New England Fishery Management Council
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John F. Quinn, J.D., Ph.D., *Chairman* | Thomas A. Nies, *Executive Director*

MEMORANDUM

DATE: May 3, 2018

TO: Groundfish Committee

FROM: Groundfish Plan Development Team

SUBJECT: **Analyses for Amendment 23/Groundfish Monitoring**

The Groundfish Plan Development Team (PDT) met on April 25, 2018 in Boston, MA and May 1, 2018 via webinar. The PDT discussed analyses for Amendment 23/Groundfish Monitoring.

This memorandum lays out the scope of the current monitoring program in the commercial Northeast Multispecies (groundfish) fishery and any associated uncertainties. The purpose of which is to identify the extent to which there is a need for change in any of the components of the current monitoring program. The PDT combines and synthesizes work on the nature and effectiveness of current monitoring, and where necessary adds additional analyses. Some analyses are underway and not included in this memo, and these will be summarized in a future memo to the Committee.

In addition, the PDT met with GARFO staff to discuss the Council request for information on catch reporting compliance and enforcement. A brief summary of the PDT's discussion is included.

Uncertainties in the current monitoring program

The PDT developed a list of uncertainties in the current monitoring program for the commercial fishery. The list is not exhaustive, but rather attempts to highlight the key issues. Attachments to this memo, as indicated (see Table 1), form the preliminary analysis to evaluate each uncertainty.

<u>The current monitoring program includes these uncertainties:</u>

1) Unreported and misreported catches (landings and discards) by species/stock
2) Disagreement between data sources (vessel trip reports [VTR]/Dealer; VTRs/vessel monitoring system [VMS])
3) The majority of analytical groundfish stock assessments contain a retrospective pattern, which may be caused in part by missing catch
4) Lack of an independent verification of landings may lead to catch reporting conspiracy/collusion between a dealer and a vessel, and has occurred
5) Fishermen behave differently when observers are on-board
6) Incentives exist in any quota-based system for misreporting/unreporting of catch (landings and discards)

Table 1- Key to attachments of analysis.

Uncertainty	Corresponding Attachments
1	**Attachment #1**
2	**Attachment #1**
3	**Attachment #2**
4	**Attachment #3**
5	*Forthcoming. To be provided in June.*
6	**Attachment #4**

Additional Analysis

Attachment #5 includes a preliminary review of international monitoring programs in catch share managed fisheries.

Compliance with catch reporting and enforcement

Mr. Jim St.Cyr, GARFO staff, attended the PDT meeting on April 25 in response to a Council letter requesting information on compliance with catch reporting. Mr. St.Cyr also will attend the Groundfish Advisory Panel and Groundfish Committee meetings on May 8 and 9, respectively, to discuss this topic. Mr. St.Cyr outlined the process for quality assurance and quality control (QA/QC) with respect to VTRs and dealer reports. He also explained new auditing rules are assisting in reconciling data between VTRs and dealer reports. The PDT discussion focused primarily on understanding how the QA/QC process works and how it has evolved.

Information presented was for fisheries within the entire Greater Atlantic region, so the PDT found it somewhat difficult to know how to interpret the details specifically for the commercial groundfish fishery. Although, Mr. St.Cyr indicated trends in the information are similar. The PDT had questions as to whether broader use of electronic VTRs could allow for the QA/QC process to be more efficient. One primary type of error occurs when linking a VTR record to a dealer record. A unique trip identifier linked among all databases/systems may resolve this common error (a known problem). The PDT also discussed the potential benefits of reducing errors at the time of reporting. For example, verifying area fished - at the level of statistical area - is necessary when reporting catches of species with multiple stocks. It is also one VTR field that is likely to have errors in reporting.

While preparing the *Dockside Monitoring Discussion Paper* (version 2, dated May 2, 2018), the PDT conveyed some questions to the Office of Law Enforcement (OLE) to which OLE responded (see **Attachment #6**). The responses are summarized in the PDT's Discussion of Considerations for a Groundfish Dockside Monitoring Problem (see pages 21-22 of the Discussion Paper).

Next Steps

In preparing the analyses, the PDT recognized that some of the work may be suitable for an independent peer review – such as one from the SSC or other experts. The PDT also discussed that program design takes time and would need to be informed by sufficient analysis.

Discrepancies in catch reporting

The measurement of fishing effort and estimation of catch are subject to a variety of errors that can compromise accuracy. Self-reported activity may provide a useful approximation to true activity but will be affected by competing objectives. Without incentives to report accurately or efforts to correct the record, some information may be particularly unreliable (e.g., discarded catch).

Statistical area fished

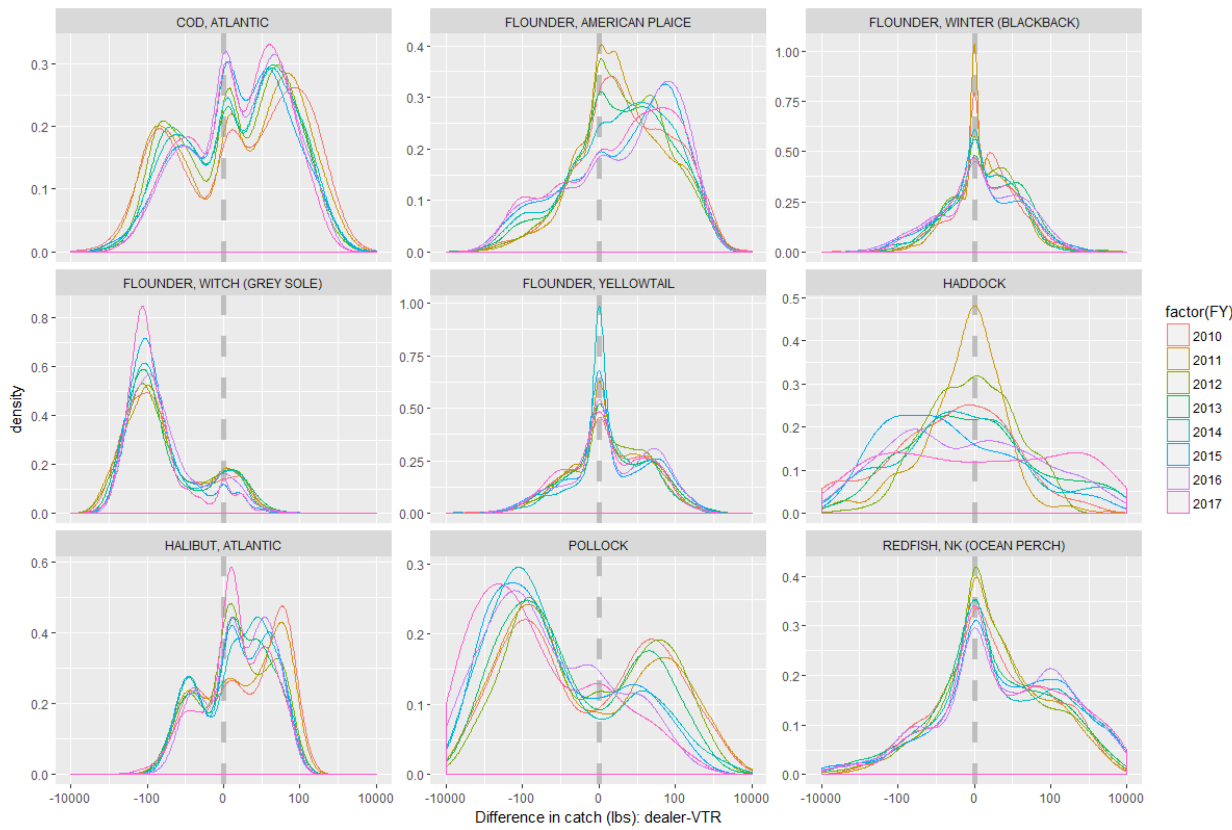
While the technology exists to record a spatial coordinate the moment gear is pulled onboard, we rely on self-reported location for apportioning catch to stock areas. Palmer (2017) identified discrepancies between stock-area apportioning of catch as reported on vessel trip reports (VTRs) with that as estimated by vessel monitoring system (VMS) data; the latter provided an approximation of the spatial distribution of fishing effort according to vessel speed. The differences were most pronounced starting in 2010 with implementation of the quota-based system for groundfish, after which incentives for misreporting of quota-limited stocks increased. Palmer (2017) suggested that while overall error was small and unlikely to substantially impact resource monitoring, the error could be particularly large in certain years for some individual stocks. Additionally, the error was disproportionately attributed to a small number of vessels and could be reduced with improved catch monitoring.

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.

Kept catch

Even with reasonable diligence, self-reported catch is unlikely to exactly match the weight reported by a dealer using scales on land. Accuracy could be affected by differences in how species are dressed and stored. Delayed recording of the catch could result in poor recollection of catch amounts. And visual estimation can have worse precision than other methods depending on the total amount of the catch.

The figure below illustrates density distributions of the differences (log10-transformed live pounds) in catch amount (dealer – VTR) across 9 allocated groundfish species from the 2010–2017 fishing years. Density that falls to the left of 0 indicates *over*-reported catch (VTR > dealer), while density on the right of 0 indicates *under*-reported catch (VTR < dealer), under the assumption that dealer amounts were accurate. Patterns differ across species, and for some species, across years.



Analytical stock assessment models for New England groundfish often have retrospective patterns, which may be caused by missing catch (landings and discards).

Retrospective patterns are systematic changes in estimates of population size or fishing mortality, which arise in analytical assessment models as more years of data are added to the model (Hurtado-Ferro et al., 2015; Miller and Legault, 2017). Retrospective error in the models occur when there is an underlying conflict among the trends in the input data (estimated removals and indices of abundance, along with size or age structure trends) in conjunction with the input biological information (life history) with the species/stock within the model. Retrospective patterns are a major concern for sustainable fisheries management. For example, when an assessment consistently overestimates stock biomass and underestimates F (the common trend for New England groundfish), catch advice (which is meant to be precautionary) may be set at levels that are too high, leading a subsequent assessment to estimate that overfishing has been occurring. This is especially problematic for New England fisheries, where assessments are typically not performed annually, and projection results are used to set catch levels for the next two to five years into the future and up to 10 years when considering rebuilding projections. At the GARM 3 benchmark assessments in 2008 it was determined that the models were not acceptable for catch advice without accounting for the retrospective issues. A rule of thumb was developed at GARM 3 to approximate the bias and adjust for it within the projections for catch advice (OFLs, ABCs). Retrospective adjustments (rho adjustments) are applied to terminal estimates of SSB and F in assessment models for New England groundfish for the recommended status determination, and the adjustments are made to the t+1 numbers at age when the retrospective bias falls outside of the 90% confident intervals of the model uncertainty estimates. These adjustments are intended to account for the magnitude of retrospective pattern, and to provide appropriate management advice.

During the 2017 Operational Assessments, 11 groundfish stocks were assessed using an age-structured analytical assessment model (e.g., VPA or ASAP). Major retrospective patterns (rho-adjusted values of F and SSB outside of 90% confidence regions for model estimates) were present in 8 of the 11 analytical assessments (Table 1). These major retrospective patterns required a retrospective (“rho”) adjustment (at the discretion of the peer review panel). The retrospective adjustments lead to a more pessimistic perception of resource productivity (i.e., lower biomass and increased F), and in some cases resulted in changes to designations of stock status (e.g., not overfished -> overfished).

It should also be noted that some regional groundfish stocks which were formerly assessed using an analytical assessment model (e.g., GB cod, witch flounder, GB yellowtail flounder) are now assessed using an empirical approach. For these stocks the analytical assessment models were rejected during prior peer reviews, in part due to the magnitude of retrospective error that were present in the models.

Analytical stock assessment models generally need to make a number of simplifying assumptions in order to reduce the number of parameters that are estimated in the model. For example, these models assume that important parameters such as natural mortality, catchability, and sometimes selectivity are constant over time. In addition the projections also assume that growth is constant into the future. However, if any of these parameters change over time in a consistent manner, it can lead to a retrospective pattern in the model. Retrospective patterns in analytical stock assessments can be caused by a number of factors including: changes in survey catchability (resource availability and/or gear efficiency), changes in natural mortality, or unreported catch (Hurtado-Ferro et al, 2015; NEFSC, 2017). To a lesser extent, retrospective patterns can also arise to due to changes in fishery selectivity or growth, although nearly all analytical assessment models for groundfish attempt to account for these changes. Unfortunately, the true cause of the retrospective pattern is never known in practice (Miller and Legault, 2017). In the case of New England groundfish, several factors may be acting in concert to contribute to the retrospective patterns, which confounds efforts to identify a single unifying cause. However, the persistence of retrospective patterns across the majority of groundfish assessment suggests that there may be a common, regional-scale driver(s) that is responsible for the retrospective patterns.

Table 1. Summary of the performance of the analytical models used to assess 11 groundfish stocks during the 2017 Operational Update assessments. The table shows the magnitude of retrospective error associated with terminal estimates of F and SSB, and indicates whether or not a retrospective adjustment was applied to the model results. See table 9 of NEFSC (2017) for a full description.

Stock	Model type	ρ_{last}	ρ_{2016}	B_{2016}	Adj.	ρ_{last}	ρ_{2016}	F_{2016}	Adj.	Last Assess.	2017	Proj. Adj.
CODGM	ASAP (M=0.2)	0.54	0.53	3046	1,997	-0.31	-0.31	0.23	0.33	pt. est.	pt. est.	none
CODGM	ASAP (M-ramp)	0.20	0.30	3262	2,502	-0.08	-0.17	0.24	0.28	pt. est.	pt. est.	none
HADGM	ASAP	-0.04		47821	NA	0.03		0.14		pt. est.	pt. est.	none
HADGB	VPA	0.50	0.89	549938	290,324	-0.34	-0.63	0.11	0.31	ρ adj.	ρ adj.	SSB
YELCCGM	VPA	0.98	0.76	2093	1,191	-0.45	-0.39	0.19	0.31	ρ adj.	ρ adj.	NAA
YELSNEMA	ASAP	1.06	0.97	300	152	-0.53	-0.47	0.58	1.09	pt. est.	ρ adj.	NAA
FLWGB	VPA	0.83	0.54	6083	3,946	-0.51	-0.31	0.08	0.12	ρ adj.	ρ adj.	SSB
FLWSNEMA	ASAP	0.21		4360	NA	-0.25		0.21		pt. est.	pt. est.	none
REDUNIT	ASAP	0.26	0.21	435852	359,970	-0.19	-0.18	0.01	0.01	ρ adj.	ρ adj.	NAA
PLAUNIT	VPA	0.32	0.14	15148	13,351	-0.32	-0.32	0.07	0.11	ρ adj.	ρ adj.	NAA
HKWUNIT	ASAP	0.18	0.20	25638	21,276	-0.13	-0.12	0.06	0.07	pt. est.	ρ adj.	NAA
POLUNIT	ASAP (base)	0.28	0.23	226371	183,907	-0.28	-0.28	0.03	0.04	ρ adj.	ρ adj.	NAA
POLUNIT	ASAP (flat)		0.41	102571	72,889		-0.35	0.05	0.08	ρ adj.	ρ adj.	NAA

Missing catch (landings and discards) has often been implicated as a potential cause of the retrospective pattern in groundfish assessments (see NEFSC, 2017), and some assessment scientists have attempted to quantify the magnitude of missing catch that is needed to “fix” the retrospective effort in the model. For example, during the 2016 witch flounder assessment (SAW 62), it was estimated that the magnitude of catch would need to be increased by 300-500% to fix the retrospective problem in the assessment. During the 2017 Operational Update assessments, it was estimated that the “recent catches” of Gulf of Maine cod would need to be roughly doubled in order to alleviate the retrospective pattern in the model. During the 2016 TRAC assessment, it was estimated that recent catches (or natural mortality) would need to be increased by 300 to 500% in order to remove the retrospective pattern in the VPA model that was formerly used to assess Georges Bank yellowtail flounder.

Trawl fisheries in New England are required to use large mesh codends, which are designed to reduce the capture and retention of sub-legal fish. Some proportion of fish which encounter a trawl net, but are not ultimately retained by the gear, may suffer acute or delayed mortality. This is referred to as “escapee mortality”. Escapee mortality is a form of missing catch, and may contribute to the retrospective pattern in some assessments. However, neither the current monitoring system, nor any of the alternatives under consideration would enable the magnitude of escapee mortality to be quantified.

It is interesting to note that retrospective errors are present in assessment models for stocks that are considered to be constraining to the fishery (e.g., GB cod, plaice), where the incentive to misreport or underreport catches would be particularly strong. At the same time, retrospective errors are also present in assessments for stocks with low utilization rates and relatively large quotas (e.g., pollock, redfish, and GB haddock), where the incentive to misreport landings would presumably be much lower, or perhaps even non-existent.

From the perspective of the PDT, missing catch may be contributing to the retrospective patterns that are present in the New England groundfish assessments. However, there is not sufficient evidence at this time to understand whether missing catch is the primary contributing factor to the retrospective problem. Further work is needed to determine whether nonstationarity (e.g., variable M, changing catchability, etc…) may be contributing to the retrospective patterns that are present in the stock assessments.

References

Miller, T.J., and Legault, C.M. 2017. Statistical behavior of retrospective patterns and their effects on estimation of stock and harvest status. Fisheries Research, 186: 109-120.

Hurtado-Ferro, F., Szuwalski, C.S., Valero, J.L., et al. 2015. Looking in the rear-view mirror: bias and retrospective patterns in integrated, age-structured stock assessment models. ICES Journal of Marine Science, 72(1): 99-110.

Northeast Fisheries Science Center (NEFSC). 2017. Operational Assessment of 19 Northeast Groundfish Stocks, Updated Through 2016. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 17-17; 259 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/publications/

Attachment #3

Catch reporting collusion between a dealer and a vessel is possible, and has occurred – no independent verification of landings

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Currently, landings data for the groundfish fishery comes from dealer reports and vessel trip reports (VTRs). VTRS require that the vessel captain reports all species caught during the trip and the weight of the catch, as well as statistical areas fished and gear used. Dealer reports include data about the date a catch was landed, the name of the vessel that brought it in, the grade, species, price and weight of the fish, and the number of the trip report that corresponds to the catch. There is no independent verification of landings.

There was a dockside monitoring (DSM) program in the groundfish fishery from 2010-2011, which was intended to verify landings of a vessel at the time it is weighed by a dealer and to certify the landing weights are accurate as reported on the dealer report.[1] However, the DSM program was later discontinued in part because landings information is already provided through the dealer reporting system and by eliminating the program, sector operating costs would be reduced and redundant accounting would be avoided.[2] The Council's rationale was that 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. NMFS determined that dealer reporting combined with dockside intercepts by enforcement personnel were sufficient to monitor landings of sector catch at the time. However, after the removal of the DSM program there have been incidents of unreported and misreported landings.

In addition to the potential for unreported and misreported landings, the lack of independent verification of landings in the groundfish fishery creates a situation in which catch reporting collusion between a dealer and a vessel is possible. The dealer reports and VTRs have intentional overlap, which allows NOAA to use the dealer reports as a check on the information vessels submit on trip reports, and vice versa. If the species and weight listed on the dealer report does not match the corresponding trip report, the discrepancy may be evidence of fraud in one or both reports. Therefore, to perpetrate an ongoing fraud regarding the species or weight of a given catch, the vessel operator and the dealer must collude. Additionally, there is that nothing prohibits a person from owning both the vessels and the wholesale dealer operation that buys fish from the vessels.

Such catch reporting collusion between a dealer and a vessel occurred in the by now familiar case of <u>United States vs. Carlos Rafael</u>.[3] On March 30, 2017, Carlos Rafael, a.k.a. the Codfather, pleaded guilty to

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[1] 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

[2] 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

[3] United States District Court, District of Massachusetts. Sept. 20, 2017. United States of America vs. Carlos Rafael Government's Sentencing Memorandum

federal criminal charges involving falsely reporting catch information on dealer reports and vessel trip reports. He was initially arrested and charged in February 2016. Rafael, the owner of Carlos Seafood Inc., based in New Bedford, Mass., owned 32 fishing vessels through independent corporate shells and 44 permits, which amounted to one of the largest commercial fishing businesses in the United States.

The charges arose out of an undercover investigation in which federal agents posed as organized crime figures interested in buying Carlos Seafood. From 2012 to January 2016, Rafael routinely lied to NOAA about the quantity and species of fish his vessels caught in order to evade federal quotas. During that period, Rafael misreported to NOAA approximately 782,812 pounds of fish, telling NOAA that the fish was haddock, or some other abundant species subject to high quotas, when in fact the fish was cod, sole, or other species subject to strict quotas. After submitting false records to federal regulators, Rafael sold much of the fish to a wholesale business in New York City in exchange for duffle bags of cash. During meetings with the undercover agents, Rafael said that in his most recent dealings with the New York buyer he received $668,000 in cash. Rafael smuggled at least some of that cash out of the United States to his native Portugal, hiding it there to evade federal taxation on that revenue.

In September 2017, Rafael was sentenced by U.S. District Court Judge William G. Young to 46 months in prison and three years of supervised release, during which time he is banned from working in the fishing industry.[4] The Court also ordered Rafael to pay a fine of $200,000 and restitution to the U.S. Treasury of $108,929. Four of his vessels were forfeited. There is also ongoing civil action pending against Rafael by NOAA.

In this particular case, Rafael owned both the vessels and the dealer, Carlos Seafood, to which those vessels sold fish. As he freely admitted to the agents, this system of vertical integration is largely what enabled Rafael to commit long-term fraud without detection: he made sure that abundant, “high quota” fish like haddock was listed on trip reports instead of what his boats actually caught, i.e., “low quota,” high value fish like cod. Rafael then made sure that Carlos Seafood, Inc.’s, receipts from “buying” the fish from his boats matched the fraudulent trip reports and, more importantly, that the dealer reports he submitted weekly to NOAA matched the fraudulent trip reports as well. It should be noted that collusion between a dealer and a vessel can still occur when these are not the same owner, and that a vertically integrated dealer/vessel business does not guarantee collusion or fraud will occur.

[4] United States Attorney’s Office, District of Massachusetts. Sept. 25, 2017 news release. https://www.justice.gov/usao-ma/pr/owner-one-nation-s-largest-commercial-fishing-businesses-sentenced-falsifying-records

Estimating Incentives to Discard New England Groundfish Stocks
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May 3, 2018

Background: Transferable quota-based systems generate incentives to discard fish (Arnason 1992). 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 landings prices. We develop a theoretical model specific to sector management that estimates the fisherman's stock and trip-level discard incentive.

Methods: We model the incentive to discard (*Id*) legal-sized fish as the difference between the costs associated with landing one additional unit (pound) of fish and the costs associated with retaining that unit. Costs of landing (*Cl*) include the cost of quota for that unit of fish, the cost of quota for all other stocks associated with landing an additional unit, together with sector and landing fees as well as any costs associated with on board handling such as the labor of properly gutting and icing the fish. 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 and the detection probability and magnitude of sanction associated with being illegal fish discards.

The fully specified equation for the incentive to discard (*Id*) follows

$$Id_{ik} = \left[\left(Cl_i\left(q_i\right) - C_d\left(q_i\right)\right)/pf_i * q_i\right]_k$$

.

The full cost of landing (*Cl*) is specified as

$$Cl\left(q_i\right)_k = \left\{pq_i * q_i + \left(1-\delta_k\right)\left[\sum_{j=1}^{n}\left(pq_j * q_j * r_i\right)\right] + Cll(q_i) + sf * q_i + lf * q_i\right\}_k$$

,

where *r* is the discard rate, as

$$r_i = disc_i/q_k$$

.

The full cost of discarding (*Cd*) is specified as

$$Cd_i\left(q_i\right)_k = \left[pf_i * q_i + Cdl(q_i) + p(d) * s\right]_k$$

where

i=stock
k=trip
j=allocated groundfish stock
pq = quota price
q = quantity (live pounds)
δ = percent of tows observed
r = discard rate
Cll = cost of labour of landing
sf = sector fees
lf = landing fees
$disc$ = quantity of discards
q_k= total trip landings (allocated groundfish stocks + non-allocated groundfish stocks + non groundfish stocks)
p_f = ex-vessel price
Cdl = cost of labor of discarding
$p(d)$ = probability of detection
s = sanction associated with getting caught.

Incentives are estimated separately for each allocated groundfish stock and each groundfish trip over fishing years 2007-2016. Trip information is selected from the DMIS database. Discard ratios are back calculated by stock and trip.

Quota prices are estimated with a robust regression model based on methods in Holland, 2013. 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 1). In other instances where estimated quota prices appear anomalous (i.e. high prices for low utilization stocks), these prices were adjusted to the median reported cash trade value. Prices for fishing year 2010 are estimated annually due to fewer reported trades and no information on within sector trades. The value of quota for fishing years 2007-2009 (pre sectors) is assumed to be zero.

Table 1. 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

Model assumptions: The incentive to discard 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 representative of true catch (e.g. no species substitution or other misreporting);
- modeled quarterly inter- and intra-sector quota prices adequately capture the quota cost faced by fisherman prior to making 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 representative of the marginal value of quota and landings and are unaffected by illegal discarding or misreporting, if any exists; and,
- 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.

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. Estimated quota prices increase for stocks and years with higher quota utilization rates (Figure 2). This follows expectations from general economic theory.

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). Discard incentives for many stocks increased notably with the implementation of the sector system (fishing year 2010). The percentage of trips landing at least one stock with a positive discard incentive has consistently increased since 2010 (Figure 4). This is most true for trips landing Gulf of Maine cod, noting a particularly strong increase in discard incentives for trips in 2015 (Figure 5).

References:

Arnason, R. 1994. On Catch Discarding in Fisheries. Marine Resource Economics, Volume 9, pp 189-207.

Holland, D.S. 2013. Making Cents Out of Barter Data from the British Columbia Groundfish ITQ Market. Marine Resource Economics. Volume 28:4.

Attachment #4

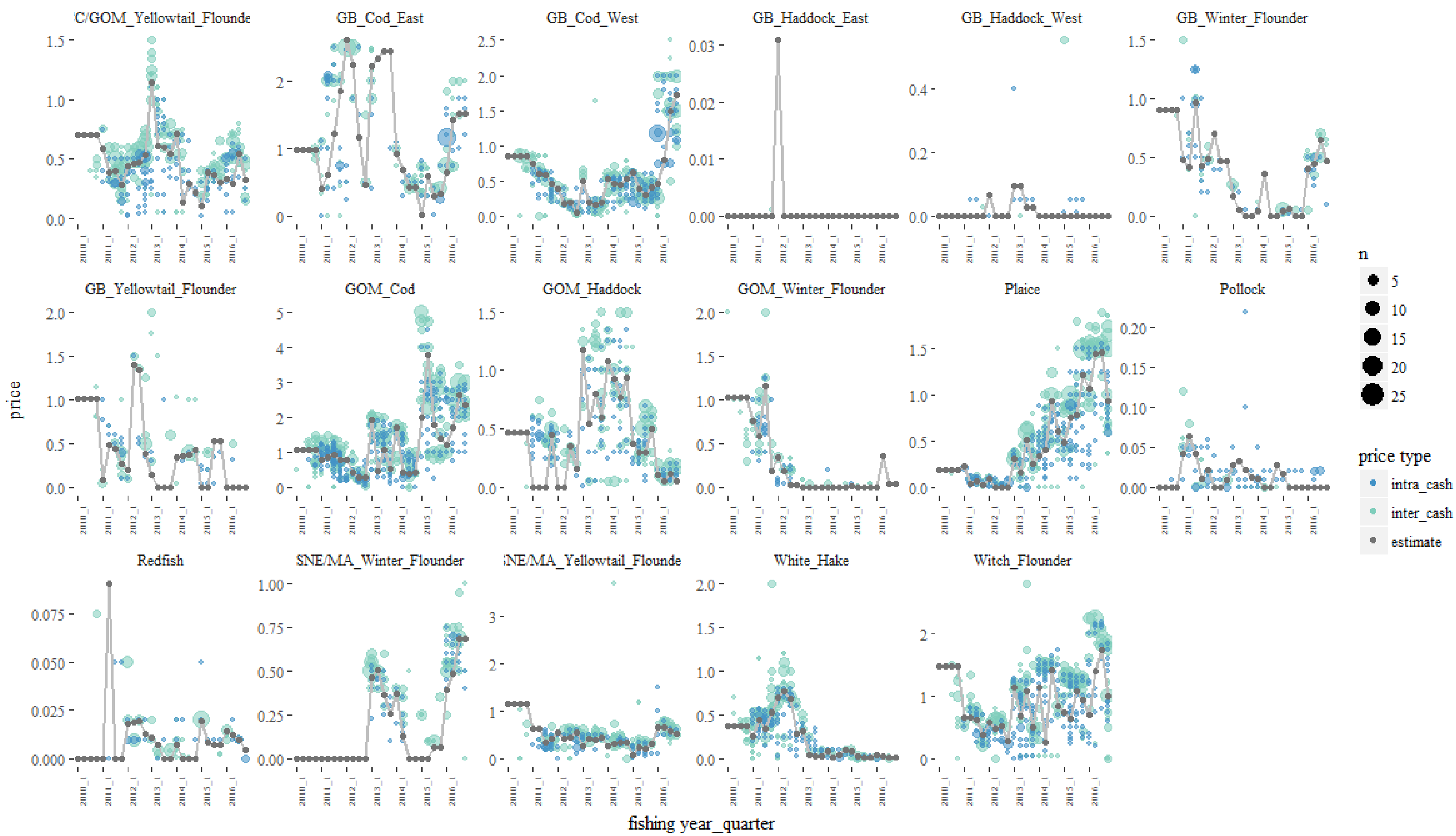

Figure 1. Estimated quota prices and sector reported single stock fish for cash trade prices by fishing year, quarter. Note that the Y-axis values differ for each stock.

Attachment #4

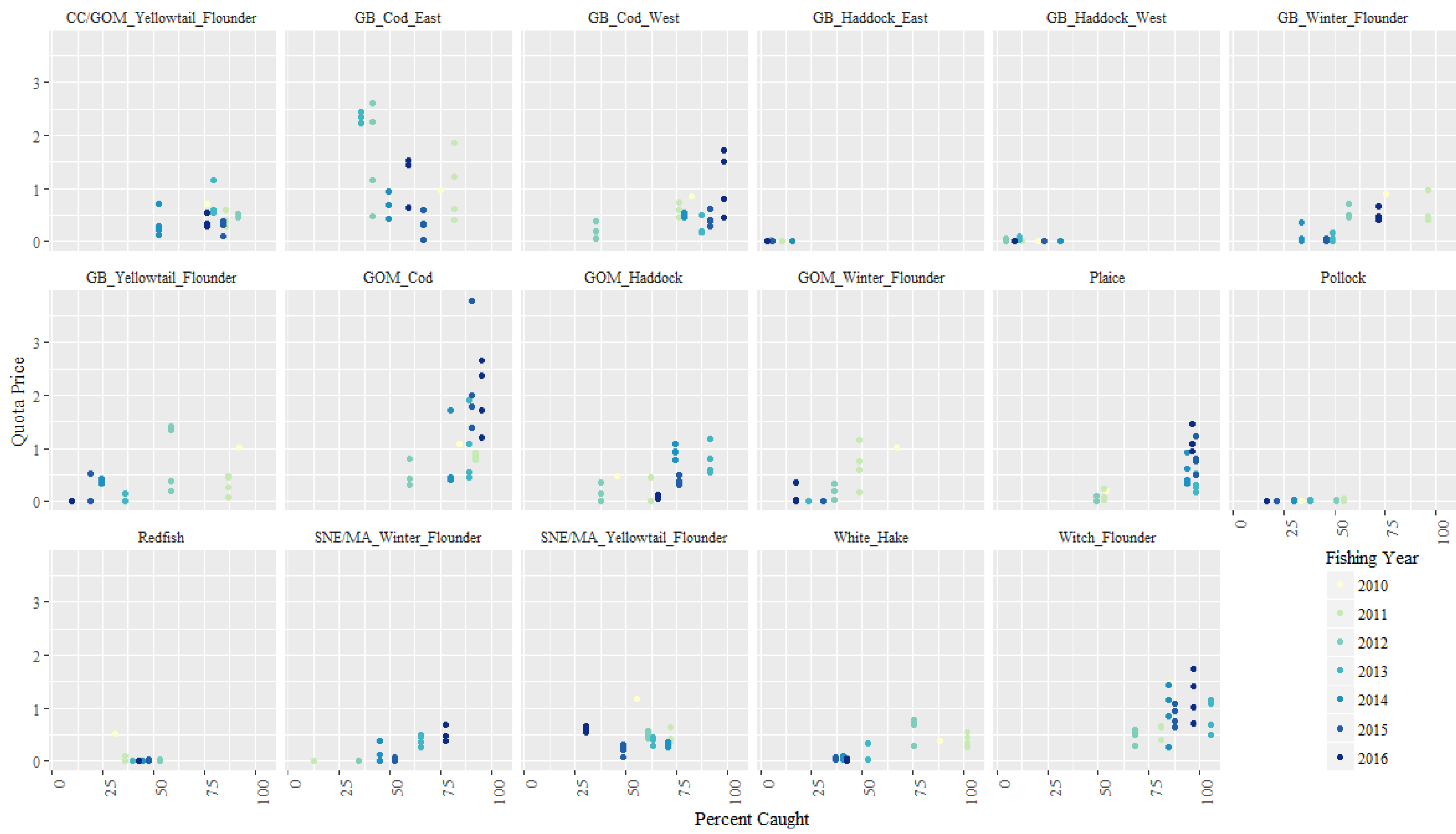

Figure 2. Percent of quota caught and estimated quota prices.

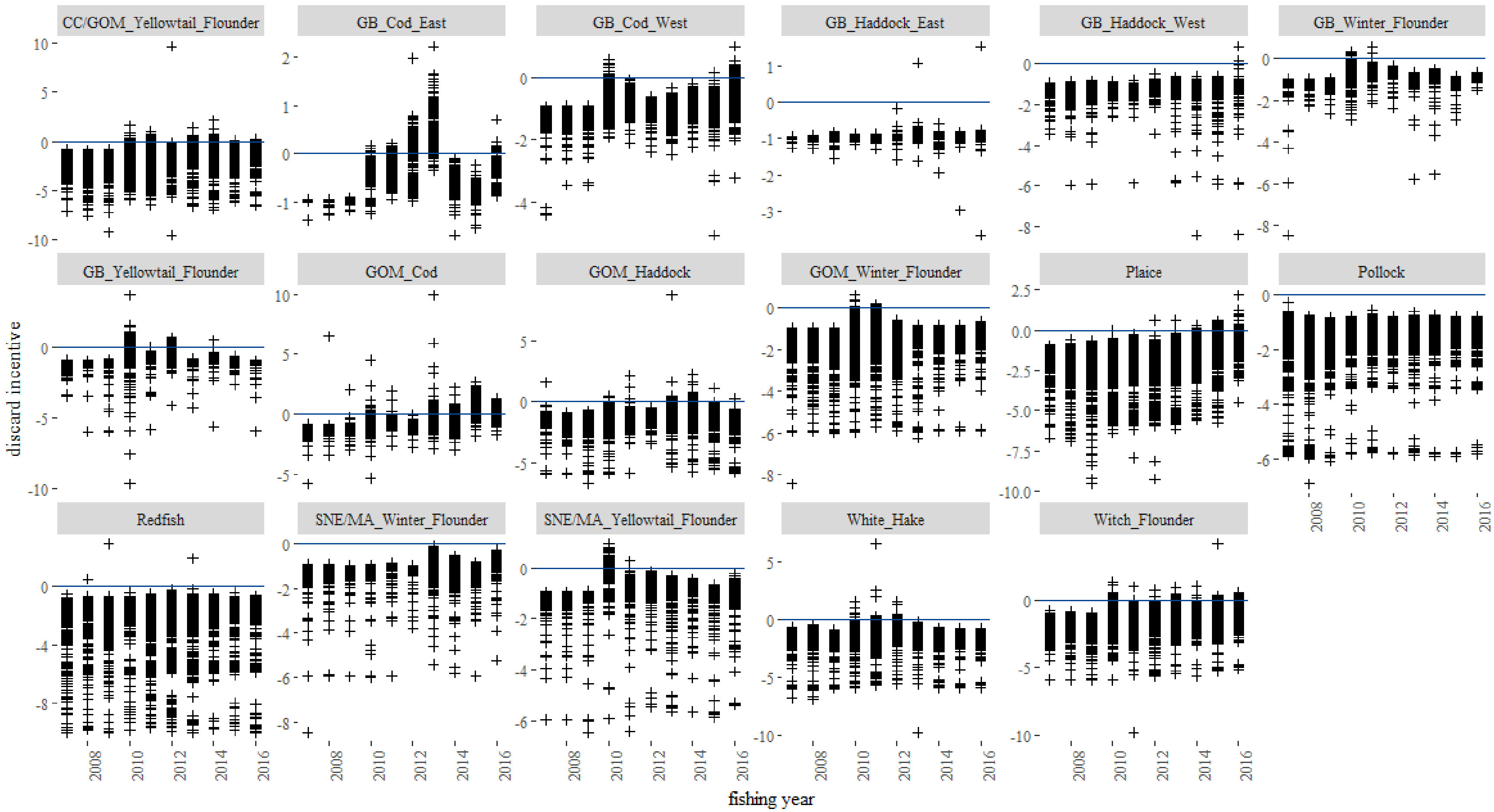

Figure 3. Estimated discard incentives for unobserved trips fishing years 2007-2016. Note that the Y-axis values differ for each stock.

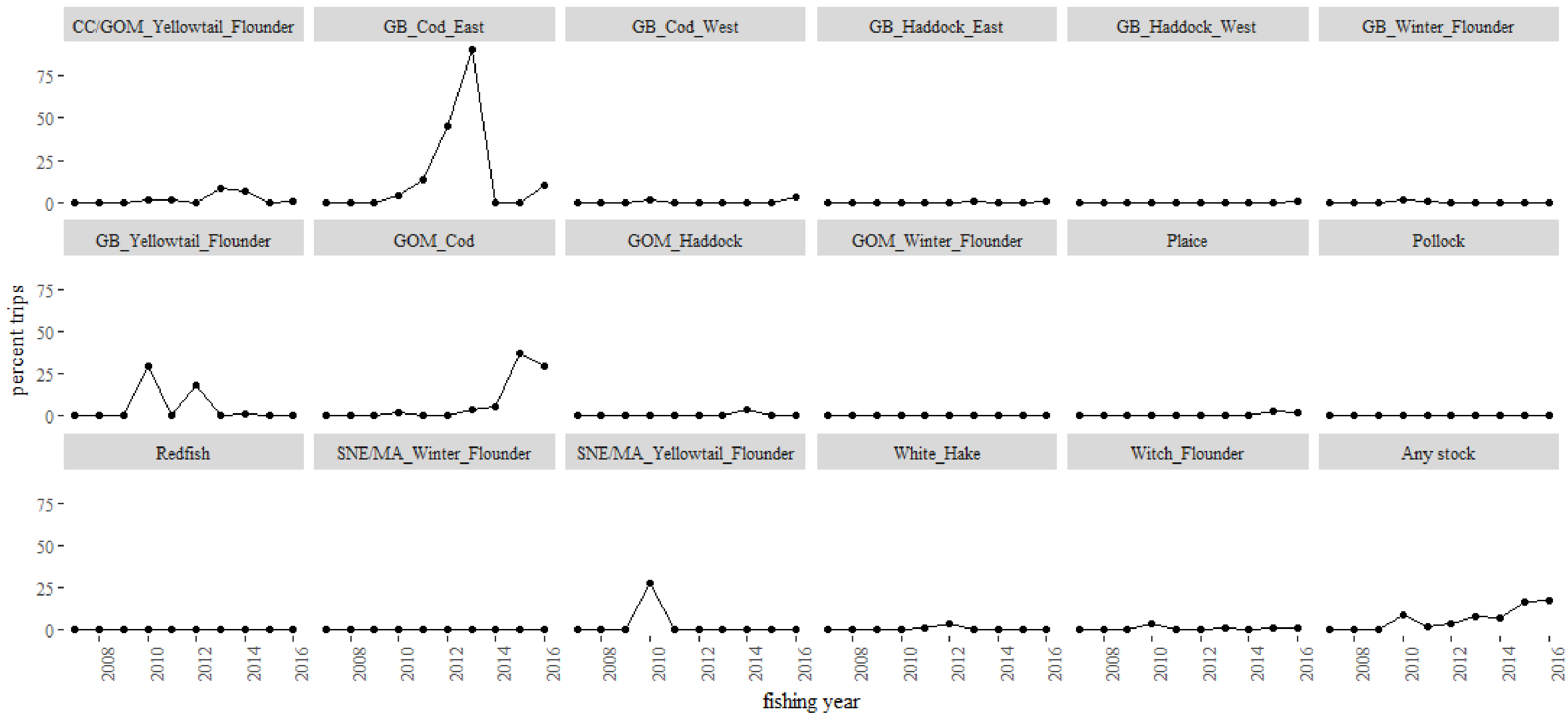

Figure 4. Percent of trips landing listed stock with positive discard on that stock. All stocks plotted on 0-75 Y-axis.

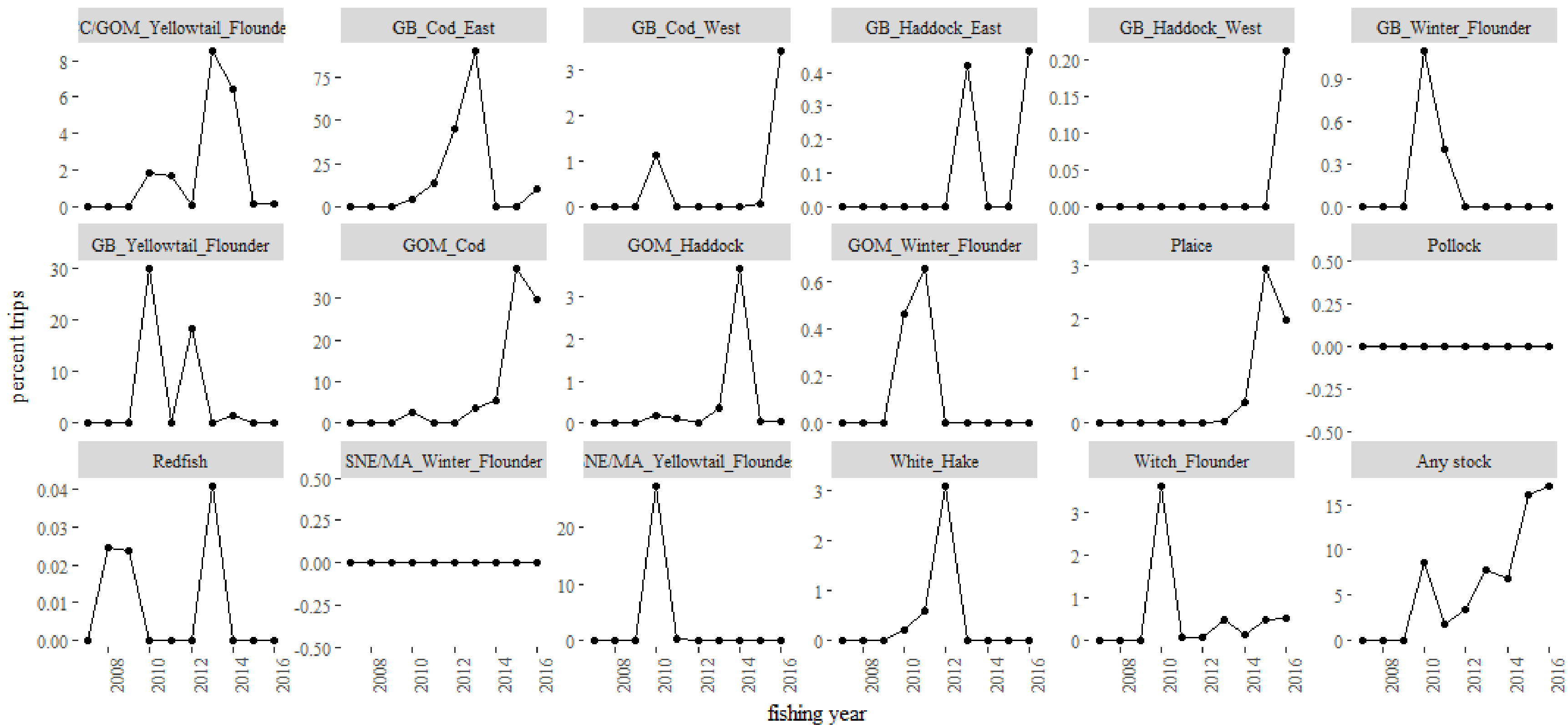

Figure 5. Percent of trips landing listed stock with positive discard on that stock. All stocks plotted with differing Y-axis by stock.

Attachment #5

Review of International Monitoring Programs in Catch Share Managed Fisheries-

Preliminary Results

Melissa Errend

Integrated Statistics in support of NOAA Fisheries, Northeast Fisheries Science Center, Social Sciences Branch

A unifying tenet of rights-based management approaches in fisheries (e.g., catch shares, ITQs, or cooperatives) is the allocation of a portion of total catch or effort to individuals or groups, thereby granting a right, or a privilege, to a portion of the resource. Under such a system, fishers are accountable for their catches, including buying, selling, or trading quota in order to keep harvests under limits set for the fishery as a whole (TACs or ACLs). Therefore, monitoring programs for catch share managed fisheries are important to ensure the requirements of catch accountability imposed by the program are met, which includes a system of matching landings with sufficient quota allocations as well as any discards. It is recognized that multispecies quota systems are particularly sensitive to monitoring requirements because discarding is incentivized when quota availability limits landings of jointly caught species (Woods et al. 2015). According to NOAA's National Observer Program's annual report:

> "Catch share programs rely on observer data to monitor catch, landings, and discards. In many cases these fisheries require enhanced observer coverage to document vessel specific, or sector-level quotas. Managers and fishermen rely on observer data to ensure that vessels or sectors do not exceed their authorized quota of target or discard species." (NMFS, 2013)

This review compares the broad structural elements of domestic and international catch share programs, including the type of monitoring and catch accounting tools employed as well as an indicator of coverage rates (full or partial). Tools compared include:

- Dockside Monitoring (DSM)
- Vessel Monitoring System (VMS)
- Hailing notifications
- At-sea observer coverage
- Logbooks (electronic or paper)
- Dealer reports (electronic or paper)
- Electronic monitoring (EM)

Vessel monitoring systems (VMS) transmit vessel location usually at a set rate may be used to ensure fishing vessels are fishing within designated areas as well as verify other self-reported information (Palmer 2017). VMS systems may also be used to send notifications to federal authorities when starting a fishing trip (hail out notification) or returning to port (hailing in). Other vessel tracking systems include AIS. Other monitoring tools include logbooks and dealer reports which contain information on species kept, discarded, and received by buyers. Generally, logbooks are dealer reports are self-reported by the industry but may be independently verified by an observer. In addition, at-sea human observers or dockside monitors may also be used to collect information on kept catch and discards, collect biological samples, or record protected species interactions. For the purposes of this review, detailed information concerning the specific duties of individual observer programs were not detailed. Current information concerning the status of any electronic monitoring programs was also included. A few programs have do not have fully operational EM programs but are in development which are denoted.

Data and Methods

For this preliminary review, comprehensive information on all global catch share programs was not available. For comparison purposes, nearly all U.S. catch share programs were reviewed with the exception of the surfclam and ocean quahog IFQ fisheries. International programs selected for review were prioritized if it was a multispecies, finfish trawl, rights-based management program and based on the availability of information. International multispecies trawl programs were prioritized for review because of the combined impact of low gear selectivity and catch-quota balancing constraints in these fisheries which may incentivize discarding (Arnason 2014). Additional international programs covering single-species, invertebrate, or highly-migratory fisheries may be included in the future.

Current federal laws, regulations, management documents, personal communication, and academic papers were the primary sources of information for all programs. Not all entries represent distinct catch share programs, information was separated within catch share programs based on the level at which monitoring tools employed varied, most commonly at the vessel size or fleet level. Activities from enforcement (port or at-sea inspections) were not counted as a monitoring program tool and did not constitute partial coverage. Results included here are preliminary and while contacts at various regional and national agencies have supported the collection of information, independent review and verification has not occurred yet.

Results

Results of the preliminary review are presented in Table 1. 21 programs were reviewed across the U.S., Canada, Iceland, Argentina, New Zealand, and Australia. Programs that institute different monitoring requirements for different vessel size classes, gear types, or catch and process at sea are separated out in Table 1. Nearly all of the 16 U.S. catch share programs are included, excluding just the invertebrate Surfclam and Ocean Quahog ITQs. Majority of programs reviewed utilize trawl gear (bottom or mid-water), but fisheries utilizing several other gear types including pots and traps, longline, vertical line, and gillnet were included as well. Table 1 lists multispecies programs and fleets in the first half of the table and single species programs in the second half.

Dockside monitoring

Excluding fleets that process at sea, of the 12 multispecies programs/fleets examined, only the New England multispecies sector program did not have any form of dockside monitoring. Of the 11 programs or fleets with dockside monitoring, 5 implement 100 percent dockside monitoring—this includes the West Coast shorebased IFQ fleet, the Alaskan Central Gulf of Alaska groundfish catcher vessel fleet, the B.C. integrated groundfish program, the Icelandic and Argentine IFQ programs. The remaining 6 programs or fleets, from the Gulf of Mexico grouper/tilefish IFQ, New Zealand, and Australia each monitor their fisheries dockside randomly, or through an annual audit. By contrast, only 1 of 8 single species catch share programs had 100% dockside monitoring, the AFA pollock trawl catcher vessel fleet, while two programs had random inspections, and the remainder had no form of dockside monitoring, excluding inspections from law enforcement.

VMS & Hailing Notifications

Nearly all programs reviewed require vessels to be outfitted with vessel monitoring or tracking systems that are approved by the government for use and has a penalty system for improperly using VMS systems. In the U.S., VMS is commonly the system through which hailing notifications can be sent (e.g., 50 CFR

660.14), which may explain why the incidence of this requirement across programs is also quite high. Only a few programs, the Alaska halibut & sablefish IFQ, the SE Atlantic wreckfish IFQ, and the Mid-Atlantic Golden Tilefish IFQ only require VMS to be used partially or are not required at all. AIS is used to track vessels for Argentine vessels (S. Stefanski, pers. comm), while New Zealand starting required its largest vessels to utilize geospatial position reporting devices (GPR) in 2017 and will implement this across all of its vessels in the fall of 2018.

At-Sea Monitoring

All multispecies programs and fleets had at least partial at-sea monitoring coverage, either through the use of human observers or a combination of humans and video compliance methods. 7 fleets implement at least 100 percent monitoring, which generally means one human observer on board on all trips, but two Alaskan programs employ 200 percent coverage on catcher-processors. However, coverage rates among partially observed multispecies programs varied widely, from 1 to 5 percent of all sea days in the Gulf of Mexico grouper-tilefish IFQ, to anywhere from 2 percent to nearly 100 percent in the Bering Strait/Aleutian Islands crab program, depending on target fishery. At-sea monitoring coverage rates were not able to be calculated from available information from either New Zealand or Australia but are estimated to be low (Helidoniotis et al. 2017; Mace, Sullivan, and Cryer 2014).

Three single species programs or fleets have at least 100 percent at-sea observer coverage, all of which are in Alaska. All but two single-species programs have some level of at-sea observing, however several of which are not determined by, or specifically for, the catch share program itself, but are set by the regional observer program which is used for other reasons other than catch accountability and applies to multiple fisheries in the region—this is the case for the West Coast sablefish permit stacking program, the New England general category scallop program, and the U.S. Atlantic individual bluefin tuna quota program (IBQ), as examples. In particular, the IBQ fishery does not have a higher at-sea monitoring rate than other pelagic longline vessels because it is subject to 100 percent electronic monitoring.

Logbooks and Dealer Reports:

All programs were classified as requiring both logbooks and dealer reports with the exception of the two Gulf of Mexico programs, which each only require participants to fill out reports on discarded species on 20% of trips. In addition, it was evident that many programs have already, or are in the process of implementing electronic reporting.

Electronic Monitoring

Several programs already employ some level of electronic monitoring across single-species and multispecies programs, while several others are in the process of implementing final rules to implement EM on their fleets (i.e., the West Coast shorebased IFQ and at-sea cooperatives and the New Zealand QMS), or have indicated that they are considering potential EM applications (NMFS 2018). Similar to other monitoring tools, of the programs reviewed, EM is implemented or will be implemented as a monitoring tool in half of the multispecies catch share programs, while roughly a quarter of the single-species programs or fleets utilize any electronic monitoring.

In addition, after catch reconstructions for New Zealand's quota managed fisheries (QMS) indicated that total catch may be over twice what is reported to the FAO the Ministry of Primary Industries (Simmons et al. 2016), and after investigations into illegal discarding (Moir 2016; Price 2016), now the Ministry is in the process of implementing full electronic reporting and requiring EM on all of its commercial vessels through an Integrated Electronic Monitoring and Reporting System (IEMRS). By contrast, Iceland has partial observer coverage on its vessels, but FAO sustainability certification documents for the Icelandic cod fishery indicate that the government's research arm does not believe that there is an illegal discard problem and is not exploring electronic monitoring (Global Trust Ltd 2014).

Conclusion

Preliminary results of this review are consistent with expectations that implementing a suite of monitoring tools may be important across catch share programs and that multispecies fisheries may implement higher levels of monitoring in order to achieve accountability of catch and discards. A greater number of monitoring tools and higher coverage rates are generally employed in multispecies catch share programs than in single-species programs. Specifically, dockside, at-sea, and electronic monitoring are currently used in a greater proportion of the multispecies programs than in single species programs reviewed thus far. Among multispecies programs, a range of different monitoring program structures are used, from partial observations and of both catches at sea and dockside landings in Australian and New Zealand programs, to programs in Alaska, Canada, and the U.S. West Coast where 100 percent of catches and landings are monitored. Both Iceland and Argentina fully monitor landings dockside but only observe a minority of trips at sea. The New England multispecies sector program is the only multispecies program reviewed that does not have any form of dockside monitoring.

There may be widespread benefits of achieving full accountability that span many common goals of catch share programs including supporting profitable harvesting practices, functional quota markets, incentivizing efficient harvesting practices, generating accurate catch data for stock assessments, promoting stability and stewardship, and rebuilding depleted stocks. More work is needed to fully characterize worldwide catch share monitoring systems in order to understand how various combinations of tools and coverage rates may affect program performance. In order to characterize these relationships, numerous aspects of program design and performance may be needed, including:

- fleet size, landings, and revenue
- discard policy
- discard incentive management
- monitoring funding sources and cost
- monitoring program goals
- estimated discard rate
- discard estimation method
- enforcement rate and penalties

While changes to monitoring programs over time were not specifically evaluated, this review found that several programs are currently in the process of implementing electronic monitoring and electronic reporting systems, while others have already implemented these technologies. There may be valuable lessons to be learned from the experiences in other regions and countries as these programs evolve. Case studies may be useful to more deeply characterize different problem-solving approaches.

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Table 1: Monitoring and catch accountability tools by program. Full coverage (dark blue) indicates that the tool is employed on all vessels and all trips, partial coverage (light blue) indicates that the tool is employed on <100% of vessels or trips. Green shaded areas in the electronic monitoring field indicates that EM is in the process of being fully operationalized. Information is not comprehensive of all catch share programs and should be regarded as preliminary. 'Unknown' indicates that a status update on whether or not a fishery/fleet utilizes a given tool has not been verified, but available sources indicate that the tool is not required.

Country/region	Program/Fleet	Multispp	Year Impl.	DSM	VMS/ tracking	Hailing/not.	At sea coverage	Logbook	Dealer report	Electronic Monitoring
U.S. New England	New England Multispecies Sector	X	2010	None	X	X	Partial, NEFOP + ASM	Paper or electronic	Electronic	EFPs
U.S. West Coast	West Coast Trawl-shorebased IFQ (fixed/trawl)	X	2011	100%	X	X	100%	Paper and electronic	Electronic fish ticket	Proposed rule
U.S. West Coast	West coast trawl- At-sea MS/CP cooperatives	X	2011	N/a	X	X	100%	Paper and electronic	Electronic fish ticket	Final rule
Canada, B.C.	B.C. Integrated groundfish program (fixed/trawl)	X	2010/2011	100%	X	X	100% EM or human	Paper or electronic	Electronic	100% EM or human
U.S. Alaska	BSAI non-pollock trawl CP (Amendment 80)	X	2008	N/a	X	X	200% (2/trip)	Electronic	Electronic	Video compliance
U.S. Alaska	Alaska CGOA Rockfish Trawl CP	X	2012	N/a	X	X	200%	Electronic	Electronic	Video compliance
U.S. Alaska	Alaska CGOA Rockfish Trawl CV	X	2012	100% one port	X	X	100%	Paper	Electronic	None, considering compliance monitoring of shoreside or to estimate prohibited species catch (PSC)
U.S. Alaska	BSAI Crab Rationalization Program- CP	X	2005	N/a	X	X	100% (state observer program)	Paper, voluntary elogbook	Electronic	Not considering EM
U.S. Alaska	BSAI Crab Rationalization Program- Catcher Vessels	X	2005	Landings on unobserved trips are monitored	X	X	Coverage varies by target fishery 2-100%	Paper, voluntary elogbook	Electronic	Not considering EM

Attachment #5

Country/region	Program/Fleet	Multispp	Year Impl.	DSM	VMS/ tracking	Hailing/not.	At sea coverage	Logbook	Dealer report	Electronic Monitoring
Iceland	Icelandic ITQ	X	2006-2007	100% at accredited landing stations	X	X	20% trips for large trawlers, one trip per year for other vessels	Electronic and paper- app pending to replace paper	Recorded by DSM	None
U.S. Gulf of Mexico	GOM Grouper-tilefish IFQ VL/LL/trap	X	2010	Random dockside	X	X, A-36A amends	RFOP: <1-5% of sea days	Paper, 20% discard reporting	Electronic	Unknown
Argentina	Argentine ITQ	X	2010	Full	AIS required	X	Partial ~15%	Paper	Paper	Exploring EM
New Zealand	New Zealand QMS >28 m trawl	X	1986	Annual audits	GPR required	X	Partial	Electronic	Electronic returns	Cameras phased in Oct 1
New Zealand	New Zealand QMS<28 m	X	1986	Annual audits	GPR after October 1	X	Partial	Electronic after Oct 1 2018	Electronic returns	Cameras phased in Oct 1
Australia	Southern and Eastern Scalefish and Shark Fishery (CTS)- Australian Southeast Trawl	X	1988-1992	Port sampling	X	Unknown	Partial	Paper or electronic	Paper or electronic	Unknown
Australia	Southern and Eastern Scalefish and Shark Fishery (CTS)-Gillnet Hook and Trap Sector	X	1988-1992	Port sampling	X	Unknown	Partial	Paper or electronic	Paper or electronic	Required
U.S. New England	NE GC Atlantic Sea Scallop IFQ		2010	None	X	X	Partial, NEFOP	Paper or electronic	Electronic	Unknown
U.S. Mid-Atlantic	Mid-Atlantic golden tilefish IFQ		2009	None	None	None	Partial	Paper or electronic VTR	Electronic	Unknown

Attachment #5

Country/region	Program/Fleet	Multispp	Year Impl.	DSM	VMS/ tracking	Hailing/not.	At sea coverage	Logbook	Dealer report	Electronic Monitoring
U.S. West Coast	West Coast Sablefish permit-stacking fixed gear		2001	None	X	X	Partial, 20-50% of landings	Paper or electronic	Electronic	Unknown
U.S. Alaska	Alaska AFA pollock trawl CP/MS cooperative		1999	N/a	X	X	200% (2/trip)	Electronic	Electronic	Video compliance
U.S. Alaska	Alaska AFA pollock trawl CV cooperative		1999	100%	X	X	100%	Paper	Electronic	None, considering compliance monitoring of shoreside or to estimate prohibited species catch (PSC)
U.S. Alaska	Alaska Sablefish/Halibut CP fixed gear IFQ		1995	N/a	Some areas only	X	100%	Paper or electronic	Electronic	None
U.S. Alaska	Alaska Sablefish/Halibut CV fixed gear IFQ		1995	Random enforcement	Some areas only	X	Partial	Paper	Electronic	Video as alternate to observer
U.S. Alaska	Alaska Halibut/Sablefish <40’ CV fixed gear IFQ		1992	Random enforcement	Some areas only	X	None	Paper	Electronic	None
U.S. Gulf of Mexico	GOM red snapper IFQ. VL/LL/trap		2007	Random dockside	X	X	RFOP: <1-5% of sea days	Paper, 20% discard reporting	Electronic real-time	Unknown
U.S. Southeast Atlantic	SE Wreckfish hook and line IFQ		1992	None	None	None	None	Paper trip ticket	Electronic	None
U.S. Atlantic HMS	HMS Individual Bluefin Quota Program		2016	None	X	X	Partial, <10%	Electronic	Electronic	100% required

Questions from the PDT to OLE regarding dockside monitoring

1. What percentage of trips are currently monitored dockside by OLE?

- In 2017 OLE performed approximately 300 inspections of groundfish/NE Multispecies inspections.
- Currently, OLE does not differentiate between dockside and at-sea inspections.
- OLE's enforcement priorities for ground fish has focused away from dockside inspections due to the self-policing construct of the sector management system.

2. What percentages of those trips are in violation?

- Based on an initial review, approximately 2% may face enforcement actions

3. Is the OLE monitoring sufficient to ensure landings are reported accurately?

- No. We have limited resources to cover the amount of trips landed, even with the JEA program as a force multiplier. Our focus is based on egregious violations or cases initiated by actionable intelligence.
- To ensure accurate reporting, a dockside inspection accompanied with confirmation of dealer reporting is necessary.

4. Does OLE inspect fish holds?

- Yes. Inspection of fish holds is a fundamental component of any fishing vessel inspection.
- Officer discretion to inspect or not can be used in cases of poor weather, poor material condition of the vessel or other relevant circumstances.

5. Can DSM replace OLE dockside enforcement to avoid duplicative efforts?

- YES, but fish holds should be inspected.

6. Does anyone compare the landings estimates from NEFOP to the dealer reports as an independent check of accuracy?

- OLE does not perform this type of check but believes data sharing of this type would extend our enforcement capacity.
- Due to current OLE staff levels, this type of comparison would best be between NEFSC / APSD.