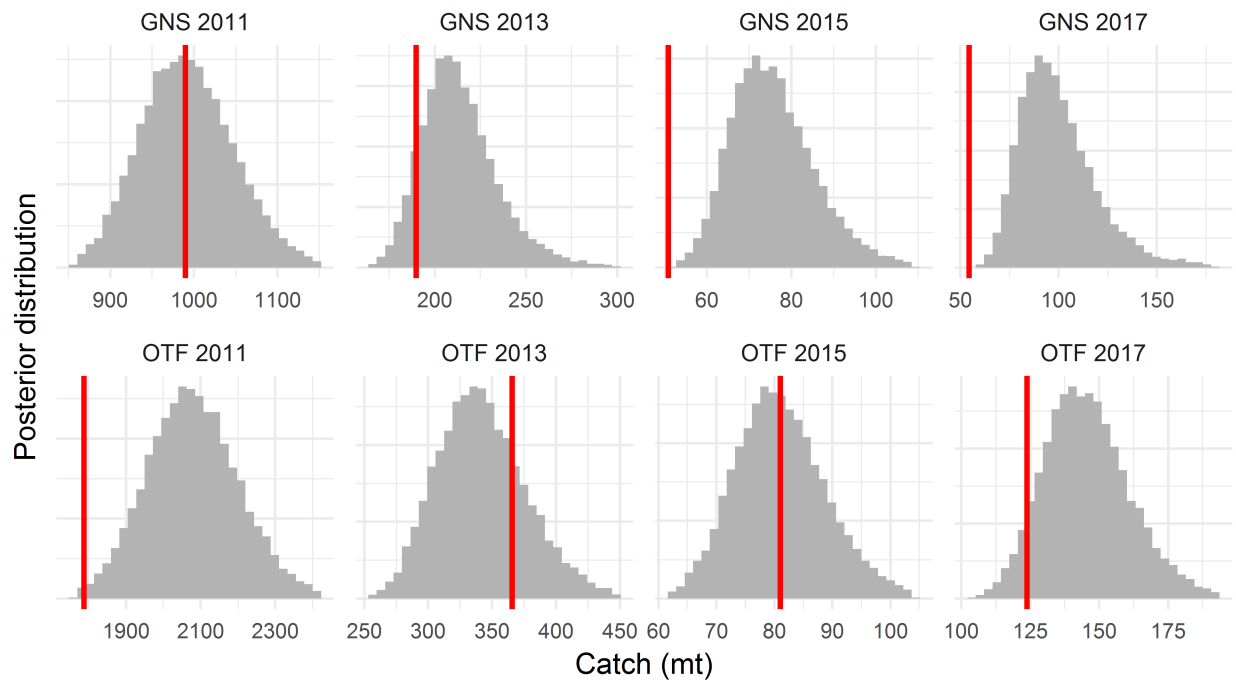


Figure 10: Model predictions of total cod catch (landed + discarded) compared to reported catch (red) on **unobserved** trips. Parameter estimates of fixed and structured random effects from the models for observed trips were used to make predictions. Gear types included otter trawls (OTF) and gillnets (GNS).

## Supplement 1 - Observed cod catch

## Observed cod catch in 2011

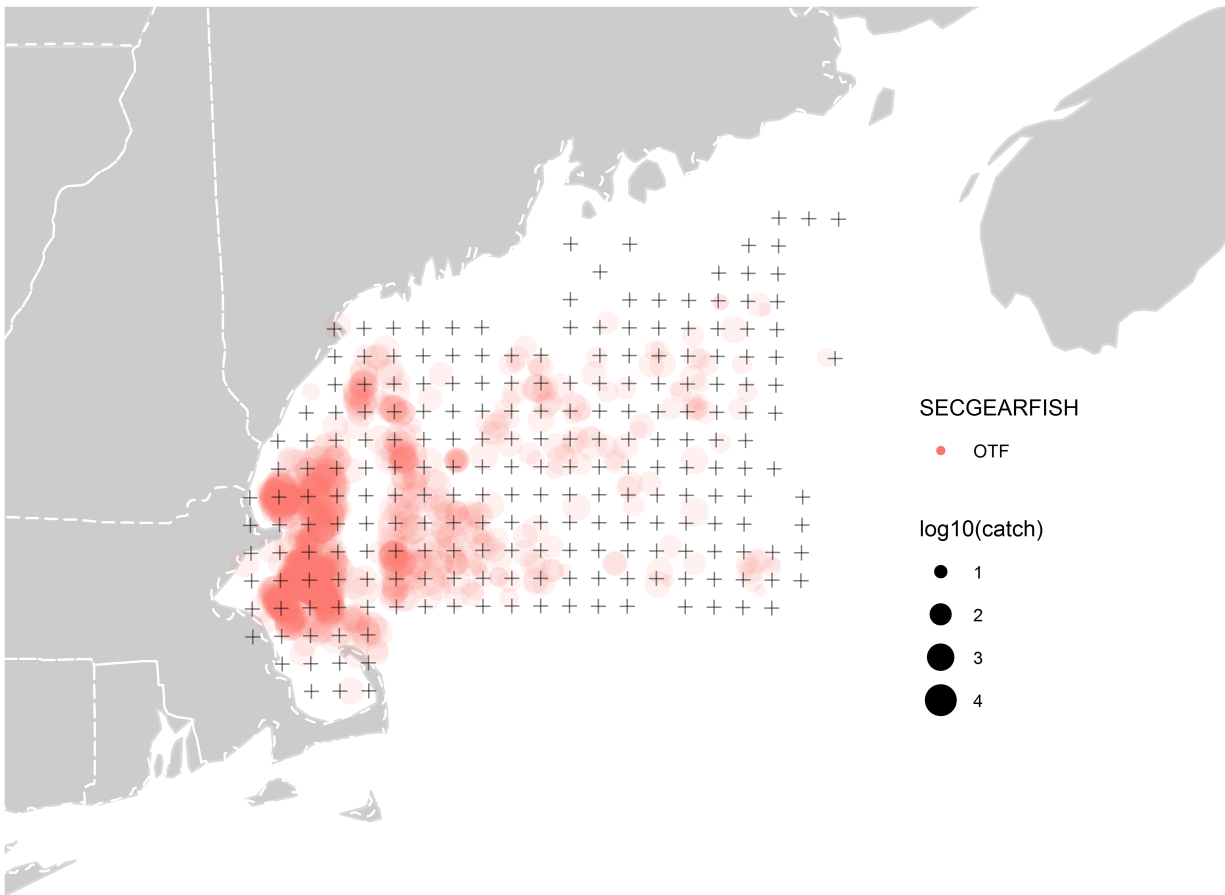


Figure S1: Cod catch (discards + landings) on observed trips by sector vessels using otter trawls in the Gulf of Maine during 2011. Crosses represent the 15-km resolution grid used in the predictive model.



## Observed cod catch in 2013

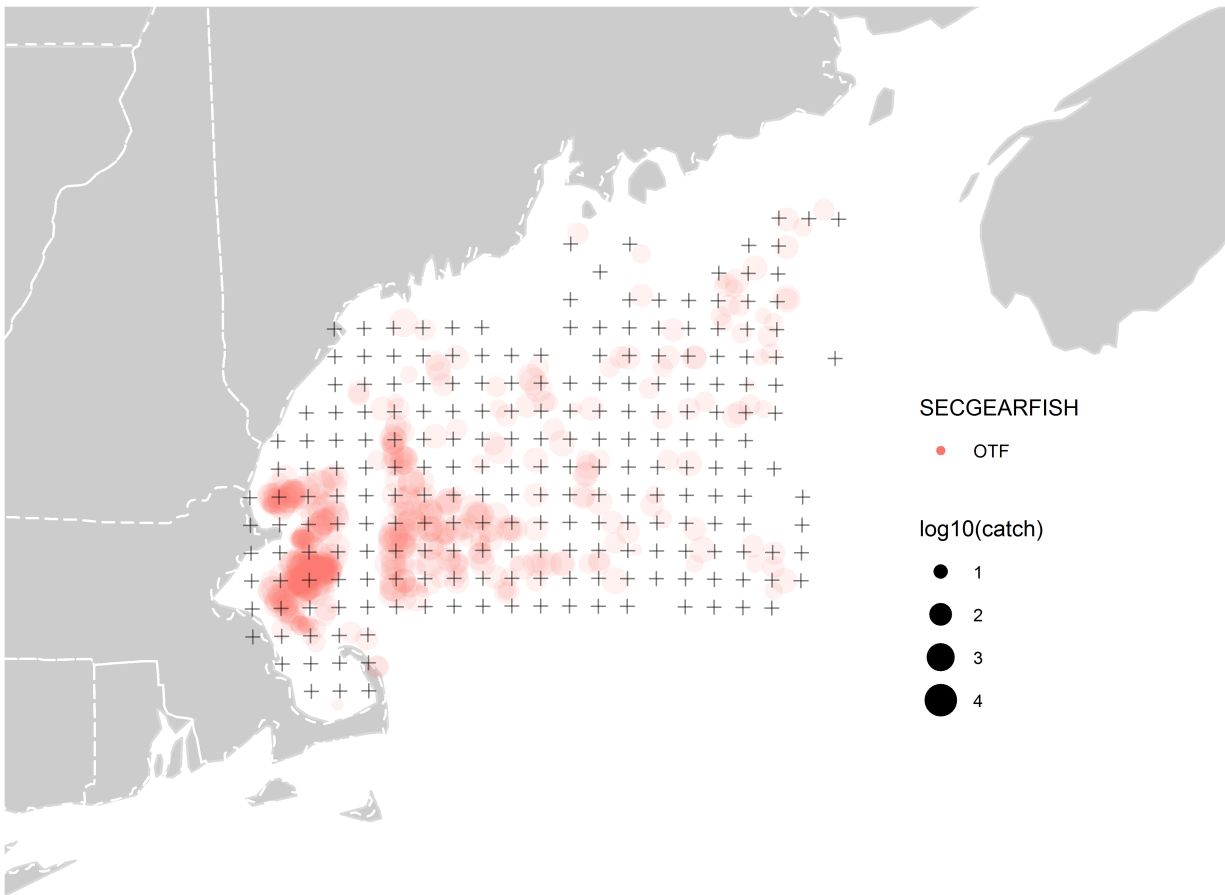


Figure S2: Cod catch (discards + landings) on observed trips by sector vessels using otter trawls in the Gulf of Maine during 2013. Crosses represent the 15-km resolution grid used in the predictive model.

## Observed cod catch in 2015

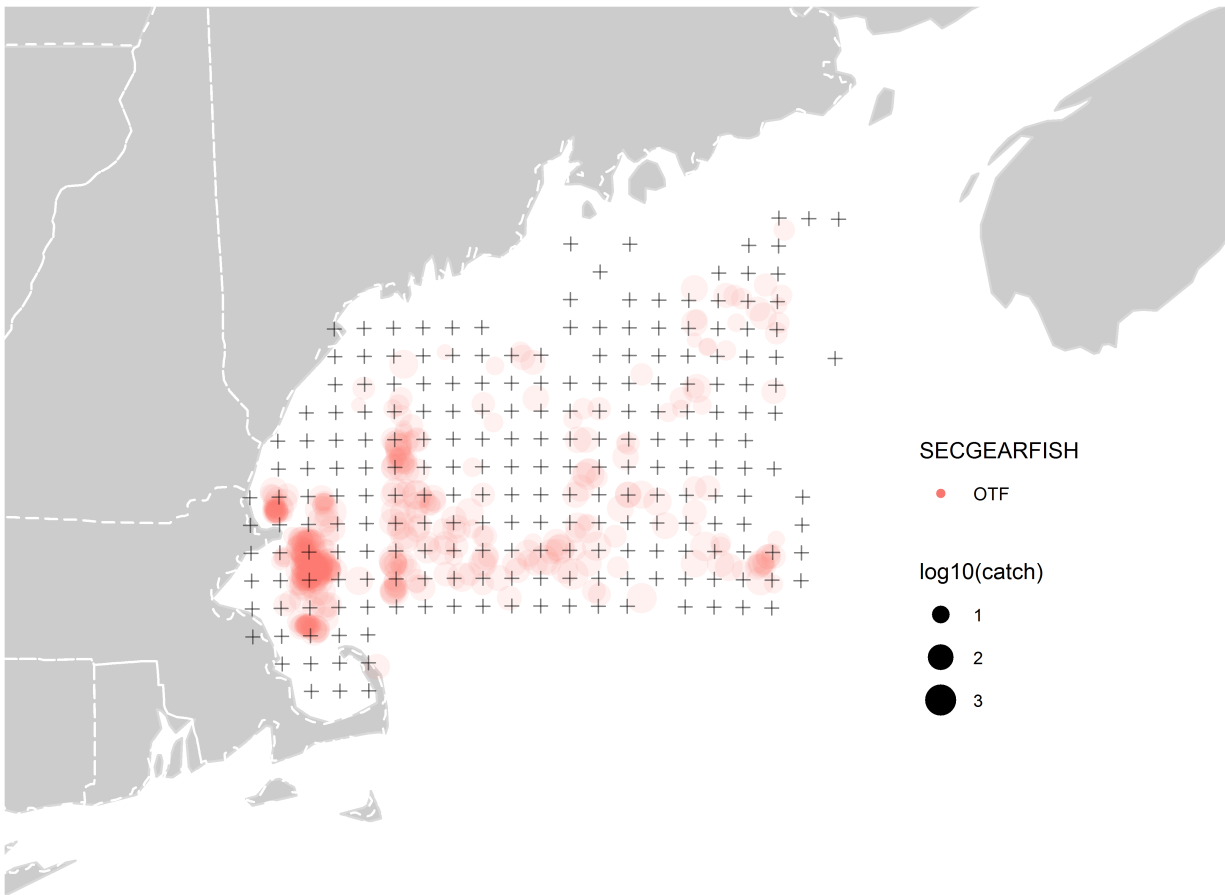


Figure S3: Cod catch (discards + landings) on observed trips by sector vessels using otter trawls in the Gulf of Maine during 2015. Crosses represent the 15-km resolution grid used in the predictive model.

## Observed cod catch in 2017

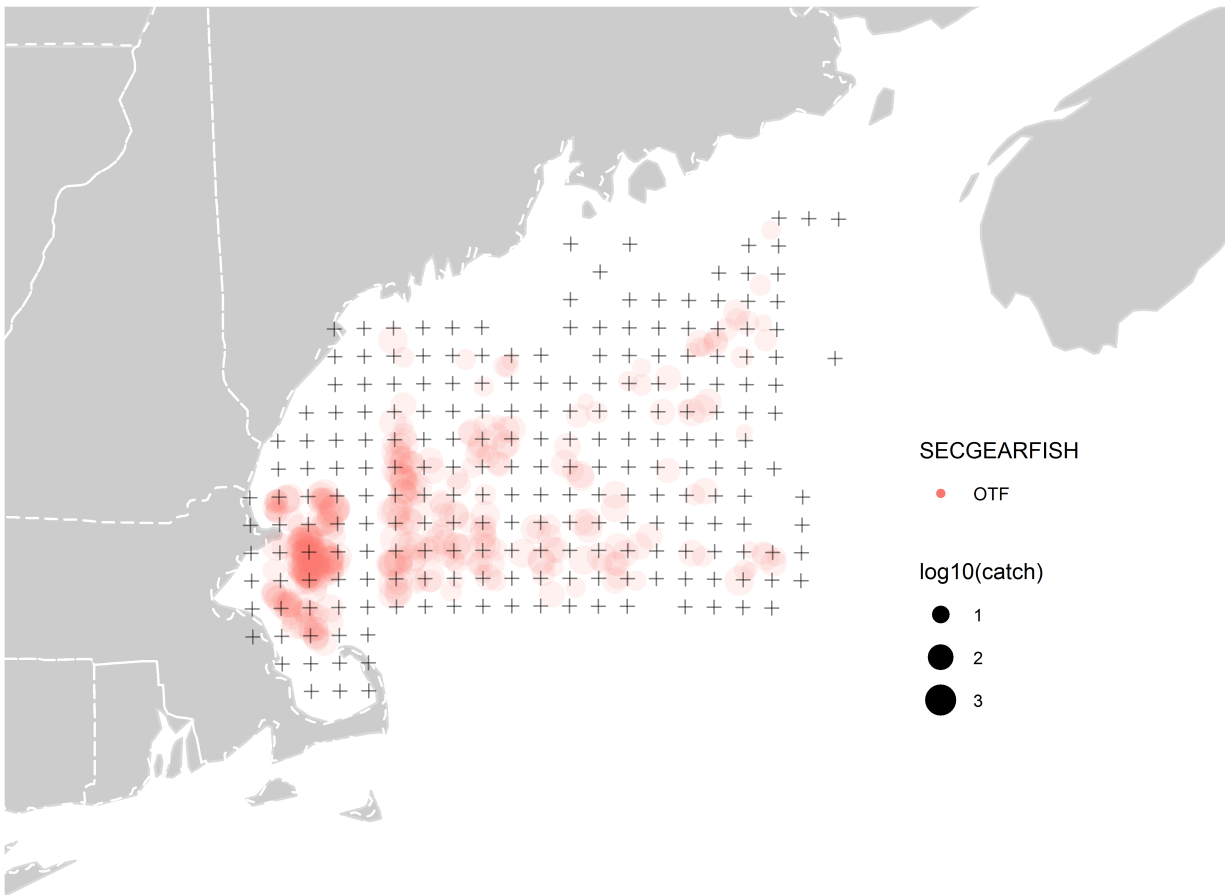


Figure S4: Cod catch (discards + landings) on observed trips by sector vessels using otter trawls in the Gulf of Maine during 2017. Crosses represent the 15-km resolution grid used in the predictive model.

## Observed cod catch in 2011

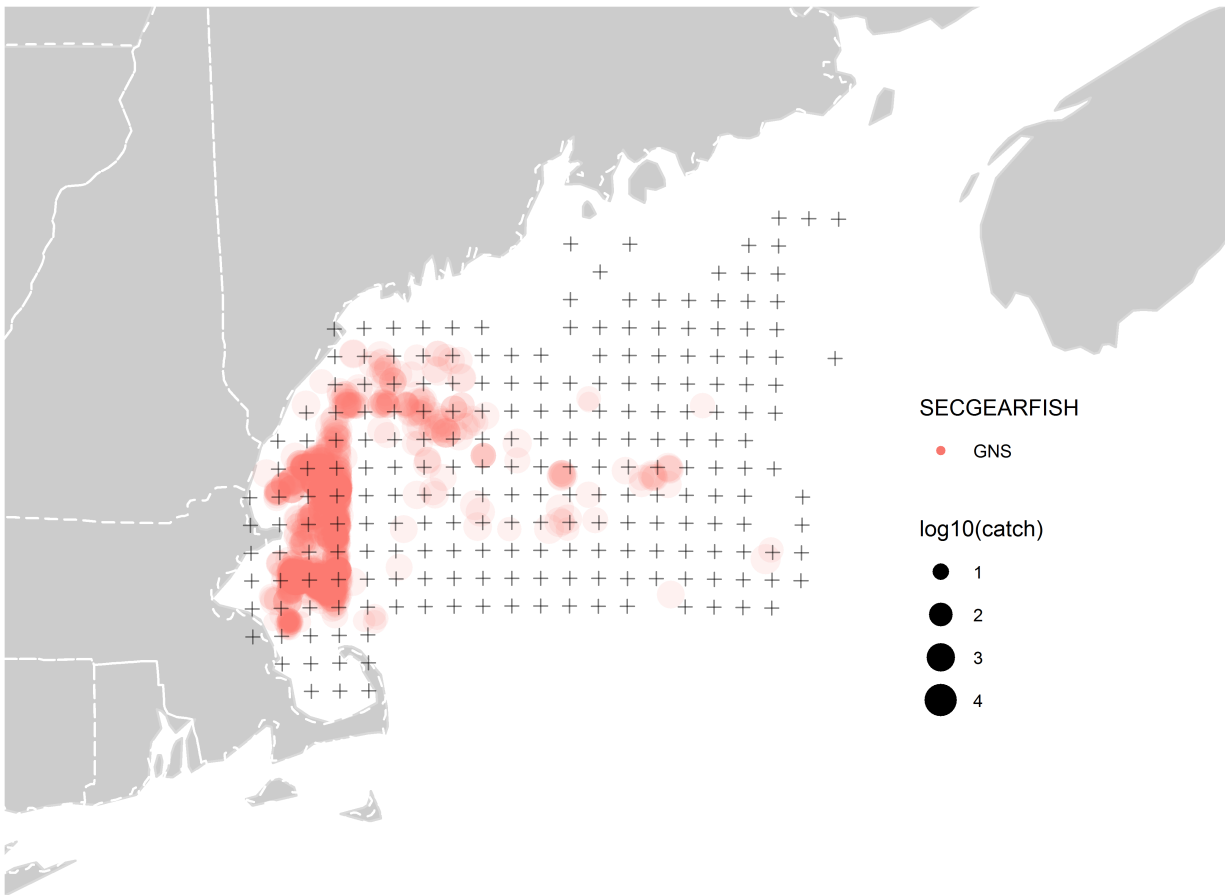


Figure S5: Cod catch (discards + landings) on observed trips by sector vessels using gillnets in the Gulf of Maine during 2011. Crosses represent the 15-km resolution grid used in the predictive model.

## Observed cod catch in 2013

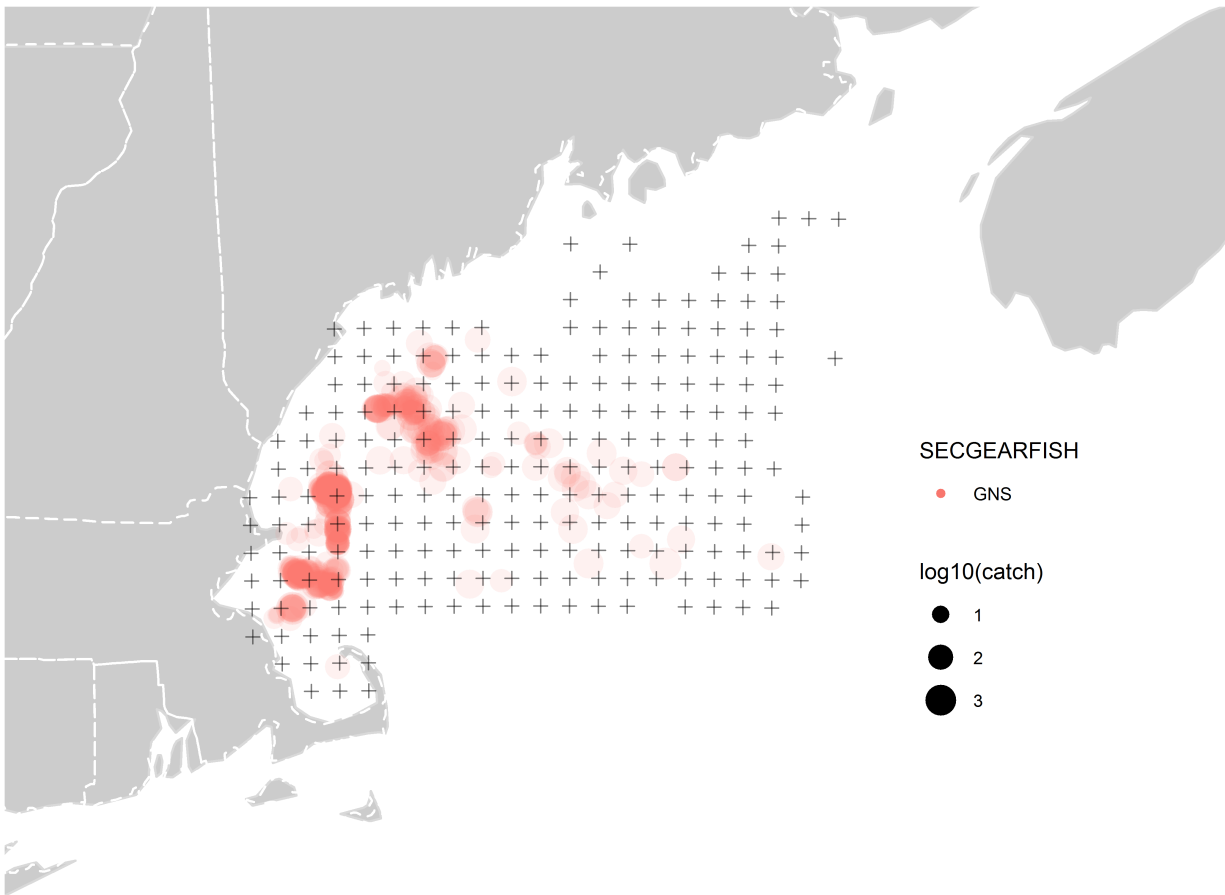


Figure S6: Cod catch (discards + landings) on observed trips by sector vessels using gillnets in the Gulf of Maine during 2013. Crosses represent the 15-km resolution grid used in the predictive model.

## Observed cod catch in 2015

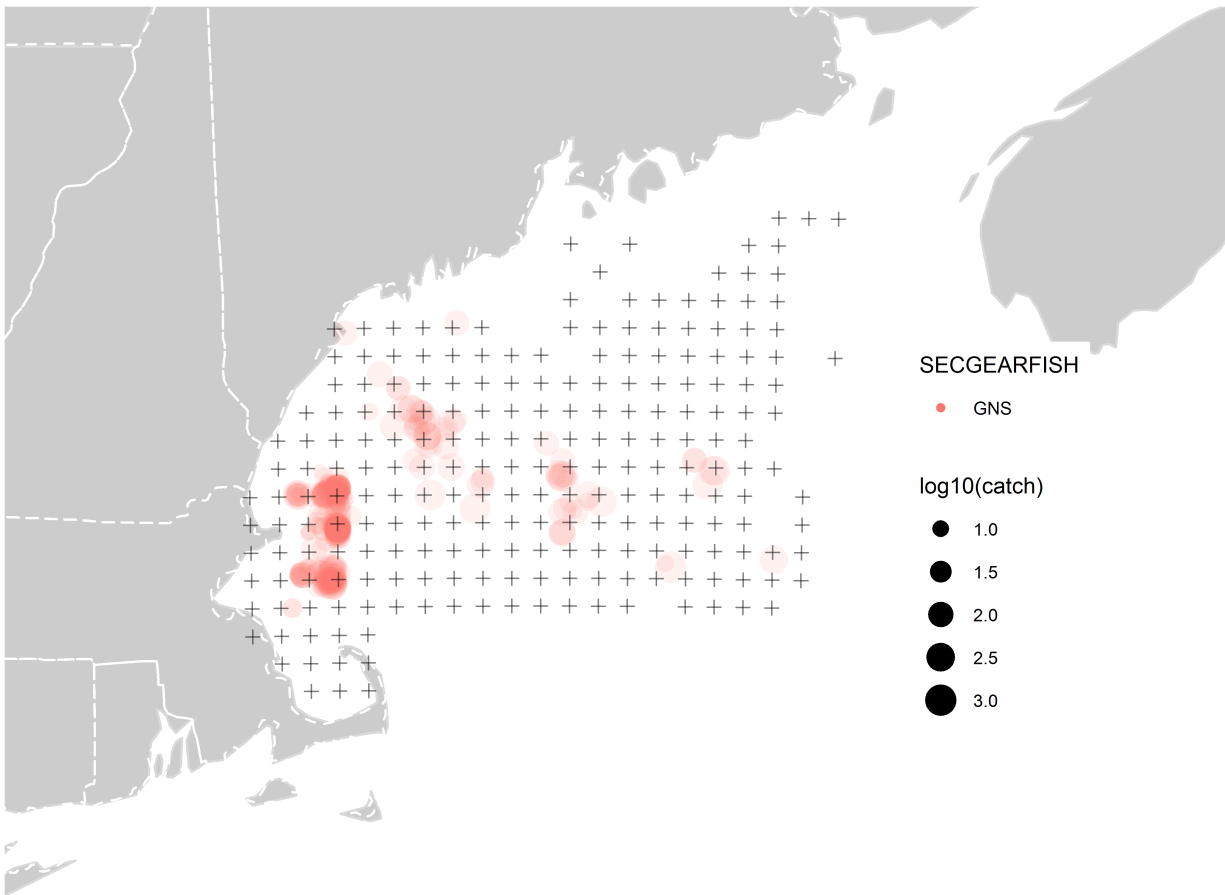


Figure S7: Cod catch (discards + landings) on observed trips by sector vessels using gillnets in the Gulf of Maine during 2015. Crosses represent the 15-km resolution grid used in the predictive model.

## Observed cod catch in 2017

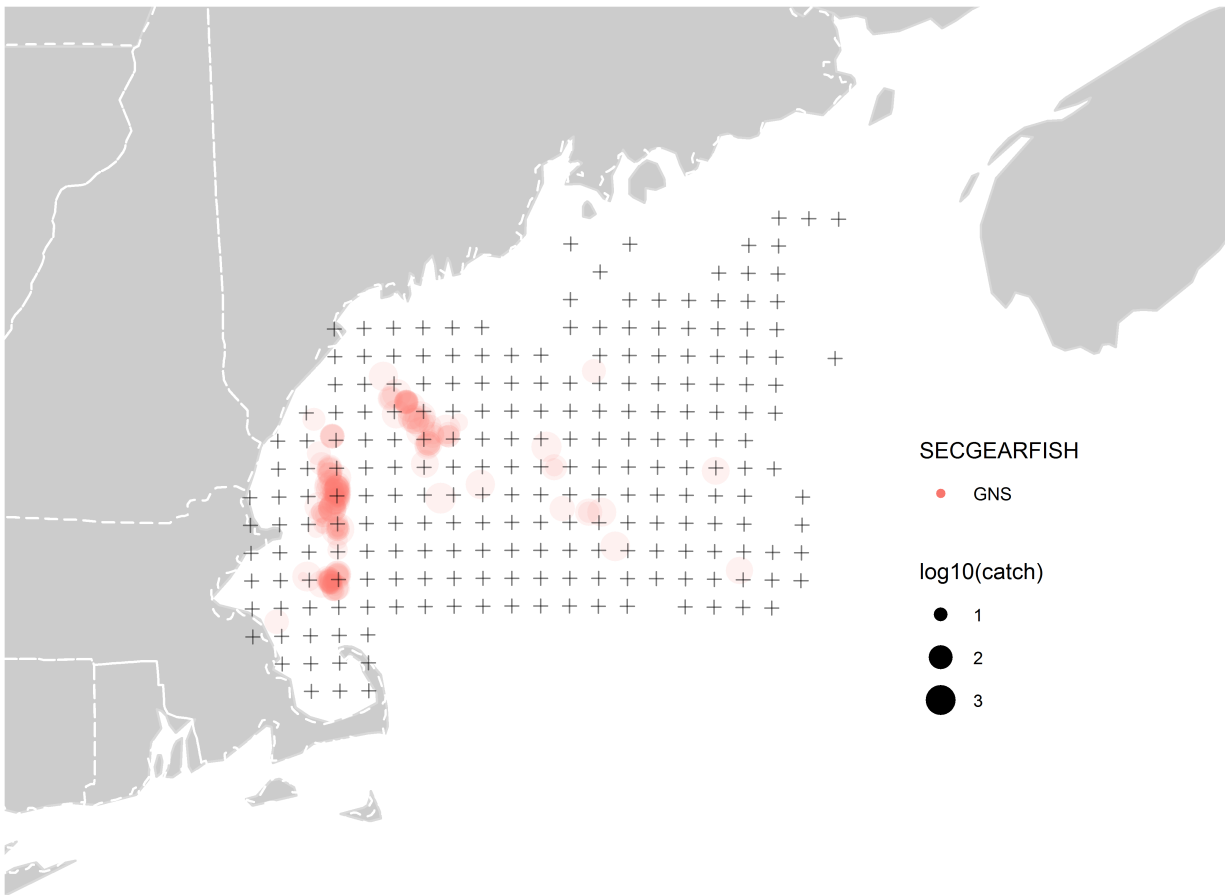


Figure S8: Cod catch (discards + landings) on observed trips by sector vessels using gillnets in the Gulf of Maine during 2017. Crosses represent the 15-km resolution grid used in the predictive model.

## Supplement 2 - Parameter estimates

Table S1: Parameter estimates for GOM cod catch. The fixed effects (beta) correspond to the following: 1) intercept; 2) kept all; 3) pollock; 4) haddock; 5) winter flounder; 6) yellowtail flounder; 7) trip length; 8) squared trip length; 9) vessel tonnage; 10) squared vessel tonnage. The variance (standard deviation) estimates correspond to random effects for vessel (nu), space (s), time (t), and residual (e). The phi parameters are scale values of the distance function for decreasing covariance in space (phi.s = km) and time (phi.t = days).

| gear | year | par      | mean   | sd     | lower95 | median | upper95 |
|------|------|----------|--------|--------|---------|--------|---------|
| OTF  | 2011 | beta[1]  | 4.564  | 0.784  | 2.922   | 4.597  | 6.042   |
| OTF  | 2011 | beta[2]  | 1.319  | 0.048  | 1.224   | 1.319  | 1.413   |
| OTF  | 2011 | beta[3]  | -0.003 | 0.053  | -0.107  | -0.003 | 0.102   |
| OTF  | 2011 | beta[4]  | -0.089 | 0.036  | -0.158  | -0.088 | -0.018  |
| OTF  | 2011 | beta[5]  | -0.109 | 0.049  | -0.206  | -0.109 | -0.013  |
| OTF  | 2011 | beta[6]  | 0.030  | 0.051  | -0.069  | 0.030  | 0.131   |
| OTF  | 2011 | beta[7]  | 0.100  | 0.108  | -0.112  | 0.099  | 0.314   |
| OTF  | 2011 | beta[8]  | -0.043 | 0.049  | -0.140  | -0.043 | 0.051   |
| OTF  | 2011 | beta[9]  | -0.036 | 0.101  | -0.238  | -0.035 | 0.158   |
| OTF  | 2011 | beta[10] | -0.142 | 0.056  | -0.252  | -0.142 | -0.031  |
| OTF  | 2011 | sigma.e  | 0.472  | 0.074  | 0.561   | 0.690  | 0.779   |
| OTF  | 2011 | sigma.nu | 0.414  | 0.058  | 0.553   | 0.642  | 0.731   |
| OTF  | 2011 | phi.s    | 71.146 | 24.394 | 35.915  | 66.471 | 130.715 |
| OTF  | 2011 | sigma.s  | 2.588  | 0.876  | 1.171   | 1.557  | 2.185   |
| OTF  | 2011 | phi.t    | 80.373 | 49.598 | 16.349  | 69.918 | 201.457 |
| OTF  | 2011 | sigma.t  | 0.070  | 0.078  | 0.055   | 0.217  | 0.517   |
| OTF  | 2013 | beta[1]  | 4.522  | 0.589  | 3.327   | 4.529  | 5.694   |
| OTF  | 2013 | beta[2]  | 0.750  | 0.095  | 0.561   | 0.750  | 0.936   |
| OTF  | 2013 | beta[3]  | 0.583  | 0.111  | 0.364   | 0.584  | 0.800   |
| OTF  | 2013 | beta[4]  | 0.086  | 0.075  | -0.060  | 0.085  | 0.235   |
| OTF  | 2013 | beta[5]  | -0.020 | 0.116  | -0.248  | -0.020 | 0.206   |
| OTF  | 2013 | beta[6]  | 0.286  | 0.113  | 0.066   | 0.286  | 0.507   |
| OTF  | 2013 | beta[7]  | 0.203  | 0.176  | -0.143  | 0.204  | 0.542   |
| OTF  | 2013 | beta[8]  | -0.216 | 0.101  | -0.414  | -0.216 | -0.018  |
| OTF  | 2013 | beta[9]  | -0.131 | 0.145  | -0.419  | -0.128 | 0.153   |
| OTF  | 2013 | beta[10] | -0.013 | 0.092  | -0.192  | -0.014 | 0.169   |
| OTF  | 2013 | sigma.e  | 0.638  | 0.097  | 0.662   | 0.801  | 0.907   |
| OTF  | 2013 | sigma.nu | 0.413  | 0.074  | 0.524   | 0.641  | 0.751   |
| OTF  | 2013 | phi.s    | 41.183 | 16.574 | 19.711  | 37.688 | 84.857  |
| OTF  | 2013 | sigma.s  | 1.175  | 0.392  | 0.780   | 1.054  | 1.462   |
| OTF  | 2013 | phi.t    | 67.192 | 46.842 | 7.971   | 57.068 | 183.913 |
| OTF  | 2013 | sigma.t  | 0.635  | 0.484  | 0.399   | 0.706  | 1.375   |
| OTF  | 2015 | beta[1]  | 3.862  | 0.454  | 2.921   | 3.868  | 4.740   |
| OTF  | 2015 | beta[2]  | 0.548  | 0.099  | 0.353   | 0.548  | 0.745   |
| OTF  | 2015 | beta[3]  | 0.302  | 0.126  | 0.056   | 0.303  | 0.554   |
| OTF  | 2015 | beta[4]  | -0.032 | 0.085  | -0.199  | -0.032 | 0.134   |
| OTF  | 2015 | beta[5]  | -0.045 | 0.141  | -0.324  | -0.045 | 0.235   |
| OTF  | 2015 | beta[6]  | 0.463  | 0.152  | 0.164   | 0.463  | 0.761   |
| OTF  | 2015 | beta[7]  | 0.007  | 0.197  | -0.377  | 0.007  | 0.392   |
| OTF  | 2015 | beta[8]  | 0.020  | 0.099  | -0.174  | 0.021  | 0.214   |
| OTF  | 2015 | beta[9]  | -0.116 | 0.172  | -0.459  | -0.114 | 0.215   |
| OTF  | 2015 | beta[10] | -0.057 | 0.095  | -0.241  | -0.058 | 0.132   |



|     |      |          |         |        |        |         |         |
|-----|------|----------|---------|--------|--------|---------|---------|
| OTF | 2015 | sigma.e  | 0.666   | 0.115  | 0.627  | 0.825   | 0.924   |
| OTF | 2015 | sigma.nu | 0.395   | 0.080  | 0.496  | 0.627   | 0.746   |
| OTF | 2015 | phi.s    | 25.414  | 15.310 | 7.338  | 21.598  | 66.064  |
| OTF | 2015 | sigma.s  | 0.339   | 0.169  | 0.298  | 0.558   | 0.851   |
| OTF | 2015 | phi.t    | 118.338 | 54.685 | 43.179 | 107.951 | 253.060 |
| OTF | 2015 | sigma.t  | 0.388   | 0.266  | 0.327  | 0.564   | 1.037   |
| OTF | 2017 | beta[1]  | 3.936   | 0.579  | 2.740  | 3.942   | 5.079   |
| OTF | 2017 | beta[2]  | 0.463   | 0.128  | 0.211  | 0.464   | 0.715   |
| OTF | 2017 | beta[3]  | 0.171   | 0.131  | -0.083 | 0.171   | 0.431   |
| OTF | 2017 | beta[4]  | 0.315   | 0.085  | 0.146  | 0.316   | 0.480   |
| OTF | 2017 | beta[5]  | -0.048  | 0.178  | -0.397 | -0.048  | 0.300   |
| OTF | 2017 | beta[6]  | 0.493   | 0.174  | 0.158  | 0.493   | 0.833   |
| OTF | 2017 | beta[7]  | -0.248  | 0.211  | -0.655 | -0.250  | 0.167   |
| OTF | 2017 | beta[8]  | 0.186   | 0.110  | -0.030 | 0.186   | 0.397   |
| OTF | 2017 | beta[9]  | -0.056  | 0.185  | -0.419 | -0.057  | 0.303   |
| OTF | 2017 | beta[10] | -0.084  | 0.143  | -0.361 | -0.085  | 0.199   |
| OTF | 2017 | sigma.e  | 0.885   | 0.103  | 0.817  | 0.942   | 1.035   |
| OTF | 2017 | sigma.nu | 0.503   | 0.099  | 0.573  | 0.705   | 0.844   |
| OTF | 2017 | phi.s    | 55.695  | 30.616 | 7.670  | 51.016  | 128.652 |
| OTF | 2017 | sigma.s  | 0.194   | 0.172  | 0.032  | 0.389   | 0.793   |
| OTF | 2017 | phi.t    | 111.238 | 51.655 | 36.305 | 102.270 | 233.774 |
| OTF | 2017 | sigma.t  | 0.599   | 0.396  | 0.396  | 0.706   | 1.275   |
| GNS | 2011 | beta[1]  | 4.874   | 0.711  | 3.386  | 4.894   | 6.247   |
| GNS | 2011 | beta[2]  | 0.391   | 0.037  | 0.319  | 0.392   | 0.463   |
| GNS | 2011 | beta[3]  | 0.305   | 0.046  | 0.215  | 0.305   | 0.395   |
| GNS | 2011 | beta[4]  | 0.251   | 0.029  | 0.193  | 0.251   | 0.309   |
| GNS | 2011 | beta[5]  | -0.016  | 0.043  | -0.100 | -0.016  | 0.068   |
| GNS | 2011 | beta[6]  | 0.007   | 0.050  | -0.092 | 0.007   | 0.105   |
| GNS | 2011 | beta[7]  | -0.179  | 0.122  | -0.419 | -0.179  | 0.056   |
| GNS | 2011 | beta[8]  | 0.062   | 0.021  | 0.022  | 0.062   | 0.103   |
| GNS | 2011 | beta[9]  | -0.031  | 0.069  | -0.166 | -0.031  | 0.105   |
| GNS | 2011 | beta[10] | -0.079  | 0.034  | -0.144 | -0.078  | -0.013  |
| GNS | 2011 | sigma.e  | 0.323   | 0.082  | 0.407  | 0.568   | 0.696   |
| GNS | 2011 | sigma.nu | 0.360   | 0.053  | 0.516  | 0.597   | 0.688   |
| GNS | 2011 | phi.s    | 39.096  | 15.541 | 19.710 | 35.216  | 78.313  |
| GNS | 2011 | sigma.s  | 1.863   | 0.643  | 0.988  | 1.314   | 1.867   |
| GNS | 2011 | phi.t    | 86.421  | 44.190 | 30.928 | 76.352  | 196.155 |
| GNS | 2011 | sigma.t  | 0.623   | 0.362  | 0.451  | 0.729   | 1.246   |
| GNS | 2013 | beta[1]  | 4.459   | 0.430  | 3.579  | 4.469   | 5.296   |
| GNS | 2013 | beta[2]  | 0.188   | 0.065  | 0.061  | 0.188   | 0.315   |
| GNS | 2013 | beta[3]  | 0.611   | 0.095  | 0.422  | 0.611   | 0.799   |
| GNS | 2013 | beta[4]  | 0.123   | 0.051  | 0.022  | 0.123   | 0.222   |
| GNS | 2013 | beta[5]  | 0.219   | 0.078  | 0.065  | 0.220   | 0.373   |
| GNS | 2013 | beta[6]  | -0.225  | 0.091  | -0.403 | -0.225  | -0.046  |
| GNS | 2013 | beta[7]  | -0.051  | 0.182  | -0.410 | -0.051  | 0.300   |
| GNS | 2013 | beta[8]  | 0.024   | 0.045  | -0.063 | 0.024   | 0.112   |
| GNS | 2013 | beta[9]  | -0.144  | 0.148  | -0.439 | -0.142  | 0.143   |
| GNS | 2013 | beta[10] | 0.047   | 0.057  | -0.064 | 0.047   | 0.161   |
| GNS | 2013 | sigma.e  | 0.475   | 0.090  | 0.539  | 0.692   | 0.802   |
| GNS | 2013 | sigma.nu | 0.685   | 0.117  | 0.693  | 0.822   | 0.969   |
| GNS | 2013 | phi.s    | 24.671  | 13.834 | 9.652  | 20.761  | 64.388  |
| GNS | 2013 | sigma.s  | 0.677   | 0.307  | 0.539  | 0.780   | 1.228   |
| GNS | 2013 | phi.t    | 77.602  | 51.374 | 12.157 | 66.315  | 205.718 |
| GNS | 2013 | sigma.t  | 0.246   | 0.231  | 0.176  | 0.425   | 0.929   |

|     |      |          |        |        |        |        |         |
|-----|------|----------|--------|--------|--------|--------|---------|
| GNS | 2015 | beta[1]  | 4.357  | 0.619  | 3.113  | 4.350  | 5.637   |
| GNS | 2015 | beta[2]  | 0.075  | 0.070  | -0.061 | 0.075  | 0.212   |
| GNS | 2015 | beta[3]  | 0.571  | 0.096  | 0.383  | 0.571  | 0.758   |
| GNS | 2015 | beta[4]  | 0.283  | 0.070  | 0.143  | 0.283  | 0.421   |
| GNS | 2015 | beta[5]  | -0.067 | 0.115  | -0.294 | -0.068 | 0.157   |
| GNS | 2015 | beta[6]  | 0.153  | 0.130  | -0.102 | 0.154  | 0.409   |
| GNS | 2015 | beta[7]  | 0.305  | 0.261  | -0.202 | 0.302  | 0.828   |
| GNS | 2015 | beta[8]  | -0.062 | 0.066  | -0.195 | -0.062 | 0.070   |
| GNS | 2015 | beta[9]  | -0.219 | 0.127  | -0.476 | -0.215 | 0.022   |
| GNS | 2015 | beta[10] | 0.100  | 0.046  | 0.009  | 0.099  | 0.191   |
| GNS | 2015 | sigma.e  | 0.531  | 0.098  | 0.558  | 0.733  | 0.841   |
| GNS | 2015 | sigma.nu | 0.386  | 0.137  | 0.359  | 0.616  | 0.822   |
| GNS | 2015 | phi.s    | 44.825 | 26.631 | 10.498 | 39.094 | 111.540 |
| GNS | 2015 | sigma.s  | 0.368  | 0.339  | 0.155  | 0.520  | 1.096   |
| GNS | 2015 | phi.t    | 87.385 | 49.409 | 22.135 | 77.556 | 207.843 |
| GNS | 2015 | sigma.t  | 0.814  | 0.570  | 0.438  | 0.814  | 1.533   |
| GNS | 2017 | beta[1]  | 4.870  | 0.584  | 3.772  | 4.849  | 6.088   |
| GNS | 2017 | beta[2]  | 0.111  | 0.093  | -0.071 | 0.111  | 0.293   |
| GNS | 2017 | beta[3]  | 0.758  | 0.137  | 0.491  | 0.758  | 1.026   |
| GNS | 2017 | beta[4]  | 0.130  | 0.120  | -0.103 | 0.131  | 0.365   |
| GNS | 2017 | beta[5]  | 0.526  | 0.173  | 0.188  | 0.526  | 0.870   |
| GNS | 2017 | beta[6]  | -0.567 | 0.183  | -0.926 | -0.566 | -0.214  |
| GNS | 2017 | beta[7]  | 0.072  | 0.365  | -0.635 | 0.068  | 0.797   |
| GNS | 2017 | beta[8]  | -0.020 | 0.118  | -0.255 | -0.019 | 0.208   |
| GNS | 2017 | beta[9]  | 0.017  | 0.189  | -0.371 | 0.025  | 0.370   |
| GNS | 2017 | beta[10] | 0.013  | 0.077  | -0.137 | 0.012  | 0.169   |
| GNS | 2017 | sigma.e  | 0.660  | 0.119  | 0.646  | 0.813  | 0.944   |
| GNS | 2017 | sigma.nu | 0.742  | 0.236  | 0.587  | 0.848  | 1.125   |
| GNS | 2017 | phi.s    | 43.795 | 25.690 | 8.319  | 39.230 | 106.607 |
| GNS | 2017 | sigma.s  | 0.356  | 0.403  | 0.105  | 0.485  | 1.214   |
| GNS | 2017 | phi.t    | 89.952 | 50.106 | 21.919 | 80.157 | 212.261 |
| GNS | 2017 | sigma.t  | 0.456  | 0.431  | 0.179  | 0.576  | 1.272   |

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## Supplement 3 - Total pollock catch predictions

Table S2: Reported vs. model-predicted pollock catch (mt) for **observed** trips, with percentage of reported by which posterior mode differs.

| Gear | FY   | Reported catch | Posterior distribution |        |         |         | % Diff. |
|------|------|----------------|------------------------|--------|---------|---------|---------|
|      |      |                | Mode                   | 2.5%   | 50%     | 97.5%   |         |
| OTF  | 2011 | 918.34         | 1033.47                | 785.78 | 1071.88 | 1421.69 | 13      |
|      | 2013 | 548.34         | 460.57                 | 341.19 | 493.03  | 722.94  | -16     |
|      | 2015 | 316.95         | 322.34                 | 224.57 | 342.43  | 526.34  | 2       |
|      | 2017 | 388.20         | 451.66                 | 303.87 | 491.37  | 766.13  | 16      |
| GNS  | 2011 | 562.31         | 664.21                 | 528.18 | 671.78  | 855.61  | 18      |
|      | 2013 | 331.07         | 368.62                 | 303.99 | 377.69  | 470.74  | 11      |
|      | 2015 | 135.68         | 165.07                 | 97.35  | 187.61  | 342.10  | 22      |
|      | 2017 | 63.26          | 77.20                  | 38.84  | 98.95   | 256.69  | 22      |

Table S3: Reported vs. model-predicted pollock catch (mt) for **unobserved** trips, with percentage of reported by which posterior mode differs.

| Gear | FY   | Reported catch | Posterior distribution |         |         |         | % Diff. |
|------|------|----------------|------------------------|---------|---------|---------|---------|
|      |      |                | Mode                   | 2.5%    | 50%     | 97.5%   |         |
| OTF  | 2011 | 1871.59        | 1793.86                | 1414.39 | 1856.95 | 2418.36 | -4      |
|      | 2013 | 1935.48        | 1430.84                | 1031.71 | 1520.90 | 2183.48 | -26     |
|      | 2015 | 1159.73        | 1100.77                | 801.81  | 1142.12 | 1596.86 | -5      |
|      | 2017 | 1641.09        | 2397.78                | 1638.53 | 2595.74 | 4082.72 | 46      |
| GNS  | 2011 | 1642.61        | 2018.28                | 1621.21 | 2045.43 | 2602.62 | 23      |
|      | 2013 | 1125.62        | 1501.24                | 1190.50 | 1542.43 | 1989.79 | 33      |
|      | 2015 | 564.31         | 1614.06                | 744.25  | 1995.07 | 4911.52 | 186     |
|      | 2017 | 311.01         | 447.34                 | 235.18  | 539.05  | 1099.93 | 44      |

# GOM Pollock catch on observed trips

Model predictions (gray) vs. GARFO estimate (red)

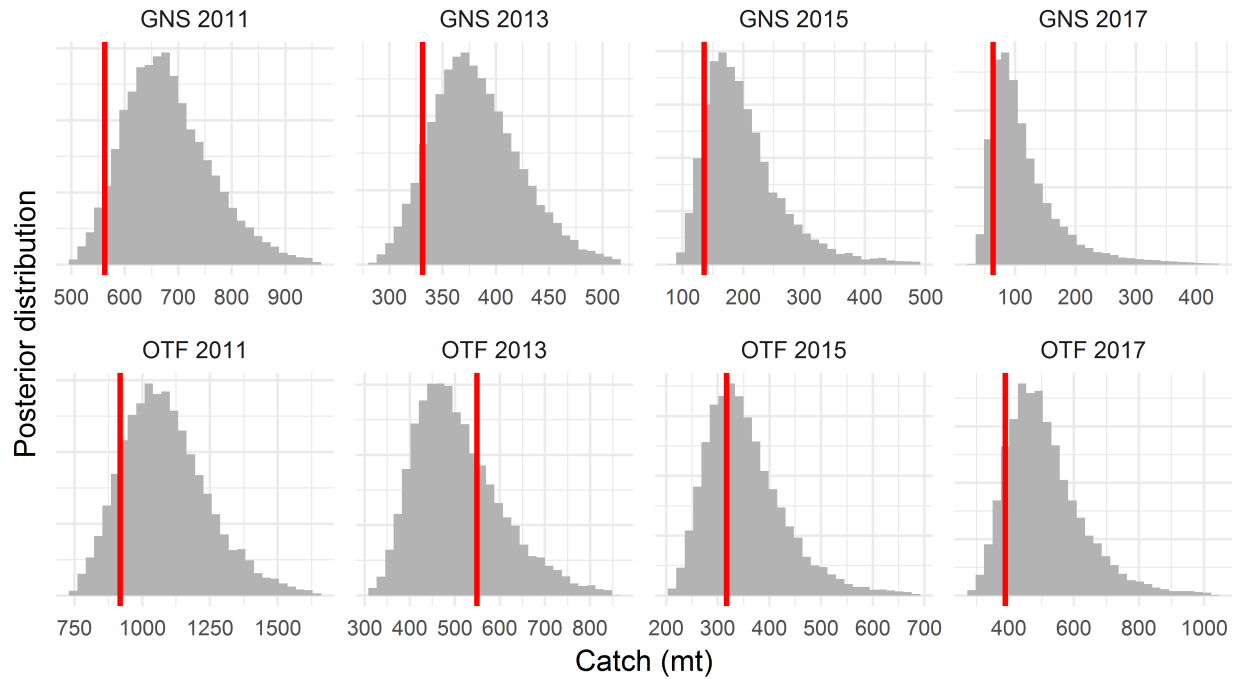


Figure S9: Model predictions of total pollock catch (landed + discarded) compared to reported catch (red) on **observed** trips. While observed trips were used to fit the models, estimates of  $\epsilon_i$  (residual variation) were not used to make predictions. Gear types included otter trawls (OTF) and gillnets (GNS).

# GOM Pollock catch on unobserved trips

Model predictions (gray) vs. GARFO estimate (red)

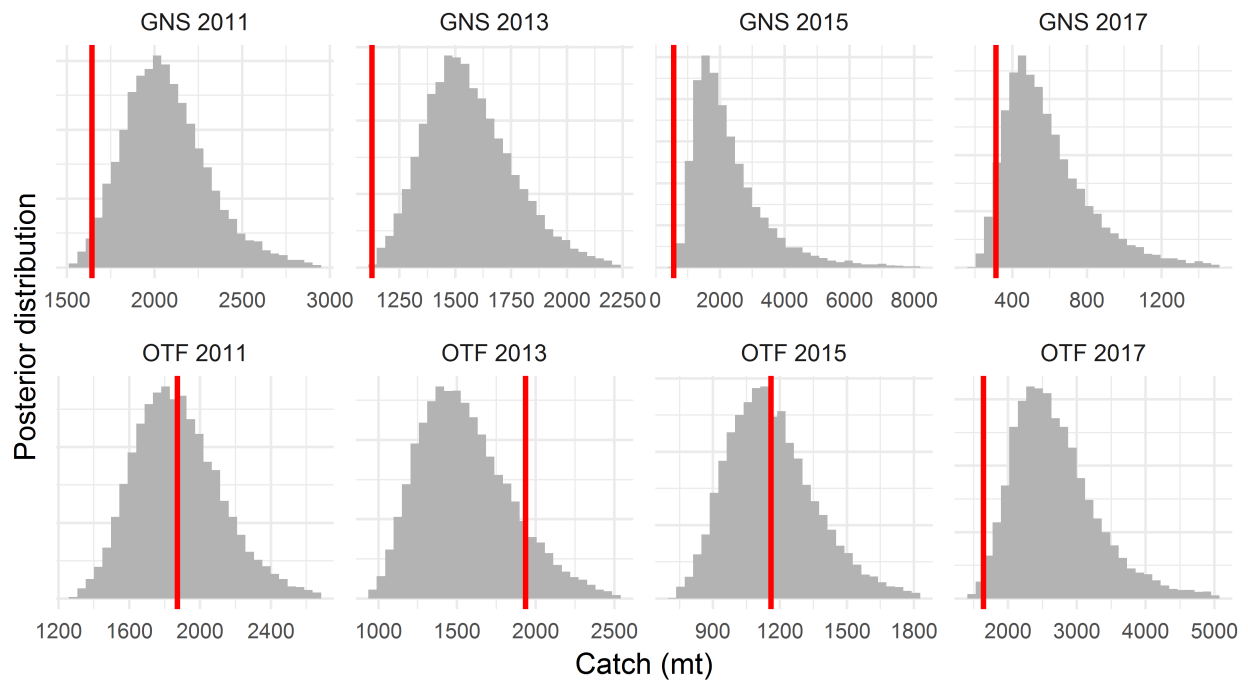


Figure S10: Model predictions of total pollock catch (landed + discarded) compared to reported catch (red) on **unobserved** trips. Parameter estimates of fixed and structured random effects from the models for observed trips were used to make predictions. Gear types included otter trawls (OTF) and gillnets (GNS).

## Comparison of sector vessel landings effort ratios between observed and unobserved trips by gear and broad stock area

Paul Nitschke

4/10/2019

### Introduction

With insufficient catch monitoring, incentives - produced from the multispecies (groundfish) fishery output control sector-based management system - can cause observer effects. Incentives, which vary both spatially and temporally, to fish differently when on observed trips will change with the degree of stock specific constraints. These constraints on the fishery should be reflected in the lease prices for stock specific quota, if the system operates as designed, such that fishing effort decreases as stock constraints increase when lease prices make fishing less profitable. Monitoring coverage at-sea based on the current precision standard assumes observed trips are representative of unobserved trips. However, stronger incentives exist to avoid constraining stocks on observed trips as lease prices increase. Therefore, as a stock becomes more constraining to a sector, the incentives for an observer effects increase. However, there are gear targeting, spatial, temporal, and logistical limits to avoiding constraining stocks in a multispecies fishery. If constraining stocks - that produce incentives for observer effects - lead to unseen legal size discards on unobserved trips, then this should result in differences in stock landings-per-unit-effort between observed and unobserved trips in a multispecies fishery.

### Objective

The objective of this analysis is to compare landings to effort ratios on observed and unobserved trips in the groundfish fishery to determine whether the landings composition changed in the presence of an observer. This analysis assumes that any potential differences in the landing to effort ratios are not caused by an observer deployment effect.

### Methods

A comparison of allocated groundfish stock landings to effort ratios was done between observed and unobserved trips by broad stock area (Figure 1) and by gear type (gillnet and trawl gear). Two ratios were examined:

$$Ratio = \sum landing / \sum Kept \text{ all and } \sum landing / \sum days \text{ absent}$$

The analyses were done by broad stock area to account for differences in quotas and incentives for species that are managed as multiple stocks (winter flounder, yellowtail flounder, cod, and haddock).

### Multi-Stock Broad Stock Area Definition

Gulf of Maine cod = Gulf of Maine (GOM) broad stock area

Georges Bank cod = Georges Bank (GB), 521, and Southern New England (SNE) broad stock areas

Gulf of Maine haddock = GOM broad stock area

Georges Bank haddock = GB, 521, and SNE broad stock areas

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Gulf of Maine/Cape Cod yellowtail flounder = GOM and 521 broad stock areas

Georges Bank yellowtail flounder = GB broad stock area

Southern New England yellowtail flounder = SNE broad stock area

Gulf of Maine winter flounder = GOM broad stock area

Georges Bank winter flounder = GB broad stock area

Southern New England winter flounder = SNE and 521 broad stock areas

Potential effects from unit stocks (witch flounder, American plaice, pollock, redfish, white hake) should be reflected in all broad stock areas. However, the landing of a unit stock in a particular broad stock area could be low.

Data was selected using dealer data where a direct match of a dealer trip can be made with a vessel trip report (VTR) trip for both area and effort in the AA tables (Alevel = A and Elevel = A). The dealer data was further limited to trips by trawl and gillnet gear which landed at least some allocated groundfish (kept > 0). Trips were limited to groundfish sector vessels within each year that have been observed at least once over the course of a year. Common pool vessels and Sector IX were omitted from the comparison. Sector IX data was omitted due to known misreporting within this sector.

Effort was defined using two different metrics for the ratio comparisons:

1. An effort proxy was defined as sum of kept catch of all species ( $K_{all}$ ), similar to how effort is defined for discard estimation in monitoring and assessments and,
2. Days absent (DA) on a trip was also used as a proxy for relative trip effort.

Gillnet gear ratios were only compared for the Gulf of Maine broad stock area where most of the groundfish gillnet effort occurs. The Southern New England (SNE) broad stock area was not included in the analysis due to the lack of groundfish effort.

## Results

Tables 1-6 compare observed and unobserved groundfish landings to effort ratios by broad stock area. Tables 1-3 compare the raw ratios from observed and unobserved trips, while Tables 4-6 compare the ratios on a relative basis (unobserved relative to observed trips; unobserved ratio / observed ratio).

Differences in the landing ratios between observed and unobserved trips suggest that observed trips are not representative of unobserved trips. The tables are color coded to help illustrate potential patterns in the data. Yellow cells consistently landed more fish on observed trips relative to unobserved trips among effort metrics ( $K_{all}$  and DA) and between gear types (gillnet and trawl) within a broad stock area, while gray cells saw more fish on unobserved trips relative to observed trips. The comparisons among gear types only apply to the Gulf of Maine, where catch ratios were compared for both trawls and gillnets. The results from the Gulf of Maine stock area suggests that there were more cod landings seen on observed trips relative to unobserved trips despite incentives to avoid cod on observed trips due to low ACLs from 2015 to 2017 (Table 7). This difference was consistent across effort metrics ( $K_{all}$  and DA) and gear types. However, the magnitude of the

difference was at times relatively small. In the GB and the 521 broad stock areas, it seems that more haddock are landed on unobserved relative to observed trips. The differences in the haddock ratios may have less to do with the influences of haddock which was not constraining but perhaps more a function of other potentially constraining stocks on these trips. However, a clear strong constraining stock could not be clearly identified in GB or the 521 broad stock areas with these ratios.

### Discussion

The management system was designed to limit fishing effort as the catch of a stock approaches the catch limit. However, if these economic incentives are instead leading to discarding of legal size fish, fishing effort and mortality may not be fully reduced as designed. In addition, if legal size discarding is occurring on unobserved trips, this behavior should be reflected in differences in the stock landing to effort relationships. Observer effects caused from constraining stocks should also produce biases for non-constraining stocks in the multispecies fishery. These effects will also change with changes in quotas over time and among stock areas. In addition, the true constraint of a stock specific quota for the fishery also depends on appropriateness of the implemented quota relative to the true abundance. Constraints for limiting stocks in poor condition should limit fishing effort over the course of the fishing year in order to promote rebuilding of the stock. A stock quota set too low relative to the true abundance should produce a greater constraint on effort. This would therefore also result in higher incentives for observer effects. Therefore, interpretation of the discrepancies in the landing to effort ratios between observed and unobserved trips can be complicated by multiple factors.

Quota constraints - which produce incentives for observer effects - do seem to produce differences in the landings-per-unit-effort between observed and unobserved trips, assuming that observers are deployed randomly on trips. However, the magnitude of the difference among the ratio comparisons are difficult to interpret. Since there are also incentives to avoid constraining stocks on observed trips, there are likely different degrees of incentives by permit percent sector contribution (PSC). Incentives can change over time and stock area, the constraints' depend on the true underlying stock abundance/distribution, and the fishery gear targeting ability. Therefore, the magnitude of the differences in the landings to effort relationships between observed and unobserved trips is likely not an accurate estimation of the true extent of the potential missing removals.

### Conclusion

In summary, discrepancies exist between observed and unobserved trips, when comparing landing to effort ratios. These differences suggest that observed trips are not representative of unobserved trips. Interpretation of the magnitude of these differences is uncertain due to the potential inherent biases caused by incentives to avoid limiting stocks on observed trips.



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Table 1. Gulf of Maine stock area allocated groundfish stock landings comparison of observed and unobserved landings to effort ratios from 2011 to 2017. Flatfish (relative to roundfish) are not caught well with gillnet gear and are not shown.

### Gulf of Maine trawl kept to kall ratios.

| year | number of trips | Observed | cod  | dabs | haddock | pollock | redfish | winter flounder | white hake | witch flounder | yellowtail flounder |
|------|-----------------|----------|------|------|---------|---------|---------|-----------------|------------|----------------|---------------------|
| 2011 | 873             | ob       | 0.21 | 0.07 | 0.03    | 0.20    | 0.08    | 0.01            | 0.15       | 0.03           | 0.02                |
| 2011 | 2300            | un       | 0.22 | 0.07 | 0.02    | 0.21    | 0.10    | 0.01            | 0.14       | 0.03           | 0.03                |
| 2012 | 1009            | ob       | 0.15 | 0.06 | 0.03    | 0.20    | 0.13    | 0.02            | 0.13       | 0.05           | 0.04                |
| 2012 | 3052            | un       | 0.12 | 0.05 | 0.02    | 0.24    | 0.21    | 0.02            | 0.10       | 0.04           | 0.04                |
| 2013 | 543             | ob       | 0.09 | 0.09 | 0.02    | 0.23    | 0.14    | 0.02            | 0.13       | 0.05           | 0.05                |
| 2013 | 2121            | un       | 0.06 | 0.07 | 0.02    | 0.27    | 0.22    | 0.01            | 0.12       | 0.04           | 0.03                |
| 2014 | 519             | ob       | 0.06 | 0.07 | 0.02    | 0.26    | 0.20    | 0.02            | 0.11       | 0.04           | 0.04                |
| 2014 | 1630            | un       | 0.05 | 0.07 | 0.02    | 0.23    | 0.26    | 0.01            | 0.11       | 0.03           | 0.03                |
| 2015 | 331             | ob       | 0.02 | 0.10 | 0.07    | 0.16    | 0.26    | 0.01            | 0.10       | 0.04           | 0.03                |
| 2015 | 1275            | un       | 0.01 | 0.08 | 0.06    | 0.14    | 0.36    | 0.01            | 0.10       | 0.03           | 0.02                |
| 2016 | 262             | ob       | 0.02 | 0.08 | 0.12    | 0.11    | 0.27    | 0.01            | 0.08       | 0.03           | 0.03                |
| 2016 | 1347            | un       | 0.01 | 0.07 | 0.13    | 0.15    | 0.27    | 0.01            | 0.08       | 0.02           | 0.02                |
| 2017 | 237             | ob       | 0.02 | 0.06 | 0.17    | 0.14    | 0.17    | 0.01            | 0.11       | 0.03           | 0.01                |
| 2017 | 1677            | un       | 0.01 | 0.06 | 0.14    | 0.16    | 0.26    | 0.01            | 0.10       | 0.02           | 0.01                |

### Gulf of Maine gillnet kept to kall ratios.

| year | number of trips | Observed | cod  | dabs | haddock | pollock | redfish | winter flounder | white hake | witch flounder | yellowtail flounder |
|------|-----------------|----------|------|------|---------|---------|---------|-----------------|------------|----------------|---------------------|
| 2011 | 1371            | ob       | 0.30 | -    | 0.01    | 0.35    | 0.01    | -               | 0.09       | -              | -                   |
| 2011 | 3423            | un       | 0.25 | -    | 0.01    | 0.40    | 0.01    | -               | 0.09       | -              | -                   |
| 2012 | 1112            | ob       | 0.20 | -    | 0.00    | 0.32    | 0.00    | -               | 0.10       | -              | -                   |
| 2012 | 3298            | un       | 0.17 | -    | 0.00    | 0.37    | 0.01    | -               | 0.12       | -              | -                   |
| 2013 | 484             | ob       | 0.10 | -    | 0.00    | 0.51    | 0.01    | -               | 0.12       | -              | -                   |
| 2013 | 2094            | un       | 0.08 | -    | 0.00    | 0.47    | 0.02    | -               | 0.16       | -              | -                   |
| 2014 | 736             | ob       | 0.09 | -    | 0.00    | 0.42    | 0.01    | -               | 0.10       | -              | -                   |
| 2014 | 1831            | un       | 0.09 | -    | 0.01    | 0.38    | 0.01    | -               | 0.09       | -              | -                   |
| 2015 | 286             | ob       | 0.04 | -    | 0.00    | 0.38    | 0.01    | -               | 0.05       | -              | -                   |
| 2015 | 954             | un       | 0.04 | -    | 0.01    | 0.39    | 0.02    | -               | 0.08       | -              | -                   |
| 2016 | 185             | ob       | 0.06 | -    | 0.00    | 0.19    | 0.01    | -               | 0.10       | -              | -                   |
| 2016 | 839             | un       | 0.06 | -    | 0.01    | 0.30    | 0.01    | -               | 0.10       | -              | -                   |
| 2017 | 144             | ob       | 0.05 | -    | 0.00    | 0.19    | 0.01    | -               | 0.06       | -              | -                   |
| 2017 | 863             | un       | 0.04 | -    | 0.01    | 0.23    | 0.01    | -               | 0.06       | -              | -                   |

### Gulf of Maine trawl kept to days absent ratios.

| year | number of trips | Observed | cod | dabs | haddock | pollock | redfish | winter flounder | white hake | witch flounder | yellowtail flounder |
|------|-----------------|----------|-----|------|---------|---------|---------|-----------------|------------|----------------|---------------------|
| 2011 | 873             | ob       | 742 | 247  | 98      | 707     | 295     | 25              | 529        | 120            | 77                  |
| 2011 | 2300            | un       | 829 | 265  | 90      | 787     | 385     | 39              | 519        | 129            | 125                 |
| 2012 | 1009            | ob       | 480 | 192  | 78      | 631     | 392     | 58              | 409        | 150            | 118                 |
| 2012 | 3052            | un       | 462 | 212  | 87      | 936     | 851     | 70              | 415        | 154            | 159                 |
| 2013 | 543             | ob       | 280 | 274  | 75      | 713     | 432     | 56              | 392        | 146            | 160                 |
| 2013 | 2121            | un       | 255 | 293  | 62      | 1100    | 921     | 59              | 497        | 149            | 138                 |
| 2014 | 519             | ob       | 270 | 312  | 102     | 1119    | 855     | 70              | 448        | 169            | 153                 |
| 2014 | 1630            | un       | 218 | 352  | 97      | 1100    | 1218    | 56              | 509        | 150            | 125                 |
| 2015 | 331             | ob       | 69  | 394  | 267     | 662     | 1052    | 55              | 406        | 166            | 118                 |
| 2015 | 1275            | un       | 56  | 446  | 314     | 767     | 1897    | 57              | 515        | 161            | 108                 |
| 2016 | 262             | ob       | 93  | 344  | 488     | 462     | 1129    | 60              | 337        | 125            | 127                 |
| 2016 | 1347            | un       | 76  | 389  | 752     | 861     | 1520    | 54              | 482        | 131            | 129                 |
| 2017 | 237             | ob       | 103 | 356  | 1012    | 817     | 985     | 68              | 661        | 152            | 79                  |
| 2017 | 1677            | un       | 66  | 391  | 984     | 1093    | 1808    | 52              | 710        | 122            | 103                 |

### Gulf of Maine gillnet kept to days absent ratios.

| year | number of trips | Observed | cod | dabs | haddock | pollock | redfish | winter flounder | white hake | witch flounder | yellowtail flounder |
|------|-----------------|----------|-----|------|---------|---------|---------|-----------------|------------|----------------|---------------------|
| 2011 | 1371            | ob       | 668 | -    | 27      | 796     | 20      | -               | 196        | -              | -                   |
| 2011 | 3423            | un       | 604 | -    | 20      | 957     | 22      | -               | 217        | -              | -                   |
| 2012 | 1112            | ob       | 411 | -    | 9       | 644     | 9       | -               | 200        | -              | -                   |
| 2012 | 3298            | un       | 374 | -    | 9       | 783     | 20      | -               | 254        | -              | -                   |
| 2013 | 484             | ob       | 201 | -    | 6       | 1046    | 18      | -               | 250        | -              | -                   |
| 2013 | 2094            | un       | 156 | -    | 5       | 870     | 29      | -               | 297        | -              | -                   |
| 2014 | 736             | ob       | 246 | -    | 12      | 1119    | 39      | -               | 257        | -              | -                   |
| 2014 | 1831            | un       | 230 | -    | 14      | 990     | 33      | -               | 247        | -              | -                   |
| 2015 | 286             | ob       | 110 | -    | 14      | 1080    | 39      | -               | 137        | -              | -                   |
| 2015 | 954             | un       | 93  | -    | 22      | 1038    | 54      | -               | 221        | -              | -                   |
| 2016 | 185             | ob       | 227 | -    | 15      | 694     | 46      | -               | 345        | -              | -                   |
| 2016 | 839             | un       | 161 | -    | 25      | 827     | 35      | -               | 266        | -              | -                   |
| 2017 | 144             | ob       | 171 | -    | 12      | 677     | 27      | -               | 210        | -              | -                   |
| 2017 | 863             | un       | 127 | -    | 24      | 773     | 37      | -               | 194        | -              | -                   |

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Table 2. Georges Bank stock area allocated groundfish stock landings comparison of observed and unobserved landings to effort ratios from 2011 to 2017.

### Georges Bank trawl kept to kall ratios.

| year | number<br>of trips | Observed | cod   | dabs  | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|--------------------|----------|-------|-------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 105                | ob       | 0.116 | 0.050 | 0.325   | 0.041   | 0.012   | 0.127              | 0.022         | 0.025             | 0.078                  |
| 2011 | 457                | un       | 0.096 | 0.038 | 0.323   | 0.067   | 0.039   | 0.137              | 0.026         | 0.021             | 0.076                  |
| 2012 | 79                 | ob       | 0.093 | 0.074 | 0.085   | 0.026   | 0.021   | 0.182              | 0.026         | 0.033             | 0.072                  |
| 2012 | 486                | un       | 0.126 | 0.057 | 0.133   | 0.047   | 0.039   | 0.185              | 0.022         | 0.030             | 0.041                  |
| 2013 | 59                 | ob       | 0.088 | 0.047 | 0.126   | 0.029   | 0.026   | 0.273              | 0.035         | 0.023             | 0.014                  |
| 2013 | 389                | un       | 0.080 | 0.039 | 0.173   | 0.045   | 0.076   | 0.244              | 0.030         | 0.020             | 0.025                  |
| 2014 | 61                 | ob       | 0.103 | 0.053 | 0.289   | 0.017   | 0.030   | 0.127              | 0.040         | 0.024             | 0.004                  |
| 2014 | 349                | un       | 0.123 | 0.051 | 0.311   | 0.033   | 0.070   | 0.131              | 0.024         | 0.017             | 0.016                  |
| 2015 | 33                 | ob       | 0.116 | 0.058 | 0.185   | 0.005   | 0.006   | 0.182              | 0.018         | 0.016             | 0.018                  |
| 2015 | 333                | un       | 0.104 | 0.032 | 0.299   | 0.042   | 0.067   | 0.098              | 0.029         | 0.015             | 0.012                  |
| 2016 | 27                 | ob       | 0.184 | 0.021 | 0.153   | 0.063   | 0.078   | 0.063              | 0.023         | 0.011             | 0.001                  |
| 2016 | 293                | un       | 0.070 | 0.027 | 0.195   | 0.070   | 0.159   | 0.068              | 0.019         | 0.010             | 0.006                  |
| 2017 | 40                 | ob       | 0.031 | 0.019 | 0.096   | 0.051   | 0.087   | 0.039              | 0.028         | 0.026             | 0.003                  |
| 2017 | 295                | un       | 0.029 | 0.024 | 0.201   | 0.037   | 0.199   | 0.058              | 0.019         | 0.015             | 0.008                  |

### Georges Bank trawl kept to days absent ratios.

| year | number<br>of trips | Observed | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|--------------------|----------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 105                | ob       | 538  | 233  | 1507    | 192     | 58      | 588                | 104           | 117               | 363                    |
| 2011 | 457                | un       | 584  | 229  | 1968    | 410     | 238     | 832                | 155           | 128               | 465                    |
| 2012 | 79                 | ob       | 438  | 346  | 399     | 120     | 99      | 854                | 122           | 156               | 340                    |
| 2012 | 486                | un       | 606  | 274  | 640     | 225     | 187     | 887                | 107           | 142               | 196                    |
| 2013 | 59                 | ob       | 308  | 165  | 442     | 103     | 92      | 952                | 121           | 81                | 50                     |
| 2013 | 389                | un       | 350  | 172  | 754     | 198     | 331     | 1065               | 132           | 89                | 109                    |
| 2014 | 61                 | ob       | 423  | 217  | 1182    | 69      | 122     | 520                | 162           | 100               | 17                     |
| 2014 | 349                | un       | 696  | 285  | 1752    | 188     | 396     | 739                | 138           | 98                | 90                     |
| 2015 | 33                 | ob       | 472  | 236  | 754     | 19      | 23      | 741                | 74            | 65                | 74                     |
| 2015 | 333                | un       | 594  | 185  | 1707    | 237     | 380     | 559                | 164           | 83                | 66                     |
| 2016 | 27                 | ob       | 1117 | 128  | 927     | 382     | 470     | 383                | 139           | 66                | 6                      |
| 2016 | 293                | un       | 473  | 181  | 1324    | 472     | 1077    | 458                | 128           | 71                | 42                     |
| 2017 | 40                 | ob       | 218  | 131  | 671     | 355     | 611     | 276                | 198           | 179               | 21                     |
| 2017 | 295                | un       | 232  | 197  | 1623    | 298     | 1608    | 466                | 151           | 123               | 67                     |

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Table 3. Mix broad stock area (521) allocated groundfish stock landings comparison of observed and unobserved landings to effort ratios from 2011 to 2017. SNE/MA winter flounder was a no possession stock in 2011 and 2012 and therefore are not shown.

### Mixed stock statistical area 521 trawl kept to kall ratios.

| number |          | Observed | cod   | dabs  | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|--------|----------|----------|-------|-------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| year   | of trips |          |       |       |         |         |         |                    |               |                   |                        |
| 2011   | 153      | ob       | 0.212 | 0.031 | 0.048   | 0.339   | 0.107   | -                  | 0.080         | 0.039             | 0.013                  |
| 2011   | 558      | un       | 0.295 | 0.034 | 0.054   | 0.233   | 0.102   | -                  | 0.079         | 0.039             | 0.021                  |
| 2012   | 103      | ob       | 0.141 | 0.059 | 0.023   | 0.277   | 0.139   | -                  | 0.121         | 0.058             | 0.003                  |
| 2012   | 570      | un       | 0.151 | 0.054 | 0.035   | 0.271   | 0.141   | -                  | 0.102         | 0.044             | 0.031                  |
| 2013   | 75       | ob       | 0.140 | 0.079 | 0.143   | 0.132   | 0.084   | 0.124              | 0.073         | 0.041             | 0.016                  |
| 2013   | 549      | un       | 0.117 | 0.079 | 0.128   | 0.139   | 0.153   | 0.069              | 0.083         | 0.036             | 0.016                  |
| 2014   | 75       | ob       | 0.092 | 0.089 | 0.168   | 0.076   | 0.129   | 0.106              | 0.069         | 0.040             | 0.007                  |
| 2014   | 472      | un       | 0.121 | 0.068 | 0.229   | 0.103   | 0.146   | 0.046              | 0.064         | 0.032             | 0.007                  |
| 2015   | 73       | ob       | 0.101 | 0.062 | 0.181   | 0.057   | 0.245   | 0.101              | 0.045         | 0.026             | 0.005                  |
| 2015   | 400      | un       | 0.107 | 0.063 | 0.181   | 0.078   | 0.201   | 0.081              | 0.044         | 0.027             | 0.012                  |
| 2016   | 52       | ob       | 0.056 | 0.062 | 0.215   | 0.087   | 0.143   | 0.080              | 0.039         | 0.027             | 0.018                  |
| 2016   | 373      | un       | 0.084 | 0.037 | 0.288   | 0.086   | 0.157   | 0.056              | 0.035         | 0.020             | 0.005                  |
| 2017   | 38       | ob       | 0.051 | 0.027 | 0.269   | 0.060   | 0.084   | 0.157              | 0.043         | 0.019             | 0.023                  |
| 2017   | 420      | un       | 0.039 | 0.027 | 0.367   | 0.087   | 0.147   | 0.045              | 0.053         | 0.014             | 0.003                  |

### Mixed stock statistical area 521 trawl kept to days absent ratios.

| number |          | Observed | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|--------|----------|----------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| year   | of trips |          |      |      |         |         |         |                    |               |                   |                        |
| 2011   | 153      | ob       | 1235 | 183  | 280     | 1979    | 624     | -                  | 468           | 228               | 74                     |
| 2011   | 558      | un       | 1773 | 204  | 327     | 1403    | 616     | -                  | 475           | 236               | 129                    |
| 2012   | 103      | ob       | 758  | 318  | 126     | 1496    | 747     | -                  | 655           | 315               | 16                     |
| 2012   | 570      | un       | 788  | 281  | 184     | 1413    | 735     | -                  | 530           | 231               | 163                    |
| 2013   | 75       | ob       | 565  | 318  | 575     | 532     | 339     | 502                | 292           | 164               | 64                     |
| 2013   | 549      | un       | 511  | 345  | 558     | 605     | 669     | 301                | 362           | 156               | 70                     |
| 2014   | 75       | ob       | 318  | 310  | 583     | 263     | 449     | 366                | 240           | 137               | 25                     |
| 2014   | 472      | un       | 585  | 326  | 1104    | 496     | 704     | 222                | 307           | 154               | 31                     |
| 2015   | 73       | ob       | 365  | 226  | 654     | 206     | 886     | 366                | 165           | 93                | 19                     |
| 2015   | 400      | un       | 448  | 264  | 756     | 324     | 838     | 339                | 183           | 114               | 50                     |
| 2016   | 52       | ob       | 259  | 286  | 986     | 400     | 658     | 366                | 181           | 123               | 83                     |
| 2016   | 373      | un       | 526  | 233  | 1797    | 536     | 977     | 346                | 216           | 124               | 31                     |
| 2017   | 38       | ob       | 310  | 164  | 1633    | 367     | 507     | 953                | 261           | 116               | 140                    |
| 2017   | 420      | un       | 306  | 210  | 2839    | 675     | 1136    | 346                | 409           | 109               | 24                     |

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Table 4. Gulf of Maine stock area allocated groundfish stock landings relative comparison of unobserved landings to effort ratios to observed ratios (unobserved ratios/observed ratios) from 2011 to 2017. Flatfish (relative to roundfish) are not caught well with gillnet gear and are not shown.

### Gulf of Maine trawl kept to kall ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 1.03 | 0.99 | 0.84    | 1.03    | 1.20    | 1.42               | 0.90          | 0.99              | 1.49                   |
| 2012 | 0.75 | 0.86 | 0.87    | 1.16    | 1.69    | 0.94               | 0.79          | 0.80              | 1.05                   |
| 2013 | 0.68 | 0.80 | 0.62    | 1.15    | 1.59    | 0.79               | 0.95          | 0.77              | 0.64                   |
| 2014 | 0.72 | 1.01 | 0.86    | 0.88    | 1.28    | 0.71               | 1.02          | 0.80              | 0.73                   |
| 2015 | 0.63 | 0.87 | 0.90    | 0.89    | 1.38    | 0.79               | 0.97          | 0.74              | 0.70                   |
| 2016 | 0.60 | 0.83 | 1.14    | 1.38    | 0.99    | 0.66               | 1.05          | 0.77              | 0.75                   |
| 2017 | 0.54 | 0.93 | 0.82    | 1.13    | 1.56    | 0.64               | 0.91          | 0.68              | 1.10                   |

### Gulf of Maine gillnet kept to kall ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 0.85 | -    | 0.70    | 1.13    | 1.03    | -                  | 1.04          | -                 | -                      |
| 2012 | 0.85 | -    | 0.93    | 1.14    | 2.04    | -                  | 1.19          | -                 | -                      |
| 2013 | 0.86 | -    | 0.95    | 0.92    | 1.79    | -                  | 1.32          | -                 | -                      |
| 2014 | 0.96 | -    | 1.26    | 0.90    | 0.86    | -                  | 0.98          | -                 | -                      |
| 2015 | 0.93 | -    | 1.76    | 1.05    | 1.50    | -                  | 1.76          | -                 | -                      |
| 2016 | 0.91 | -    | 2.06    | 1.52    | 0.98    | -                  | 0.98          | -                 | -                      |
| 2017 | 0.80 | -    | 2.15    | 1.23    | 1.47    | -                  | 0.99          | -                 | -                      |

### Gulf of Maine trawl kept to days absent ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 1.12 | 1.08 | 0.92    | 1.11    | 1.30    | 1.54               | 0.98          | 1.07              | 1.62                   |
| 2012 | 0.96 | 1.10 | 1.12    | 1.48    | 2.17    | 1.20               | 1.01          | 1.02              | 1.35                   |
| 2013 | 0.91 | 1.07 | 0.83    | 1.54    | 2.13    | 1.06               | 1.27          | 1.02              | 0.86                   |
| 2014 | 0.81 | 1.13 | 0.96    | 0.98    | 1.42    | 0.79               | 1.13          | 0.89              | 0.81                   |
| 2015 | 0.82 | 1.13 | 1.18    | 1.16    | 1.80    | 1.03               | 1.27          | 0.97              | 0.92                   |
| 2016 | 0.81 | 1.13 | 1.54    | 1.87    | 1.35    | 0.90               | 1.43          | 1.05              | 1.01                   |
| 2017 | 0.64 | 1.10 | 0.97    | 1.34    | 1.84    | 0.76               | 1.07          | 0.80              | 1.30                   |

### Gulf of Maine gillnet kept to days absent ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 0.90 | -    | 0.75    | 1.20    | 1.10    | -                  | 1.11          | -                 | -                      |
| 2012 | 0.91 | -    | 0.99    | 1.22    | 2.17    | -                  | 1.27          | -                 | -                      |
| 2013 | 0.78 | -    | 0.85    | 0.83    | 1.61    | -                  | 1.19          | -                 | -                      |
| 2014 | 0.94 | -    | 1.24    | 0.88    | 0.85    | -                  | 0.96          | -                 | -                      |
| 2015 | 0.85 | -    | 1.61    | 0.96    | 1.37    | -                  | 1.61          | -                 | -                      |
| 2016 | 0.71 | -    | 1.61    | 1.19    | 0.77    | -                  | 0.77          | -                 | -                      |
| 2017 | 0.74 | -    | 1.99    | 1.14    | 1.36    | -                  | 0.92          | -                 | -                      |

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Table 5. Georges Bank stock area allocated groundfish stock landings relative comparison of unobserved landings to effort ratios to observed ratios (unobserved ratios/observed ratios) from 2011 to 2017.

### Georges Bank trawl kept to kall ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 0.83 | 0.75 | 0.99    | 1.62    | 3.14    | 1.08               | 1.14          | 0.84              | 0.98                   |
| 2012 | 1.36 | 0.78 | 1.57    | 1.83    | 1.85    | 1.02               | 0.87          | 0.89              | 0.57                   |
| 2013 | 0.91 | 0.83 | 1.37    | 1.55    | 2.89    | 0.90               | 0.87          | 0.88              | 1.73                   |
| 2014 | 1.20 | 0.95 | 1.08    | 1.99    | 2.37    | 1.03               | 0.62          | 0.71              | 3.92                   |
| 2015 | 0.90 | 0.56 | 1.61    | 9.07    | 12.02   | 0.54               | 1.58          | 0.91              | 0.63                   |
| 2016 | 0.38 | 1.26 | 1.27    | 1.10    | 2.04    | 1.07               | 0.82          | 0.96              | 6.31                   |
| 2017 | 0.93 | 1.30 | 2.10    | 0.73    | 2.28    | 1.47               | 0.66          | 0.60              | 2.76                   |

### Georges Bank trawl kept to days absent ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 1.09 | 0.98 | 1.31    | 2.13    | 4.12    | 1.42               | 1.50          | 1.10              | 1.28                   |
| 2012 | 1.38 | 0.79 | 1.60    | 1.86    | 1.88    | 1.04               | 0.88          | 0.91              | 0.58                   |
| 2013 | 1.14 | 1.04 | 1.71    | 1.94    | 3.62    | 1.12               | 1.09          | 1.10              | 2.16                   |
| 2014 | 1.65 | 1.31 | 1.48    | 2.74    | 3.26    | 1.42               | 0.85          | 0.98              | 5.40                   |
| 2015 | 1.26 | 0.78 | 2.26    | 12.72   | 16.85   | 0.75               | 2.22          | 1.28              | 0.89                   |
| 2016 | 0.42 | 1.41 | 1.43    | 1.23    | 2.29    | 1.20               | 0.92          | 1.07              | 7.07                   |
| 2017 | 1.07 | 1.50 | 2.42    | 0.84    | 2.63    | 1.69               | 0.77          | 0.69              | 3.18                   |

Table 6. Mix broad stock area (521) allocated groundfish stock landings relative comparison of unobserved landings to effort ratios to observed ratios (unobserved ratios/observed ratios) from 2011 to 2017. SNE/MA winter flounder was a no possession stock in 2011 and 2012 and therefore are not shown.

### Mixed stock statistical area 521 trawl kept to kall ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 1.39 | 1.08 | 1.13    | 0.69    | 0.96    | -                  | 0.98          | 1.00              | 1.69                   |
| 2012 | 1.08 | 0.92 | 1.51    | 0.98    | 1.02    | -                  | 0.84          | 0.76              | 10.37                  |
| 2013 | 0.84 | 1.00 | 0.90    | 1.05    | 1.82    | 0.56               | 1.15          | 0.88              | 1.01                   |
| 2014 | 1.32 | 0.76 | 1.36    | 1.36    | 1.13    | 0.43               | 0.92          | 0.81              | 0.92                   |
| 2015 | 1.06 | 1.01 | 1.00    | 1.37    | 0.82    | 0.80               | 0.96          | 1.06              | 2.28                   |
| 2016 | 1.49 | 0.60 | 1.34    | 0.99    | 1.09    | 0.70               | 0.88          | 0.74              | 0.27                   |
| 2017 | 0.77 | 1.00 | 1.36    | 1.44    | 1.76    | 0.28               | 1.23          | 0.74              | 0.13                   |

### Mixed stock statistical area 521 trawl kept to days absent ratios.

| year | cod  | dabs | haddock | pollock | redfish | winter<br>flounder | white<br>hake | witch<br>flounder | yellowtail<br>flounder |
|------|------|------|---------|---------|---------|--------------------|---------------|-------------------|------------------------|
| 2011 | 1.44 | 1.11 | 1.17    | 0.71    | 0.99    | -                  | 1.02          | 1.03              | 1.74                   |
| 2012 | 1.04 | 0.88 | 1.46    | 0.94    | 0.98    | -                  | 0.81          | 0.73              | 10.02                  |
| 2013 | 0.90 | 1.08 | 0.97    | 1.14    | 1.97    | 0.60               | 1.24          | 0.95              | 1.09                   |
| 2014 | 1.84 | 1.05 | 1.89    | 1.89    | 1.57    | 0.60               | 1.28          | 1.12              | 1.28                   |
| 2015 | 1.23 | 1.17 | 1.16    | 1.58    | 0.95    | 0.93               | 1.11          | 1.22              | 2.63                   |
| 2016 | 2.03 | 0.81 | 1.82    | 1.34    | 1.49    | 0.95               | 1.19          | 1.01              | 0.37                   |
| 2017 | 0.99 | 1.28 | 1.74    | 1.84    | 2.24    | 0.36               | 1.57          | 0.94              | 0.17                   |

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Table 7. Groundfish US ACLs from 2010 to 2020.

| <b>stock</b>                 | <b>Annual Catch Limit (US ACL)</b> |             |             |             |             |             |             |             |             |             |             |
|------------------------------|------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                              | <b>2010</b>                        | <b>2011</b> | <b>2012</b> | <b>2013</b> | <b>2014</b> | <b>2015</b> | <b>2016</b> | <b>2017</b> | <b>2018</b> | <b>2019</b> | <b>2020</b> |
| GB cod                       | 3,620                              | 4,540       | 4,861       | 1,907       | 1,867       | 1,886       | 730         | 637         | 1519        | 1741        |             |
| GOM cod                      | 8,088                              | 8,545       | 6,700       | 1,470       | 1,470       | 366         | 473         | 473         | 666         | 666         | 666         |
| GB Haddock                   | 42,768                             | 32,611      | 29,260      | 27,936      | 18,312      | 23,204      | 53,309      | 54,574      | 46,312      | 55,249      |             |
| GOM Haddock                  | 1,197                              | 1,141       | 958         | 274         | 641         | 1,375       | 3,430       | 4,285       | 12,409      | 11,803      | 9,626       |
| GB Yellowtail Flounder       | 1,021                              | 1,416       | 547.8       | 209         | 318         | 240         | 261         | 201         | 206         | 103         |             |
| SNE Yellowtail Flounder      | 470                                | 641         | 936         | 665         | 665         | 666         | 256         | 256         | 65          | 66          | 66          |
| CC/GOM Yellowtail Flounder   | 822                                | 992         | 1,104       | 523         | 523         | 524         | 409         | 409         | 490         | 490         | 490         |
| Plaice                       | 3,006                              | 3,280       | 3,459       | 1,482       | 1,442       | 1,470       | 1,235       | 1,272       | 1,649       | 1,532       | 1,420       |
| Witch Flounder               | 899                                | 1,304       | 1,563       | 751         | 751         | 751         | 441         | 839         | 948         | 948         | 948         |
| GB Winter Flounder           | 1,955                              | 2,118       | 3,575       | 3,641       | 3,493       | 1,952       | 650         | 683         | 787         | 787         | 787         |
| GOM Winter Flounder          | 231                                | 524         | 1,040       | 1,040       | 1,040       | 489         | 776         | 776         | 428         | 428         | 428         |
| SNE/MA Winter Flounder       | 605                                | 842         | 603         | 1,612       | 1,612       | 1,607       | 749         | 749         | 700         | 700         | 700         |
| Redfish                      | 7,226                              | 7,959       | 8,786       | 10,462      | 10,909      | 11,393      | 9,837       | 10,514      | 10,986      | 11,208      | 11,357      |
| White Hake                   | 2,697                              | 3,138       | 3,465       | 3,974       | 4,417       | 4,484       | 3,572       | 3,467       | 2,794       | 2,794       | 2,794       |
| Pollock                      | 18,929                             | 16,166      | 14,736      | 14,921      | 15,304      | 15,878      | 20,374      | 20,374      | 38,204      | 38,204      | 38,204      |
| Northern Windowpane Flounder | 161                                | 161         | 163         | 144         | 144         | 144         | 177         | 170         | 86          | 86          | 86          |
| Southern Windowpane Flounder | 225                                | 225         | 381         | 527         | 527         | 527         | 599         | 599         | 457         | 457         | 457         |
| Ocean Pout                   | 253                                | 253         | 240         | 220         | 220         | 220         | 155         | 155         | 120         | 120         | 120         |
| Halibut                      | 69                                 | 76          | 83          | 96          | 106         | 97          | 119         | 119         | 100         | 100         | 100         |
| Wolffish                     | 77                                 | 77          | 77          | 65          | 65          | 65          | 77          | 77          | 84          | 84          | 84          |

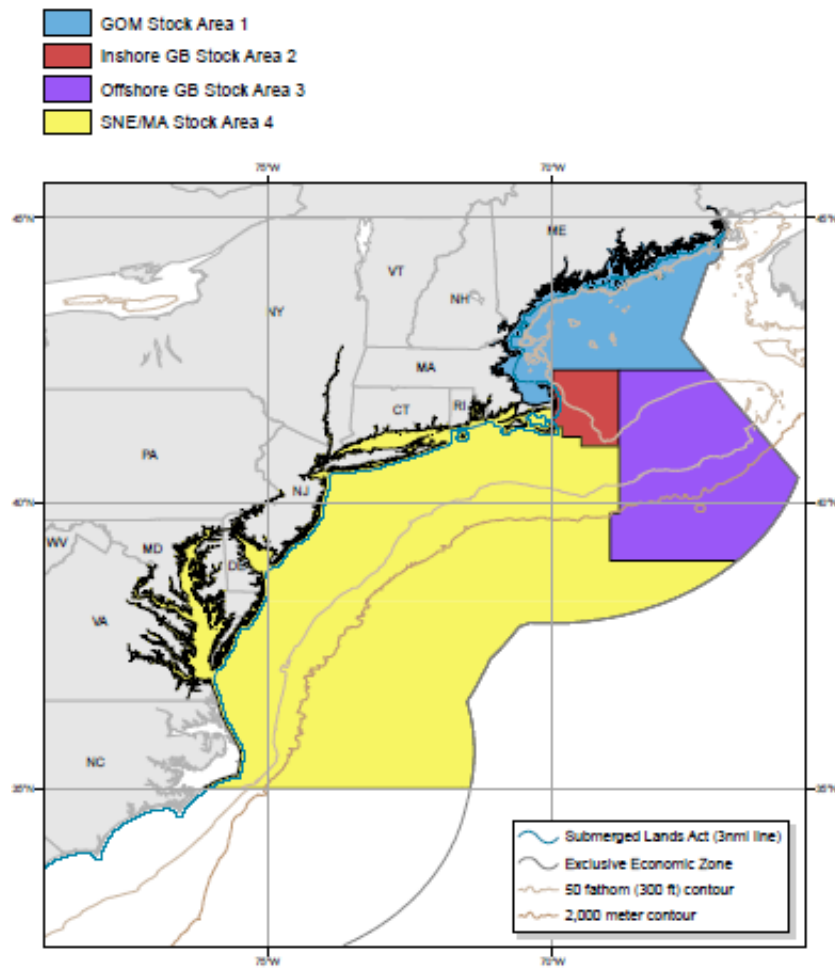


Figure 1. Multispecies broad stock area map. Inshore Georges Bank (GB) stock area 2 is statistical area 521.

Groundfish Plan Development Team  
April 15, 2019

## **Groundfish Plan Development Team Conclusions**

### **Based on Monitoring Analyses Conducted**

#### **1a) Modeling discard incentives for Northeast Multispecies (groundfish) stocks**

- Stocks landed with a positive discard incentive may indicate bias in the total catch estimate for that stock.
- In general, yellowtail flounder and cod stocks have the highest modeled discard incentives over time, but these are highly variable on a year to year basis.
  - All three (Georges Bank, Southern New England/Mid-Atlantic, and Gulf of Maine) yellowtail flounder stocks had higher discard incentives in earlier years (2010, 2012).
  - Both (Gulf of Maine and Georges Bank) cod stocks had higher discard incentives in recent years (2015-2017).
- Stocks with consistently low discard incentives include those with relatively low quota price to ex-vessel price ratios, including pollock, redfish, and Georges Bank haddock.
- Quota prices as a ratio of ex-vessel price drives modelled discard incentives. This ratio is the strongest theoretical predictor of bias.
- Utilization (catch: annual catch limit) is weakly related to quota price and varies by stock.
- The model can only identify when landings or trips comply with the discarding prohibition, even when it may not be economically rational to do so. The model cannot quantify the proportion of trips or catch that does not comply with the discarding prohibition.
- More precise estimates of quota prices will enhance the ability to model discard incentives under current conditions.
- There may be other social, cultural, or normative factors that may influence individuals' decisions to comply with discard rules that we do not account for in this analysis.

#### **1b) Evaluating the Observer Effect for the Northeast U.S. Groundfish Fishery**

- This analysis demonstrates that fishing vessels in the Northeast multispecies (groundfish) fishery alter their behavior in response to human observers (distinct from selection bias/observer deployment effects). The analysis documents a consistent pattern of different fishing behaviors when an observer is on board.
- Data generated on observed trips are not representative of the whole fleet.
  - Generally, the most pronounced effects are seen across trip duration, kept catch, kept groundfish, and trip revenue.
  - Observer presence has the smallest effect on the number of groundfish market categories and non-groundfish average prices, but even in these instances differences are observed.
  - The data show a trend for three key metrics, in almost all circumstances, such that when an observer is onboard, vessels appear to:
    1. Retain fewer fish,
    2. Fish for less time and,
    3. Obtain lower revenues.



- Persistent differences such as higher average groundfish prices with an observer on board (trawl vessels) and emerging differences like a greater number of market categories retained with an observer (gillnet vessels) indicate that the composition of catch on observed trips is different than unobserved trips.

### **1c) Predicting Gulf of Maine cod catch on Northeast Multispecies (groundfish) sector trips, implications for observer bias and fishery catch accounting**

- By modeling patterns of cod catch across space, time, and other attributes of fishing effort on observed trips, predictions of expected catch on unobserved trips were compared to the reported catch on these trips.
  - For gillnet trips, predicted cod catch was increasingly higher than reported catch from 2013 to 2017. Differences between predicted and reported catch on trawl trips were variable across time without an apparent trend. For both gear types, the proportion of total catch consisting of cod decreased over time, suggesting less targeting.
  - There is some evidence that the magnitude of unreported cod catch (potentially illegal discarding) could have been >60% of reported catch on unobserved trips.
- An important caveat is that conclusions depend on validity of the model structure and predictions. If unmeasured attributes of effort (e.g. tow speed) and/or relationships between effort predictors and catch outcomes differ between observed and unobserved trips, predictions may not be valid. Differences in catch outcomes are assumed to be attributed to post-catch behavior (compliance, or lack thereof, with discarding regulations) and not pre-catch behavior (how the gear was fished).
- Results from models for pollock suggested a lack of model fit compared to those for cod, making conclusions equivocal for this species.

### **1d) Comparison of sector vessel landings effort ratios between observed and unobserved trips by gear and broad stock area**

- Discrepancies exist between observed and unobserved trips, when comparing landing to effort ratios. Differences in the landing ratios between observed and unobserved trips suggest that observed trips are not representative of unobserved trips. This analysis assumes there are no observer deployment effects.
- For the Gulf of Maine broad stock area, this analysis demonstrates there were slightly more cod landings seen on observed trips relative to unobserved trips despite incentives to avoid cod on observed trips due to low ACLs from 2015 to 2017. This difference was consistent across effort metrics ( $K_{all}$  and  $DA^1$ ) and gear types.
- For the Offshore Georges Bank broad stock area and Inshore Georges Bank broad stock area (Statistical Reporting Area 521), more haddock are consistently landed on unobserved trips relative to observed trips. The differences in the haddock ratios may have less to do with the

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<sup>1</sup>  $K_{all}$  = sum of kept catch of all species, similar to how effort is defined for discard estimation in monitoring and assessments;  $DA$  = days absent on a trip, a proxy for relative trip effort

influences of haddock which was not constraining but perhaps more a function of other potentially constraining stocks on these trips targeting haddock.

- Documented differences in the stock landing to effort relationships reflects differences in discarding of legal sized fish on unobserved trips relative to observed trips.
- Interpretation of the magnitude of these differences is uncertain due to the potential inherent biases caused by incentives to avoid limiting stocks on observed trips.
- The magnitude of the differences in the landings to effort relationships between observed and unobserved trips is likely not an accurate estimation of the true extent of the potential missing removals.

### **Overall Groundfish Plan Development Team Conclusions Based on the Analyses**

- All three analyses that compare observed and unobserved trip data conclude that observed trips are not representative of unobserved trips. The dimensions where observed trips differ from unobserved trips include:
  - Gulf of Maine cod catch rates,
  - Groundfish landings to effort ratios,
  - Trip duration,
  - Pounds of kept groundfish,
  - Pounds of total kept catch, and
  - Trip revenue.
- Documented differences in the stock landing to effort relationships reflect differences in discarding of legal sized fish on unobserved trips relative to observed trips.
- Despite removing Sector IX data from these analyses, fishery-wide bias is still demonstrated.
- The discard incentive model describes one mechanism to explain differences between observed and unobserved trips: the sector system increases the incentive to illegally discard legal-sized fish on unobserved trips.
- Discard incentives have varied across time and stock area. After full sector implementation, the accountability of discards and the application of sector/gear specific discard rates to unobserved trips, together with the potential catch of constraining stocks, increased the incentive to not comply with retention regulations.
- Given these conclusions, the current precision standard is not an appropriate method to set at-sea monitoring coverage levels because the assumption that observed trips are representative of unobserved trips is false.
- These analyses cannot quantify the differences between observed and unobserved trips in a way that allows for either a mathematical correction to the data or a survey design that resolves bias.
- Non-compliance with the requirement to land legal-sized fish of allocated stocks (excluding LUMF<sup>2</sup>) undermines any sampling design and should be addressed.
- While direct evidence of the incidence and magnitude of non-compliance is not captured, the documented differences in behavior are substantial enough to warrant concern that non-compliance is occurring, especially in view of incentives to be non-compliant while unobserved.
- Revisions to the monitoring program should consider ways to increase compliance or account for non-compliance. Substantially increasing the management uncertainty buffer might account for this non-compliance but would not improve our understanding of true removals and would result

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<sup>2</sup> LUMF = legal-sized un-marketable fish

in foregone revenue for the fishery. Alternatively, increased monitoring and catch accounting may be one way to increase compliance and may be necessary to provide accuracy of catch.

- The analyses support more comprehensive monitoring in the fishery.

# New England Fishery Management Council

## Scientific and Statistical Committee Sub-Panel Peer Review Report for the Groundfish Plan Development Team Analyses of Groundfish Monitoring

Conducted April 24 and 25, 2019 in Providence, Rhode Island

Prepared by the Peer Review Panel: Dr. Dan Holland<sup>1</sup>, Dr. Lisa Kerr<sup>2</sup>, Dr. Jason  
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## **Executive Summary**

A sub-panel of the Scientific and Statistical Committee (“the peer review panel”) was convened on April 24 and 25, 2019 to review four analyses along with a conclusions statement conducted by the New England Fishery Management Council’s (NEFMC) Groundfish Plan Development Team (PDT). The analyses were conducted to look at the potential effects on harvest and discards in the Northeast Multispecies (here after “groundfish”) fishery when an at-sea observer is present on a fishing trip relative to when no observer is present. This is important because sector program accountability and estimation of discards is largely derived from observed trips, so if there are differences in fishing behavior on those trips, this could impact the effectiveness of management of this fishery.

The first analysis modeled incentives to discard in the groundfish fishery. The analysis is done at the trip level, but results are presented on an annual species/stock level. The analysis shows that, while on average there are no positive incentives to discard for any species across years, there are positive discard incentives for a proportion of trips for some species/stocks, notably for cod and yellowtail flounder stocks in certain years. There are reasons to believe that the estimated discard incentives are conservative such that even when the estimated incentive is not above zero, there may still be incentives to discard that are not captured by the model. The analysis was not able to estimate the frequency of trips or the magnitude of catch that may be subject to positive discard incentives and thus cannot quantify the magnitude of the problem. Rather it provides an indicator of where and when discarding may have been incentivized, and therefore indicates that discarding in this fishery is economically incentivized in some instances. This could help managers focus efforts on to the areas of the fishery where the main problems likely exist.

The second analysis examined whether fishing vessels in the groundfish fishery alter their behavior in response to human observers. The measures examined in this analysis cover a broad range of impacts that are relevant for observer-related fisheries management policy. The analysis found statistically significant differences in many measures (but not all) between unobserved and observed fishing trips of the same vessels, strongly suggesting that fishers do alter their fishing behavior when a human observer is onboard. However, since a key difference is shorter duration of unobserved trips, this may explain at least part of the differences in other variables such as kept catch.

The third analysis used observed trips to model cod (and pollock) catch while accounting for typical effort attributes in addition to spatial and temporal covariance in catch. The approach creates a predictive model, which was used to predict total cod catch (kept + discarded) on observed trips, and then was also used to predict catch for unobserved trips, which were then compared to catch reports from the National Marine Fisheries Service (NMFS). The method indicated differences between the predictions of unobserved catch and the catch as reported by NMFS. This finding suggests a potential for unreported catch on the unobserved trips if it is assumed that observed trips can adequately represent unobserved trips. This method has an ability to predict unobserved discards controlling for differences in spatial distribution of unobserved trips relative to observed trips and showed promise for informing the Council

quantitatively in their deliberations on Amendment 23 with some additional refinement and testing.

The final analysis compared species/stock landings to effort and total catch ratios on observed and unobserved trips in the multispecies groundfish fishery to determine whether there is evidence of an observer effect. The analysis assumes that differences are due to the observer effect and are not due to the deployment effect, so this is an important consideration when interpreting results from this method. The reviewers appreciated the parsimony of this approach, but felt it needed a little more refinement before it could be used by managers. The method did indicate the potential for differences between observed and unobserved trips, and therefore it corroborated the other results from the other analyses.

Generally, the reviewers appreciated all of the work done by the PDT and felt that the analyses, taken comprehensively, create a weight of evidence that disproves the null hypothesis, namely that there is no effect from the presence of an observer on a fishing trip. In other words, the work taken collectively show that there is an observer effect, and therefore managers need to account for this when basing management off information derived from observed trips. The analyses suggest that estimates of discards on unobserved trips derived from discards rates on observed trips may not be accurate, and likely to be an underestimated reflection of actual discards. In their current form the analyses do not offer a specific quantification of the problem, but the methods show promise for being able to focus efforts on to the most problematic species in the fishery, and some of them also show promise for being able to quantify the magnitude of the issue with additional work. The following report details these findings.

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## **Report**

### **I. Methods to explore discard incentives of groundfish stocks**

#### **a. Reviewer Summary Comments:**

This paper models' incentives to discard catch of groundfish stocks based on the estimated economic incentives to retain or discard the catch. The analysis is done at the trip level and, for each species, subtracts the benefits of retaining catch (mainly ex-vessel value) from the cost of retaining catch (mainly quota leasing costs) to estimate the incentive to discard. The discard incentive measure is standardized by the ex-vessel value of catch so might be thought of as the monetary incentive to discard per dollar value of retained catch. Results are presented on an annual species/stock level. The analysis shows that, while on average there are not positive incentives to discard for any stock or year, there are positive discard incentives for a proportion of trips for some species/stocks, notably for cod and yellowtail flounder stocks in certain years. There are reasons to believe that the estimated discard incentives are conservative such that even when the estimated incentive is not above zero, there may still be incentives to discard. The presentation of methods and results is clear, and the methodology and assumptions made are generally sound as are the conclusions drawn from the analysis. The analysis is applied only to unobserved trips but could and should be applied to observed trips. The analysis is not able to estimate the frequency of trips or magnitude of catch that may be subject to positive discard incentives and thus cannot quantify the magnitude of the problem. Rather it provides an indicator of where discarding may have been incentivized.

#### **b. Terms of Reference:**

1. Are the methods adequately described and based on sound analytic techniques and statistical principles?

The methods for this paper are generally well described and based on sound theoretical and analytic techniques. As with most economic models that represent human decision making as a purely economic and rational process, there are several assumptions made in the model that may not strictly hold. In addition, the model does not represent the potential heterogeneity of decision makers that may alter what costs and benefits of landing fish are included in decision making. However, the assumptions made are generally reasonable and clearly stated, and their rationale is described.

The paper should be clearer about the type of decision maker that is represented. The decision of a vessel owner might be different from a hired captain based on differences in costs and benefits considered. For example, a hired captain or crew member on a boat that does not deduct the cost of quota when determining crew share might not consider the quota cost and thus would have a lower incentive to discard than is estimated here. Alternatively, a captain who is also the owner of the vessel and the quota might consider the net value of the fish after both crew share and quota costs are deducted and thus have a higher incentive to discard than is estimated. It appears the model best represents the viewpoint of a hired captain or crew member that expects quota costs to be deducted off the top and their compensation to reflect a share of the difference between ex-vessel value and quota cost. To the extent it is known, it would be useful to discuss



how prevalent this type of decision-making is, e.g., how prevalent is it to deduct the value of quota from ex-vessel value before calculating crew share for hired captains and crew?

Other background that is not made clear in the paper is that observed trips were excluded from the analysis. The analyst stated in post presentation discussions that only data from unobserved trips was used, and this should be clarified in the paper. It is not clear why observed trips should be excluded as these trips seem likely to be a substantial source of data on trips where discard incentives existed for legal size fish but where those fish were retained due to the presence of the observer.

2. Are important uncertainties in the data and the analyses (possibly including the effects of year to year variations in fishing practices) identified, and are the impacts of these uncertainties on the analyses adequately described?

There are many uncertainties in the data and analysis, but they are generally identified in the paper and the impacts of these uncertainties are discussed. The most important uncertainty is the accuracy of quota prices that are a key factor in the decision to land or discard fish. The analysts noted in discussions after the presentation that it is the magnitude of the margin between ex-vessel price and quota price that is the primary determinant of the estimated discard incentive. Quota prices are based on reported data on quota leases (i.e., annual catch entitlement (ACE) sales) within and between sectors and provide the best representation available of quota value; however, they undoubtedly depart somewhat from the perceived opportunity cost of quota in the mind of the decision maker deciding whether to discard or retain fish. Quota prices are mostly based on quarterly estimates but there may be variations in market values within quarters.

More fundamentally, there may be a variety of reasons for decision makers to use something other than the market price of quota in making their determination of whether to discard or land fish. A basic assumption of the model is that there are known market prices for quota, and that the decision maker uses these prices to estimate the cost of landing fish. The analysis assumes away any impact that the quota holdings of the vessel at the time of landing, or the expected need for future quota, might have on the discard decision. It basically assumes the quota can be bought for that price upon landing the fish and that the same quota price will continue to prevail. This is a reasonable assumption if the quota market is efficient, information on quota prices is readily available, transactions costs are low, and decision makers are rational. However, the assumed value of quota to the individual may in fact be affected by quota endowments and expectations of whether vessel owners/decision makers will or will not need to seek quota on the market at some point and what prices may be at that time. For decision makers that expect to have to lease quota to cover catch of otherwise discarded fish, there may be a risk premium applied to account for the risk of not being able to acquire quota in a timely fashion. This would increase the discard incentive. There might be pressure from vessel/quota owners/holders to limit the landings of stocks for which quota is limiting. On the other hand, a vessel owner with extensive quota holdings might be less concerned about quota prices and might assume a lower quota value in the discard decision.

As noted in the paper, a positive discard incentive does not necessarily mean discarding will occur. There are many reasons including moral values and social norms that might motivate landing of fish when discard incentives are positive. Furthermore, sectors may have implemented programs that change incentives, either by increasing the likelihood of detection and penalty for illegal discarding, or by changing incentives. An example of the latter would be if the sector maintains a pool of quota available to cover catch that can be purchased with certainty at a price lower than ex-vessel price or the prevailing market price of quota.

Overall the uncertainties and caveats of the analysis are well described, and the reader can draw their own conclusions. It seems likely the analysis is conservative in estimating the discard incentive. A key factor that may make the estimates of the discard incentives conservative is risk. If a captain (or decision maker) is uncertain they will be able to acquire quota to cover the fish they would otherwise discard and may be forced to stop fishing, they may add a risk premium to the cost of quota considered in Equation 2 from the document (see page 3), which will tend to increase the discard incentive. Because the estimates of discard incentives may have a conservative bias, it may be that discard incentives did exist in some cases where the estimated discard incentive is less than zero.

3. Are the analyses conducted at the appropriate temporal and spatial scale such that the existence of regional or seasonal differences in monitoring performance can be identified?

To the extent possible, the analysis is done at an appropriate temporal and spatial scale. The primary limiting factor is the data used to estimate quota values. These are generally quarterly estimates but sometimes annual estimates. However, the prices or expected prices could vary within quarters, by sector or by individual. This creates uncertainties in the analysis, but the decisions of the analysts appear appropriate.

It might be of interest to disaggregate the analysis and presentation of results to the sector level or some other grouping of vessels for which we might expect heterogeneity in incentives or behavior in relation to incentives. For example, different ports may have different ex-vessel prices. Some sectors may have different internal quota prices or a pool of quota that can be accessed at a known price. It might also be useful to present results on a quarterly basis. This might better identify times and stocks where discard incentives were positive.

4. What are the strengths and weaknesses of the methods? Are there constraints that would hinder the use of the catch monitoring analyses?

As the PDT notes in their own summary conclusions: "The model when it is applied to unobserved trips can only estimate a discard incentive when landings or trips comply with the discarding prohibition, even when it may not be economically rational to do so." The method is useful in showing that incentives to discarding did likely exist in certain circumstances. It is, however, unable to quantify the frequency or magnitude of actual discards. The analysis almost certainly underestimates the percentage of trips where discard incentives existed to the extent that there are trips where catch was discarded and thus was not included in the analysis. We

know, as the paper notes, that fish were landed in compliance with regulations despite a positive incentive to discard it. What we don't know is how often catch was discarded.

A simpler analysis might also be informative. Simply comparing ex-vessel prices (by grade and perhaps port) to quota lease prices would probably be almost as good an indicator of incentives to discard. It would not indicate the percentage of trips or catch for which incentives exist, but the current method underestimates this anyway since it does not apply the estimate to discarded catch. It would be possible, using this suggested method, or the method used in the analysis reviewed, to estimate the percentage of catch from observed trips where a discard incentive existed. This would be a useful exercise though it may also underestimate the percentage of catch subject to positive discard incentives to the extent that behavior on observed trips is different and leads to lower catch of fish with positive discard incentives.

5. Are the conclusions of the Plan Development Team supported by the analyses (see 1e)?

The conclusions of the PDT related to this analysis are reasonable and capture most of the key conclusions and caveats associated with the analysis. None of the conclusions of the PDT seem inappropriate, and the limitations of the analysis are acknowledged. The PDT notes that a positive discard incentive may indicate a bias in landings data, but they do not state that the analysis definitively proves the existence of substantial discards. They note that the analysis cannot quantify the proportion of trips where discards did occur or the amount of discards. As the PDT notes, more precise estimates of quota prices would enhance the ability of the model to identify where discard incentives existed.

6. Are there recommendations for improving the analyses, or for additional research or data collection that can help address improving groundfish monitoring?

A key to this analysis and a limiting factor is good approximations of the opportunity cost of quota that was used in making the decision to land or discard the fish. As noted by the PDT, better or more complete quota lease price data would help this. However, even with better estimates of market value of quota, the value assumed by the decision maker may depart from market value for reasons described above. This is probably an unresolvable problem.

The primary determinant of the discard incentive is the margin (or lack of margin) between ex-vessel price and quota price. It would be useful to include a chart or table comparing quarterly average ex-vessel price for various grades or the lowest grade and quarterly average quota lease price for stocks where discard incentives were relatively higher (though perhaps still negative on average). It appears that in most cases quota prices do not exceed average ex-vessel value, but the question remains as to whether this is the case for the lowest market grade. The table or chart suggested would provide an indication of where incentives for high grading exist, namely where higher grades of the species might be profitable to retain while lower grades of fish are not.

The analysis did not include data on observed trips. It would be useful to analyze these trips and compare the results with those from the unobserved trips already analyzed.

It might be useful to more carefully analyze trips where incentives to discard were positive or closer to zero to determine what drove these higher incentives in relation to the average incentive for that period and stock. For example, we might find that those trips tended to land a substantial amount of small or lower grade fish, or perhaps unmarketable fish. This would indicate a high grading issue rather than an incentive to discard all catch of that species. It might also identify heterogeneity across groups (e.g. ports with lower ex-vessel prices that have higher discard incentives).

*Editorial comments for authors:*

Throughout this paper and some of the other documents reviewed, authors refer to quota and quota price instead of ACE and ACE prices. If this is a standard convention in discussions in the Council arena, this may be appropriate. However, referring to ACE and ACE sales or trades would be more accurate than referring to quota and quota lease.

Pg. 1 paragraph 2: It is not clear what the authors mean by "we lack the terminology to communicate precisely what we are estimating." Please clarify this.

Pg. 2. 2nd paragraph, 2nd sentence. There is not necessarily an incentive to discard in all quota-based fisheries. It depends whether quota is limiting and how limiting it is and the cost of avoidance.

Pg. 2 last sentence of paragraph 3: Those less able or willing to discard may gain from a lower quota price. Quota owners lose from lower quota value to the extent that they lease rather than use quota and to the extent that discarding undermines the long term value of the quota.

Pg. 8, 1st full sentence. The value of forgone future catches of jointly caught stocks should be captured in the quota price unless quota price is being kept down by discarding or other factors (e.g. unwillingness to "gouge" in lease transactions as found by Holland (2013)).

## **II. Methods to evaluate observer effects in the groundfish fishery**

### **a. Reviewer Summary Comments:**

This analysis demonstrates that fishing vessels in the groundfish fishery alter their behavior in response to human observers. The analysis looked at eight measures: namely (1) trip duration, (2) kept catch, (3) kept groundfish, (4) kept non-groundfish, (5) total revenue, (6) groundfish average price, (7) opportunity cost of quota, and (8) number of groundfish market categories included in kept catch. These measures cover a broad range of impacts that are relevant for observer-related fisheries management policy. The analyses were conducted separately for four stanzas (one pre-sector stanza and three post-sector stanzas) and also by fishing gear (gillnet and trawl). Additionally, the approach was unique in how it chose its sequence of trips for analysis, which the reviewers appreciated. The analyses found statistically significant differences in many measures (but not all) between non-observed and observed fishing trips of the same vessels, strongly suggesting that fishers do alter their fishing behavior when a human observer is onboard.

b. Terms of Reference:

1. Are the methods adequately described and based on sound analytic techniques and statistical principles?

Yes. The core method used to construct the comparison pairs of non-observer and observer trips followed the procedure of Benoit and Allard (2009) and was explained well.

The only suggestion the reviewers have is to clearly state that the comparisons were made also with the same vessels. This is clear in Equation 3 from the document (see page 3), however only if one pays close attention to the use of subscripts. The term “exact matching” is used in the matching method literature and does not necessarily point to same-entity matching. Use of the same vessel for constructing the sequence of UUU and UOU trips as well as conducting the comparisons is the key feature of this study and what makes the analysis so clean, and thus deserves to be emphasized.

2. Are important uncertainties in the data and the analyses (possibly including the effects of year to year variations in fishing practices) identified, and are the impacts of these uncertainties on the analyses adequately described?

Yes. The use of four stanzas and constructing the UUU/UOU sequences that are within 45 days apart minimizes the temporal unobservable impacts on the analyses, such as seasonal and other environmental effects. Depending on the time of year, the 45-day decision is an important uncertainty in the analysis, as this could be a biologically meaningful period of time at the change of a season (for instance). However, the analyst made this decision as a trade-off between minimizing the amount of time while keeping enough data to analyze, which is justified. The use of the same vessels for the trip sequence and comparison controls for unobservable fixed effects unique to a vessel.

3. Are the analyses conducted at the appropriate temporal and spatial scale such that the existence of regional or seasonal differences in monitoring performance can be identified?

Yes, as described above.

4. What are the strengths and weaknesses of the methods? Are there constraints that would hinder the use of the catch monitoring analyses?

The strengths of the method used are as described above. Not as weaknesses but more as suggestions to make the results more robust, the reviewers have following suggestions.

For each of the eight measures, state the expected direction(s) of change or impacts of the human observer being present. The paper should explain not just that some behavioral changes were detected, but also whether those changes make sense. Some measures may be ambiguous, i.e., the impacts can go both ways, which is fine and makes a stronger case for having the “two-sided problem” section in the document. Also, along this line of thought, it would be helpful to link the five reasons for behavioral change outlined on p.2 to the eight measures.

Related to the comment above, it is strongly recommended that some of the measures be standardized by the trip duration. For example, a “kept catch” measure might be expected to go up, *ceteris paribus*, with an observer because there will be no illegal discarding but could also go down if vessels avoid areas with higher target catch but also higher catch of unwanted species. The results show, for trawls and gillnets, that kept catch was lower on observed trips. This may be due, at least in part, to the decline in trip duration. Revenue on observed trips also was lower than unobserved trips, which is in line with a priori expectation, but it also could be an artifact of shorter trip duration. It was discussed during the presentation that if all detected differences are stemming from shortened trip duration then there is no behavioral change that regulators need to be concerned about. Economic intuition tells us that is highly unlikely (i.e., there are likely to be behavioral changes in discarding and fishing location choice), but to make that point clearer and stronger these measures need to be standardized in a meaningful way. This may be partially accomplished by looking at changes in kept catch per day, but if catch increases nonlinearly with duration (e.g., because steam and search time are a lower proportion of trip length) we might expect kept catch to decline more than proportionately with duration. Alternatively, vessel monitoring system (VMS) data may be utilized to distinguish the tow/fishing time from steaming or searching time and it could be used to standardize the measures.

5. Are the conclusions of the Plan Development Team supported by the analyses (see 1e)?

Yes, but they will be strengthened by standardizing the measures as described above.

6. Are there recommendations for improving the analyses, or for additional research or data collection that can help address improving groundfish monitoring?

See item #4 above about standardizing the measures. Additionally, for clarification purposes, it will be helpful to define “opportunity cost of quota” (or simply linking the reason #5 described on p.2 of the document), along with how this was calculated.

Conjectures (or anecdotes) on the differences between the trawl and gillnet in the context of pre-harvest behavioral manipulation should be explicitly explained for the two following reasons. One is it motivates why the analysis should be conducted separately between these two fishing gear types. Another is it may be the core factor of why some results, i.e., behavioral responses to observed trips, are different.

The reviewers were told that more than the presented eight measures were analyzed but some were excluded from the report primarily because no statistically significant differences were detected. Some of them, however, would merit inclusion. Herfindahl-Hirschman Index (HHI) is one example; HHI is a measure of concentration and in this context can be used to measure whether the variety of fish species landed is more “concentrated” in handful of species. Intuitively, we think fishers will attempt to alter the composition of fish caught (e.g., less bycatch) through a strategic choice of fishing location in response to an observer on board. HHI is a measure that can detect such behavioral change.

Lastly, during the presentation the authors explained why they chose the max days between the fishing trips within a sequence (UUU or UOU) to be 45 days, and how they tested for both

shorter and longer durations. The reviewers feel this discussion merits inclusion as it would more strongly justify the choice of 45-days.

### **III. Methods to predict groundfish catch in the presence of observer bias**

#### **a. Reviewer Summary Comments:**

This method used observed trips in the Gulf of Maine (GOM) stock area to model expected cod catch while accounting for typical effort attributes (e.g., total kept catch, vessel size, trip length) in addition to spatial and temporal covariance in catch. The approach creates a predictive model, which was used to predict total cod catch (kept + discarded) on observed trips, to test the performance of the model. The predictive model was then used to predict catch for unobserved trips. Both predictions were compared to the summed predictions across a fishing season to the catch estimates for sectors reported by NMFS.

The method did a fair job of predicting catch for the observed trips, which is the dataset that the model was developed on, showing that the modeling approach has value and predictive power for the data used. The method also indicated discrepancies for the prediction of unobserved catch relative to the catch as reported by NMFS. This finding suggests a potential for unreported catch on the unobserved trips if it is assumed that observed trips can adequately represent unobserved trips with regard to “pre-catch” behavior, meaning a fisherman will operate in the same manner prior to catching fish on a fishing trip whether an observer is present or not. Pre-catch behavior was also modeled using several attributes of effort (e.g., kept all, location) that were expected and shown to influence catch outcomes.

Due to its current configuration, the method is likely conservative in its predictions (i.e. will produce lower expected catches than is true), because it is not proven that “pre-catch” behavior is similar between trips that are observed and unobserved. In particular for the case of otter trawl, even with short notice of a trip being observed, a fisherman could alter behavior more easily than a gillnet operation, which likely already has gear set before leaving the dock. There are still modifications that a gillnet operation could make, like shortening trips and only hauling certain strings of gear that they believe will be less likely to have unwanted species, but there are less options for modification for gillnetters relative to otter trawl.

The review panel offered suggestions on ways to improve the model. Generally, these had to do with the addition of new explanatory variables (potentially some of the information generated for the other methods examined during this review), additional data sources (vessels with cameras, VMS data, Industry-Based Survey (IBS) cod survey), and potential ways to include trips that did not land cod.

This method has an ability to predict unobserved discards controlling for differences in spatial distribution of unobserved trips relative to observed trips. The approach was novel and interesting, and showed some promise for informing the Council quantitatively in their

deliberations on Amendment 23 with some additional refinement and testing. For these reasons the review panel believes additional effort should be invested in this approach.

b. Terms of Reference:

1. Are the methods adequately described and based on sound analytic techniques and statistical principles?

Yes. The approach uses well defined statistical modeling principles, the documentation of the equations and underlying assumptions was thorough, and the model choices (e.g. error distribution) and other underlying theoretical aspects of the model were well justified for the hypothesis being tested.

Spatial and temporal covariance are two of the more interesting aspects of this approach. This was an area that was highlighted as worthy of additional investigation as far as how these aspects were parameterized, however even in their current state, these aspects of the model provide valuable insight into the issue of potential things that could influence observer bias and are based on sound principles and techniques.

There is one potentially important problem with the model specification that could cause bias and inconsistency in model predictions. The explanatory variables include a variable for all kept catch (namely, “kept\_all”). Part of this catch is cod, which is the dependent variable for the model. This is likely to lead to correlation between the residuals in the model and the variable kept\_all. For observations where cod is a large proportion of the total catch, the residual is likely to be increasingly negative (the model will likely be underpredicting the cod catch). This may account for the fact that the model, when applied to observed trips, tended to underpredict catch.

2. Are important uncertainties in the data and the analyses (possibly including the effects of year to year variations in fishing practices) identified, and are the impacts of these uncertainties on the analyses adequately described?

Yes. As highlighted by the analyst, other statistical distributions for expected catch on a trip (e.g., quasi-Poisson, negative binomial) could have been used. These alternate distributions may provide a better fit to the catch data; however, the analyst made a good case as to why he used the selected distributional assumption, namely that the random error term was useful at capturing over-dispersion in the predictions. This could be an area of further exploration.

As noted, the most unique aspect of the analysis was the temporal and spatial aspects of the model. The scale chosen for the spatial and temporal knots were not explored beyond those presented. Other choices should be investigated with a focus on finding the best trade-off between more refinement in the number of “knots” but not decreasing sample size to the point of adding an unreasonable amount of uncertainty in to this part of the analysis. This portion of the analysis also highlighted the limitations of using VTR data only as the data source in particular for the spatial information. VMS data might offer a refinement of this aspect of the data.

The reduction in effort and observer coverage across time was also an area highlighted as an uncertainty. The reviewers suggested adding more years of information to the model and the analyst noted that this would leverage parameter pooling across years and might yield more



accurate parameter estimation, the current configuration only used a small subset of years. A final note was that this model makes inferences from observed trips on to unobserved trips. This is important with respect to testing the hypothesis that there are likely differences between these two treatments, however this is an important uncertainty as you might never be able to know the full extent of the issue through this process. The reviewers offered additional analyses and modifications that might help address some of these uncertainties and are presented in this section (see #6 below).

3. Are the analyses conducted at the appropriate temporal and spatial scale such that the existence of regional or seasonal differences in monitoring performance can be identified?

Yes. In particular, the temporal scale of two weeks is likely adequate to capture things like seasonality in species abundance. The spatial resolution should be investigated to see if there could be more refinement, however there is a balance between refinement of the scale and loss of information in the data, so this should be investigated further.

4. What are the strengths and weaknesses of the methods? Are there constraints that would hinder the use of the catch monitoring analyses?

Strengths of the analysis include: it is predictive; it quantifies the potential difference between observed and unobserved trips; it is based on sound principles and statistical techniques; it accounts for heterogeneity in catch due to differences in space and time; it is able to account for biases of underlying data sources; and, as currently configured, it does not need additional or unique data sources.

Weaknesses of the analysis include: it was developed mainly for cod at this point; it is limited in some aspects by available data; it is computationally intensive; there is variability in the predictions for otter trawl that need further investigation; its use as a predictive tool will be bolstered by more data informing potential changes in “pre-catch” behavior and more refinement in spatial information; and more work on justifying the co-occurrence species is needed.

The model may be conservative in predicting cod catch on unobserved trips if fishermen were generally attempting to avoid cod catch on observed trips used to parameterize the model. This is partially controlled for with the spatial correlation terms, but fishermen could have employed other methods or information to avoid cod catch on observed trips.

5. Are the conclusions of the Plan Development Team supported by the analyses (see 1e)?

Yes, all of the comments about this method made by the PDT are noted in the documentation of the analysis or in this review of the method. The one caveat to this statement is with regard to the last statement made on the analysis for pollock by the PDT. This was done to show robustness of the method; however, the reviewers don’t believe that as much time was invested in this analysis, nor should there be an expectation that the same covariates that are useful for cod are useful for pollock. With a more species-specific model, the power of this method for use on other species should improve.

6. Are there recommendations for improving the analyses, or for additional research or data collection that can help address improving groundfish monitoring?

The reviewers made several recommendations for improvement to the model. These include eliminating cod from the right-hand side of the model either by replacing kept\_all with a new parameter comprised of kept\_all minus cod catch or by eliminating kept\_all and adding additional species catch variables but leaving cod out. Investigating new and/or additional covariates to help better inform the model could also improve the model performance. The reviewers suggested trying covariates that help in the prediction based on changes in population size such as using acceptable biological catch (ABC), or spawning stock biomass in the model as available or appropriate. Additionally, the reviewers thought that adding in some of the information generated by the other methods reviewed, such as using the discard incentive work might also be helpful. The reviewers suggested running the analysis across multiple years and to better refine the species selected as appropriate covariates in the model coupled with potentially finding ways to use these co-occurring species to bring in tows with no cod catch and develop an index such as employed in the development of a Jaccard Index (Jaccard 1901). The reviewers suggested using other data sources beyond observer data such as the Massachusetts IBS for cod and/or using data from vessels with cameras. Some other factors noted by the reviewers were that model validation was needed. The method was validated with respect to its predictive capacity, but should also be tested against an independent dataset, such as a fishery independent survey dataset). The reviewers also suggested running the model without discarded catch, and finally that the description of the results should try to better characterize the most likely outcome and uncertainty around that most likely outcome as many will likely be unfamiliar with the Bayesian approach to describing solutions and results.

#### **IV. Methods to evaluate groundfish catch ratios**

##### **a. Reviewer Summary Comments:**

The objective of the study was to compare ratios of stock-specific landings to effort and total catch on observed and unobserved trips in the multispecies groundfish fishery to determine whether there is evidence of an observer effect. The hypothesis of the study was that if constraining stocks lead to illegal discards, this should be evident in differences in the stock-specific ratios of landings to effort and total catch between observed and unobserved trips. The study assumes that differences are due to the observer effect (i.e., observed trips do not represent unobserved trips) and not due to the deployment effect (i.e., observers are not randomly distributed among fishing trips). Landings ratios were characterized at an aggregate level by gear type and broad stock area over an annual time step for both observed and unobserved trips. The reviewers appreciated the parsimony of this approach, but felt it needed a little more refinement as described below before it could be used by managers.

##### **b. Terms of Reference:**

1. Are the methods adequately described and based on sound analytic techniques and statistical principles?

Yes, the methods for this study are relatively straightforward and clearly described, although some aspects of the study would benefit from additional description.

The reviewers suggest that the report more clearly explain that the calculation of ratios of landing to total catch or effort ratios was conducted at the aggregate gear-area level rather than individual trip level. For example, the equation should include subscripts for species, area, and gear type, and a subscript on the sum function indicating summing across trips. Additionally, the description of the data should be clarified, and the “AA table” should be specifically defined.

While there is no statistical analysis of the differences in landings ratios, color coding is used to identify patterns that are consistent across landings ratios. Further description of criteria for what constitutes the identification of a pattern should be included as this plays an important role in interpretation of the results. The analyst should describe the rationale for assigning results using the yellow and gray color assignment and make clear that these do not indicate statistical significance.

2. Are important uncertainties in the data and the analyses (possibly including the effects of year to year variations in fishing practices) identified, and are the impacts of these uncertainties on the analyses adequately described?

The uncertainties in the data and analyses are not discussed extensively in the report, although it was noted that Sector IX trips were excluded from the analysis because they are known to be subject to misreporting. A key uncertainty not addressed in the study was the large differences in the sample size of observed to unobserved datasets, which introduces potential issues for the validity of the comparison of landings ratios. A more detailed description of the breakdown of data by finer spatial resolution and time step (season or month) would allow a more thorough evaluation of whether the observed samples were representative and comparable to unobserved samples. However, a more statistically robust treatment of the data is recommended (further detail is provided below).

3. Are the analyses conducted at the appropriate temporal and spatial scale such that the existence of regional or seasonal differences in monitoring performance can be identified?

The analyses appear to be conducted at the appropriate temporal and spatial scale. The analyses are conducted at the broad stock area (Gulf of Maine, Georges Bank, mixed stock statistical area 521) over the years 2011-2017. This allows for identification of regional and annual differences in observer effect but does not allow for seasonal differences to be identified. A more detailed description of the spatial and temporal distribution of the data would allow a comprehensive evaluation of whether the analysis could be conducted at a finer spatial or temporal scale. The limited number of observed trips included in the analysis suggests this may not be possible.

4. What are the strengths and weaknesses of the methods? Are there constraints that would hinder the use of the catch monitoring analyses?

**Strengths of the analysis include:** The study provides an evaluation of the observer effect in the groundfish fishery by gear type and area across years. The analysis was conducted at the

species/stock level which allowed for evaluation of the relative importance of the observer effect for certain stocks (e.g. Gulf of Maine cod). This study enabled identification of the direction of the observer impact (i.e. landings ratios on observed trips are greater/less than unobserved trips) and the relative magnitude of the effect through the ratio of observed to unobserved landings ratios (ratio of ratios). However, it stops short of characterizing the magnitude of the observer effect in quantities of pounds of fish landed (or discarded).

Weaknesses of the analysis include: The characterization of the results of this study seems to be narrow in scope and there is an opportunity to expand on this. An expanded description of the findings in the text and presentation of results in figures, rather than table format, would be helpful. For example, plots of landings ratios across years, may be easier for the reader to resolve patterns than the table format. The conclusions of this study could be strengthened through approaches that would allow for characterization of the variance between observed and unobserved landings ratios and explicit statistical testing for an observer effect. There is unequal sample size between observed and unobserved trips, with unobserved trips being an order of magnitude greater in number than observed trips. This unequal sample size could result in unequal variance that would challenge the ability to draw robust conclusions about an observer effect. Bootstrap resampling of trips could resolve this issue and could provide a good alternative to derive confidence intervals around the ratio estimates. This would allow for evaluation of whether observed landings ratios fall outside the bootstrap estimates of unobserved landings ratios. Alternatively, statistical testing of an observer effect could be addressed by conducting the analysis at the trip level and employing a generalized linear model or generalized mixed model (which may accommodate unbalanced design) to test for the effect of year, area, observer, and vessel factor (e.g. size/tonnage). Care should be taken in selection of the statistical distribution for modeling trip-level ratios however, since the distributions of ratios are likely to be highly skewed.

5. Are the conclusions of the Plan Development Team supported by the analyses (see 1e)?

In general, the conclusions of the PDT are consistent with the results of the analysis. The PDT concluded that: 1) there are discrepancies between the observed and unobserved trips, 2) more cod landings were seen on observed vs. unobserved trips in the Gulf of Maine stock area, and 3) less haddock landings were seen on observed vs. unobserved trips. The PDT cautioned against interpretation of the magnitude of the differences and indicated that the results were not likely an accurate estimation of the true extent of the potential missing removals. The study identifies absolute and relative differences in landings to effort ratios between observed and unobserved trips and may be useful in informing identification of patterns across years, species, and area. However, without characterization of the variance of observed and unobserved landings to effort ratios and statistical testing of differences it is challenging to draw robust conclusions. This study is helpful in identifying the problem, but it is challenging to use this in characterizing the magnitude of the problem. Also, the paper is helpful in that it supports findings of other papers.

However, the review panel would recommend further research to strengthen the robustness of this analysis.

6. Are there recommendations for improving the analyses, or for additional research or data collection that can help address improving groundfish monitoring?

The conclusions of this study could be strengthened through additional analysis that would allow for characterization of the variance between observed and unobserved landings ratios and statistical testing of the observer effect. To characterize variance, the reviewers suggest conducting bootstrap resampling of trips. This would allow for evaluation of whether observed landings ratios fall outside the bootstrap estimates of unobserved landings ratios.

Furthermore, the reviewers suggest calculating landings ratios at both the individual trip and aggregated gear level. This would allow for different types of statistical analysis to be applied to the dataset. For example, utilizing data at the trip level would allow for application of a generalized linear model or generalized mixed model to test for observer effect as well as the influence of other factors, such as year, area, and vessel factors.

The analyst could take a next step toward characterizing the magnitude of the illegal discard problem by calculating what the landings would have been based on the ratio of observed to unobserved trips on a species basis. This could provide perspective on the magnitude of the discard problem; however, the reviewers suggest that the analyst is the best judge as to whether calculation of magnitude is appropriate based on knowledge of the data and analysis.

## **V. Term of Reference 8**

### **a. Reviewer Summary Comments:**

This was a term of reference for all of the methods and was titled “Are the data, methods, and analytic tools sufficient for the Council to identify and analyze monitoring alternatives for the Northeast Multispecies Fishery Management Plan Amendment 23 management action?” The reviewers felt that this term of reference was cross cutting for all of the methods, therefore it was given its own section and answered in a way that is comprehensive across all of the methods examined.

### **b. Reviewer Comments:**

Each of the methods has strengths and weakness, but together the set of studies provide substantial support to conclude that there are differences both in discarding behavior and in fishing behavior between observed and unobserved trips. The analyses suggest that discard estimates from observed trips should not be used to estimate discards from unobserved trips, or at minimum not without some adjustments. In addition, this suggests it is not appropriate to determine a level of observer coverage that should be deployed by considering the coefficient of variation of discard estimates from observer coverage since observed trips are not representative of unobserved trips. Furthermore, these studies suggest that the direction of the impact of the observer effect on landings (positive or negative) appears to vary by species/stock.

The analyses do not quantify the magnitude of the problem of unaccounted discards. Both PDT analyses reviewed in section III (*methods to predict groundfish catch in the presence of observer bias*) and section IV (*methods to evaluate groundfish catch ratios*) of this report both could be used to provide estimates of the total quantity of unreported discards relative to annual catch limits (ACL) or ABCs with some additional refinement.

By way of some potential pathways for the Council to use this information, the reviewers offer the following comments. First, if the percentage of the ACL that is discarded on unobserved trips is not large (e.g. less than 10%) then it might be feasible to use the section III (*methods to predict groundfish catch in the presence of observer bias*) approach to estimate discards on unobserved trips and use this to determine an appropriate buffer between the ABC and ACL to account for management uncertainty.

Second, if discards are a large proportion of the ACL, then the above approach is unlikely to be successful and may be counterproductive. What we mean by this is that the increased buffer would have to be large and would aggravate the illegal discard problem, which could make estimating discards for unobserved trips more difficult and uncertain. In this situation, rather than attempting to estimate the discards, the analysis reviewed in section I (*methods to explore discard incentives of groundfish stocks*) suggests that there may be a need for increased monitoring and enforcement or increased penalties to deter illegal discarding. It would be useful to apply the discard incentive analysis to observed trips to see if a higher percentage of landed catch has positive discard incentives which would indicate more clearly the likelihood that discarding is occurring on unobserved trips. However, this would still suffer from the problem that observed trips' catch composition may differ from unobserved trips due to differences in fishing behavior.

In conclusion, the reviewers note that unaccounted mortality from the fishery is one of several contributors to issues in our understanding of groundfish populations. Resolving to better understand this potential bias will be a step forward in improving our understanding of groundfish populations and will contribute to improved accounting of fishery mortality in our management process.

## **References**

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## **Appendices**

### **Appendix 1 – Terms of Reference**



## New England Fishery Management Council

50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116  
John F. Quinn, J.D., Ph.D., *Chairman* | Thomas A. Nies, *Executive Director*

### MEMORANDUM

**DATE:** April 12, 2019  
**TO:** Scientific and Statistical Committee Subpanel for Groundfish Monitoring  
**FROM:** Tom Nies, Executive Director  
**SUBJECT:** **Terms of Reference – Review of Groundfish PDT Information and Analyses of Groundfish Monitoring Issues**

#### Background

The New England Fishery Management Council has organized this review to ensure that any new and novel analyses of Amendment 23 issues and management alternatives get sufficient independent review.

#### Terms of Reference

1. For each of the Plan Development Team's four analytic methods listed below (1a – 1d), please address the questions in numbered sections 2 through 8 below:
  - a. Methods to explore discard incentives and estimate prohibited discards of groundfish stocks.
  - b. Methods to evaluate observer effects in the groundfish fishery.
  - c. Methods to predict groundfish catch in the presence of observer bias.
  - d. Methods to evaluate groundfish catch ratios.
  - e. Groundfish PDT conclusions based on the analyses conducted
2. Are the methods adequately described and based on sound analytic techniques and statistical principles?
3. Are important uncertainties in the data and the analyses (possibly including the effects of year to year variations in fishing practices) identified, and are the impacts of these uncertainties on the analyses adequately described?
4. Are the analyses conducted at the appropriate temporal and spatial scale such that the existence of regional or seasonal differences in monitoring performance can be identified?
5. What are the strengths and weaknesses of the methods? Are there constraints that would hinder the use of the catch monitoring analyses?
6. Are the conclusions of the Plan Development Team supported by the analyses (see 1e)?
7. Are there recommendations for improving the analyses, or for additional research or data collection that can help address improving groundfish monitoring?
8. Are the data, methods, and analytic tools sufficient for the Council to identify and analyze monitoring alternatives for the Northeast Multispecies Fishery Management Plan Amendment 23 management action?



**1. Groundfish Plan Development Team (PDT) Analyses to be Reviewed**

- a. Methods to explore discard incentives and estimate prohibited discards of groundfish stocks
- b. Methods to evaluate observer effects in the groundfish fishery
- c. Methods to predict groundfish catch in the presence of observer bias
- d. Methods to evaluate groundfish catch ratios
- e. Groundfish PDT conclusions based on the analyses conducted
- f. Presentations

**2. Additional background materials**

- a. Draft Alternatives for Amendment 23/Groundfish Monitoring
- b. Gulf of Maine cod hotspot analysis by the Groundfish PDT

## **Appendix 2 – Review Agenda**



## New England Fishery Management Council

50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116

John F. Quinn, J.D., Ph.D., *Chairman* | Thomas A. Nies, *Executive Director*

### Meeting Agenda

#### New England Fishery Management Council

#### Peer Review of Groundfish Plan Development Team Analyses of Groundfish Monitoring

Hotel Providence  
139 Mathewson Street, Providence, RI 02903  
Telephone: (401) 861-8000

#### Day 1- Wednesday, April 24, 2019

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10:00 | Welcome, introductions and agenda review (Chair)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 10:15 | Review of Terms of Reference (Chair)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 10:30 | Groundfish Plan Development Team (PDT) Presentations and Panel Questions <ul style="list-style-type: none"><li>• Overview (Cournane)</li><li>• Methods to explore discard incentives and estimate prohibited discards of groundfish stocks (Errend)</li><li>• Methods to evaluate observer effects in the groundfish fishery (Demarest)</li><li>• Methods to predict groundfish catch in the presence of observer bias (Linden)</li><li>• Methods to evaluate groundfish catch ratios (Nitschke)</li><li>• Groundfish PDT conclusions based on the analyses conducted (Cournane)</li></ul> |
| 12:30 | LUNCH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 1:15  | Presentations and Panel Questions ( <i>continued</i> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 3:30  | Opportunity for public comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 3:45  | Review Panel discussion *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5:30  | Adjourn                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

- ***Note: The Chair may take public comments throughout the Review Panel discussion as appropriate.***

#### Day 2- Thursday, April 25, 2019

|      |                                                                |
|------|----------------------------------------------------------------|
| 8:30 | Review Panel comments and development of Review Panel report * |
| 1:30 | Adjourn                                                        |

- ***Note: The Chair may take public comments throughout the Review Panel discussion as appropriate.***

*This meeting is physically accessible to people with disabilities. This schedule is subject to change. If you have questions, please call the Council office for final confirmation of meeting times, dates and locations.*

**Amendment 23**

**To the**

**Northeast Multispecies Fishery Management Plan**

**Appendix VI**

**Cost Efficiency Analysis of Fisheries Monitoring for Catch Accounting in the  
Northeast Multispecies (Groundfish) Fishery**

## A Cost Efficiency Analysis of Fisheries Monitoring for Catch Accounting in the Northeast Multispecies (Groundfish) Fishery

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Updated September 15, 2019

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## SUMMARY

This report aims to illustrate differences in the costs associated with, and the underlying qualities of, data generated by various catch monitoring technologies in the commercial groundfish fishery in the Northeast US. For at-sea catch monitoring, our comparison primarily focuses on human at-sea monitors/observers (ASM) and electronic monitoring with video recording cameras (EM). Three EM models, census, audit and compliance, are analyzed. We compare single-year ASM costs by gear, vessel length, and homeport state to costs for EM technologies averaged over five years, the typical lifespan of EM onboard equipment. We provide a brief discussion of the cost and data quality associated with dockside monitoring of landings (DSM). For each monitoring technology, we report on two aspects of data quality: internal validity and external validity (Schram 2006). Internal validity refers to the error associated with sampling using the monitoring technology and external validity is associated with how those data are applied to catch monitoring. Understanding the qualities of data generating processes is integral to designing an efficient and effective monitoring system.

## INTRODUCTION

### Purpose of report

This report focuses on differences in costs and qualities of data generated by three technologies suitable for independent catch monitoring in the Northeast US commercial groundfish fishery: 1) human at-sea monitors/observers (ASM), 2) electronic monitoring with video recording cameras (EM) and 3) dockside monitoring of landings (DSM). Each of these technologies are designed to address different aspects of catch accounting that are potentially subject to independent verification. They each differ in the data they provide, the quality of those data, their up-front and life cycle costs, and their impact on various components of the fishing fleet. We estimate the costs associated with each technology and provide comparable cost estimates across technology platforms, both fleet-wide and disaggregated by various fleet components (e.g. gear type, vessel length categories, vessel principal port and state).

Cost efficiency analysis is best thought of as an optimization problem, where the objective is to minimize costs subject to a constraint. In this case, the constraint is a minimum coverage level capable of generating precise and unbiased catch data. The most cost efficient monitoring program is the one that provides data at or above this “precise and unbiased” threshold, at the lowest possible cost.

To provide an accurate comparison of monitoring technologies we must understand not only how the potential range of costs vary, but how the data they provide vary, and how the aspects of program design influence these differences in costs and data quality. For the latter, we report on two aspects: internal and external validity (Schram 2006). Internal validity refers to the error associated with sampling using the monitoring technology (i.e. is the monitoring program measuring what it’s supposed to measure and how precise are those measurements?) External validity is associated with how those data are applied to catch monitoring (i.e. can the data be generalized beyond the collected sample?) This information is integral to designing an efficient and effective monitoring system.

### Fishing fleet characteristics

We restrict our analysis to vessels making groundfish trips, identified using a definition from the NEFSC Report on the Performance of the Northeast Multispecies (Groundfish) fishery:

A groundfish trip is defined as a trip where the vessel owner or operator declared, either through the vessel monitoring system (VMS) or through the interactive voice response system, that the vessel was making a groundfish trip. This includes trips on which groundfish DAS were used, including monkfish (*Lophius americanus*) trips that used groundfish DAS (Murphy et al 2018).

Some of these trips may not have landed groundfish but are still subject to groundfish monitoring requirements. Trips exempted from current ASM requirements (eg. NEMS Framework 55-exempted trips) are excluded (NEFMC 2016). Figures 1 and 2, and Tables 1 and 2 summarize fleet characteristics for the vessels used on our analysis.



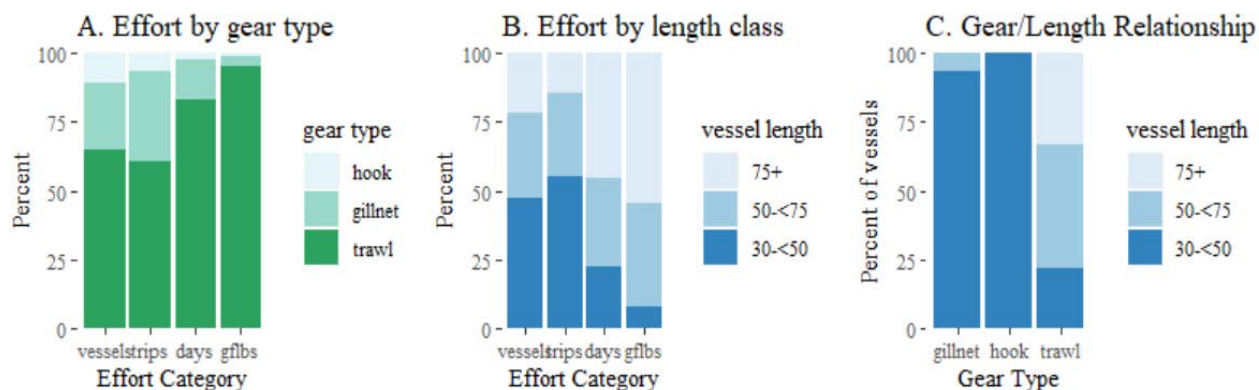


Figure 1, Percent of effort by gear type (A) and length class (B). Percent of vessels in each gear type by length class (C). Data are from FY 2017.

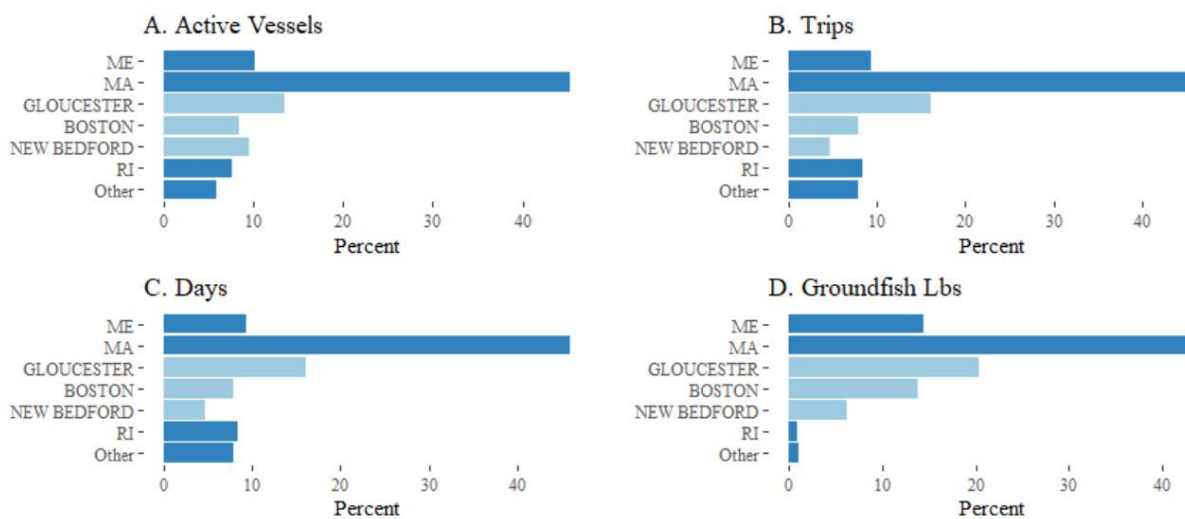


Figure 2, A-D. Percent of effort by Principal Port State (dark shade) or Principal Port (light color). Principle Port declared on permit application. Data are from FY 2017.

*Table 1. Number of active vessels by length, gear, and trip state, FY13-17. Vessels that fished across categories in a given year were placed in the category of maximum number of trips.*

| <b>Vessel Length</b> | <b>2013</b> | <b>2014</b> | <b>2015</b> | <b>2016</b> | <b>2017</b> |
|----------------------|-------------|-------------|-------------|-------------|-------------|
| 30 - <50             | 107         | 101         | 86          | 92          | 94          |
| 50 = <75             | 82          | 82          | 80          | 72          | 61          |
| 75+                  | 45          | 43          | 43          | 43          | 42          |
| <b>Gear Type</b>     |             |             |             |             |             |
| Gillnet              | 57          | 60          | 50          | 45          | 47          |
| Handgear/Longline    | 10          | 8           | 8           | 19          | 20          |
| Trawl                | 167         | 160         | 151         | 143         | 130         |
| <b>Trip State</b>    |             |             |             |             |             |
| MA                   | 144         | 144         | 134         | 132         | 130         |
| ME                   | 29          | 27          | 23          | 25          | 26          |
| RI                   | 37          | 29          | 31          | 27          | 23          |
| OTHER                | 26          | 28          | 22          | 24          | 19          |

*Table 2. Number of groundfish trips by length, gear, and landed state, FY13-17.*

| <b>Vessel Length</b> | <b>2,013</b> | <b>2014</b> | <b>2015</b> | <b>2016</b> | <b>2017</b> |
|----------------------|--------------|-------------|-------------|-------------|-------------|
| 30 - <50             | 4,646        | 4,057       | 3,199       | 3,057       | 3,305       |
| 50 = <75             | 2,472        | 2,232       | 2,213       | 1,755       | 1,829       |
| 75+                  | 987          | 1,064       | 972         | 960         | 834         |
| <b>Gear Type</b>     |              |             |             |             |             |
| Gillnet              | 3,234        | 3,082       | 2,097       | 1,981       | 1,870       |
| Handgear/Longline    | 134          | 55          | 97          | 232         | 401         |
| Trawl                | 4,644        | 4,200       | 4,109       | 3,488       | 3,632       |
| <b>Trip State</b>    |              |             |             |             |             |
| MA                   | 4,807        | 4,268       | 4,170       | 3,994       | 3,963       |
| ME                   | 901          | 878         | 532         | 427         | 571         |
| RI                   | 916          | 752         | 809         | 644         | 638         |
| OTHER                | 1,318        | 1,293       | 735         | 646         | 673         |

### Monitoring in catch share fisheries

Catch share management<sup>3</sup> requires information on the quantity, species and capture location of all fish that are retained (landed and sold) and discarded on every trip. This combination of information is necessary to account for the total amount of fishery removals by stock at the sector level, a process referred to as “catch accounting.” Presently, catch accounting uses a combination of self-reported data provided by industry (fishermen, sector managers or dealers) and independent data provided by fisheries monitors (Table 3). Fishery landings are recorded by vessel captains in Vessel Trip Reports (VTRs), by commercial fish dealers in Dealer Reports, and, on some proportion of trips, by contracted Observers in the Northeast Fisheries Observer Program (NEFOP) or At-Sea Monitors (ASM)<sup>4</sup>. Dealer reports are the primary source of pounds landed for catch accounting purposes. Fishery discards are required to be recorded by vessel captains on all trips, and by onboard fishery observers when present. Captain-reported discards are not currently used for catch accounting, and trip-level discard estimates are calculated on the basis of discards recorded on observed trips. Landings are not independently monitored, nor are discards on unobserved trips. Observers record kept catch weight estimates for the sole purpose of creating a ratio of kept catch to discards, which are used by NOAA’s Greater Atlantic Regional Fisheries Office (GARFO) to estimate a ratio of discards to landings for each strata of sector, stock area and gear type. This Discard Ratio (D/K, discards divided by kept catch) is applied to unobserved trips, by strata, to estimate pounds of discards on those trips. The estimated discards are added to the landings on unobserved trips for the total amount of fish deducted from the sector’s catch allocation (NOAA Fisheries 2010). Observer estimates of kept catch may be informally compared to VTR and dealer data, but are not formally utilized to verify either dealer or captain’s reports. Table 3 summarizes current data sources for catch accounting.

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<sup>3</sup> Since 2010 New England groundfish have been managed through an output control system known as catch share management (also referred to as sector management). Vessels voluntarily enroll in a sector that contractually agrees to specific fishing protocols and are allocated a portion of the overall quota, or catch share based on the catch history of their membership. Vessels are mandated to discard fish under minimum size limits and are required to land all legal sized fish they catch. Throughout the fishing year each member’s landings and discards are counted against the sector quota. The sector system is a voluntary system and vessels that elect not to join sectors can continue operating under the prior days at sea management system. These vessels are termed the “common pool” and account for a relatively small portion of total ground fishing effort. The common pool accounted for 23% of active groundfish vessels, 12% of groundfish trips, and 2% of groundfish revenue in FY2015 (Murphy et al 2018).

<sup>4</sup> NEFOP is a government-funded regional observer program that covers multiple fisheries. NEFOP observers collect catch data and biological information to inform stock assessments and bycatch estimation. NEFOP coverage levels are determined annually based on the number of sea days needed to achieve a coefficient of variation of 30% (CV30) of discard estimates for 14 fish and invertebrate species groups (Wigley and Tholke 2017). For the purpose of this report NEFOP is a sunk cost, as the NEFOP coverage fulfills a statutory requirement to determine discards of all species (not just groundfish). NEFOP observers also collect important biological samples required for stock assessments that cannot be completed by other monitoring technologies. Monitoring specifically for groundfish catch accounting is completed by the ASM program with the main goal of providing information on sector quota utilization. ASM monitors collect information on area fished, gear used and species and amounts of landings and discards.

Table 3. Fishing information provided by data source for catch accounting purposes. I=Independent data, S=Self-reported data. \*Location is independently reported but fishing activity is not.

| Data Source                                                | Gear | Fishing Location | Fishing information provided |         |          |         |          |         | Biological info |
|------------------------------------------------------------|------|------------------|------------------------------|---------|----------|---------|----------|---------|-----------------|
|                                                            |      |                  | Kept Catch                   |         | Discard  |         | Landing  |         |                 |
|                                                            |      |                  | quantity                     | species | quantity | species | quantity | species |                 |
| At Sea Monitors (ASM)                                      | I    | I                | I                            | I       | I        | I       |          |         |                 |
| Northeast Fisheries Observer Program (NEFOP)               | I    | I                | I                            | I       | I        | I       |          |         | I               |
| Dealer Reports (Electronic) Vessel Trip Reports (eVTR/VTR) | S    | S                | S                            | S       | S        | S       | S        | S       |                 |
| Vessel Monitoring System (VMS)                             | S    | I*               |                              |         |          |         |          |         |                 |

### Importance of monitoring

Monitoring provides an independent data source for verification of self-reported data. Much of the data used in the current catch accounting system are self-reported, and these data are not always perfectly reliable. Investigations of self-reported stock area on VTRs showed that on trips covering multiple areas, VTRs match observer reported stock area less than 50% of the time. For some stocks, this area misreporting implied a potential relative error in annual landings apportionment of up to 10 times when compared to landings estimated from independent stock area sources (Palmer 2017). Fishing location is just one aspect of self-reported data that may lack in accuracy. Recent enforcement investigations provide evidence that species and amounts of landings have also been misreported. One of the most prolific figures in New England groundfish recently plead guilty and was sentenced for filing reports falsifying the species of over 780,000 pounds of groundfish landings (Cramer 2017).

Accurate catch accounting information in the New England groundfish fishery is important for at least four reasons. First, there is a regulatory mandate to end overfishing (MSA 2007). At a basic level, this mandate cannot be met without accurate knowledge of the total removals of fish by stock. Second, overfishing limits are determined through stock assessments, which are reliant on fishery-dependent catch data as well as fishery-independent survey data. Stock assessments as employed in the Northeast assume that catch is known “without error,” a false assumption. Third, prevention of overages, through accountability measures (AMs), require monitoring to ensure they are implemented appropriately. Accountability Measures are fishing restrictions that are implemented to constrain or prevent catch for components of the fishery that have removals beyond the allowable catch. In groundfish sectors, overages of allocated stocks require sectors to payback the overage in the following year. For non-allocated stocks, gear restricted areas are typically enacted when a fishery-wide overage occurs. Timely, accurate catch information insures against allowing overages to occur without consequence or preemptively punishing segments of the fleet that are undeserved. Fourth, catch accounting information is important for the proper function of the inter-sector catch allocation lease market. Without adequate monitoring, fishermen have an incentive to highgrade or discard certain groundfish stocks if they do not have quota available or if the cost of leasing quota will exceed the revenue generated from landing (Batsleer et al, 2015). If, due to lack of monitoring, fishermen are only required to have enough quota to cover the fish that they land, rather than their total catch, the price signals provided by the lease market will not adequately allocate fishing

effort in space and time. This drives cost and revenue inequities between rule followers and rule breakers, and between active fisherman who may benefit from muted price signals, and fisherman who chose to lease out their allocations, who will lose income when lease prices fail to represent those consistent with true (fully monitored) demand. Furthermore, catch data are critical inputs into stock assessments. In fact, a feedback loop exists: quota allocations are based on stock assessments, which are based in varying degrees on catch monitoring. If catch is inadequately monitored, assessment quality may decline or fishing mortality signals may be missed, resulting in the need for lower future catch allocations, higher relative demand for constraining stock quotas, and increased highgrading and discarding incentives that mute price signals and exacerbate problems created by a poorly functioning market for catch allocations.

### Catch monitoring technologies

Three components of catch are important to groundfish fishery administration, each potentially subject to independent monitoring: landings, discards and the stock area from which the harvest was extracted. This report focuses primarily on technologies for monitoring discards.

#### Landings

As previously mentioned, dealer reports are the official data source for landing. Compliance with reporting requirements may be imperfect due to imprecision, loss of data from illegally discarded unmarketable or low-value fish, or intentional data manipulation. We discuss dockside monitoring (DSM) only as a tool for monitoring landings, and therefore this technology is not strictly a part of our cost efficiency analysis as no alternative methods of landings verification (e.g., so-called “weighmaster” systems, targeted enforcement) are assessed. To our knowledge, no formal assessment of the precision or bias associated with landings data has been produced, and, beyond DSM, a full suite of options for independent verification of landings has not been investigated.

#### Discards

For monitoring discards, we focus on the use of human observers under the ASM program and on a few strategies employing electronic monitoring using cameras. Critically, monitoring discards includes both accurately characterizing the size and species of fishery-wide discards and ensuring compliance with mandatory discarding and retention regulations. These dual priorities imply that discard monitoring must provide relatively precise and unbiased estimates of true at-sea discarding.

#### *At-Sea Monitoring*

Since 2010, the ASM program has been the sole method of estimating discards and ensuring compliance with mandatory discard and retention regulations. Monitoring coverage rates in the NEFOP and ASM program vary year to year (Table 4). ASM coverage rates are calculated by GARFO and are set such that when combined with NEFOP they are likely to provide discard estimates of each groundfish stock with a precision of CV30 or better (GARFO ASM 2017). Annual realized coverage rates can fall short of target rates due to a number of factors, including noncompliance with the pre-trip notification system (PTNS), a lack of available observers and trip cancellations by vessels.

A sub-committee of the New England Fishery Management Council’s Science and Statistical Committee reviewed several reports designed to investigate the precision and bias associated with discard data collected by human observers in the groundfish fishery, and found that estimates generated by the program to date (ie. partial fleet coverage) were likely to be biased and inaccurate (NEFMC 2019). We report cost estimates for varying levels of partial fleet coverage, but for cost efficiency purposes the cost of full coverage is the appropriate value to compare to other technologies. Defining full coverage for

human observers is not straightforward. Because the NEFOP program operates somewhat independently, and has averaged 9.1% coverage over the previous three years, a lower bound of full coverage implies approximately 91% of all trips. Noting that observers do not observe every tow of a trip, even this may not provide coverage that is directly equivalent to that provided by other technologies (Table 6).

*Table 4. Target and realized observer coverage rates, by fishing year. Reprinted from Table 4 in NOAA, GARFO ASM Requirements Summary FY2019.*

| <b>Fishing Year</b> | <b>NEFOP target coverage</b> | <b>ASM target coverage</b> | <b>Total target coverage</b> | <b>Realized coverage</b> |
|---------------------|------------------------------|----------------------------|------------------------------|--------------------------|
| 2010                | 8%                           | 30%                        | 38%                          | 32%                      |
| 2011                | 8%                           | 30%                        | 38%                          | 27%                      |
| 2012                | 8%                           | 17%                        | 25%                          | 22%                      |
| 2013                | 8%                           | 14%                        | 22%                          | 20%                      |
| 2014                | 8%                           | 18%                        | 26%                          | 25.7%                    |
| 2015                | 4%                           | 20%                        | 24%                          | 19.8%                    |
| 2016                | 4%                           | 10%                        | 14%                          | 14.8*                    |
| 2017                | 8%                           | 8%                         | 16%                          | 14.1%                    |
| 2018                | 5%                           | 10%                        | 15%                          | n/a                      |

### ***Electronic monitoring using cameras***

Electronic monitoring (EM) has been researched as a potential alternative to human fisheries observers for over a decade (i.e. Ames et al 2005, McElderry 2005, White 2006). EM systems have been approved and are currently in use in numerous fisheries, including groundfish fisheries on the US West coast (Fed Reg 2016)) and in British Columbia Canada (Stanley 2011). In New England, pilot projects for the use of EM in the groundfish fishery have been conducted since 2010 (NEFSC 2010-14), and this technology has been used by segments of the fleet as a replacement for ASMs under experimental fishing permits.

Electronic monitoring is a broad term that is often used to describe systems of varying complexity from anything that utilizes electronic data entry or collection to systems that use electronics to identify and quantify catch. For the purposes of this report, electronic monitoring refers to a camera-based system that collects video footage of fishing operations and electronically records other vessel activity and location data. This type of EM system includes, at minimum, two cameras (most vessels require more), a control box, user interface, a GPS receiver, a hydraulic pressure transducer, and a drum rotation sensor (Figure 6). In general, EM units shall be configured to provide GPS location and date at all times while the vessel is at sea, video imagery of all fishing operations with adequate resolution for species identification and estimate of fish size (depending on program design and requirements) and video imagery of transit operations with adequate coverage and resolution to determine if discarding is occurring.

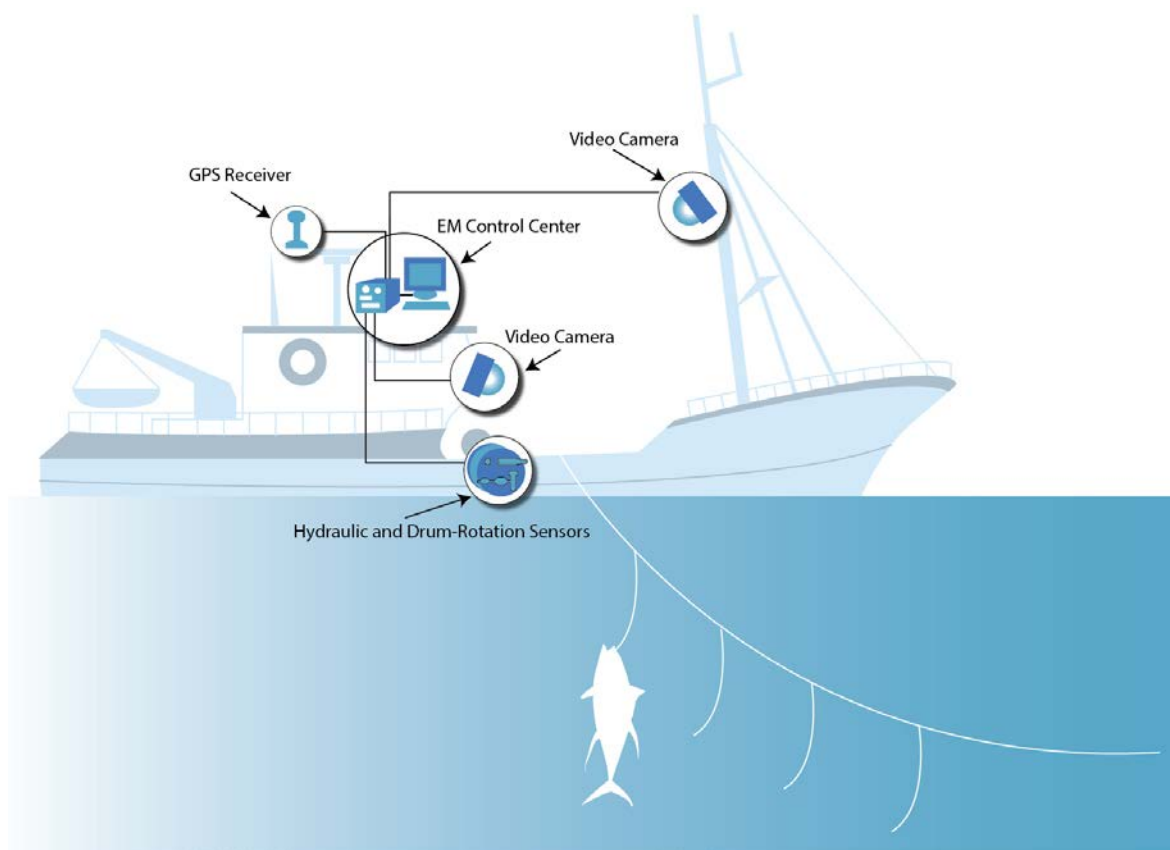


Figure 3. NOAA schematic of general EM setup.

EM models and program designs vary depending on the goals and objectives of the data collection. In New England, the goal has been accounting species and quantity of allocated groundfish discards. We investigate three EM models: 1) A census model where EM video is reviewed and used to directly identify and quantify discards. 2) An audit model where fishermen fill out electronic vessel trip reports (eVTRs) or other approved logbooks for each haul and discards are calculated directly from logbooks; a portion of the EM video is reviewed to verify and validate the accuracy of the logbook reports. 3) A compliance model where a majority of the catch is retained and EM footage is used to determine if discarding occurs but there is no attempt to quantify discards using video review<sup>5</sup>. Each system has various advantages and disadvantages (Table 5) and may be more or less suitable for different gear types and/or catch quantities.

<sup>5</sup> Maximum retention is not a one-size fits all definition. In the current EFP pilot project in the groundfish fishery, maximum retention consists of retention of all allocated groundfish, whether legal or sub-legal size. Non-allocated groundfish continue to be discarded.



*Table 5. Basic Electronic Monitoring program designs and associated advantages and disadvantages.*

| <b>Program design</b> | <b>Discard data source</b>            | <b>Disadvantages</b>                                          | <b>Advantages</b>                                                                             |
|-----------------------|---------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Census                | EM footage                            | high footage review time<br>specific catch handling protocols | high data quality                                                                             |
| Audit                 | logbook                               | specific catch handling protocols                             | lower footage review time<br>fishermen participation in data<br>incentives for catch handling |
| Compliance            | EM footage<br>(presence/absence only) | no discard quantity/composition<br>information                | lower footage review time<br>normal catch handling protocols                                  |

### Assignment of catch to stock area

The groundfish fishery regulations cover four species with multiple sub-stocks: cod, haddock, winter flounder and yellowtail flounder. These four species comprise 12 independent catch allocations, each generating it's own quota lease prices. As noted in Table 3, stock area catch allocation is primarily driven by self-reported VTR data. Given differences in quota lease prices for the same species, there are incentives to report catch into areas where it may not have been caught. Two mechanisms are at play. First, regulations allow reporting of catch in the area where a haul was ended and not necessarily the area where the fishing took place. Second, captains may strategically report catch into areas where they spent little time fishing. Palmer (2017) shows that inaccurate assignment of catch to stock area may be a significant problem for this fishery. Little research has yet been published comparing the efficacy of either human observers or EM for accurate stock area assignment, though it is generally assumed that both EM and human observers at high fleet-wide coverage rates will improve stock-specific catch data. Other cost-efficient technologies for improving the assignment of catch to stock area are not investigated here, noting that this is an important avenue for future research.



## METHODS AND MODELS

### At-Sea Monitors (ASM)

Using methods described in Ardini, et. al. (2019), sea day costs were attributed based on contracted rates specified in service agreements between sectors and monitoring provider companies for FY16-18, on an annual basis.<sup>6</sup> Sea day rates are generally calculated to cover all provider costs associated with providing ASM monitors, such that overall costs of program management (hiring, paperwork, reporting, etc.), as well as observer training, are built in to the sea day rates. Observer travel costs are based on percentages received from the ASM providers (Ardini et al 2019). The at-sea costs and travel costs were combined to give total ASM costs.

Current ASM coverage rates only place monitors on a relatively small portion of overall groundfish trips (see Table 2 for yearly ASM coverage rates). To compare ASM costs with different monitoring schemes, which may provide more complete monitoring coverage, we estimate ASM costs at coverage rates up to 100% ASM coverage, recognizing that NEFOP coverage exists in the groundfish fishery and comprehensive monitoring will likely imply an ASM coverage rate equal to 100 minus the NEFOP coverage rate. Over the fishing years 2016-2018, 9% of groundfish trips have been covered by a NEFOP observer.

ASM contracted rates have been negotiated on a yearly basis. Since there has been limited variability in ASM coverage rates, there is some level of uncertainty regarding how costs change when coverage is increased or decreased. We expect that higher coverage rates will decrease observer travel costs since there will be a greater pool of available observers to cover trips. We are less certain how a change in coverage may affect seaday rates. We estimate costs at increased rates as a function of the current contracted rates, with the following assumptions: Seventy percent of the sea day cost is fixed to cover the actual cost of having a monitor at sea, 10% scales based on the number of trips covered, 10% scales based on the total number of observers required to cover the specified level of coverage and 10% of the cost scales based on the coverage rate. Total cost is specified as

$$\sum_{t=1}^n \left[ (0.7 C_t) + (0.4 C_t \square (obs_o / obs_r)_t) \right] , \quad (Equation 1)$$

where  $C$  is the total cost of the trip estimated at the negotiated sea day rates averaged across the FY16-18 contracts,  $obs_o$  is the number of observers at the FY17 coverage rate and  $obs_r$  is the number of observers needed for the number of days observed.

For each 10% coverage rate interval we select a pool of trips for the given year. We repeat selections 20 times, so as to have 200 selections of trips for each fishing year (10 coverage rates, 20 pool selections for each). We then repeat this process for each of the five fishing years (2013-2017). For 100% coverage, every groundfish trip is selected, though even at 100% trip coverage, some hauls will be unobserved

<sup>6</sup> A majority of ASM costs have ultimately been reimbursed by NOAA. For July 2016 through April 2017, 85% of monitoring costs were reimbursed. For the entirety of FY17, the reimbursement rate was 85% [https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2017/06/16\\_asmreimbursement2017.html](https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2017/06/16_asmreimbursement2017.html)

(Table 6). ASM observers are able to observe virtually every haul on single day trips, but miss ~15% of hauls on multi-day trips.

To estimate the number of observers required for higher ASM coverage rates, we fit a simple linear function to combined ASM and NEFOP observer data from FY10-17 to determine the number of observers required annually to cover the various number of fishing days by month and provider (Figure 4). The slope of the regression line indicates that each additional day observed at the sector/month level results in .096 additional observers. Dividing 1 by this number yields an additional observer hired for every 11 days observed. This function slightly underestimates the number of ASM observers at lower coverage rates. For our purposes we use the number of ASMs used in FY17 (47) as our lower bound.

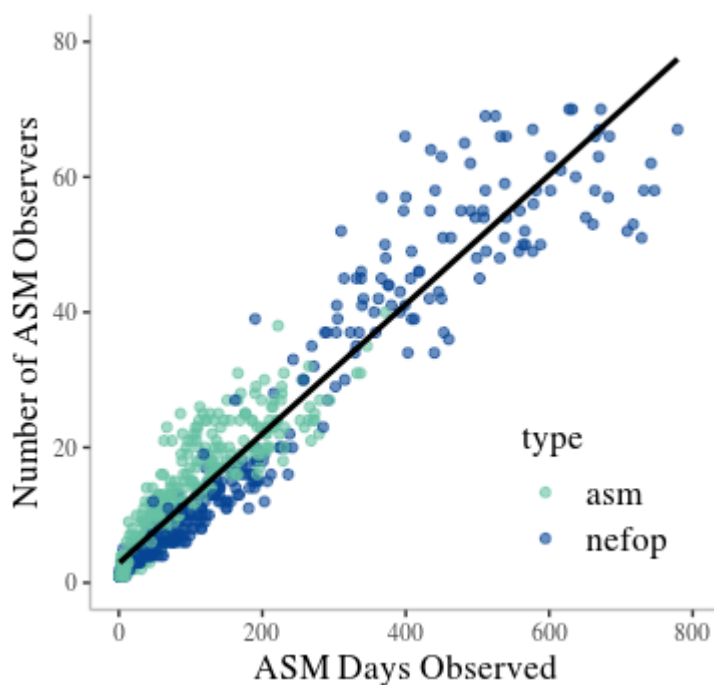


Figure 4. Total number of observers per fishing year to cover number of days by month and observer program using data from FY10 through FY17. Fit with linear function  $Y \sim 2.8742 + 0.0957DA$  with an  $R$ -sq of 0.91).

*Table 6. Percent of hauls unobserved on ASM covered trips by fishing year (Source: NOAA NEFSC Fisheries Sampling Branch. NEFSC protocols require that a minimum of 75% of all trawl hauls are observed).*

| <b>Fishing Year</b> | <b>% hauls unobserved on single day trips</b> | <b>% hauls unobserved on multi day trips</b> |
|---------------------|-----------------------------------------------|----------------------------------------------|
| 2010                | 2%                                            | 14%                                          |
| 2011                | 2%                                            | 14%                                          |
| 2012                | 1%                                            | 13%                                          |
| 2013                | 2%                                            | 14%                                          |
| 2014                | 1%                                            | 15%                                          |
| 2015                | 2%                                            | 14%                                          |
| 2016                | 1%                                            | 16%                                          |
| 2017                | 1%                                            | 15%                                          |
| 2018                | 2%                                            | 20%                                          |

## Electronic Monitors (EM)

Based on a literature review of existing EM programs and pilot projects, we developed a standardized survey to collect cost data from EM providers (see Appendix). The goal was to provide enough context of the fishery to allow respondents to provide specific cost information at a level of detail sufficient for modeling the costs component costs of many different management designs. Using data from these surveys and subsequent conversations with providers, we developed provider-specific cost functions for four separate EM program aspects: 1) Equipment, 2) Field services, 3) Data review, 4) Data storage. To maintain confidentiality, for each component cost function we ran 1,000 simulations that randomly select input variables from the four providers. One drawback of this method is that it washes out a lot of the variance in potential costs, particularly the common situation where providers optimize around different component of cost. Combining what should be inseparable components centralizes out around a mean cost that may not adequately capture the true cost from any one provider. Further, the actual range of potential costs will have greater variance than our estimates. We cannot maintain proper data confidentiality while still representing the cost actual variance because provider-level costs may be easily inferred. Last, we add additional uncertainty to model variables that we have lower confidence in based on conversations from program participants and/or actual data from pilot programs.

### Equipment

One-time EM equipment costs are estimated per-vessel, and include all hardware and software required for a fully functioning EM system. These do not include labor or travel costs for installation, which are included in the field services costs. We assumed three cameras are required for a system on all vessels with hook gear, and for all vessels that are less than 40 feet long. Four cameras are required for vessels using all other gear types greater than 40 feet in length<sup>7</sup>.

<sup>7</sup>

Based on specifications as noted in vessel monitoring plans for the three New England pilot projects.

One-time equipment costs were estimated as

$$\sum_{v=1}^n (SC_v + nC_{lg_v} + S_v + Sp_{l_v} + Hd_v + O_v)$$

(Equation 2)

Where  $SC$  is the System Cost (including two cameras, a control box, user interface, a GPS receiver, a hydraulic pressure transducer, and a drum rotation sensor),  $n$  is the number of additional cameras beyond three (taking a value of one or zero as four is the maximum number of cameras needed, depending on vessel length ( $l$ ) and gear type ( $g$ )),  $C$  is the cost of additional cameras,  $S$  is the cost of Software,  $Sp$  is the cost of spare parts, scaled by the vessel length ( $l$ ),  $Hd$  is the cost of 3 hard drives and  $O$  is all other costs required for an equipment system or install, indexed across each vessel,  $v$ . Uncertainty is added as a CV of 0.1 for the cost of spare parts and other costs, as these are variable.

### Field services

Field services include all field-based technical support such as equipment installation and maintenance, travel to and from vessels, support and feedback in case of equipment malfunction and data transfers. Where other aspects of an EM program such as equipment costs or data storage costs scale linearly with effort or are otherwise invariant, field services costs are highly variable based on the fleet's geographic composition, program design, and the desired level of operator interaction. These costs are also impacted by the enthusiasm for participation by the fleet—if vessels are committed to the process, it will run more efficiently. If they are not, costs will increase as installations are rescheduled, or proper care and maintenance of on-board EM systems do not occur. Field services are one of the most difficult aspects of EM costs to model. Further, field services, more than other aspects of EM costs, change with time. Costs are front loaded in the first year of programs when equipment installations occur and captains are getting familiar with the systems and processes and require more support.

We estimate field services separately for year one and subsequent years. Year one field service costs are represented as  $I+M+O$  where  $I$ =Install costs,  $M$ =Maintenance costs and  $O$ =Other costs. Year one costs are higher because they include system installation costs as well as frequent return visits to check on systems and make adjustments.

Subsequent year field service costs include maintenance costs (which decline by half in year two, by a third in year 3 and by a quarter in year four, after which they are fixed) and other costs, fixed for each year and include on-call phone response to service events plus costs for data transfer to and from the vessel.

Install costs are the sum of labor and travel costs. We assume two technicians are required, one at a random range of the lower hourly wage provided in our survey and one at a random range of the higher survey-provided hourly wage. Thus,

$$\sum_{v=1}^n (h_{cl_v} e + 2) * w_{h_v} + (h_{cl_v} e + 2) * w_{l_v} ,$$

(Equation 3)

where  $h_{cl}$  is the hours per install scaled by the number of cameras in the system and the vessel length,  $e$  is an error of CV0.1 associated with that hour estimate  $w_h$  is a randomly selected high hourly wage and

$w_l$  is a randomly selected low hourly wage, indexed by vessel. We assume each vessel requires a fixed two hours of organizational and prep time. This may include coordinating with the captain or developing a vessel install plan.

Travel costs are estimated similarly for install and maintenance. We assume technicians are traveling from one of six ports: Portland, ME, Gloucester, MA, Boston, MA, Chatham, MA, New Bedford, MA or Point Judith, RI. We used the R package `gmapsdistance` to identify which of these six ports was closest to the vessel homeport and the associated distance and travel time. We assume travel costs are reimbursed at the technicians hourly rate, mileage is reimbursed at \$0.54/mile, per diem is between \$40 and \$61 and lodging is between \$120-\$150/night. As per federal travel regulations, lodging is only incurred if the technician is traveling over 50 miles. We assume installs are scheduled back to back in each home port. This likely overestimates install efficiency. Maintenance and scheduling assumptions may, however, underestimate efficiency and we believe these assumptions are therefore unbiased.

Maintenance costs are estimated assuming: 1) Vessels require a visit from a technician at a rate of every 7<sup>th</sup> trip with a maximum of three visits per vessel. 2) Each maintenance check takes 4 hours and is performed by the technician at the lower hourly wage rate. 3) Two vessels can be checked per location per day but a technician spends a maximum of three days in a row in a port. 4) Technicians travel to and from their base port to the vessel's home port after each three day stay is completed.

Other costs include one technician on-call for phone response to service events and the cost to mail hard drives from the vessel after every trip plus an additional half hour for handling and tracking data. Many pilot programs mail hard drives after two or three trips are completed, which could be implemented as a cost savings measure but also increases the likelihood of lost or corrupted data.

## Review Costs

Video footage review is a substantial component of overall EM program costs. There are two common methods for estimating video review costs. The first is a "ratio method," which estimates the amount of time required for an analyst to review a set amount of footage based on a ratio of review time to total video footage. This estimate is multiplied by the hourly wage of an analyst to estimate cost. However, the ratio of review time to footage time is highly variable and is impacted by many factors, themselves quite variable, which include, but are not limited to, the skill and experience of the reviewer, the catch handling capabilities of the crew, the quality of the video footage, the gear type and the species composition (both total number and type of species) of the catch, and the program design (personal communication, Amanda Barney). Using data from pilot projects in the region, we estimate a regression to relate review time to these other variables. Importantly, the variable that had the largest impact on review times was the individual vessel (standardizing for catch composition, gear type, trip length, etc).

Another challenging feature of review costs is estimating the amount of footage requiring review. One aspect depends on the design of the program and whether transit times are reviewed, or if only haul back and catch handling/sorting require review. Another aspect is estimating the relationship between fishing effort and sorting/catch handling time.

We estimate review costs as

$$\sum_{g=1}^3 \sum_{t=1}^n (R_{S_{gt}} * T_{d_{gt}} + R_{f_{gt}} * F_{d_{gt}} + P_{gt}) * L_{gt}$$

(Equation 4)

where  $R_s$  is the review ratio for transit time,  $T_d$  is transit time (duration),  $R_f$  is the review ratio for fishing time,  $F_d$  is the fishing duration,  $P$  is footage/data preparation time and  $L$  is the hourly rate for a reviewer. The total cost is the sum of these costs, indexed across each trip,  $t$  and gear type  $g$ . These are estimated separately for each program design. The review ratio method assumes that review costs scale linearly.

An alternative method to estimate review costs, not used here, would assume that they do not scale linearly and, rather, are subject to specific thresholds of video footage at which point more analysts are hired. Numerous providers state that this is how they approach budgeting for review costs (personal communication, Alaska EIS). We were unable to produce credible estimates of such thresholds, but felt it was important to mention that the linearity assumed in the ratio method may overestimate costs.

### **Fishing duration estimation**

Observers collect data on fishing duration (the time fishing gear is in the water) for observed trips, but there are no equivalent data for unobserved trips. Other effort proxies such as total trip duration and number of hauls are reported for all trips on VTRs. To estimate time fishing, we used observer data from 2013-2017 and model, by gear type, the relationship between fishing time and total trip duration (see appendix for detailed modeling information). These models were used to estimate fishing duration for all FY17 trips. Figure 5 compares predicted estimates to actual fishing duration for observed trips in the FY17 data.

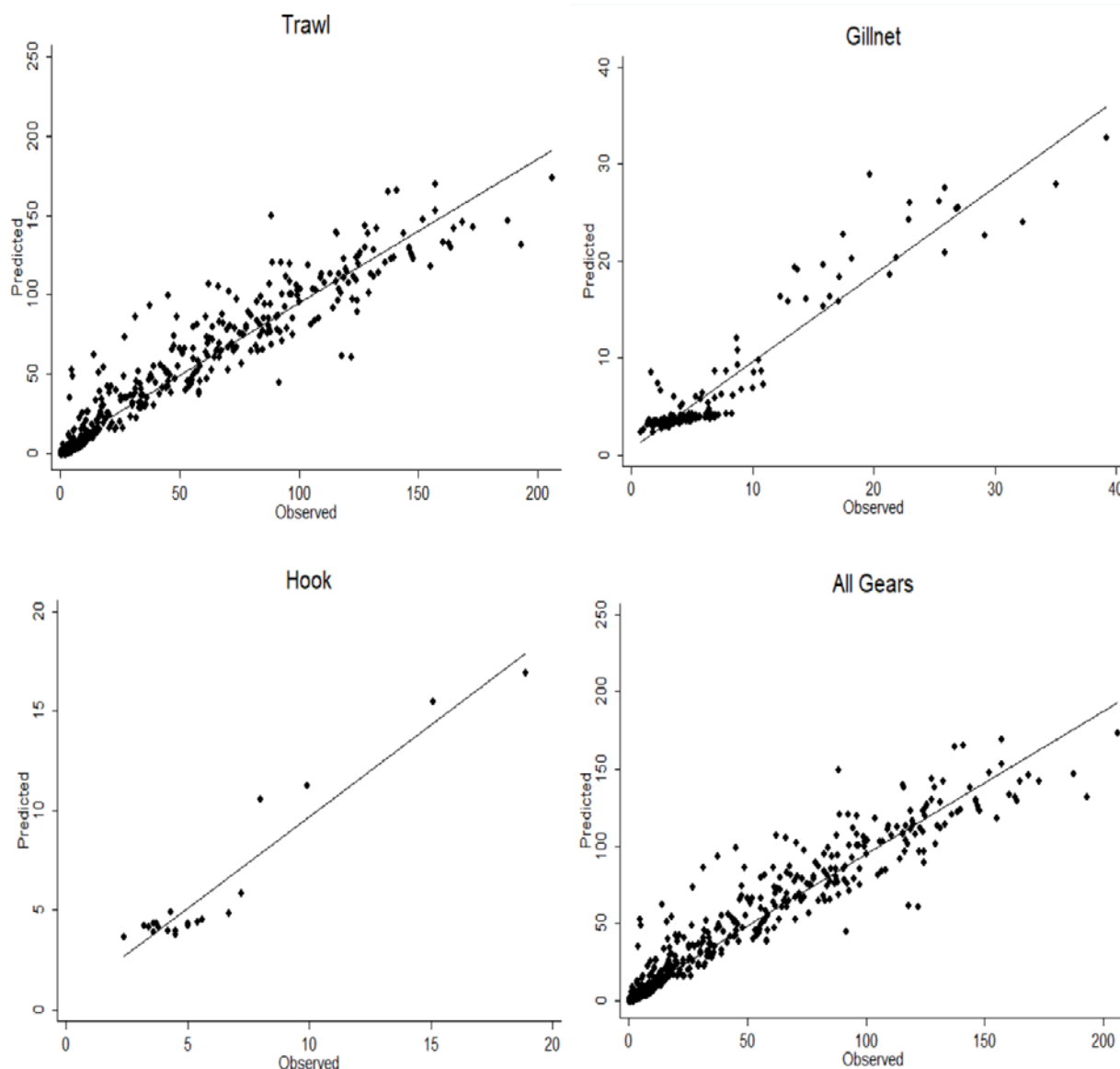


Figure 5. Fishing time (duration) in hours from observer data, plotted against fishing times predicted from linear models using all observed groundfish trips in FY17. One to one line is added for comparison. Trawl  $N=490$ ,  $R^2=0.91$ ; Hook  $N=22$ ,  $R^2=0.92$ ; Gillnet  $N=206$ ,  $R^2=0.90$

For estimates of  $R_s$ ,  $R_f$ ,  $P$  and  $L$ , we randomly select from a uniform distribution between the minimum and maximum estimates provided in the cost surveys. Review ratios differ by program type based on the data collected and recorded. Census programs require the most review time, followed by audit programs, and trailed by compliance programs, which enable substantially faster video review.

### Data storage

There are two main options for storing data: cloud storage and on site servers. On site storage can be a less expensive option when the exact amount of data to be stored is known and servers of the appropriate size can be built; or when data locations are remote and (slow) internet speeds or other expenses prohibit

sending data to the cloud. Additionally, federal data redundancy requirements impose costs for on site server storage that could require building the same storage center in two locations. Our cost estimates assume EM data will be stored in the cloud. Estimating prices for cloud based storage is relatively straightforward and many companies, such as Amazon and Google, list their price structures publicly (Table 9).

Estimating the volume of data created is more complex, as it is a function of numerous technical variables and policy decisions. Video footage data volume is primarily based on four variables:

- 1). Resolution (pixel dimensions) - Also referred to as frame size this is the amount of pixels an image contains. It is specified as the number of horizontal pixels by the number of vertical pixels. For example a resolution of 1280x720 is the minimum resolution to be considered high definition.
- 2). Frame Rate (frames per second) - The number of individual frames in each second of video recorded.
- 3). Bit rate (MBPS-mega bits per second) - The number of bits that are processed in a unit of time or the amount of data used for each second of video. For example most DVDs are 4-8 MBPS while a Blu-ray is 25 MBPS. Most cameras record at varying bit rates and allow you to set a maximum bit rate.
- 4). Subject (what you are recording) - video records a still image and software converts that to moving images. Two videos of the same duration taken with the same camera with identical resolution, frame rate and bit rate can create different amounts of data depending on how they are rendered and the content of their images. For example a two minute recording of a blank wall will be much smaller in size than a two minute recording of a kayaker going through whitewater. These variables also impact the quality of the video, noting that this is also related to external variables such as lens cleanliness and the amount of ambient light. A more complete description of the data usage associated with different subjects can be found in the Appendix.

EM video quality specifications are mostly in the form of performance requirements specifying data needs and objectives (i.e. systems must be able to “Identify, count, and assign a catch disposition--kept or discarded--for individual catch items” or “Obtain an accurate estimated length per catch item, sufficient to obtain a weight estimate from length:weight keys” (NMFS 2016).

The latest draft specifications from the Northeast Fisheries Science Center adopt some minimum technical specifications: “Camera resolution must be a minimum of 1,280 x 720 (720p) for enhanced identification and measurement during video review” and “Each camera must record at a speed of no less than 15 unique frames per second when the use of a video monitoring system is required” (NMFS 2016).

Additional policy specifications will impact how much data volume is created.

- What qualifies as data? Will all footage from the entire fishing trip need to be retained and stored, or just haul back and sorting time?
- What are the retention duration requirements, and where do they apply? Is video footage considered a federal record that must be retained for seven years, or do retention requirements apply only to the data derived from the video?
- How often do data need to be accessed or stored? What are the access requirements, and who will manage access?



Under particular specifications, shipboard systems could be developed triggering hydraulic sensors such that video is recorded only during necessary times (e.g. when the gear is hauled back with a set additional time after for catch handling). If not all footage is considered a federal record, or if resulting data tables meet the records retention requirement, shipboard systems could be simplified to record everything.

Table 7. Cloud data storage/access pricing (<https://cloud.google.com/pricing/>,  
<https://aws.amazon.com/glacier/pricing/>, accessed 11/16/17)

| Provider        | Storage                  | put                            | get                             | Access              |
|-----------------|--------------------------|--------------------------------|---------------------------------|---------------------|
| Amazon Glacier  | per GB/Month<br>\$ 0.004 | per 1,000 requests<br>\$ 0.05  | per 1,000 requests<br>\$ 0.025  | per GB<br>\$ 0.0025 |
| Google Coldline | per GB/Month<br>\$ 0.01  | per 10,000 requests<br>\$ 0.05 | per 10,000 requests<br>\$ 0.004 | per GB<br>\$ 0.05   |

The cost of storage is mainly a function of datavolume ,  $V$ , defined as the footage duration multiplied by the GBPH. For our estimations we assumed fishing footage would be captured at a higher quality than transit footage. More information on data storage and quality can be found in the Appendix. Assuming Amazon and Google provide similar services, we use Amazon's price structure as it is slightly less expensive, particularly if there is no need for frequent data access, unlikely in most management scenarios.

We estimate annual storage costs as:  $S+P+G+A$ ,

where  $S$  is the storage cost defined as  $V*0.04*12$ ,  $P$  is the put fee which, assuming there are no more than 1,000 annual requests is a constant of \$0.06 ( $\$0.005*12$ months),  $G$  is the get fee which, assuming there are no more than 1,000 annual requests is a constant of \$0.30 ( $\$0.025*12$ months) and  $A$  is the access cost defined as  $\$0.0025*V_a$  where  $V_a$  is the volume of data that must be accessed. We assume only 10% of the total data needs to be accessed on an annual basis, estimating  $V_a$  as  $0.10V$ .

## MONITORING DISCARDS

The quality of data produced is an important consideration when comparing relevant costs between monitoring technologies. For example, the improvements in data quality associated with increases in ASM coverage vs. EM video review rates are not equivalent, making direct comparison difficult. To approximate feasible program designs with equivalent data quality we compare costs of an ASM program at 91% coverage with the three EM programs. Proportion of video reviewed is the primary driver of EM program cost, and to keep things simple we use the following review rates in our cost models: audit 15%, census 50%, and compliance 100%.

### At-Sea Monitors

Marginal (per-day) ASM costs are estimated to decline as coverage increases, primarily driven by operational efficiencies from a larger cadre of available observers. Cost per day ranges from a median of \$590 at 10% coverage to \$518 at 100% coverage, noting that unless NEFOP rates decline to zero, 100% ASM coverage is not a feasible outcome. NEFOP coverage has averaged 9.1% over the previous three years, and the daily rate estimated for 91% ASM is \$524 (Figure 6).

We present total ASM costs at 10% coverage intervals (Figure 7). Costs in earlier years are higher, driven by more fishing effort. Variability in ASM costs for a given year and coverage rate is a function of the trips selected during simulation and the per-day ASM costs, which we model as declining slightly at coverage levels above 50%. The cost estimates for 100% ASM coverage for a single year range from \$6.9m (FY17) to \$9.6m (FY13) (Table 8). However, with NEFOP coverage, an 100% ASM coverage would not be necessary to achieve universal fleet-wide coverage.

Over the five-year period, 91% ASM coverage averaged \$7.6m annually and comprehensive ASM coverage cost was \$6.4m in 2017. At FY 2013 effort levels, 91% ASM coverage is estimated to have cost \$8.8m (Table 9) Average per-vessel costs vary substantially by size class and gear type, driven by the number of days fished in any given year (Table 10). At 91% coverage, the largest vessels have an predicted per-vessel average cost of \$67k per year while the smallest are predicted to average \$15k (Table 11). These averages mask tremendous variability, as, again, ASM costs are driven by days fishing more than gear type or vessel size.

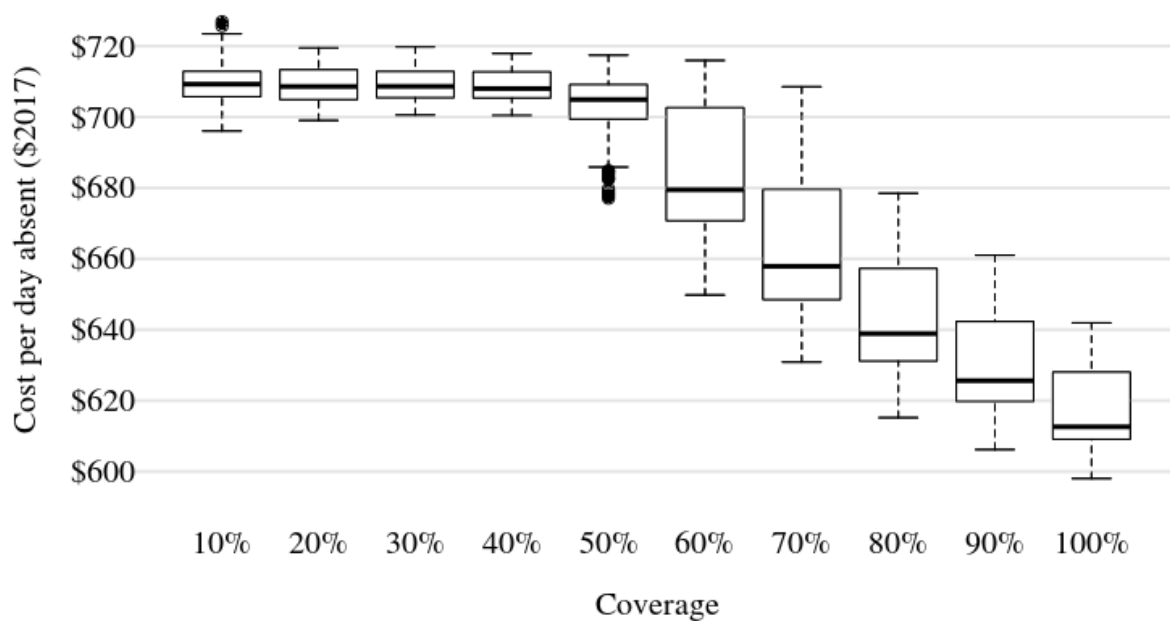


Figure 6. ASM cost per day at various coverage levels, estimated using FY13-17 effort data

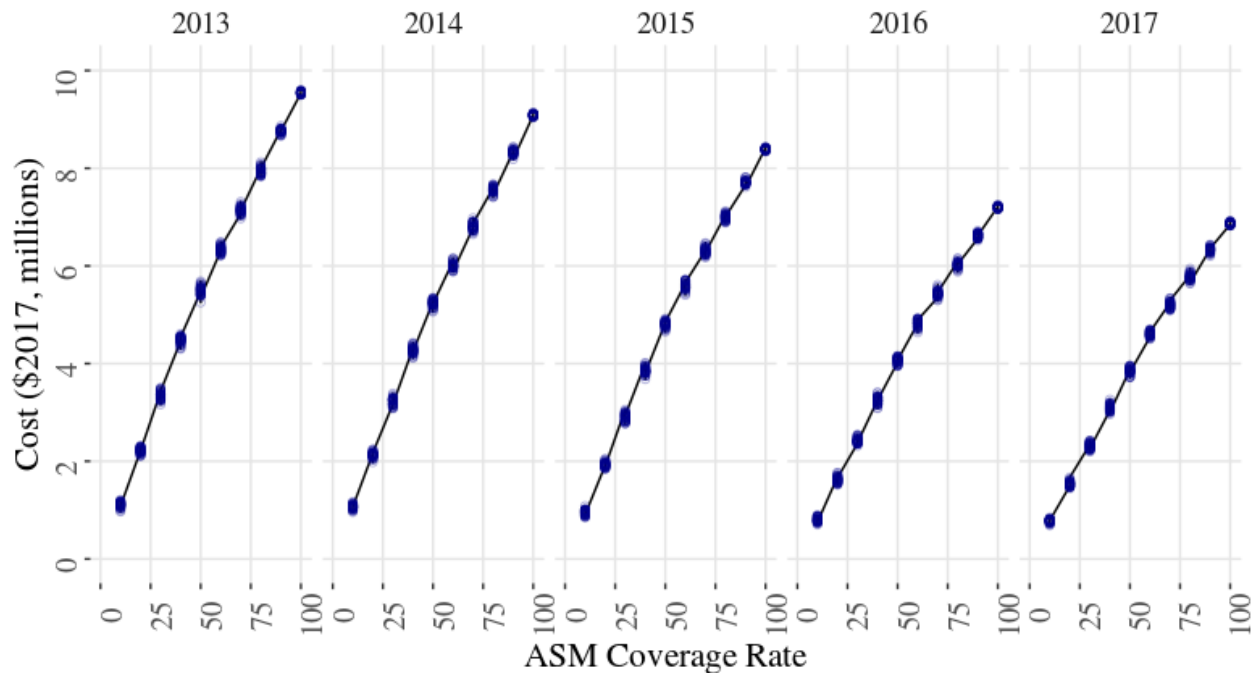


Figure 7. Fleet-wide ASM costs estimated from FY13-17 fishing effort

*Table 8. Median estimated ASM costs for fishing years 13-17 at 10% coverage rate intervals (\$2017, millions)*

| <i>Coverage rate</i> | <b>2013</b> | <b>2014</b> | <b>2015</b> | <b>2016</b> | <b>2017</b> |
|----------------------|-------------|-------------|-------------|-------------|-------------|
| 10                   | 1.1         | 1.1         | 1.0         | 0.8         | 0.8         |
| 20                   | 2.2         | 2.1         | 1.9         | 1.6         | 1.5         |
| 30                   | 3.4         | 3.2         | 2.9         | 2.4         | 2.3         |
| 40                   | 4.5         | 4.3         | 3.9         | 3.2         | 3.1         |
| 50                   | 5.5         | 5.2         | 4.8         | 4.1         | 3.9         |
| 60                   | 6.3         | 6.0         | 5.6         | 4.8         | 4.6         |
| 70                   | 7.1         | 6.8         | 6.3         | 5.4         | 5.2         |
| 80                   | 7.9         | 7.6         | 7.0         | 6.0         | 5.8         |
| 90                   | 8.8         | 8.3         | 7.7         | 6.6         | 6.3         |
| 100                  | 9.6         | 9.1         | 8.4         | 7.2         | 6.9         |

*Table 9. Median estimated ASM costs for fishing years 13-17 at 91% coverage rate (\$2017, millions)*

|                     | <b>2013</b> | <b>2014</b> | <b>2015</b> | <b>2016</b> | <b>2017</b> |
|---------------------|-------------|-------------|-------------|-------------|-------------|
| <b>91% coverage</b> | 8.84        | 8.4         | 7.78        | 6.68        | 6.39        |

Table 10. Mean estimated per-vessel ASM costs for fishing years 13-17 at 10% coverage rate intervals (\$2017, thousands)

| Length class | Coverage rate | 2013 | 2014 | 2015 | 2016 | 2017 |
|--------------|---------------|------|------|------|------|------|
| >=30', <50'  | 10            | 2.4  | 2.1  | 2.1  | 1.6  | 1.8  |
|              | 20            | 4.8  | 4.2  | 4.2  | 3.2  | 3.7  |
|              | 30            | 7.2  | 6.2  | 6.4  | 4.8  | 5.5  |
|              | 40            | 9.6  | 8.3  | 8.5  | 6.4  | 7.3  |
|              | 50            | 11.8 | 10.2 | 10.6 | 8.1  | 9.1  |
|              | 60            | 13.6 | 11.7 | 12.3 | 9.6  | 10.9 |
|              | 70            | 15.4 | 13.2 | 13.8 | 10.8 | 12.4 |
|              | 80            | 17.1 | 14.7 | 15.3 | 11.9 | 13.7 |
|              | 90            | 18.8 | 16.2 | 16.9 | 13.1 | 15.0 |
|              | 100           | 20.5 | 17.7 | 18.4 | 14.3 | 16.3 |
| >=50', <75'  | 10            | 5.0  | 5.0  | 4.4  | 3.7  | 4.1  |
|              | 20            | 10.0 | 10.0 | 8.9  | 7.4  | 8.2  |
|              | 30            | 15.0 | 15.0 | 13.3 | 11.2 | 12.3 |
|              | 40            | 20.0 | 20.0 | 17.7 | 14.9 | 16.4 |
|              | 50            | 24.7 | 24.4 | 22.1 | 18.6 | 20.5 |
|              | 60            | 28.4 | 28.0 | 25.6 | 22.1 | 24.6 |
|              | 70            | 32.0 | 31.7 | 29.0 | 24.9 | 27.9 |
|              | 80            | 35.6 | 35.3 | 32.1 | 27.5 | 30.7 |
|              | 90            | 39.2 | 38.8 | 35.4 | 30.3 | 33.8 |
|              | 100           | 42.8 | 42.4 | 38.5 | 33.0 | 36.6 |
| >=75'        | 10            | 9.7  | 10.2 | 9.7  | 9.0  | 8.1  |
|              | 20            | 19.5 | 20.3 | 19.4 | 18.0 | 16.2 |
|              | 30            | 29.2 | 30.5 | 29.2 | 27.0 | 24.3 |
|              | 40            | 38.9 | 40.7 | 38.9 | 36.0 | 32.4 |
|              | 50            | 48.0 | 49.7 | 48.6 | 45.0 | 40.5 |
|              | 60            | 55.2 | 57.2 | 56.3 | 53.4 | 48.5 |
|              | 70            | 62.3 | 64.6 | 63.6 | 60.2 | 55.0 |
|              | 80            | 69.2 | 71.9 | 70.5 | 66.7 | 60.6 |
|              | 90            | 76.3 | 79.2 | 77.7 | 73.3 | 66.7 |
|              | 100           | 83.2 | 86.5 | 84.6 | 79.8 | 72.2 |

Table 11. Mean estimated per-vessel costs for fishing years 13-17 at 91% ASM coverage (\$2017, thousands)

| Length class | 2013 | 2014 | 2015 | 2016 | 2017 |
|--------------|------|------|------|------|------|
| >=30', <50'  | 19.0 | 16.4 | 17.1 | 13.2 | 15.2 |
| >=50', <75'  | 39.6 | 39.2 | 35.7 | 30.6 | 34.0 |
| >=75'        | 77.0 | 79.9 | 78.3 | 73.9 | 67.2 |

## Electronic Monitoring

### Equipment

Total equipment cost estimates for the entire fleet range from a low end of \$1.5m to an upper bound of about \$2.4m<sup>8</sup>. Per vessel estimates range from \$6.2k to \$9.1k. These estimates do not follow a normal distribution, and median values are on the high end of these ranges (Fig 8, Table 12). Total costs by gear type length class and home state scale mainly by the number of vessels though, in general, per vessel costs are slightly lower for smaller vessels (Table 13).

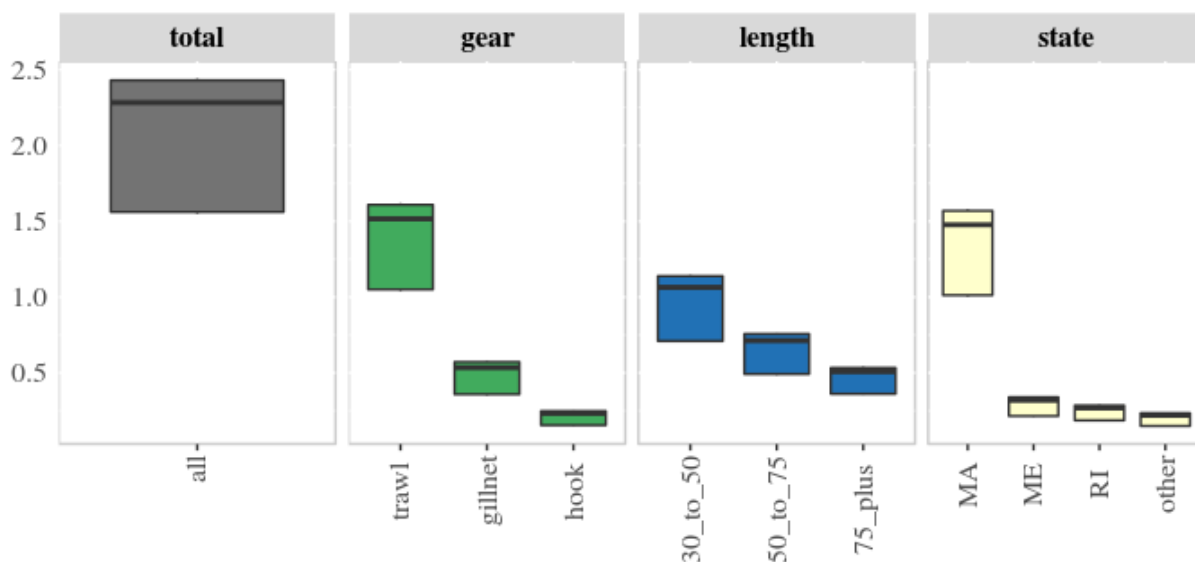


Figure 8. EM equipment cost estimates modeled using fishing year 17 data (\$2017, millions)

<sup>8</sup>

Based on the 198 vessels that made non-FW55 exempt groundfish trips in 2017.

Table 12. Mean estimated per-vessel equipment costs (estimates generated from fishing year 17 data, \$2017, thousands)

| Length class | State group | Gillnet | Hook | Trawl |
|--------------|-------------|---------|------|-------|
| >=30', <50'  | MA          | 7.6     | 7.3  | 7.6   |
|              | ME          | 7.6     | 7.3  | 7.6   |
|              | other       | 7.7     | 7.3  | 7.7   |
|              | RI          | 7.5     | 7.3  | 7.7   |
| >=50', <75'  | MA          | 8.1     | -    | 8.0   |
|              | ME          | -       | -    | 8.0   |
|              | other       | 8.0     | -    | 8.0   |
|              | RI          | -       | -    | 8.0   |
| >=75'        | MA          | -       | -    | 8.4   |
|              | ME          | -       | -    | 8.4   |
|              | other       | -       | 7.9  | 8.4   |
|              | RI          | -       | -    | 8.4   |
| >30          | MA          | -       | 7.0  | -     |
|              | other       | 7.0     | 7.0  | -     |

Table 13. Descriptive statistics for estimated per-vessel equipment costs (estimates generated from fishing year 17 data, \$2017, thousands)

| Length class | Minimum | Maximum | Median | 5th Percentile | 95th Percentile |
|--------------|---------|---------|--------|----------------|-----------------|
| >30          | 6.2     | 7.9     | 7.0    | 6.7            | 7.4             |
| >=30', <50'  | 6.5     | 8.6     | 7.6    | 7.0            | 8.1             |
| >=50', <75'  | 7.1     | 9.0     | 8.0    | 7.7            | 8.4             |
| >=75'        | 7.3     | 9.1     | 8.4    | 7.9            | 8.8             |

### Field Services Costs

Year one field cost estimates (includes install, maintenance, on-call response and data transfer) range from \$1.5m to \$1.8m with a median cost of \$1.65m. A majority of these costs are related to equipment installation, which has a median cost of \$810k (Fig 19). In subsequent years, composite costs no longer include the cost of installation, and maintenance visits decline, therefore median cost estimates drop to \$600k in year 2, \$550k in year 3 and \$530k in year 4 (Fig 10).

These total estimates translate into roughly \$8.3k per vessel for year one field service costs. Cumulative year 2 through 4 field service costs are estimated to average \$2.8k per year per vessel (Table 14, dividing totals by 198 vessels).

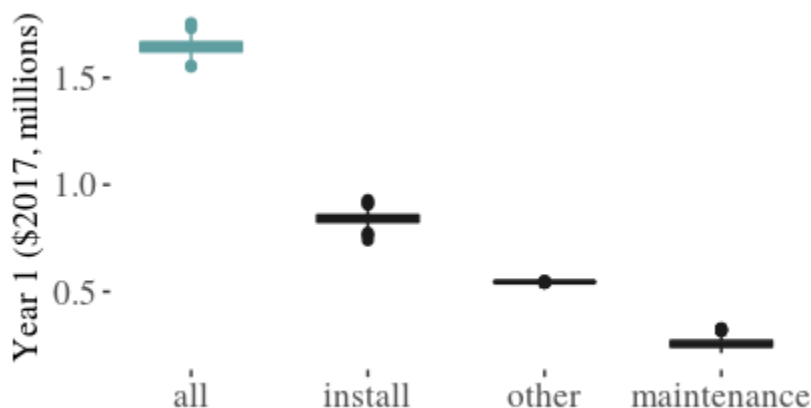


Figure 19. Year one field service cost estimates by component (estimates generated from fishing year 17 data, \$2017, thousands)

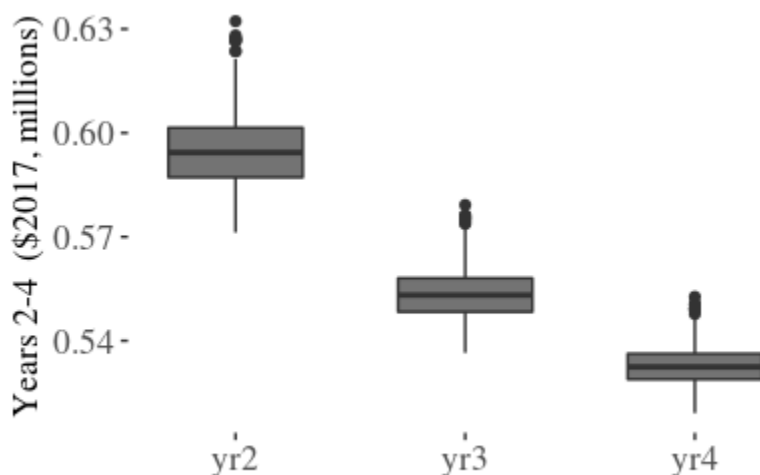


Figure 10. Field service cost estimates for subsequent years (estimates generated from fishing year 17 data, \$2017, thousands)

### Review Costs

Review costs are modeled for three review programs and summarized by gear type (Figures 11-12). Costs were generated for various randomly selected review rate (selected anywhere from 0 to 100%) and plotted. Each randomly selected review rate was replicated 10 times to account for random trip selection and, for the aggregated model, a total of 400 randomly generated review rates were modeled (Figure 11). For the disaggregated gear-based models, 10 replicates were generated for 200 random review rates (Figure 12). A regression line was fit to model review costs as a function of review rates for each gear type. Each of the nine gear-based linear models yields R squared values ranging from 0.79 to 0.98. From



these models, total costs for each gear group are estimated across various review rates for each of the three programs (Census, Audit and Compliance).

As a direct comparison, at 100% video review under each model for full fleet-wide implementation in FY17 yields a cost estimate of \$3.9m for the compliance model. The census model costs just over \$15m at 100% review. The audit model costs slightly more than \$13.1m. At any given review rate, the costs of video review for the compliance model are substantially lower than those of the audit and census models (Figure 11).

For the census and audit models, 100% video review is not necessary to achieve precise and unbiased discard estimates. Other regions including British Columbia have settled on a 15% review rate for an audit model. At this rate, the audit model presents a total review cost of ~\$2.1m (Figure 11, Table 14). More work would be required to estimate the review rate that would provide precise discard estimates under a census model, but at a 50% video review, the census model is more costly than either the compliance or audit models at ~\$7.2m (Figure 11, Table 14).

Trawl gear vessels contribute the bulk of these costs, noting that trawl gear review costs increase at a higher rate than either hook or gillnet gears due to more variability footage review time, driven by greater diversity of species caught (which may add to review time) and, sometimes, more challenging camera locations and more frequent periods of deteriorated images. It is important to note that, of all the variables analyzed to predict video review times, the overwhelming driver was the vessel itself. Operational consideration of image quality can cut needed review times in half, whereas lack of understanding or consideration can add 3x or 4x to the review process.

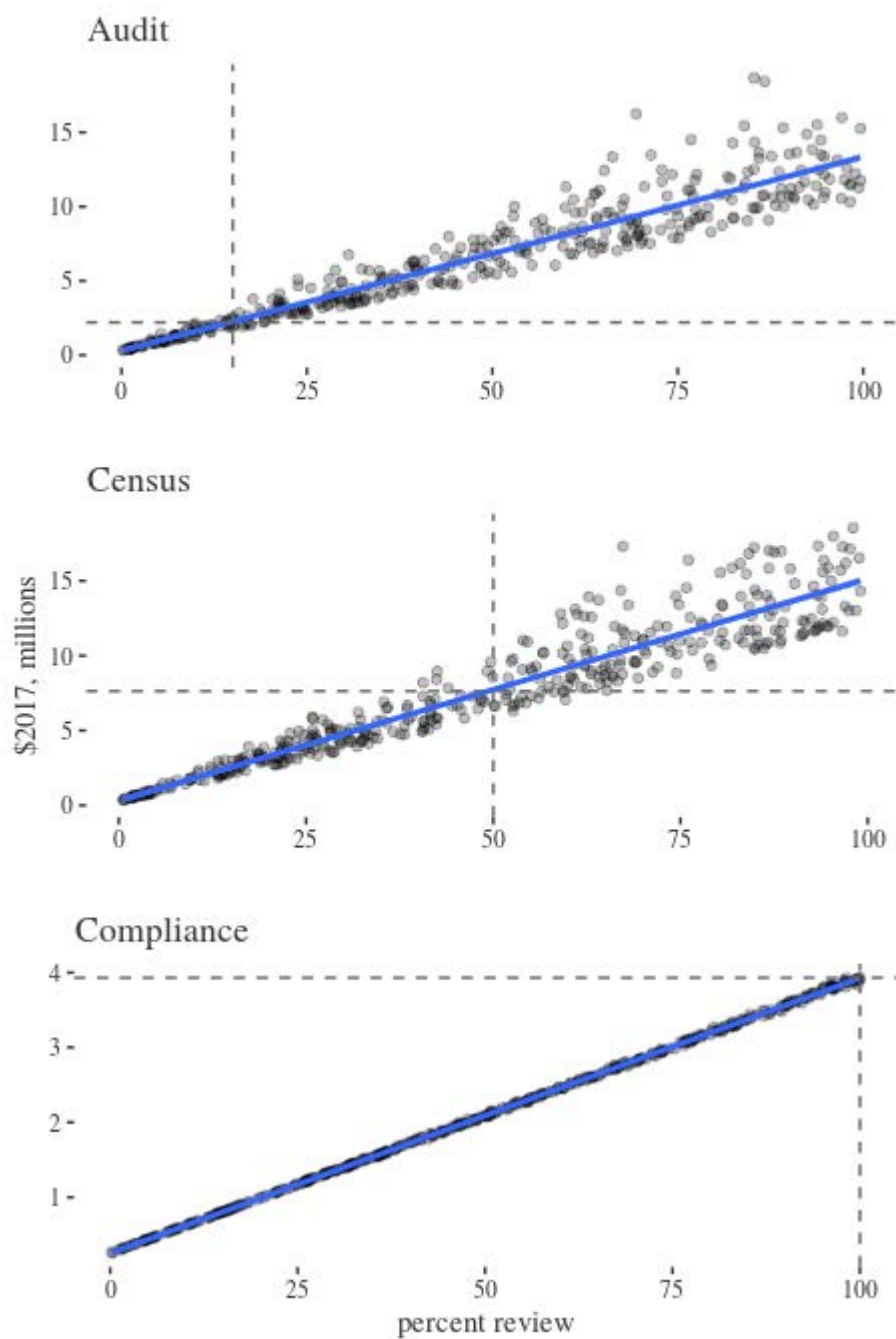


Figure 11. Total video review cost estimates for the three EM models, vertical and horizontal lines corresponding to the review rates selected for comparison. (Source: pilot project video review from 2015-16 and applied to fishing year 17 fishing effort data)

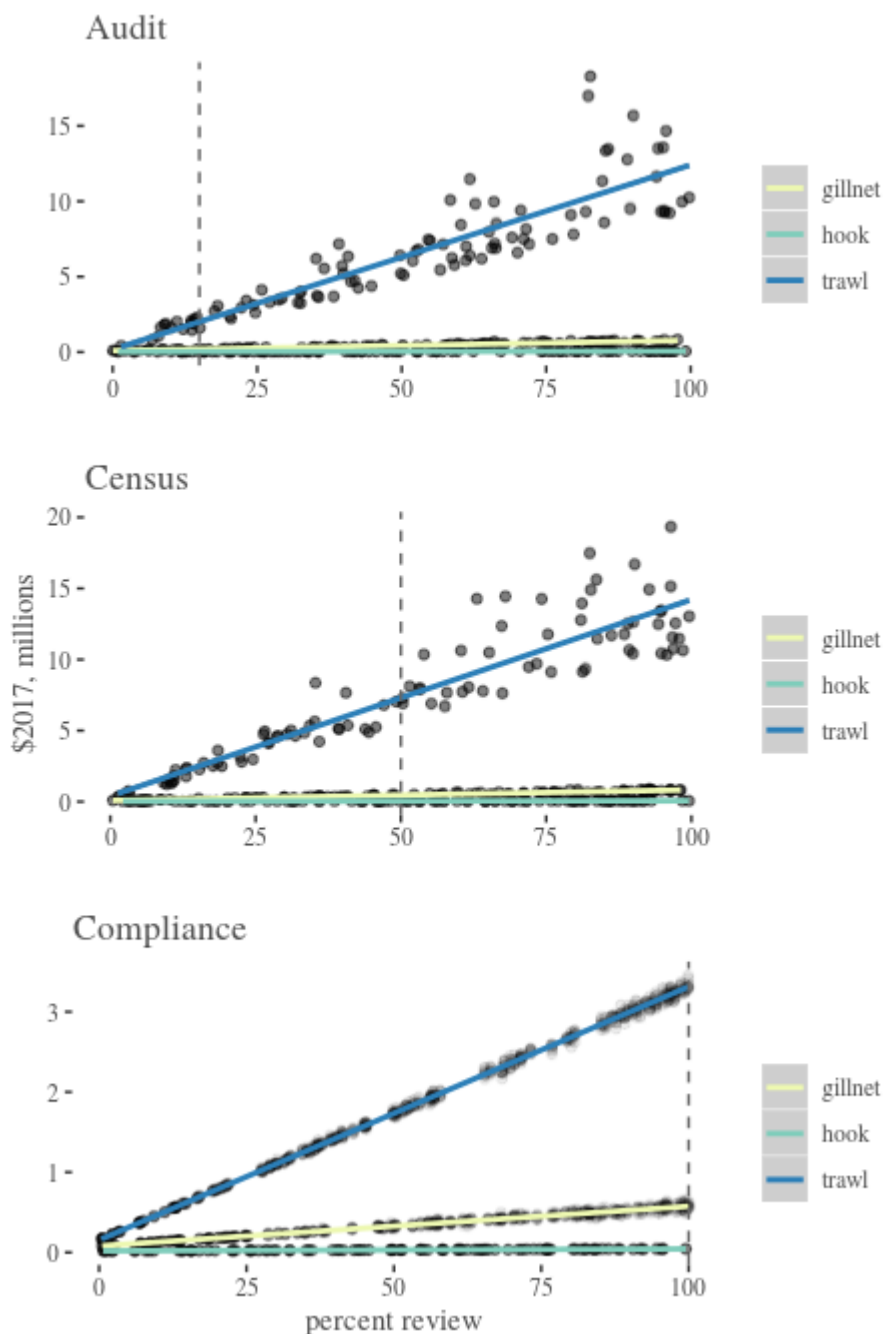


Figure 12. Video review cost estimates by gear type. (Source: pilot project video review from 2015-16 and applied to fishing year 17 fishing effort data)

### Data storage

Median annual data storage costs for 100% of the footage accumulated for groundfish trips in FY17 is estimated at approximately \$208k (Fig 13). Under this scenario we do not differentiate footage quality by

program design. In reality, storage costs will likely differ by program model (audit, census, maximum retention) if these models require differing levels of footage quality and therefore have differing GBPH rates. Storage costs are distributed across the fleet in proportion to fishing effort. Higher data volumes cost more to store (Figure 14). We assume these storage costs accrue annually and data are stored for three years, based on the specifications for the west coast groundfish fishery (Fed Reg 2016).

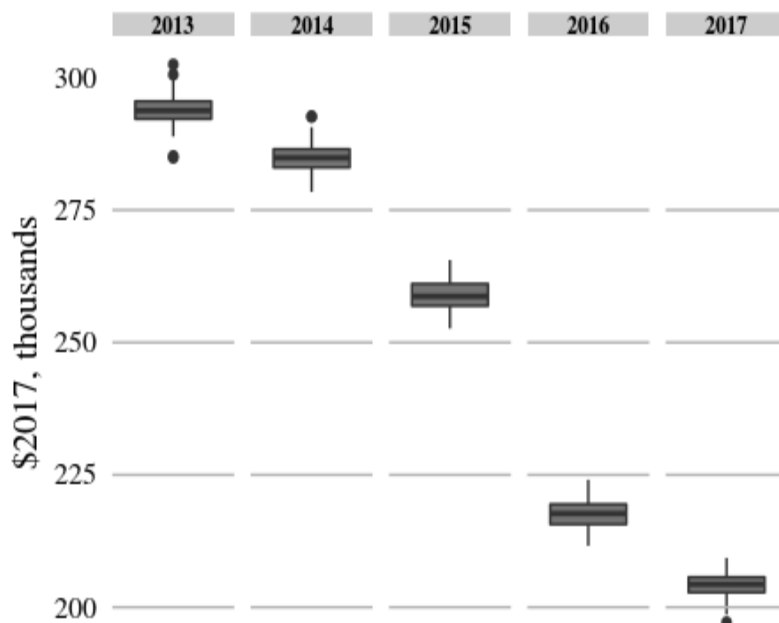


Figure 13. Aggregate data storage costs by year

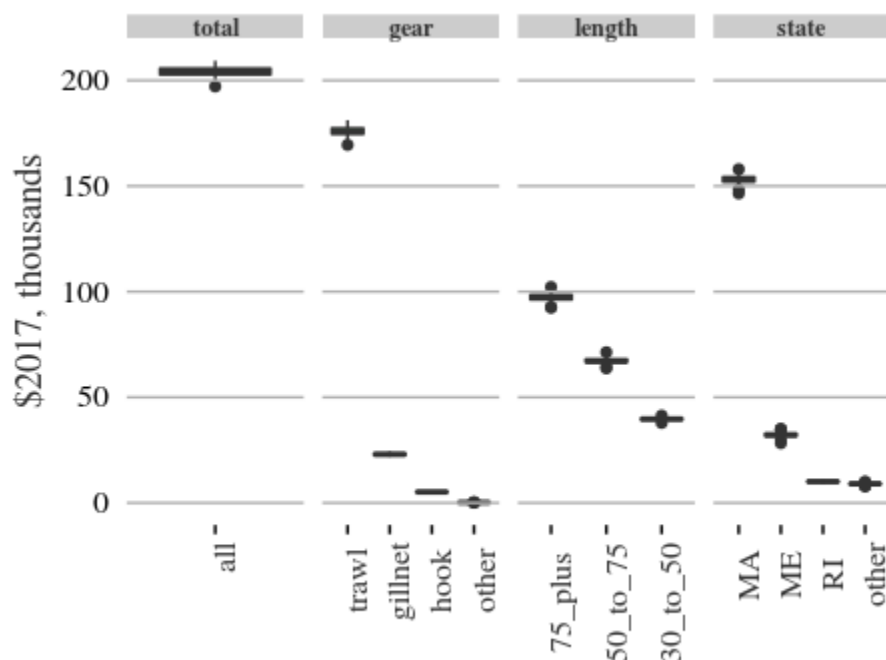


Figure 14. Data storage costs, total and disaggregated by gear, length and state group based on fishing year 17 fishing effort data.

### Total costs

EM programs have high up-front costs due to the fixed costs associated with equipment and installation at the beginning of any EM program. Estimates of the average lifespan of EM equipment vary and depend upon the frequency and conditions of use. A commonly used estimate of EM system lifespan, is five years, and we accordingly estimate costs over this timespan.

To arrive at a total annual EM cost, mean values for equipment, field costs, and storage costs were averaged across five years. In year one, equipment costs and field costs represent substantial cost components. Once the equipment is installed we assume no further installations will be needed over the five years. Field service costs remain after year one, but decrease sharply. In years 2-5, the majority of EM costs are attributable to video review. This is true even at low review rates (such as the audit model at a 15% review rate). We assume review costs will decline over time, particularly if there exists some cost-based incentive for operators to continually optimize their operations in order to assure high-quality video, noting that vessel operations are the primary driver of review times. To model this, we simply costs from different locations in the overall cost estimates at the assumed model-specified review rates—higher in the distribution of modeled estimates in yearlier years, and lower in later years.

The average annual cost for the audit model at a video review rate of 15%, is \$3.5m. Video review represents 60% of total EM costs under the audit model. Review costs represent about 35% of total costs in year one, but ~80% in subsequent years (Table 14).

Average annual cost for the census model at a video review rate of 50%, is \$8.5m. Review costs are represent most of these costs, about 88% over the five-year period. During year one, review costs are 71% of total costs, increasing to ~95% in subsequent years. Average annual cost for the compliance model at a

video review rate of 100% is \$ 5.0m. Video review represents 68% of total EM costs under the compliance model. During year one, review costs are 41% of the total, and ~85% in subsequent years. Review costs under a 100% compliance model are slightly higher than those estimated under a 15% audit model, but well below those estimated for a census model at 50% video review.

We make no assumptions about the role of technology improvement over time in bringing review costs down below those modeled here—cost savings are assumed to come from improvements in operations alone. Technological advances will likely reduce these costs, in fact it's likely that costs have declined since these models were developed.

*Table 14. EM Audit, Census and Compliance model costs, program implementation in fishing year 13. Costs in \$2017, millions. Audit review rate = 15%, Census review rate = 50%, Compliance review rate = 100%.*

| <b>AUDIT MODEL</b> |                        |                    |                     |                      |              |
|--------------------|------------------------|--------------------|---------------------|----------------------|--------------|
| <b>Year</b>        | <b>Equipment Costs</b> | <b>Field Costs</b> | <b>Review Costs</b> | <b>Storage Costs</b> | <b>Total</b> |
| 1                  | 2.09                   | 1.65               | 2.33                | 0.21                 | 6.28         |
| 2                  | 0                      | 0.60               | 2.13                | 0.21                 | 2.93         |
| 3                  | 0                      | 0.55               | 2.06                | 0.20                 | 2.82         |
| 4                  | 0                      | 0.53               | 2.03                | 0.20                 | 2.76         |
| 5                  | 0                      | 0.53               | 1.95                | 0.20                 | 2.68         |
| <i>Mean</i>        | <i>0.42</i>            | <i>0.77</i>        | <i>2.10</i>         | <i>0.20</i>          | <i>3.49</i>  |

| <b>CENSUS MODEL</b> |                        |                    |                     |                      |              |
|---------------------|------------------------|--------------------|---------------------|----------------------|--------------|
| <b>Year</b>         | <b>Equipment Costs</b> | <b>Field Costs</b> | <b>Review Costs</b> | <b>Storage Costs</b> | <b>Total</b> |
| 1                   | 2.09                   | 1.65               | 8.04                | 0.21                 | 11.99        |
| 2                   | 0                      | 0.60               | 7.25                | 0.21                 | 8.05         |
| 3                   | 0                      | 0.55               | 7.01                | 0.20                 | 7.76         |
| 4                   | 0                      | 0.53               | 6.87                | 0.20                 | 7.61         |
| 5                   | 0                      | 0.53               | 6.70                | 0.20                 | 7.43         |
| <i>Mean</i>         | <i>0.42</i>            | <i>0.77</i>        | <i>7.17</i>         | <i>0.20</i>          | <i>8.57</i>  |

| <b>COMPLIANCE MODEL</b> |                        |                    |                     |                      |              |
|-------------------------|------------------------|--------------------|---------------------|----------------------|--------------|
| <b>Year</b>             | <b>Equipment Costs</b> | <b>Field Costs</b> | <b>Review Costs</b> | <b>Storage Costs</b> | <b>Total</b> |
| 1                       | 2.09                   | 1.65               | 3.92                | 0.21                 | 7.87         |
| 2                       | 0                      | 0.60               | 3.69                | 0.21                 | 4.49         |
| 3                       | 0                      | 0.55               | 3.60                | 0.20                 | 4.36         |
| 4                       | 0                      | 0.53               | 3.54                | 0.20                 | 4.28         |
| 5                       | 0                      | 0.53               | 3.48                | 0.20                 | 4.21         |
| <i>Mean</i>             | <i>0.42</i>            | <i>0.77</i>        | <i>3.65</i>         | <i>0.20</i>          | <i>5.04</i>  |

## Internal and External Data Validity of ASM and EM Technologies

### Internal validity

Internal validity of ASM data refers to the sampling error that occurs when the monitor is sampling the catch. At sea monitors are charged with the difficult task of identifying and quantifying all discards before they are tossed over the rail, as well as all kept catch before it gets stored in the fish hold. All this information is collected while minimizing the impact on normal fishing operations. To collect these data efficiently, numerous methods are used to estimate the amount of catch or discards recorded by the observer. These estimation methods have differing levels of accuracy and precision ranging from highly accurate “actual” weights which are directly measured, to less accurate visual estimations and other subsampling methods. A complete discussion of the various estimation methods is provided in the Appendix. An increase in ASM coverage would not change the internal data validity. Monitoring protocol and estimation methods would not change, meaning the quality of the data collected would remain more-or-less consistent regardless of what percentage of trips are covered.

In census and audit model EM programs, discard weights are estimated using length-weight tables calculated from numerous years of NEFSC survey data (Wigley et al 2003). While there is some error associated with these calculations, they are relatively small. Weights calculated using these relationships have been used in numerous data collections in the northeast. Other errors that occur during review are associated with the length of the fish as estimated from the footage and the species identification. Pilot projects have reported minimal errors associated with length and these are reduced as crew becomes more familiar with the procedures and places more importance on proper catch handling. Error in species identification is dependent on the species. Hakes (red/white) and some flat fish have been especially problematic during pilot programs.

In an audit system, there is error associated with how the captains fill out their logbooks. This can be due to unintentional inaccuracies or strategic misreporting. This will be impacted by the percent of logbooks audited as well as the standards for an acceptable logbook report. There is a potential for bias depending on how the audit “pass/fail” criteria are determined. For example, if captains know that everything within 10% is considered a pass, they could systematically under-report within 10% and consistently “pass” the audit. Additionally, the review rate of an audit program must be such that it is unlikely that misreporting, rare events, or consistent biases go undetected. A description of EM projects in the Northeast groundfish can be found in Fitzgerald et al (2019).

Both census and audit models provide the benefit of consistent estimation methods across gear types, catch volumes, and catch compositions. conditional on well-trained operators, all discard data are collected using the same processes for a specific program design, so there is no variability in data quality based on estimation methods. In an audit model, one particular benefit is that the fishermen are actively participating in collecting and reporting data that are directly used in the catch accounting process. This keeps the process transparent, increasing the credibility of the estimates from the fishermen’s perspective (Stanley et al 2011).

Different error structure is associated with compliance programs, as the compliance systems are not designed to collect discard data, rather to ensure discarding is not occurring. If discard events occur under a compliance EM system, identifying the quantity and composition of the discards will be challenging. In the west coast pacific whiting fishery, estimates of total volume discarded are made when reviewing video footage based on size and number of codend straps. Discard composition is then assumed to be identical

in proportion to landed catch. In this case, data quality depends on the randomness of discard events and the randomness of which species are discarded.

### **External validity**

The external validity of ASM data refers to the sampling error that is associated with applying the ASM data to unobserved trips. One aspect of external validity is the process of creating the discard ratios used to estimate total discards. The discard methodology was reviewed in November 2016 (Zhou 2016, Cook 2016). Analysis reported for this review show that for most species of groundfish the current observer coverage meets the CV 30 requirement but for others the discard estimates are less precise (the CV is higher than 0.3) (Caless 2016). Previous analysis has shown that increased monitoring coverage leads to more precise discard estimates (NEFMC 2016). The discard methodology review focused on the “application of (the discard methodology) and alternative stratification schemes” not the validity of applying ASM data to unobserved trips. However, reviewers noted the utility of addressing this: “This review is confined to the statistical methods used to estimate discards given the samples available. It assumes that observer coverage is, in general, adequate, representative and unbiased. The latter are extremely important issues that merit careful review in their own right to ensure that the overall performance of the monitoring system is sound, but they were not subjects for this review (Cook 2016:4). And if the statistical impacts if these assumptions are not met: “missing data (such as unobserved trips) will introduce additional uncertainty whereas erroneous data will bias the estimate” (Zhou 2016:9).”

The amount of uncertainty and bias introduced by applying ASM data to estimate discards on unobserved trips has not yet been quantified, however the potential existence of this bias has been illustrated (Demarest 2019). Analysis of Canadian groundfish fisheries showed non-random patterns in observer deployment which would bias discard estimates low (p.2033) as well as statistical differences in numerous variables by vessel between observed and unobserved trips such as lower overall landings and lower landings of non-target species on observed trips (Benoit and Allard 2009).

External data validity would greatly improve under increased ASM coverage rates. As coverage increases, a smaller portion of the data would rely on the assumption that fishing behavior is equivalent on observed and unobserved trips. At 100 percent coverage this assumption would not apply because observers would be onboard every trip. This would remove the biggest source of uncertainty and bias in the current ASM system that occurs when applying observer data to unobserved trips.

One of the biggest advantages of an EM system is that it can run on every trip. Unlike an ASM program where the captain knows from the start of the trip if it is monitored or not, depending on program design, a captain may not know if an EM trip has been selected for review until after the trip is completed. Therefore, regardless of the review rate, the footage that is reviewed is a random sample from a population that includes the whole universe of trips. This minimizes the potential for an observer effect and leads to a less biased sample of fishing effort. Depending on the review rate selected, fishermen may still feel incentivized to discard legal-sized fish, as they will have different levels of comfort with the probability that their trips will be reviewed.



## MONITORING LANDINGS

### Dockside Monitors (DSM): Methods, Models, and Data

Both at sea monitoring and electronic monitoring programs focus on collecting data on discarded catch. At sea monitors collect kept catch data but the primary purpose of this is to calculate discard to kept catch ratios to estimate discards on unobserved trips. Absent any additional monitoring, these systems rely on self-reporting to document landings, the vast majority of fish removals among allocated groundfish stocks. Many other quota based management systems implement dockside monitoring (DSM) programs to document kept or landed catch. The West Coast IFQ fishery requires that all landings are monitored by certified catch monitors who are present during the entire duration of the offload and ensure accurate sorting, weighting and reporting of landings (PSMFC 2017). The British Columbia Groundfish fishery also requires that a dockside monitor is present before an offload can begin. These monitors verify the weight and species of all landed fish (DFO 2013).

As originally implemented in 2010, Amendment 16 required dockside monitoring for 50% of each sector's trips, with the coverage rate decreasing to 20% in subsequent years (NEFMC 2009). These monitors observed offload activity and verified the accuracy of dealer reported weights. A proposal to require monitors to board the vessels and inspect fish holds to ensure all catch was offloaded was discussed but eventually removed due to safety concerns (FW45). The DSM program was eliminated in 2011 citing concerns of costs and duplicative data collection: FW48 to the groundfish FMP stated, "as long as unreported landings do not occur, the dealer reports can be used to monitor sector landings and there is little advantage to having dockside monitors verify these reports." (NEFMC 2013). Recent discoveries of unreported and misreported landings has renewed discussions regarding the value of a dockside monitoring program (Cramer 2017).

We estimate DSM costs based on actual cost data from the DSM program in 2010. We have information on the monthly costs billed by sector as well as the total groundfish pounds monitored, total number of trips monitored, and the number of trips in remote ports (as specified in provider contracts). Using these data we model monthly cost by sector ( $C$ ) as a linear function of groundfish pounds monitored ( $g$ ), trips monitored ( $t$ ) and remote trips monitored ( $r$ ), as

$$C = a + b_1g + b_2t + b_3r + e$$

(Equation 5)

This model has an adjusted r-squared of 0.8398 and all variables are statistically significant at  $p < 0.001$ . Using data from FY17 trips we predicted DSM costs using this model. We then adjusted these predicted costs to \$2017 using the GDP Implicit Price Deflator<sup>9</sup>. We estimated costs under two scenarios, first, assuming all live groundfish pounds that are landed are monitored, and second, assuming all live groundfish pounds landed and live groundfish discarded are monitored. This second scenario is similar to landings under compliance management. The linear model estimates costs on a monthly basis per sector. We randomly resample these 100 times to display the potential cumulative monitoring sums if monthly costs occurred in any order.

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<sup>9</sup> GDP Implicit Price Deflator from the Federal Reserve Bank of St. Louis, available at: <https://fred.stlouisfed.org/>

### Costs and cost incidence

The median for DSM cost for all trips that landed groundfish in FY17 is \$376K (Figure 13, A, B). Including both discards and landings increases total DSM costs to \$383K (Figure 13, C, and D).

The cumulative total cost for all trips that landed groundfish in FY17 at 100% DSM is equal to \$747,874 (Figure 13, A, B). Including both discards and landings (under a compliance EM model, for example) increases total DSM costs to \$ 759,420 (Figure 13, C, and D).

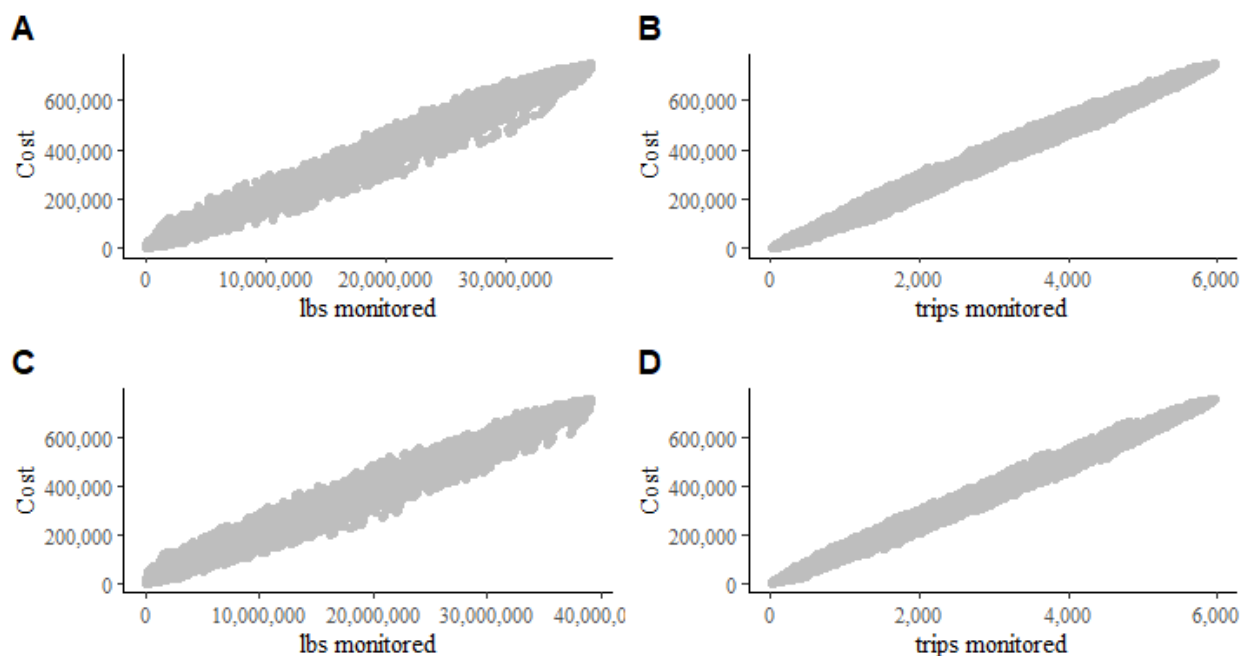


Figure 13. Estimated DSM costs for live groundfish pounds offloaded in FY17 by live groundfish pounds (A) and trips monitored (B). Estimated DSM costs for groundfish pounds offloaded including discards in FY17 by live groundfish pounds (C) and trips monitored (D). Note x axis of A and C are not aligned.

Contracts were negotiated under the assumption that at minimum, 50% of each sector's trips would be monitored. In 2010, this would have been approximately 4,678 trips (half of all sector trips landing groundfish). However when the contracts were negotiated, the amount of trips estimated to be covered was much greater based on fishing effort in previous years. Because rates were negotiated under the expectation of relatively high fishing effort, the model may underestimate costs for lower coverage levels, assuming there would be diminishing marginal costs for dockside monitoring providers.

The costs presented here represent our best estimation for a dockside monitoring program in the groundfish fishery. A reintroduced program may result in higher costs, given how limited the data collection efforts were in the initial program. A more rigorous program include higher hourly rates for monitors and more time monitoring each vessel offload.

### Internal and external data validity

Data produced by DSM programs are generally of high quality. The conditions are such that a dockside monitor should be able to accurately monitor and record all landings as they are offloaded. The dockside

monitoring program in place for FY10 was of a very limited nature and a reintroduced program may have to be adjusted to allow for accurate catch accounting.

## DISCUSSION

Designing a proper comparison of catch monitoring technologies is not without challenges. We have generally focused on two aspects of monitoring technologies, cost and data quality.

### Cost

An ASM program at 91% coverage is estimated to cost roughly \$6.4m annually based on FY17 fishery data. These costs exceed that of fleet-wide EM under both the audit and compliance models. The audit model is estimated to have a fleet-wide aggregate cost of \$3.5m annually, roughly equal to the estimated cost of 45% ASM coverage. The compliance model is estimated to cost roughly \$5m annually, roughly equal to 65% ASM coverage. The compliance model uses 100% video review, but the nature of the review activities is much less labor and time intensive and thus is less expensive. A census model, which requires significantly higher video review than an audit model, is the most expensive of the technologies investigated here, costing roughly \$1m more than 91% ASM coverage and more than twice as much as a comprehensively applied audit model (Tables 8 and 14).

In comparing ASM and EM costs, it is important to recognize the difference in cost drivers between the two monitoring options. While ASM costs are driven largely by trip length, EM costs, especially review costs, may differ by gear type or species composition. The monitors themselves change the way they collect the data which may impact the data quality, but the costs do not differ. Furthermore, the burden of costs can incentivize better/worse compliance, and who will opt in. If ASM and EM are both viable monitoring options, cost structure is of primary importance. If ASMs were required to collect data the same way on every trip and every haul (i.e. remove the volume extrapolations) it would change the cost structure of the ASM program considerably. Part of this is because EM places that additional burden of the catch handling time on the vessel. For ASM programs we try to limit the impact on normal fishing operations while audit and census style EM programs significantly impact the flow of fish on a boat. Another component of an EM program, that is beyond the scope of this paper, is the design of proper incentives for captains to record accurately, and for crew to handle catch appropriately, under an EM audit or compliance model. If EM review rates are low, fishermen may be incentivized to misreport without proper repercussions in place. The possible repercussions are wide-ranging, but may include increased monitoring for the vessel, a reduction in quota, or monetary fine.

How marginal ASM and EM costs increase is an important consideration. We presented ASM costs that increase both linearly and at a diminishing rate. What the appropriate rate should be set at is a difficult question. For our EM program analysis, we presented review costs only as a linear function of effort. In reality, these costs may not scale linearly if there are certain review thresholds which require hiring additional staff.

The cost estimates we present for electronic monitoring are based off current technology and market conditions. EM costs may decrease with technological changes, such as automated review and wireless data transfer. Furthermore, an expansion of EM technology may drive down costs. For these reasons, future costs for electronic monitoring are likely more uncertain than with human at-sea monitors.

### Data Quality

- Internal validity-
  - ASM: high variability based on catch estimation method.
  - EM: consistent methodology (regardless of gear type/catch volume/composition).
- External validity-

- ASM: biased, degree of bias based on coverage rates, observer effect, deployment effect
  - EM: representative sample
- Quantifying the impacts of the data quality of our current monitoring system on the catch accounting and stock assessment process is outside the scope of this report. However, other research has shown that when the level of misreporting and subsequent bias in data is inconsistent year to year it can impact the assessment process (Rudd, et al.).

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## APPENDIX A: Estimation methods of at-sea monitors

Table 1 includes a description of each method at-sea monitors utilize to estimate groundfish catch. The accuracy of high volume subsampling methods depends in large part on the size of the subsample with increasing accuracy corresponding to larger subsamples (Heales et al 2003). Monitors are instructed that their target subsample should be at least 20% of the overall catch, however, there is no data field to document the size or number of subsamples taken.

Figure 1 shows the percentage of observed pounds of catch (discards and kept) in FY2015 that were estimated using the different estimation methods and how this varies across components of the fleet based on length classes and gear groups<sup>10</sup>. Observers work very hard in difficult conditions to collect a large amount of data so it would be unfeasible to expect actual measurements on a substantially larger portion of the catch, but it is important to note that there are considerable differences in data quality within observer data as a whole.

*Table 1. Descriptions of ASM catch estimation methods. Adapted from NOAA NEFSC FSB Observer Operations Manual 2016.*

| Method                     | Description                                                                                                                           |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preferred methods</b>   |                                                                                                                                       |
| Actual weights             | Actual weight taken using spring or electronic scale                                                                                  |
| Tally counts               | Obtain actual weights of representative sample, determine an average weight per individual and multiply by number of individuals      |
| Basket/tote counts         | Obtain actual weight of subsample of full container, determine average weight per container and multiply by number of full containers |
| <b>Visual methods</b>      |                                                                                                                                       |
| Captain's estimates        | Provided by the vessel captain                                                                                                        |
| Visual estimates           | Made without weighing , counting or subsampling                                                                                       |
| <b>Subsampling methods</b> |                                                                                                                                       |
| Count-to count             | Count the total number of individuals, extrapolate the weight of the subsample based on the ratio of individual animals               |
| Weight-to-weight           | Obtain a total weight, extrapolate the weight of the subsample based on the ratio of the weights                                      |
| Volume-to-volume           | Weigh subsamples of a container with known volume (i.e. baskets, totes), extrapolate based on total volume of catch                   |
| Cumulative sum             | Distribute an actual weight for the total catch amongst several hauls                                                                 |
| Combination                | Two or more estimation methods are used for a single species and disposition                                                          |

<sup>10</sup>

Note that vessel length and gear are related with hook gear and gillnet gear more commonly used on smaller vessels and trawl gear associated with larger vessels (see figure 2A for gear/length relationship).

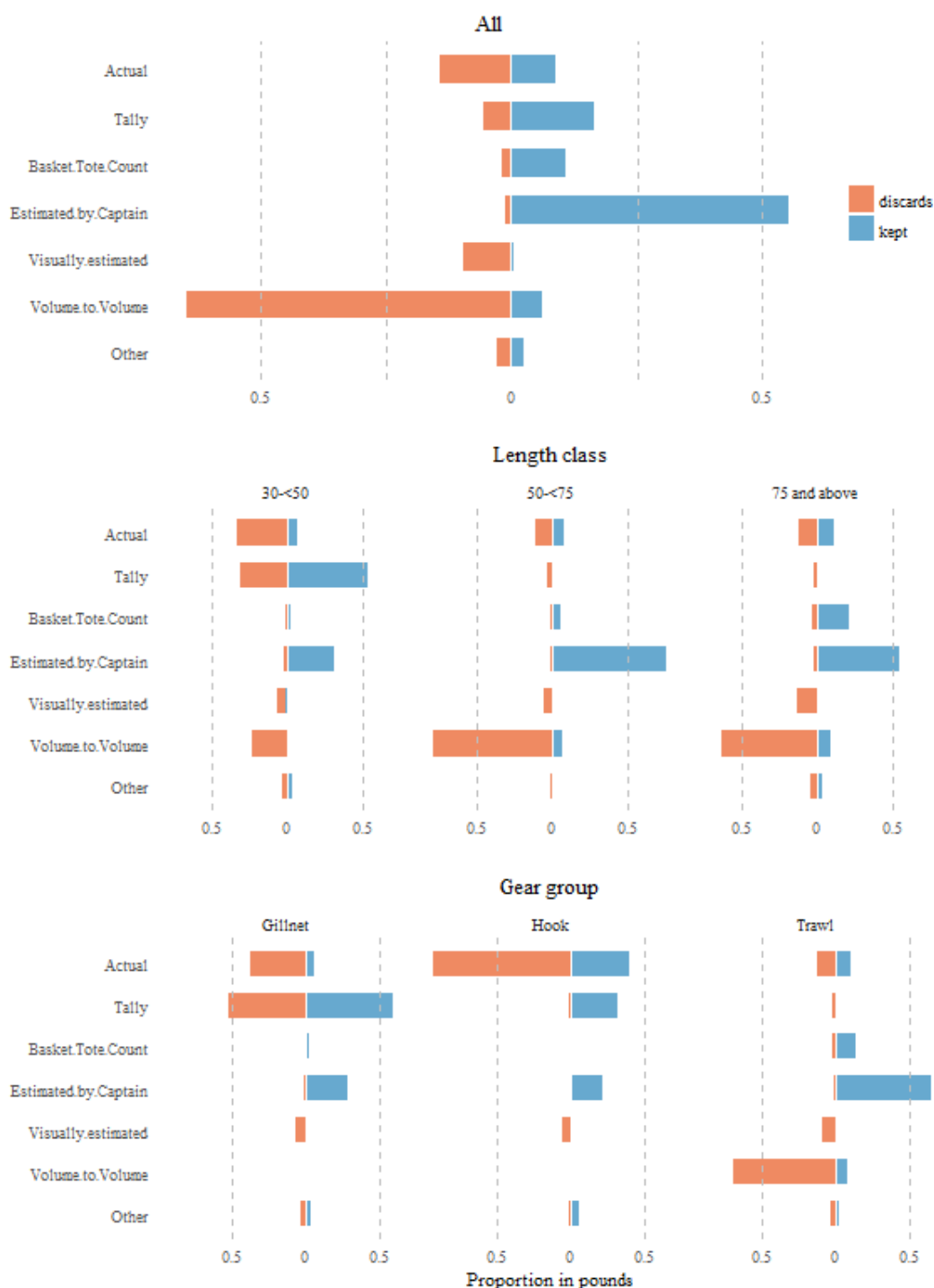


Figure 1. Proportion (in pounds) of kept and discarded catch, observed by ASMs on groundfish trips using each estimation method for Fishing Year 2015. Estimation methods are listed in order of preference according to the Observer manual with Actual measurements being the most preferred method and volume to volume the least preferred.

Additionally, ASMs have varying priorities for data collection, so it should be expected that higher priority data will be collected using more accurate methods than lower priority data. The sampling priorities on ASM trips are listed in the Observer On-Deck Reference Guide (2016) as follows:

1. Actual weight of discarded groundfish. If actual weights are not possible, tally or basket count are next preferred method.
2. Weights of all other discarded catch, using most accurate method possible.
3. Weights of all kept catch, using basket/tote counts (preferred) or captain's estimate (less preferred).

Despite these differences in data quality associated with catch estimation methods, kept catch and discard data of all estimation methods are treated comparably when used to estimate discards for catch accounting (NOAA 2010). GARFO D/K ratio estimates use all observer data pooled by strata with no accounting for the differences in quality within each data type.

## APPENDIX B: Electronic monitoring data storage

Figure 2 shows data volume generated (in gigabytes per hour, GBPH) for EM video showing a sorting table in the pacific cod fishery during three scenarios: 1) at daytime, 2) at nighttime and 3) a changing image (whitewater footage). The whitewater footage is used as a “worst case scenario” as the subject matter is constantly changing so it would result in large data volumes. Using the same data from Figure 2, but setting the frame rate constant at 15FPS<sup>11</sup>, still generates a range of data volume depending upon the values of the other variables (resolution, bit rate and subject matter) (Figure 3). We use a distribution of the nine highest GBH scenarios from Figure 2 (rnorm mean 2.03, sd 0.373) for fishing footage and the nine lowest GBH scenarios from Figure 8 (rnorm mean 1.03, sd 0.285) for the transit footage.

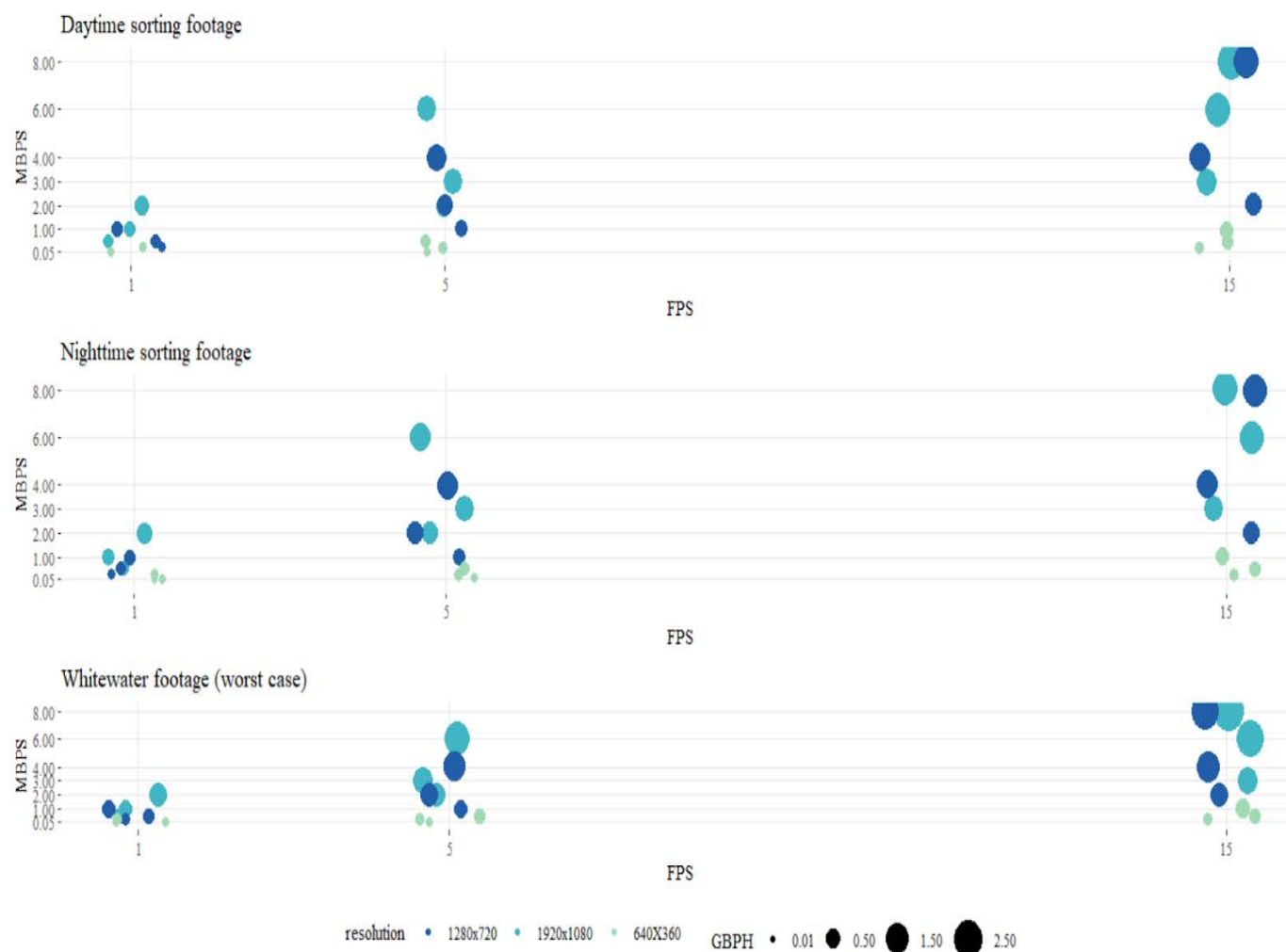
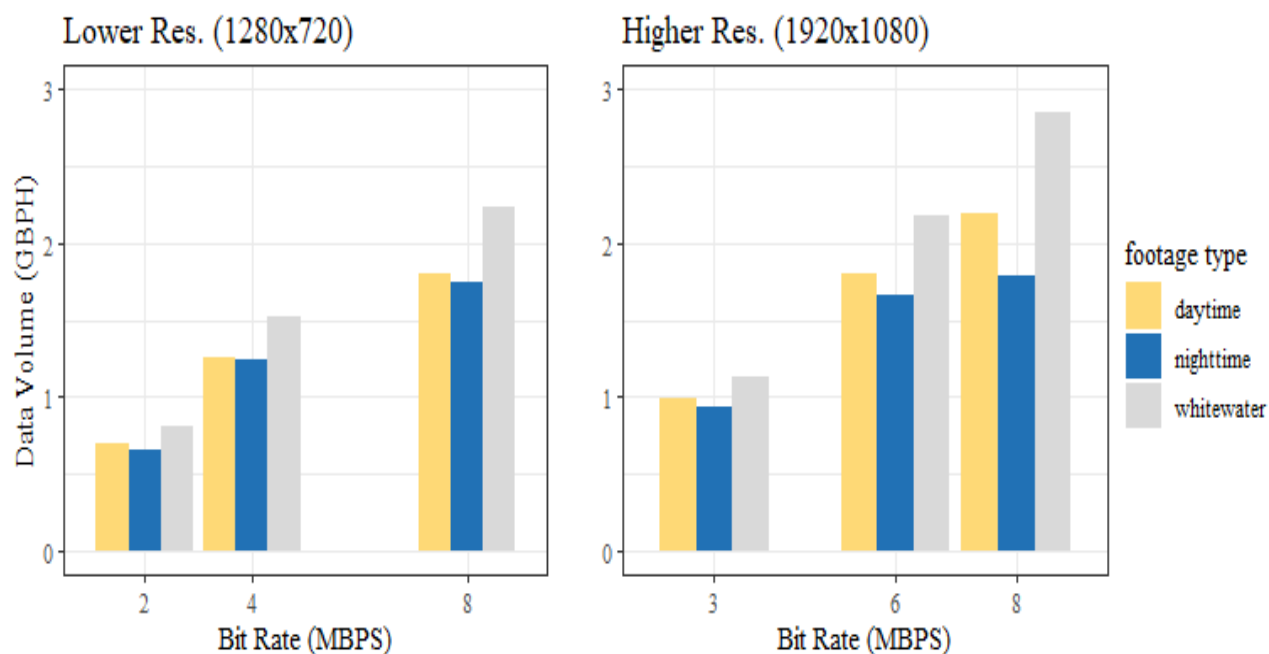


Figure 2. Relationship between compression-Megabits per Second (MBPS), Frame Rate Frames per Second (FPS), resolution and data volume, Gigabytes per hour of video footage (GBPH) (personal communication Eric

<sup>11</sup>

We do not hold the resolution constant at 1080 x 720 because a current pilot EM project in New England is using 1920 x 1080 resolution cameras (Integrated Monitoring).

*Torgerson). Note that MBPS and FPS are at constant intervals, slight randomness is added to figure so that the data points aren't overlapping.*



*Figure 3. Data quality variables impact on data volume with frame rate set at 15 FPS (Torgerson 2017).*

### APPENDIX C: Field services cost sub-components of electronic monitoring

Under an electronic monitoring program, field services represents one component of total costs. Field services include all of the technical support for vessels and the activity that occurs in the field. Within this cost category, there are sub-components: maintenance costs, labor costs, and travel costs for the technician. All three of these sub-components have costs estimated for fishing years 2013-2017 (Figures 4-6). These cost estimates are assumed to be equal across all three EM programs (Census, Audit, and Compliance).

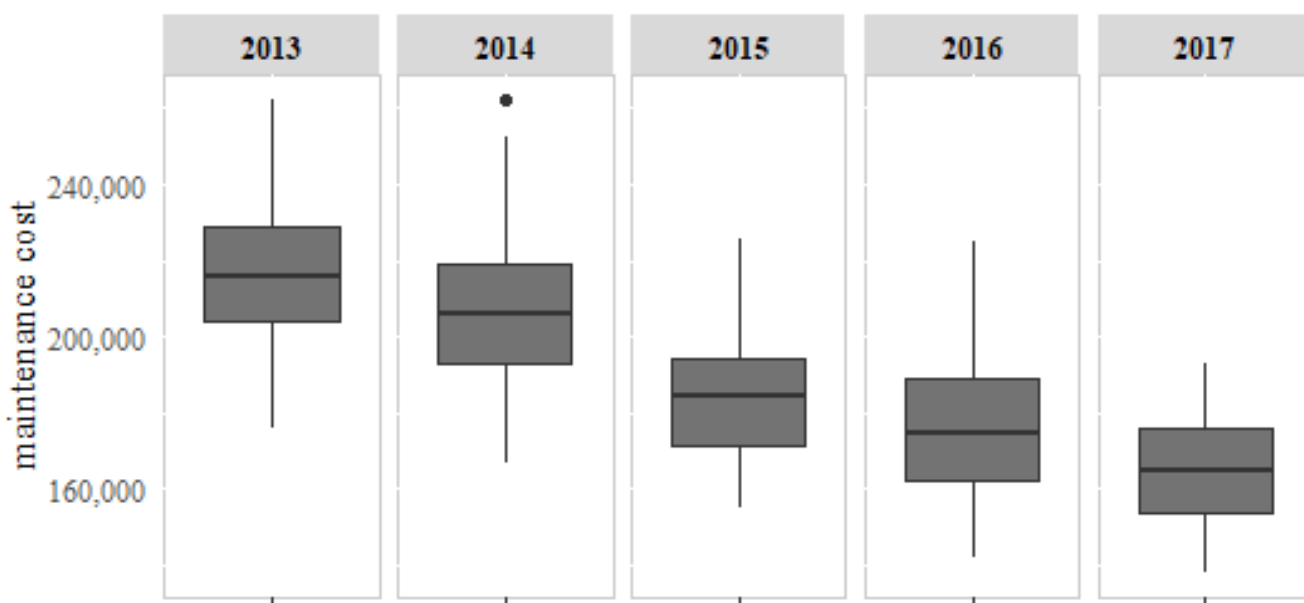


Figure 4. Technician maintenance costs (2017 USD) under electronic monitoring programs, FY13-17

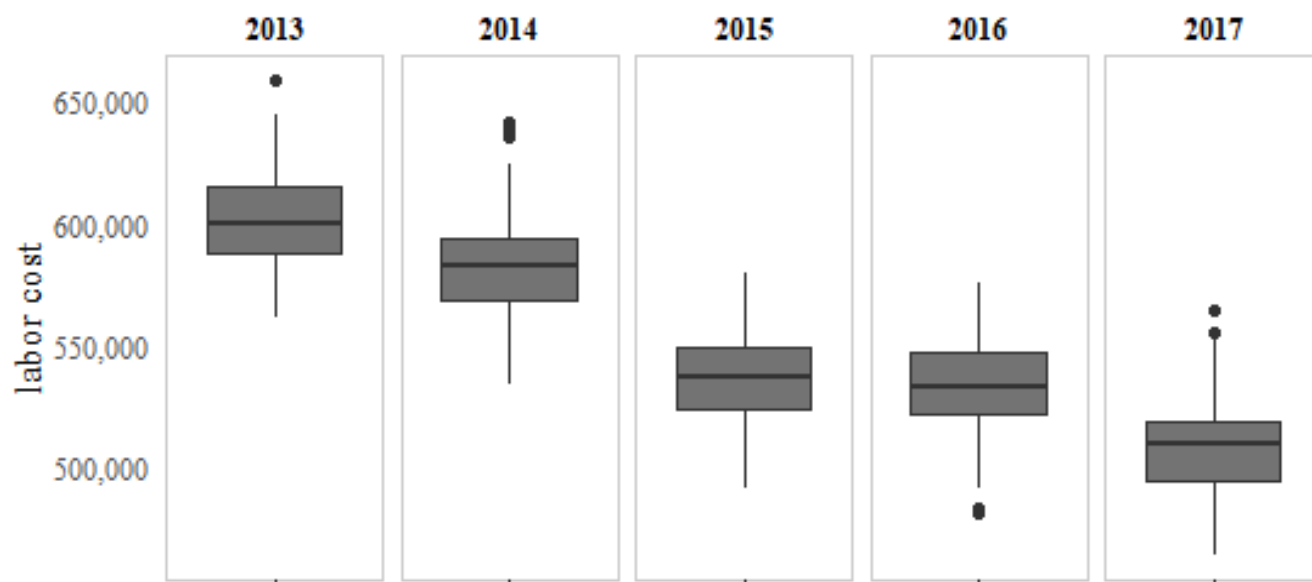


Figure 5. Technician labor costs (2017 USD) under electronic monitoring programs, FY13-17

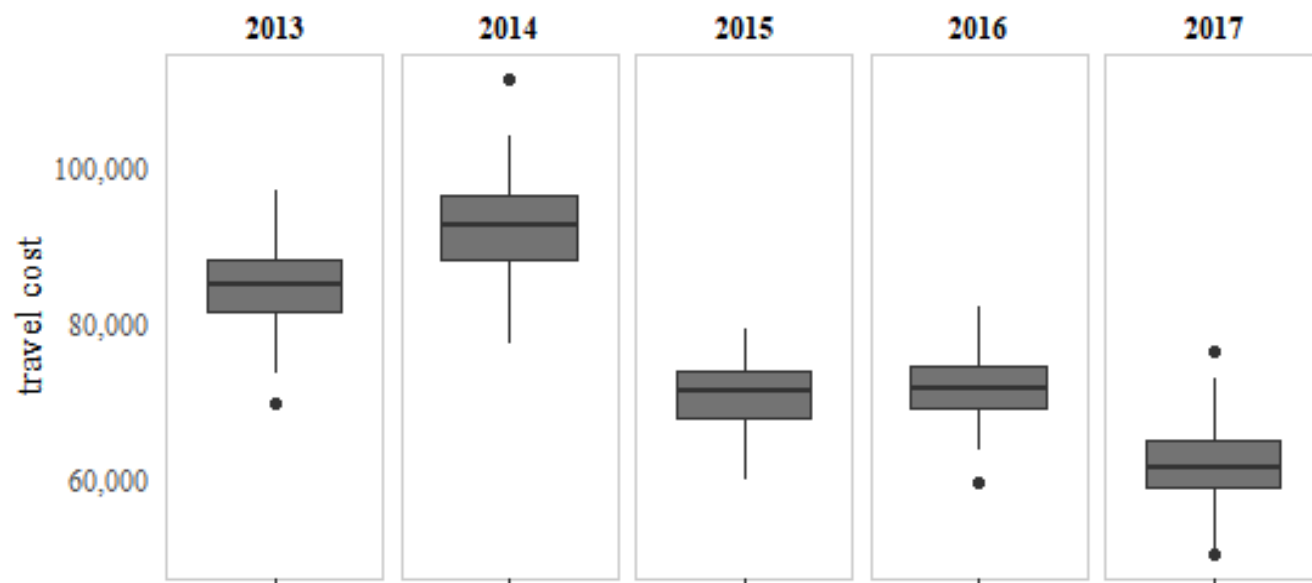


Figure 6. Technician travel costs (2017 USD) under electronic monitoring programs, FY13-17

**Amendment 23**

**To the**

**Northeast Multispecies Fishery Management Plan**

**Appendix VII**

**At-Sea Monitoring Costs under Government Subsidies and Private Contracts  
in the Northeast Multispecies (Groundfish) Fishery**



# **At-Sea Monitoring Costs under Government Subsidies and Private Contracts in the Northeast Multispecies (Groundfish) Fishery**

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## **Abstract**

An At-Sea Monitoring (ASM) program has been a required supplement to the Northeast Fisheries Observer Program (NEFOP) for monitoring catch and discards in the Northeast Multispecies (groundfish) fishery since the inception of comprehensive sector-based management in May 2010. For the initial years of the management program, the National Marine Fisheries Service (NMFS) administered and funded all ASM-related services, effectively providing a monitoring subsidy to the groundfish fleet. Starting in March 2016, groundfish sectors have been required to cover the cost of the ASM program by contracting directly with NMFS-approved ASM providers on an annual basis. While subsequent developments have resulted in NMFS reimbursing sectors for the majority of their billed costs, the salient shift has been from government to private negotiation of service provision contracts. We investigate whether this private contracting has reduced ASM costs by applying the terms of the sector contracts for groundfish fishing years 2016-2018 to trip level data over the 2013-2018 groundfish fishing years. This payment regime is then compared to average seaday costs from the NMFS-negotiated contracts. We find that private contracts, averaged across the three years, would have resulted in cost reductions of 14% over the comparison period for the at-sea component of the ASM program. The distribution of these reductions varies substantially based on vessel type (large trawl, small trawl, gillnet). When the costs of observer travel and training are included, we estimate total ASM cost reductions from private contracts to be 28%.

## Introduction

Amendment 16 to the Northeast Multispecies (groundfish) Fishery Management Plan (FMP) implemented a comprehensive, cooperative-based catch allocation scheme called “sector management” that allowed vessel owners to pool harvest right allocations and fish them collectively within “sectors”. While Amendment 16 did not mandate joining a “sector”, the majority of vessels active in the fishery enrolled in one of seventeen sectors for the 2010 fishing year<sup>2</sup> (FY10), rather than operate under the input control-based alternative, called the “Common Pool”. The sector component of the groundfish fishery has continued to make up the vast majority of effort and catch (Murphy *et al.*, 2018). Amendment 16 stipulated a variety of catch reporting requirements for sectors, including: all legal-sized fish must be landed, catch must be accurately reported by statistical area, sector-level catch must be reported weekly to the National Marine Fisheries Service (NMFS), and a list of ports where members land their fish must be specified. Sector participants were also required to fund the At-Sea Monitoring (ASM) program, designed to collect catch and discard data for sector-enrolled vessels<sup>3</sup>, beginning in FY12, with NMFS agreeing to fund the program in the interim (75 FR, 2010). The transition to industry-funded monitoring, however, did not occur in FY12 as originally planned, and fully government-subsidized monitoring continued until March 2016.

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<sup>2</sup> The groundfish fishing year runs from May through April (i.e. the 2010 fishing year lasts from 1 May 2010 through 30 April 2011).

<sup>3</sup> Before a sector vessel embarks on a groundfish trip, the captain must declare an intent to fish through the Pre-Trip Notification System (PTNS). Any trip that will be targeting species managed under the groundfish FMP is eligible to be chosen by PTNS to carry an ASM observer. Trips that will be targeting species in other FMPs (e.g. spiny dogfish, monkfish, skates) may also be eligible, with a few exceptions (81 FR, 2016). For more information on PTNS trip selection see Palmer *et al.* (2013).

To implement industry funded monitoring, groundfish sectors were required to have contracts in place with private ASM service providers. These contracts, which have been re-negotiated on an annual basis, specify costs for all components of ASM services including observer time at-sea, observer travel, observer training, and other miscellaneous items<sup>4</sup>. Under the sector contracts, the duties of ASM observers are still defined by NMFS<sup>5</sup>; these duties have remained consistent since the ASM program was first implemented. Each sector has been required to submit their ASM contract to NMFS to ensure compliance with applicable sector operations regulations. During FY16-18, each of the sectors that actively fished<sup>6</sup> (16 sectors in FY16-17; 14 sectors in FY18) contracted with one of four NMFS-approved ASM providers.<sup>7</sup> Though sectors have been the nominal payer since March 2016, a majority of actual ASM costs have been reimbursed by NMFS. Rates of reimbursement have been 85% in FY16 (starting in July), and 85% (initially 60%) in FY17 (NOAA Fisheries, 2017a; NOAA Fisheries, 2018). For FY18, sectors were fully-reimbursed for their ASM costs (NOAA Fisheries, 2018).

Regardless of cost reimbursement, the negotiation of private contracts by multiple buyers (sectors) and multiple sellers (providers) implies the potential for a competitive ASM

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<sup>4</sup> Such as if a vessel fails to take a trip when they had notified their intent to sail.

<sup>5</sup> For a list of ASM observer duties, see: [https://www.nefsc.noaa.gov/fsb/asm/ASM\\_Monitor\\_Duties.pdf](https://www.nefsc.noaa.gov/fsb/asm/ASM_Monitor_Duties.pdf)

<sup>6</sup> Within each sectors' operations plan, which are reviewed and approved by NMFS, the sector must indicate whether or not they intend to actively participate in the groundfish fishery in the fishing year(s) specified in the plan. Sectors that indicate they will be actively fishing for groundfish must contract with an ASM observer provider. Those sectors that indicate that they will not be actively fishing for groundfish may operate on a "lease only" basis for quota and therefore do not have to contract with an ASM provider.

<sup>7</sup> In order for a sector to contract with an ASM provider, NMFS must have approved the provider's ability to meet the objectives of the ASM program. During FY16-18 five providers received approval, one of which did not contract with any sector throughout this period. Three of the four providers that contracted with sectors for FY16-18 had previously contracted with NMFS for ASM coverage prior to March 2016.

services market. Competition is one of the important factors in making contracting services more cost-effective in the public or private sector (Prager, 1994). Given heterogeneity along dimensions relevant to the cost of placing monitors on vessels, such as landing ports and fishing trip durations, the depth of knowledge sectors possess regarding their vessels' operations could, in theory, result in lower costs relative to more homogeneous government-negotiated contracts.

The transition from government-funded monitoring to industry-funded monitoring is not unique to the Northeast groundfish fishery. When catch shares were implemented in the West Coast trawl fishery in 2011, a large portion of monitoring costs were subsidized. This subsidy decreased over time, and industry was fully responsible for monitoring costs starting in 2016 (PFMC and NMFS, 2017). To our knowledge, however, no previous work exists comparing government and industry rates with observer providers in U.S. fisheries.

We test the hypothesis of lower private rates by calculating the actual costs incurred for the at-sea component of the ASM program under NMFS-negotiated contracts (FY13-15) and compare these costs to a counter-factual of privately-negotiated contract terms from FY16-18. Using actual ASM-observed trips from FY13-18, we directly compared costs under the two different contracting schemes, noting changes in aggregate at-sea costs, as well as the distribution of these costs across trip-type (single vs. multi day), vessel types (large trawl/small trawl/gillnet), and landing regions. We also estimated changes in the total cost of the ASM program under NMFS and sector contracts by including the costs of observer travel and observer training. As we were unable to disaggregate these cost components to the trip-level, we only included them in the aggregate. Finally, we looked

at changes in fishing practices, specifically trip duration, on ASM trips that may have resulted from cost-reduction incentives incorporated in the privately-negotiated contracts.

## **Methods**

### *Government-negotiated contracts*

The ASM program was fully funded by NMFS from the start of FY10 (May 2010) through February 2016. NMFS contracted with three different service providers throughout this time period. ASM contracts were renegotiated during FY12-13, changing the ASM billing schedule from full to partial seadays, resulting in substantially lower costs.<sup>8</sup> To establish costs under the government-negotiated contracts, we used billing information from the Northeast Fisheries Science Center (NEFSC) Fisheries Sampling Branch over FY13-15, allowing us to assign a cost per observed seaday (hereafter “observed seaday” is shortened to “seaday”) for all aspects of the ASM program. A seaday is based off the billing schedule, which was rounded up to quarter days (6 hours) under the renegotiated NMFS contracts, such that a trip in which a vessel departed and landed on the same day and was at sea for 20 hours would count as one full (1.0) seaday. In terms of days absent, another margin we consider in our analysis, this same trip would simply be 0.83 (20/24) days absent.<sup>9</sup>

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<sup>8</sup> Under the full seaday billing schedule of FY10-11, NMFS was charged based on rounding of observer trip duration up to the nearest whole seaday (e.g. a 15 hour trip would be billed as a 24 hour trip). Under partial seadays, NMFS was charged based on observer trip duration rounded up to the nearest quarter seaday (e.g. a 15 hour trip would be billed as an 18 hour trip). The net effect of this change was to decrease at-sea costs by 25%.

<sup>9</sup> To calculate days absent, we use the Vessel Trip Report filled out by the captain. The trip duration recorded by the captain and observer are not always identical, but generally very close.

Over the September 2013 through December 2015 time period, the average at-sea cost per seaday was \$685 (in 2017 dollars), with limited variability.<sup>10</sup> The relative consistency in at-sea rates is largely based on the fact that the billing schedule (quarter seadays) did not change over the time period. The average cost for travel and lodging over the time period was \$101 per seaday. Training costs, associated with both shore-side and at-sea training, were \$70 per seaday. Adding the three components together, total ASM costs were \$856 per seaday (Table 1).

#### *Privately-negotiated contracts*

Groundfish sectors negotiated contracts with service providers on an annual basis for FY16-18. Once a sector and provider reached an agreement, the sector would send the contract to the NMFS Greater Atlantic Regional Office (GARFO) for approval. We use the approved contracts for all active groundfish sectors for each of the three fishing years. For FY16-17, 16 sectors had approved ASM contracts in place, while 14 sectors received approval for FY18. Sectors contracted with four service providers in total in each year. Provider's contracts were generally similar for the sectors covered in each year, but the cost structure of the contracts varied considerably by provider. For example, some contracts applied a universal daily rate per 24-hour period of service, while other contracts charged on a pro-rated basis and/or charged partial rates for the first and last days of a fishing trip. Some contracts applied different daily rates to single-day trips relative to multi-day trips. The contracts also handled observer travel costs in different ways. Some sectors were billed only if the port of departure and return port were not

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<sup>10</sup> The monthly at-sea cost range for the 28-month period was \$653-\$729 per seaday.

among those listed in the contract, or if the departing port and landing port were not the same. Other contracts stipulated that sectors would only be charged if observers had to travel a certain distance to board the departing vessel. Lastly, in contrast to the NMFS-negotiated contracts, the costs associated with new observer training were borne by the providers and incorporated into their charged sea-day rate.

We estimated the variable cost of ASM services for each sector as a function of the relevant component provisions contained within each contract. Broadly, variable costs for ASM services are the sum of the daily rates applied to monitored trips, any compensated travel costs, and, where applicable, lodging costs. Each component of these costs are uniquely specified in the contracts. Arithmetically, a full specification of the cost equation may be represented as:

$$ASM_{cost} = \sum_{i=1}^{15} \sum_{t=1}^n \left[ ((\alpha_1\beta_1)_i D_{first}) + ((\alpha_2\beta_2)_i \sum D_{whole}) + ((\alpha_3\beta_3)_i D_{last}) + ((\alpha_4\beta_4)_i T) + ((\alpha_5\beta_5)_i L) \right] \quad (Equation 1)$$

where, for  $i$  sectors and  $t$  trips, costs are the sum of a parameter alpha, a binary variable taking the value of one when a cost component applies and zero when it does not, multiplied by a parameter beta, indicating the applicable marginal rate for each billable service sub-component, and further disaggregated by service type where  $D$  represents billable days absent (with partial first, last and any intervening whole days treated uniquely),  $T$  is billable travel miles, and  $L$  is billable lodging days.

Ideally, total ASM costs under sector contracts would be estimated using Equation 1, however we ran into two issues regarding travel ( $T$ ) and lodging ( $L$ ) costs. First, some sectors were charged for observer travel and lodging only when the observer traveled



considerable distance to reach the vessel's port of departure<sup>11</sup>. Since we did not have access to observer travel distances, we were not able to determine the frequency with which travel and lodging charges would be applicable for these sectors. Second, even for sectors in which we knew when observer travel costs would be incurred, based on the ASM contract, we did not have access to data that would allow us to know the actual cost for mileage, lodging, tolls, etc. As a work around, we were able to obtain the percent of total ASM charges accrued to travel/lodging in FY16 directly from the four ASM providers. Since the conditions for being charged for observer travel were generally unchanged between the three contract years for all providers, we made an assumption that travel as a percentage of costs remained the same for the FY17 and FY18 contracts. We estimated total ASM costs to the fishery by first calculating at-sea costs using Equation 2, which contains only the at-sea components of Equation 1. We then took the at-sea costs and added on observer travel based on the information obtained from the contract providers. The government and privately negotiated ASM contract periods are visualized in Figure 1.

$$\text{At-sea}_{cost} = \sum_{i=1}^{15} \sum_{t=1}^n \left[ ((\alpha_1 \beta_1)_i D_{first}) + ((\alpha_2 \beta_2)_i \sum D_{whole}) + ((\alpha_3 \beta_3)_i D_{last}) \right]$$

*(Equation 2)*

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<sup>11</sup> The observer travel distance is generally from their assigned port to their port of departure/landing.

### *Comparing the contracts*

To facilitate consistent comparison of ASM costs between the sector and NMFS-negotiated rates, all groundfish sector trips<sup>12</sup> from September 2013 – August 2018 were retrieved from the Data Management and Imputation System database (DMIS) maintained by GARFO. DMIS is a comprehensive system of tables that matches records from a variety of reporting sources including dealers, captains (Vessel Trip Reports), and observers. Groundfish trip records were merged with a table of ASM trips from the NEFSC using SAS Universal Viewer 1.4 (SAS Inst., Inc., Cary, NC), ensuring only those trips that had an ASM observer on board were included. By linking each vessel with its sector affiliation, the data allowed for exact matching of trips and contracted providers.<sup>13</sup> Trip duration was primarily calculated by taking the difference between the observer recorded date/time of disembarkment and the date/time of boarding the vessel. For a small number of observations, the observer did not record this information, in which case we used trip length recorded by the captain on the Vessel Trip Report. Our dataset contained 4,072 ASM-observed trips out of 34,956 sector groundfish trips during the study period, yielding a composite ASM coverage rate of 11.65%.

We calculated at-sea costs and total ASM costs by seaday and day absent. We then aggregated these costs by fishing year. For perspective on the relative magnitude of total

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<sup>12</sup> A groundfish trip is generally identified through the Vessel Monitoring System (VMS) declaration code. A small number of trips that were not declared as groundfish trips through VMS also are considered groundfish trips in DMIS if they meet a threshold for groundfish landed (pers. comm. Dan Caless).

<sup>13</sup> When sectors negotiated ASM contracts for FY16-18, the membership may or may not have been the same as in previous years. A change in membership may affect the negotiated contract terms. There was not, however, a great deal of change in sector affiliation for active vessels in our dataset. Among the 366 active vessels, 300 (82%) were active in only one sector throughout the six-year period.

ASM costs, we calculated ASM costs as a percentage of operating profit from sector groundfish trips. We defined operating profit as net revenue minus operating costs and sector fees.<sup>14</sup> All revenues and costs were adjusted to 2017 dollars using the Gross Domestic Product (GDP) Implicit Price Deflator.<sup>15</sup> Additionally, we analyzed at-sea costs by vessel type (gear/length) and region of landing. As we were unable to disaggregate observer travel costs, we did not compare total ASM costs at these margins.

Finally, we analyzed changes in fishing behavior on ASM-observed trips during the period of government contracts (September 2013 – February 2016<sup>16</sup>) as compared to the period covered by private contracts (March 2016 – August 2018). Specifically, we measured changes in days absent, the primary driver for the at-sea cost component of the ASM program. In doing so, we also compared trip length to Northeast Fisheries Observer Program (NEFOP) observed trips. The purpose of this comparison was to inform whether any apparent change on ASM trips may have been driven by factors affecting all observed groundfish trips rather than cost reductions from incentives embedded in the privately negotiated contracts.

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<sup>14</sup> Operating costs were estimated as a linear equation based on operating cost information collected by observers in the ASM and NEFOP programs. The equation includes variability for monthly fuel prices, trip duration, number of crew, vessel size, and gear type. Groundfish sectors collect fees, on landings or quota contributions, to cover administrative costs associated with running a sector. Sector fees were estimated as a flat fee of \$0.035 per pound of groundfish landed and \$0.0075 per pound of non-groundfish landed on groundfish trips. For more information on the estimation of operating costs, see Framework 58 to the Groundfish FMP (84 FR, 2019).

<sup>15</sup> GDP deflator from the Federal Reserve Bank of St. Louis, available at: <https://fred.stlouisfed.org/>

<sup>16</sup> We do include Jan. and Feb. 2016 when comparing trip duration. These months were not included in our calculation of seaday rates under NMFS contracts since provider subcontracting during these two months affected rates.

## Results

### *At-sea and total cost comparison*

We first present results on a seaday and day absent basis across the six-year comparison period for the entire sector groundfish fleet (Table 2). Since the NMFS at-sea cost per seaday (\$685) and total cost per seaday (\$856) over the actual NMFS funding period (Table 1) were applied to the comparison period, the cost per observed seaday numbers under NMFS contracts in Table 2 are identical. For the sector contracts, the three years resulted in similar rates; at-sea costs per seaday were \$83 (12.08%) to \$106 (15.41%) lower than NMFS rates. Total costs per seaday were \$233 (27.21%) to \$257 (30.02%) lower, noting the disclaimer that travel costs were based on FY16 data.<sup>17</sup> ASM costs relative to total days absent, another margin of cost per unit effort, were ~\$80 for sector contracts at the 11.65% aggregate coverage rate for the period of study. This is distinguished from the cost per observed seaday or observed day absent, obviously higher numbers that are less sensitive to overall coverage rates. Finally, no trend emerged from the three sector contract years (slight increase in costs in FY17 and slight decrease in costs in FY18), at relatively similar coverage rates between FY16-18. Given these findings, we present results as the average of the three sector contract years.

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<sup>17</sup> In many contracts, the sector is only responsible for covering travel costs if a vessel lands in a different port than the observer boarded, or if the vessel lands in a port outside of the primary ports listed in the contract. During FY16, 30% (79/260) of ASM trips by vessels operating in such sectors where these contract specifications existed would have resulted in the sector being charged for observer travel.

We next focus on the fishery-wide comparison of both at-sea costs and total costs aggregated over the six-year period (Table 3). Averaged sector contracts resulted in at-sea costs \$0.83 million (13.63%) lower than NMFS contracts and total costs \$2.17 million (28.45%) lower. At-sea cost reductions were consistent, ranging from 12.20% in FY18 to 14.96% in FY16. At-sea costs comprised 80.02% of total costs under NMFS contracts and 96.60% under sector contracts over the course of the study period. Total costs as a percent of gross revenue generated from sector groundfish trips aggregated over the six-year period were estimated to be 2.67%, with a high of 4.57% in FY14 and a low of 1.07% in FY18 (Table 4). Year-to-year variation was driven largely by the ASM coverage rate. Total ASM costs as a percentage of operating profit (gross revenue minus operating costs and sector fees) under the averaged sector contracts were estimated to be 1.91%, with a high of 3.28% in FY14 and a low of 0.79% in FY18. Operating profit was 75.47% of gross revenue over the course of the study period, with lower percentages in FY13-14.

There was a declining trend (excluding the incomplete FY13) in both ASM costs as a percentage of operating profit and coverage rates during our comparison period. Because our time series is limited, our analysis of the relationship between these two is not complete. Though, as one would expect, higher ASM coverage resulted in the costs associated with paying for the program being a greater burden under both NMFS and sector contract rates. The coverage rate calculation was also impacted by the implementation of the extra-large mesh (ELM) exemption beginning in FY16. This rule eliminated ASM coverage requirements from ELM trips fishing in portions of southern New England due to generally low amounts of groundfish caught on such trips (81 FR,

2016). These exempted fishing trips were not counted as sector groundfish trips (the coverage rate numerator); the resulting decline in sector groundfish trips for FY16-18 as compared to FY14-15 was significant. So while coverage rates during FY16-18 were lower than those from FY13-15, a consistent formula across all years would have further lowered the FY16-18 ASM coverage percentages. Revenue from the exempted trips, however, was factored into the Table 4 totals so as to not impact the calculation of ASM costs relative to revenue.

#### *Disaggregated at-sea cost comparison*

The difference in at-sea costs between NMFS and sector contracts was heavily influenced by trip duration. On single-day trips (where sail and land date are the same), costs associated with sector contracts were comparable with those from NMFS contracts (Figure 1). In fact, average, at-sea costs on single day trips were \$26 (6.23%) higher under sector contracts (\$451) relative to NMFS contracts (\$425). The breakeven point was around 15 hours, after which NMFS contracts resulted in higher costs. There was a moderate level of variability in single-day trip costs under industry contracts (adj.  $R^2 = .634$ ). On multi-day trips (where sail and land date differ), costs associated with sector contracts were significantly lower (Figure 2). The average cost on multi day trips was \$613 (18.01%) lower under sector contracts (\$2,789) than NMFS contracts (\$3,402). The regression lines on multi-day trips fit the data very well, giving us a reliable estimate of trip duration's impact on costs.

Since short and long duration trips yielded considerably different results, it follows that cost savings from sector contracts also varied when presented across vessel

characteristics (Table 5). Large trawlers (>60' in length), which primarily take multi-day trips, achieved an 18.54% reduction in costs under sector contracts. By contrast, minimal cost savings were associated with small trawlers (<=60' in length) and gillnetters, which primarily take single day trips. On a regional landing basis, cost savings were more uniformly distributed. All three regions achieved at-sea cost reductions of at least 10% from sector contracts. In absolute terms, Massachusetts trips achieved by far the greatest cost reduction, though this was based largely on the volume of trips compared to the other two regions (Maine/New Hampshire and Rhode Island/Connecticut/Mid-Atlantic states).

#### *Effects on trip length*

Lastly, as our cost analysis is retrospective, we checked for changes in trip duration resulting from embedded incentives in sector contracts. In doing so, we chose to remove ASM trips from FY13-15 that would have fallen under the ELM exemption had they taken place in FY16-18. We felt this was appropriate for an accurate comparison between the two ASM-funding periods since ELM exempt trips averaged 11 hours over FY16-18, while ASM observed trips averaged 52 hours in length over this time period. Private contracts do not appear to have incentivized significant changes in trip length when an ASM observer was on board (Table 6). The smallest two size classes generally fit into the single-day trip category, and minimal changes in mean and median trip length were observed between the two ASM funding periods. The largest two size classes generally fit into the multi-day trip category. A reduction in mean trip length on ASM trips in these size classes was found during the sector funding period compared to the NMFS payment period. However, these decreases were not as sharp, in absolute or percentage terms,

compared to the reductions in mean trip length on NEFOP trips between the two periods. ASM trips made by vessels in the 60' to <75' size category, in fact, experienced an increase in median length during the sector funding period.

Averaged over all vessel size categories, ASM trip length increased from 2.14 days under NMFS funding to 2.28 days under sector funding. Average NEFOP trip length decreased from 2.06 days to 1.81 days. These results cannot be attributed to differences in coverage for the two observer programs across vessel size categories. For both programs, there was a shift in coverage away from the smallest vessels in the groundfish fishery (Table 6). During the NMFS funding period, 40% (1,078/2,670) of ASM trips and 46% (867/1,876) of NEFOP trips were made on vessels <45'. During the sector funding period, these percentages dipped to 28% (289/1,030) and 35% (414/1,185) respectively. The share of ASM trips on the largest vessels ( $\geq 75'$ ) increased by 8% (from 14% to 22%) over the sector funding period, while the change was only 1% (from 12% to 13%) for NEFOP trips.

## **Discussion**

At-Sea Monitoring (ASM) costs in the NE Multispecies (groundfish) fishery would have been lower under private contracts than those negotiated by the National Marine Fisheries Service (NMFS) over our comparison period of September 2013 – August 2018. We estimate at-sea costs would have been 14% lower under sector contracts (averaged for groundfish fishing years 2016-18 {FY16-18}) than under NMFS contracts (average costs for September 2013 – December 2015). Aggregate reductions for the at-sea component of



the ASM program were driven by sectors comprised primarily of vessels taking longer trips (e.g. large trawlers). We find day trip rates to have been comparable between the government and sector-negotiated contracts, implying that sectors comprised mainly of small trawlers and gillnetters contributed little to fishery-wide savings under private contracts. It seems likely that providers have lower marginal per-observed-day costs on multi-day trips, perhaps due to lower associated administrative and transportation costs. Alternatively, this may reflect a broad, fishery-wide effort shift towards larger vessels (Murphy *et al.*, 2018), and providers optimizing their contracts around covering sectors containing larger vessels. On the demand side, the implementation of the extra-large mesh (ELM) gillnet exemption (81 FR, 2016) starting in FY16, and continuing for FY17-18, effectively lengthened ASM trips, as ELM exempt trips were substantially shorter, on average, than other groundfish trips. This exemption alone likely accounted for a shift toward covering longer trips during the sector-funded ASM period: 69% of trips covered by an ASM observer were single day during FY13-15, while the number of single day trips fell to 62% of trips during FY16-18. Other changing conditions in the fishery, such as quota allocations and quota prices, may have also contributed to this shift toward multi-day trips. In any case, if sectors were aware that fewer short duration trips would be covered, they may have placed a greater focus on multi-day trip rates in contract negotiations. If the shift to sector-funded ASM had occurred in FY12, as originally stipulated (75 FR, 2010), the at-sea rates under private contracts may have looked quite different due to a higher proportion of coverage on single-day trips.

When observer travel and training costs were included, the savings under private contracts were significantly larger (28%). We were unable to analyze distributional

impacts for total ASM costs because we only had aggregated provider-level information on observer travel costs. As observer travel was a small cost component, and observer training was not a separable cost to any sector, total ASM costs would have been only slightly higher than at-sea costs for any particular segment of the sector groundfish fishery. Under NMFS contracts, observer travel and training imposed much higher costs. Therefore, when looking at small trawl and gillnet vessels, which experienced minimal at-sea cost reductions from sector contracts, total ASM cost reductions were more substantial.

It is important to note that we assigned at-sea costs on a trip basis in our analysis. In actuality, no regulatory restriction on sectors currently exists on how they secure payment to ASM providers. Sectors may bill vessels individually for each ASM trip, or estimate their aggregate ASM costs and apportion them across their membership in some other envy-free manner. The method of assigning costs is an important consideration in the distributional results we present. A payment mechanism such as the one we assumed here may provide an incentive for vessels to cut ASM-observed trips short, though we did not find evidence of such a behavioral change following the transition to sector-funded ASM when comparing to Northeast Fisheries Observer Program (NEFOP) trips<sup>18</sup>. Intra-sector cost incidence is a critical component of the shift from government to private contracts, and one for which we currently have no data to inform.

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<sup>18</sup> This may be due to government reimbursement for nearly all of the ASM program costs nominally borne by sectors.

While private contracting appears to have reduced the cost of ASM services, the transition to sector funding may have induced other effects to the monitoring program, either directly or indirectly, that are beyond the scope of this paper. To the extent that ASM is a cost to sectors and their members, the shift to private contracts may create consistent pressure on fishery managers to reduce coverage. As evidence, changes were made to the calculation of the total (ASM+NEFOP) target observer coverage rate for groundfish in FY16 (81 FR, 2016), and the target was lowered from a range of 22-26% for FY12-15 to 14% for FY16. The targets for FY17 and FY18 were then slightly higher (16% and 15%, respectively) (NOAA Fisheries, 2017b). Additionally, if compensation to the ASM observers themselves were to decline under private contracts, employee turnover may increase and the quality of recruited monitors may decrease. Higher turnover would not only result in relatively higher observer training costs, it may also decrease the quality of the data collected by observers. In essence, the shift to privately negotiated contracts for ASM services presents a principal-agent problem, the effects of which are not yet well understood.

The long-term applicability of our findings to other fisheries in the U.S. is uncertain. Other fisheries in the future may follow the same route as the Northeast groundfish fishery in having additional monitoring requirements, especially with the implementation of catch shares, and undergoing a transition from government to private funding of this additional monitoring. The West Coast trawl fishery followed this general path, though catch shares were implemented in the form of IFQs. Furthermore, individual vessels in the West Coast trawl fishery do not have the same ability to negotiate seaday rates as with Northeast groundfish sectors (pers. comm. David Edick: Alaskan Observers Inc. and

Erica Westly: Saltwater Inc.). Our results may be applicable to the partial observer coverage fisheries in Alaska, some of which operate under catch shares<sup>19</sup>. These fisheries currently have landings fees in place to pay for observer coverage. NMFS collects and administers the fees, which are used to pay contracting costs with a third party observer provider. A co-op model may potentially decrease observer costs by allowing fishing fleets to contract directly with observer providers, as is currently done in the full observer coverage co-op fisheries in Alaska (pers. comm. Elizabeth Figus; North Pacific Fishery Management Council). Given the possibility of electronic monitoring taking on an increasing role in at-sea coverage in U.S. fisheries, including the Northeast groundfish fishery, it is important to mention that this technology was not part of our cost comparison. Given the large upfront cost associated with electronic monitoring (Cap Log Group, LLC & The Nature Conservancy, 2019), a cost comparison of initial government funding, followed by a shift to industry funding, would be quite different for that technology.

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<sup>19</sup> For a complete list of partial coverage fisheries in Alaska see the North Pacific Observer Program Report, Alaska Fisheries Science Center and Alaska Regional Office (2019).

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## Tables

Table 1: ASM seaday rates paid by NMFS for fishing years 2013-2015 (in 2017 USD)

| <b>Fishing Year</b> | <b>ASM Observed Seadays</b> | <b>NMFS Cost</b>   | <b>At-Sea Cost per Seaday</b> | <b>Travel Cost per Seaday</b> | <b>Training Cost per Seaday</b> | <b>Total Cost per Seaday</b> |
|---------------------|-----------------------------|--------------------|-------------------------------|-------------------------------|---------------------------------|------------------------------|
| 2013*               | 1557                        | \$1,084,591        | \$696                         | \$108                         | \$56                            | \$859                        |
| 2014                | 3327                        | \$2,271,070        | \$683                         | \$93                          | \$63                            | \$833                        |
| 2015**              | 1192                        | \$805,558          | \$676                         | \$111                         | \$108                           | \$894                        |
| <b>Total</b>        | <b>6076</b>                 | <b>\$4,161,220</b> | <b>\$685</b>                  | <b>\$101</b>                  | <b>\$70</b>                     | <b>\$856</b>                 |

\*FY13 includes Sept. 2013 – April 2014.

\*\*FY15 includes May 2015 – Dec. 2015. Jan. and Feb. 2016 involved subcontracting between ASM providers; costs per seaday for these months were deemed invalid for comparison.

Table 2: At-sea and total cost rates (2017 USD) under NMFS contracts and sector contracts, applied to fishing years 2013-2018, through August 2018.

|                                                                    |                       | <b>Average At-Sea Cost</b> | <b>Average Total Cost</b> |
|--------------------------------------------------------------------|-----------------------|----------------------------|---------------------------|
| <b>Cost per observed seaday<br/>(observed seadays=8918)</b>        | NMFS contracts        | 685                        | 856                       |
|                                                                    | <i>FY16 contracts</i> | 579                        | 599                       |
|                                                                    | <i>FY17 contracts</i> | 602                        | 623                       |
|                                                                    | <i>FY18 contracts</i> | 593                        | 615                       |
|                                                                    | Avg. FY16-18          | 592                        | 612                       |
| <b>Cost per observed day absent<br/>(observed day absent=7743)</b> | NMFS contracts        | 789                        | 986                       |
|                                                                    | <i>FY16 contracts</i> | 667                        | 690                       |
|                                                                    | <i>FY17 contracts</i> | 694                        | 718                       |
|                                                                    | <i>FY18 contracts</i> | 683                        | 709                       |
|                                                                    | Avg. FY16-18          | 681                        | 705                       |
| <b>Cost per total day absent<br/>(total days absent=66,626)</b>    | NMFS contracts        | 92                         | 115                       |
|                                                                    | <i>FY16 contracts</i> | 78                         | 80                        |
|                                                                    | <i>FY17 contracts</i> | 81                         | 83                        |
|                                                                    | <i>FY18 contracts</i> | 79                         | 82                        |
|                                                                    | Avg. FY16-18          | 79                         | 82                        |

Note: Cost per observed seaday is based on the billing schedule for seadays paid by NMFS (quarter days).

Table 3. Fishery-wide estimated ASM costs (in millions 2017 USD) under NMFS contracts and sector contracts (averaged over three years).

| <b>Fishing Year</b> | <b>Sector Groundfish Trips</b> | <b>ASM Observed Trips</b> | <b>ASM Coverage Rate</b> | <i>At-sea cost</i>    |                                        | <i>Total cost</i>     |                                        |
|---------------------|--------------------------------|---------------------------|--------------------------|-----------------------|----------------------------------------|-----------------------|----------------------------------------|
|                     |                                |                           |                          | <b>NMFS Contracts</b> | <b>Sector Contracts (avg. FY16-18)</b> | <b>NMFS Contracts</b> | <b>Sector Contracts (avg. FY16-18)</b> |
| 2013*               | 5549                           | 580                       | 10.45%                   | 1.06                  | 0.90                                   | 1.32                  | 0.93                                   |
| 2014                | 8972                           | 1616                      | 18.01%                   | 2.27                  | 1.97                                   | 2.83                  | 2.03                                   |
| 2015                | 7640                           | 972                       | 12.72%                   | 1.29                  | 1.13                                   | 1.61                  | 1.17                                   |
| 2016                | 5112                           | 475                       | 9.29%                    | 0.83                  | 0.71                                   | 1.04                  | 0.73                                   |
| 2017                | 5304                           | 315                       | 5.94%                    | 0.51                  | 0.44                                   | 0.64                  | 0.46                                   |
| 2018**              | 2379                           | 114                       | 4.79%                    | 0.15                  | 0.13                                   | 0.19                  | 0.14                                   |
| <b>Total</b>        | <b>34,956</b>                  | <b>4072</b>               | <b>11.65%</b>            | <b>6.11</b>           | <b>5.28</b>                            | <b>7.63</b>           | <b>5.46</b>                            |

\*FY13 includes Sept. 2013 – April 2014.

\*\*FY18 includes May – Aug. 2018.

Table 4: Total estimated ASM costs as a percent of operating profit (in millions 2017 USD) on sector, groundfish trips under NMFS and sector contracts (averaged over three years).

| <b>Fishing<br/>Year</b> | <b>Gross<br/>Revenue</b> | <b>Operating<br/>Profit</b> | <b>NMFS<br/>Contracts<br/>Total Cost</b> | <b>Cost as % of<br/>Operating<br/>Profit</b> | <b>Sector<br/>Contracts<br/>Total Cost</b> | <b>Cost as % of<br/>Operating<br/>Profit</b> | <b>Coverage<br/>Rate</b> |
|-------------------------|--------------------------|-----------------------------|------------------------------------------|----------------------------------------------|--------------------------------------------|----------------------------------------------|--------------------------|
| 2013*                   | 55.92                    | 37.07                       | 1.32                                     | 3.56%                                        | 0.93                                       | 2.51%                                        | 10.45%                   |
| 2014                    | 85.86                    | 61.96                       | 2.83                                     | 4.57%                                        | 2.03                                       | 3.28%                                        | 18.01%                   |
| 2015                    | 76.39                    | 59.37                       | 1.61                                     | 2.71%                                        | 1.17                                       | 1.97%                                        | 12.72%                   |
| 2016                    | 72.11                    | 57.62                       | 1.04                                     | 1.80%                                        | 0.73                                       | 1.27%                                        | 9.29%                    |
| 2017                    | 65.57                    | 51.77                       | 0.64                                     | 1.24%                                        | 0.46                                       | 0.89%                                        | 5.94%                    |
| 2018**                  | 22.43                    | 17.68                       | 0.19                                     | 1.07%                                        | 0.14                                       | 0.79%                                        | 4.79%                    |
| <b>Total</b>            | <b>378.29</b>            | <b>285.48</b>               | <b>7.63</b>                              | <b>2.67%</b>                                 | <b>5.46</b>                                | <b>1.91%</b>                                 | <b>11.65%</b>            |

\*FY13 includes Sept. 2013 – April 2014.

\*\*FY18 includes May 2018 – Aug. 2018.

Table 5. Breakdown of trip type and at-sea costs (in millions 2017 USD) by vessel type (A) and region (B). Large trawl vessels are those >60' in length; small trawl vessels are those <=60' in length. Sector at-sea costs are averaged over three contract years.

| <b>Vessel Type</b> | <b># Single Day Trips</b> | <b># Multi Day Trips</b> | <b>% Multi Day Trips</b> | <b>Sector Contracts At-Sea Cost</b> | <b>NMFS Contracts At-Sea Cost</b> | <b>Cost Reduction Under Sector Contracts</b> |
|--------------------|---------------------------|--------------------------|--------------------------|-------------------------------------|-----------------------------------|----------------------------------------------|
| Gillnet            | 1453                      | 209                      | 12.58%                   | 1.09                                | 1.12                              | 2.79%                                        |
| Large Trawl        | 249                       | 1000                     | 80.06%                   | 3.44                                | 4.23                              | 18.54%                                       |
| Small Trawl        | 945                       | 116                      | 10.93%                   | 0.65                                | 0.65                              | 0.97%                                        |

| <b>Region</b>  | <b># Single Day Trips</b> | <b># Multi Day Trips</b> | <b>% Multi-Day Trips</b> | <b>Sector Contracts At-Sea Cost</b> | <b>NMFS Contracts At-Sea Cost</b> | <b>Cost Reduction Under Sector Contracts</b> |
|----------------|---------------------------|--------------------------|--------------------------|-------------------------------------|-----------------------------------|----------------------------------------------|
| CT/RI/Mid Atl. | 507                       | 119                      | 19.01%                   | 0.43                                | 0.49                              | 11.74%                                       |
| MA             | 1679                      | 998                      | 37.28%                   | 4.09                                | 4.78                              | 14.45%                                       |
| ME/NH          | 542                       | 227                      | 29.52%                   | 0.76                                | 0.84                              | 10.02%                                       |

Table 6: Trip length (days) by vessel size on ASM, and NEFOP sector groundfish trips.

|                               | ASM Payment Period            |                                 |
|-------------------------------|-------------------------------|---------------------------------|
|                               | NMFS (Sept. 2013 - Feb. 2016) | Sectors (Mar. 2016 - Aug. 2018) |
| <b>&lt;45' vessels</b>        |                               |                                 |
| ASM trips (N=1,078; 289)      |                               |                                 |
| Mean                          | 0.75                          | 0.69                            |
| Median                        | 0.50                          | 0.50                            |
| <i>St. Dev</i>                | 0.96                          | 0.95                            |
| NEFOP trips (N=867; 414)      |                               |                                 |
| Mean                          | 0.80                          | 0.76                            |
| Median                        | 0.54                          | 0.50                            |
| <i>St. Dev</i>                | 0.90                          | 1.03                            |
| <b>45' to &lt;60' vessels</b> |                               |                                 |
| ASM trips (N=725; 315)        |                               |                                 |
| Mean                          | 0.93                          | 0.83                            |
| Median                        | 0.63                          | 0.54                            |
| <i>St. Dev</i>                | 1.10                          | 1.01                            |
| NEFOP trips (N=482; 395)      |                               |                                 |
| Mean                          | 1.10                          | 0.86                            |
| Median                        | 0.60                          | 0.58                            |
| <i>St. Dev</i>                | 1.29                          | 1.03                            |
| <b>60' to &lt;75' vessels</b> |                               |                                 |
| ASM trips (N=481; 196)        |                               |                                 |
| Mean                          | 3.49                          | 3.04                            |
| Median                        | 2.42                          | 2.73                            |
| <i>St. Dev</i>                | 3.05                          | 2.51                            |
| NEFOP trips (N=302; 221)      |                               |                                 |
| Mean                          | 4.03                          | 3.07                            |
| Median                        | 3.52                          | 1.96                            |
| <i>St. Dev</i>                | 3.13                          | 2.83                            |
| <b>&gt;=75' vessels</b>       |                               |                                 |
| ASM trips (N=386; 230)        |                               |                                 |
| Mean                          | 6.65                          | 5.61                            |
| Median                        | 6.94                          | 5.46                            |
| <i>St. Dev</i>                | 2.65                          | 2.54                            |
| NEFOP trips (N=225; 155)      |                               |                                 |
| Mean                          | 6.37                          | 5.26                            |
| Median                        | 6.58                          | 5.17                            |
| <i>St. Dev</i>                | 2.76                          | 2.53                            |

## Figures

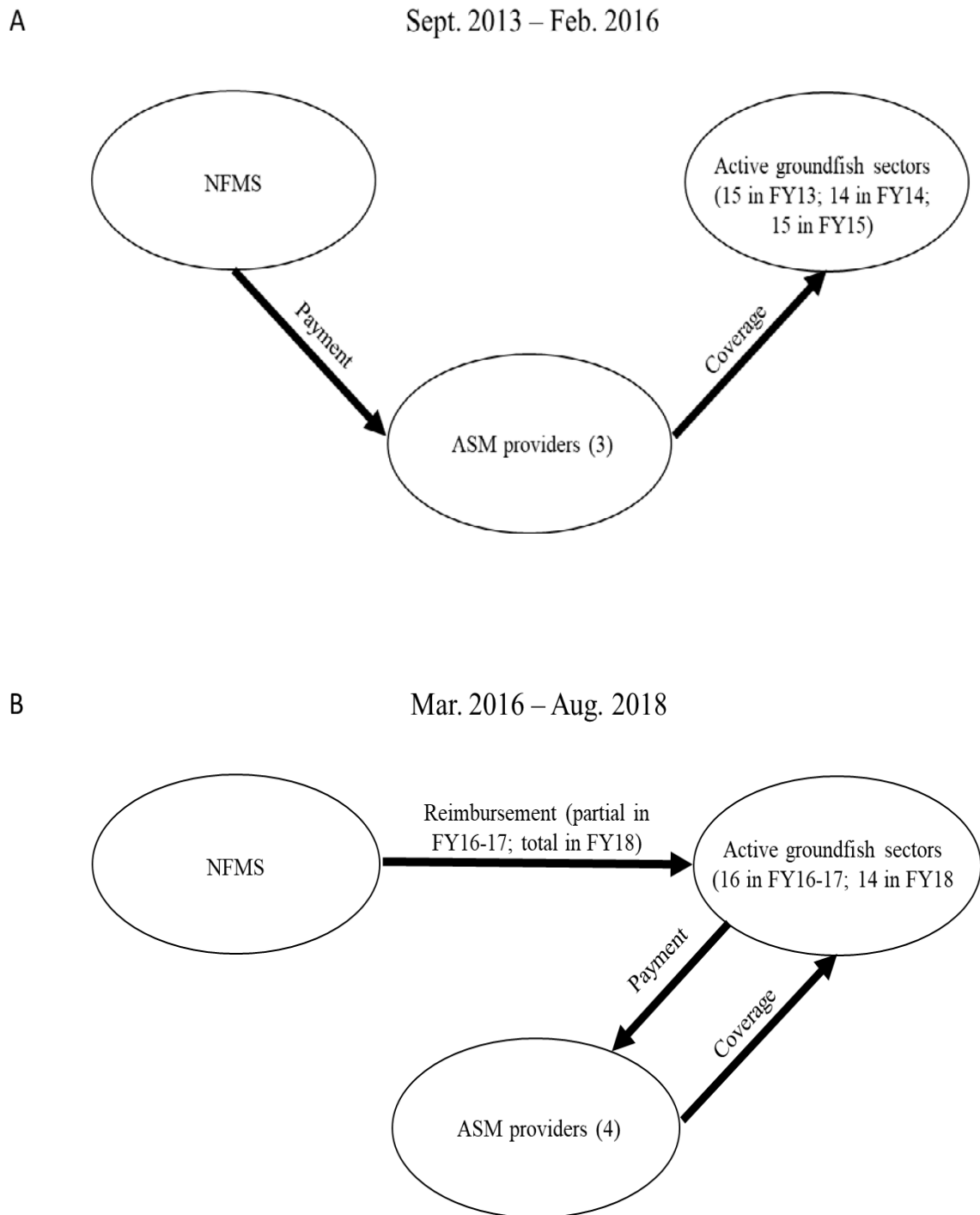


Figure 1: Diagram of NMFS ASM funding scheme (A) and sector funding scheme (B)

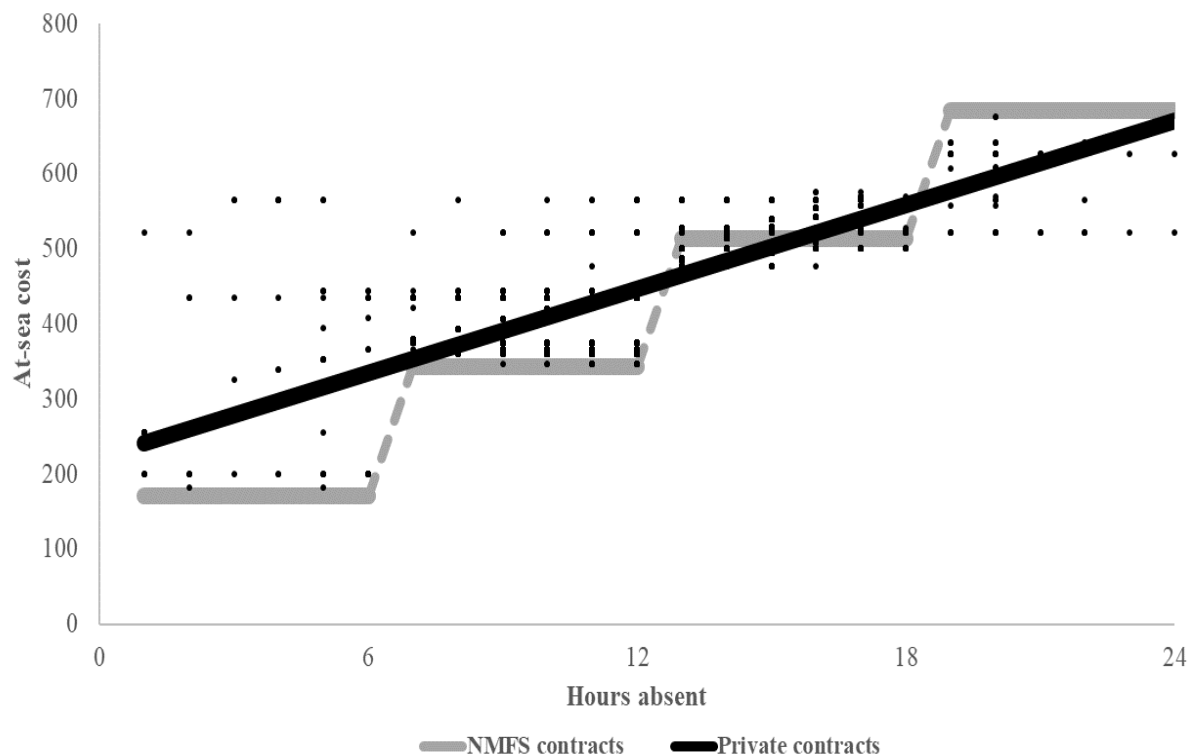


Figure 2: At-sea costs per trip (in thousands of 2017 dollars) as a function of hours absent on single-day trips. NMFS contracts represent actual trip costs (costs increase in 6 hour increments). Private contracts are averaged values over FY16-18 contracts.

\* N single-day trips = 2,601

\*\* Adj.  $R^2$  private contracts = .634



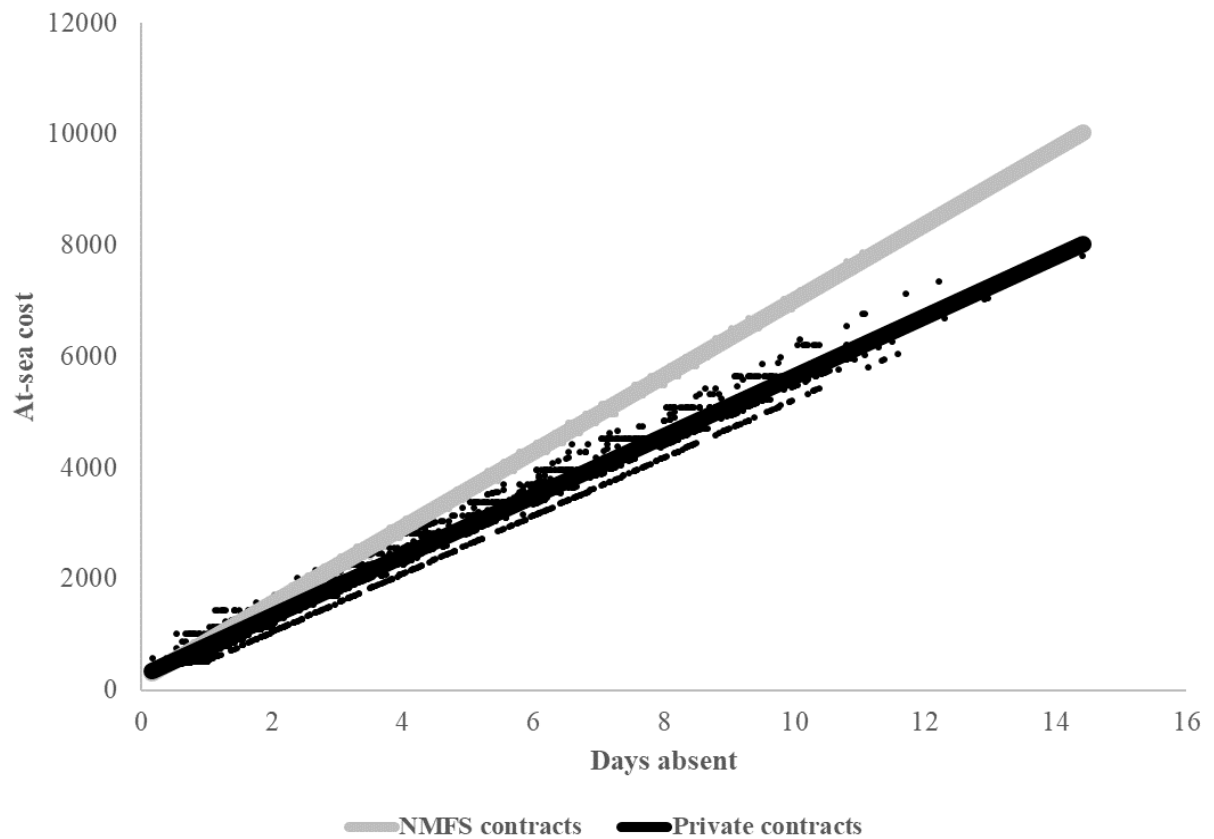


Figure 3: At-sea costs per trip (in thousands of 2017 dollars) as a function of days absent on multi-day trips. Private contracts are averaged values over FY16-18 contracts.

\* N multi day trips = 1,471

\*\* Adj.  $R^2$  NMFS contracts = .999; Adj.  $R^2$  private contracts = .976