CORRESPONDENCE

June 23, 2022

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166 Water Street
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Re: Utilization of ASM Monies to offset Sector Costs

We write today to request that the Agency include monies in its 2022 Spend Plan that provides direct assistance to sectors and their professional affiliations to cover the overhead incurred implementing and managing these monitoring programs as well as other programs as listed below. We greatly appreciate the continued Congressional support for at sea monitoring for the groundfish sector program; including Congress's recognition that the current ex-vessel revenues and sector income generated cannot absorb the additional costs associated monitoring;. The CLS 2022 clearly directs sector costs, which are industry costs, to be covered. Similar to how the Agency has factored in administrative costs to their shoreside expenses and Agency software needs under prior Spend Plans, we again, request that the Agency include monies in its 2022 Spend Plan that provides direct assistance to sectors and their professional affiliations. Sectors continue to be financially challenged to cover the overhead costs incurred implementing and managing these monitoring programs as well as other programs as listed below. Direct financial assistance is even more critical now with the increased ASM coverage implemented for this 2022 fishing year and considered under Amendment 23 for future years.

We offer our recommendations to the NOAA spend plan under development to comply with the following CJS 2022 language:

> Northeast Multispecies Fishery.—The Committee recognizes that the New England groundfish fisheries management programs continue to present substantial financial challenges to the participants as well as to the economic sustainability of those fisheries and fishing communities. Therefore, the Committee rejects the proposed cut to Observers and Training and provides not less than $6,000,000 within Observers and Training for grants to the fishing industry to fully cover At-Sea Monitoring industry costs**, including sector costs**, in the New England groundfish fishery. Any additional At-Sea Monitoring costs, including shore side infrastructure, observer training, observer equipment and gear, electronic monitoring, and NOAA support costs shall, to the extent practicable, be included in subsequent budget requests, starting in fiscal year 2023.

> NOAA shall ensure the costs and benefits of At-Sea Monitoring are commensurate with the gross revenues of vessels in the fishery. Before obligating any of these funds, NOAA shall provide the Committee with a detailed spending plan. (*Emphasis added)*

As noted to the Agency for a number of years now, Sectors incur considerable costs facilitating ASM programs, Electronic Monitoring Programs and Electronic Reporting. Sectors pay for and rely heavily upon IT programs to assist them with management and reporting of ACE for their members and administrative costs incurred with each fishing trip that becomes part of the operating expenses of a Sector. Additionally, Sector Managers spend an inordinate amount of time coordinating, facilitating and educating industry on monitoring and reporting elements adopted by the Agency. This sector workload will be elevated in the coming year as the monitoring targets are increased to meet the Agency and Amendment 23 coverage targets.

Over the years it has become common for the Agency to assume Sectors will take on the responsibility of implementing and overseeing any number of programs that impact the management of their members and/or their Sector. Sector's increase in workload is directly impacting sector viability. NOAA needs sectors to be viable, sector's industry members want to be viable but there is not sufficient funding (through various sector fee structures) for sectors to absorb these costs anymore. Sectors and their professional affiliations incur numerous costs associated with these programs. This includes but is not limited to,

- programming costs to retool quota management systems and software;
- staff time to participate in various implementation efforts;
- accounting costs associated not only with the reimbursement program but the implications those have on annual tax filings;
- insurance costs associated with having staff available to be on the vessel for assistance with install etc.;
- staff time to support training and integration of ER technology amongst industry members, staff time to ensure ER technology is effectively integrating with GARFO;
- staff time to ensure Sector compliance is continuing to be met due to the infancy of systems developed around EM/ER;
- missed opportunity costs due to time spent working on these implementation programs over day to day quota management;
- and, at times, the cost of additional support staff to help manage workload responsibilities.

Over a year ago we wrote to you to identify these Sector costs paid for by the industry through sector fees and requested consideration that such Sector costs be incorporated into the Fiscal Year 2021 Spend Plan. The Agency did not include sector costs in the FY 2021 Spend Plan and to date has not explained why we were excluded or what additional information we could have provided to be included. We appreciate that understanding the day to day management and overhead of Sectors is challenging for those not in the middle of it but we continue to be very willing to sit down with you to help the appropriate decision makers better understand our costs and to work collaboratively with you on development of the 2022 Spend Plan, specifically that portion which addresses sector costs. Thank you in advance for your consideration and we look forward to working with you on this critical matter.

Sincerely,

Mary Hudson,
Sector Manager, Maine Coast Community Sector

Hank Soule,
Sector Manager, Sustainable Harvest Sectors

Dan Salerno,
Sector Manager, Northeast Fishery Sector 5 & 11

Dave Leveille,
Sector Manager, Northeast Fishery Sector 2 & 6

Vito Giacalone,
Sector Manager, Northeast Fishery Sector 4

Paula Lynch,
Sector Manager, Northeast Fishery Sector 12

Amy Morris,
Sector Manager, GB Cod Fixed Gear Sector

Stephanie Sykes,
Sector Manager, Mooncusser Sector

Linda McCann,
Sector Manager, Northeast Fishery Sector 8

John Haran,
Sector Manager, Northeast Fishery Sector 10 and 13

Elizabeth Etrie,
Program Director, Northeast Sector Service Network

Attachment: Letter re. Utilization of ASM Monies to offset Sector Overhead Costs dated 6/2/2021

CC:
Chairman Reid, New England Fishery Management Council
Jackie Odell, Executive Director Northeast Seafood Coalition

June 2, 2021

Jonathan Hare, Ph.D.
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Woods Hole, MA 02543

Michael Pentony
Regional Administrator
Greater Atlantic Regional Fisheries Office
55 Great Republic Drive
Gloucester, MA 01930

Re: Utilization of ASM Monies to offset Sector Overhead Costs

Dear Jon and Mike,

We write today to encourage you to include in the FY 2021 At Sea Monitoring (ASM) Spend Plan monies to provide direct assistance to Sectors to offset the costs they will continue to incur facilitating ASM programs as well as implementation of Electronic Monitoring (EM) and Electronic Reporting (ER). We also strongly encourage the use of other funds appropriated by Congress, in prior years and/or to help facilitate Agency directives related to EM/ER technologies. To date, Sectors have been the missing component when considering ASM Spend Plans. In light of the increased hardships associated with the implementation of measures associated with ASM, EM and ER technologies, it is imperative the Agency acknowledge the critical role that Sectors and their professional affiliations play.

Over the years it has become common for the Agency to assume Sectors will take on the responsibility of implementing and overseeing any number of programs that impact the management of their members and/or their Sector. The Agency's recent announcement that Sectors would be responsible for coordinating all aspects of implementation to the EM program including reimbursement of EM installation costs for any of their members who choose to take advantage of the recent funding announcement is just an example of this expectation.

While we appreciate any assistance that offsets costs to our members, we would be remiss not to highlight that Sectors and their professional affiliations are presented with management challenges and will be incurring substantial costs as the Agency moves towards full implementation of EM and ER technologies. For Sectors, these additional administrative costs become the burden of their fishing members.

Sectors and their professional affiliations incur numerous costs associated with these programs, including but not limited to programming costs to retool quota management systems, staff time to participate in various implementation discussions, accounting costs associated not only with the reimbursement program but the implications those have on annual tax filings, insurance costs associated with having staff available to be on the vessel for assistance with install etc., staff time to support training and integration of ER technology amongst industry members, staff time to ensure ER technology is effectively integrating with GARFO, staff time to ensure Sector compliance is continuing to be met due to the newness of systems developed around EM/ER, missed opportunity costs due to time spent working on these implementation programs over day to day quota management, and at times the cost of additional support staff to help manage workload responsibilities.

For example, the Audit EM program as currently developed requires Sectors to utilize data from different data sets than what non-EM trips use for weekly reporting. In order to ensure Sectors are able to efficiently incorporate the data from these EM trips into their weekly reports, quota management tools will need to be reprogrammed to incorporate new file formats. Similar steps may need to be taken to incorporate the fleet moving to ER in the fall of this year. These changes will not be minor and they will not be inexpensive. The last time the Agency did a major data change to file structures in the SIMM system, Sectors were required to absorb programming costs to respond to such changes. Previous changes were to existing SIMM files but these new programs are establishing new data files therefore, we anticipate much larger costs associated with program adjustments. After the previous data set change imposed by the Agency, some Sectors had to abandon existing reporting tools and contract with third party service providers to manage the large, complex, and changing datasets in order to generate the reports required. This is just one example of the unintended consequences of program changes that lead to financial challenges that Sectors must absorb in order to maintain compliance and general operations.

Another example of costs that should be offset is that of Sector Manager and support staff time helping members investigate and implement these various new programs. It is estimated that managers and support staff spend on average 10-15 hours educating and facilitating one vessel considering and implementing an EM option. While this may seem like a small amount of time, when it is multiplied by Sector participants it quickly becomes a substantial amount of time spent away from other pressing matters. Further, not all Sectors have full time staff and/or the technological background to provide this assistance so they either may need to draw on another manager's expertise or leave their members completely on their own to navigate these new options which does not foster positive evaluations of any system.

As we understand it, the Agency utilizes ASM funds to cover shoreside infrastructure costs which include salaries of some of their staff who are currently working on these programs. We see no reason why a similar approach could not be adopted for Sectors to help meet objectives and deliverables of that program plus other Agency program spend plans. Additionally, we see no reason why the separate EM/ER monies appropriated cannot be utilized to reimburse Sectors for costs associated with any system reprogramming that must occur in light of these changes. Alternatively, approaches utilized at the start of the Sector system, such as those followed during Amendment 16 implementation, could easily be utilized as a framework for how the Agency can ensure some of these appropriated monies are utilized to offset sector costs of these various programs.

We have been so grateful for the foresight and ASM support the commercial groundfish fishery has received from Congress. Congress has recognized that the New England groundfish fisheries management programs continue to present substantial financial challenges to the participants as well as to the economic sustainability of those fisheries and fishing communities. They have approved monies to fully fund the At-Sea Monitoring costs which has included sea and shore side infrastructure costs. Congress has also appropriated monies for EM/ER program implementation. The Agency now needs to acknowledge that Sectors are a cost to fishing businesses and their work is critical to the success of the programs implemented by the Agency. The viability of the sector system depends on it.

Thank you in advance for your consideration of this request. We would appreciate the opportunity to discuss and explore spend plan options in more depth with you to ensure a practical and equitable options can be developed for Sectors and their professional affiliations.

Sincerely,

Deven Franco,
Sector manager, Northeast Fishery Sector 7

Vito Giacalone,
Sector Manager, Northeast Fishery Sector 4

John Haran,
Sector Manager, Northeast Fishery Sector 10 and 13

Mary Hudson,
Sector Manager, Maine Coast Community Sector

Dave Leveille,
Sector Manager, Northeast Fishery Sector 2 & 6

Paula Lynch,
Sector Manager, Northeast Fishery Sector 12

Linda McCann,
Sector Manager, Northeast Fishery Sector 8

Amy Morris,
Sector Manager, GB Cod Fixed Gear Sector

Dan Salerno,
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Hank Soule,
Sector Manager, Sustainable Harvest Sectors

Stephanie Sykes,
Sector Manager, Mooncusser Sector

Elizabeth Etrie,
Program Director, Northeast Sector Service Network

CC:
Associated Fisheries of Maine
Cape Cod Commercial Fishermen’s Alliance
Maine Coast Fishermen’s Association
Northeast Seafood Coalition

Northeast Fisheries Science Center Reference Document 22-11

An Economic Analysis of the Multispecies Catch Share Program

July 2022

Northeast Fisheries Science Center Reference Document 22-11

An Economic Analysis of the Multispecies Catch Share Program

by Samantha L. Werner[1]

[1] ECS Federal, 2750 Prosperity Avenue, Fairfax, VA 22031

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

July 2022

Northeast Fisheries Science Center (NEFSC) Reference Documents

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I. EXECUTIVE SUMMARY

This report evaluates the economic performance of the groundfish fleet over fishing years (FY) 2007-2015 to capture and compare economic trends before and after implementation of catch share management enacted under Amendment 16 to the Multispecies Fishery Management Plan (FMP) (NEFMC 2009).[1] Economic performance is evaluated at 3 operational perspectives: the groundfish trip-, vessel-, and entity/business-level. Where possible, average economic performance during FY 2007-2009 is compared to that of 2010-2015 to assess changes both before and after groundfish catch share management. Information on groundfish fishing fleet structure, landings trends and compositions, operating costs, revenues, and net revenues are summarized and compared across the 2 time periods. A summary of major findings is presented in Table 1. The number of trips, vessels, and entities follow an overall decreasing trend over the entire analysis period (FY 2007-2015), each decreasing by an average of 57%, 40%, and 37%, respectively, post-catch share implementation. Every vessel size class decreased in number of vessels when comparing averages from the 2 time periods, with the <30’, 30’ to <50’, 50’ to <75’ and 75+’ size classes decreasing in average numbers by 37%, 45%, 40%, an 16%, respectively. Vessel characteristics change marginally when comparing pre- and post-catch share averages, where average vessel length, gross tons, and horsepower increases by 4%, 11%, and 6%, respectively, and vessel age decreases by 6%, which may suggest a shift toward a more efficient fleet. Similar to fleet size, gross landings also follow a more or less decreasing trend over the analysis period (FY 2007-2015) with average gross landings decreasing by 24% and 10% for trips and vessel, respectively, between the 2 time periods. Despite decreases in gross landings, median trip landings increased from 1,128 lbs. to 2,284 lbs. (102%), and median vessel landings increased from 147 thousand lbs. to 202 thousand lbs. (38%) when averaged over 2007-2009 and 2010-2015, respectively. Trip and vessel landings compositions show signs of higher diversification post-catch share implementation with increases in the median numbers of landed species and decreases in the average Herfindahl-Hirschman index (HHI) values. Groundfish trip and vessel operating costs, revenues, and net revenues are overall higher during the 2010-2015 period compared to the 2007-2009 period. The average percent of revenue earned from groundfish species decreased post-catch share by 9% and 35% for trips and vessels, respectively. Median groundfish trip net revenue increased from $1,452 to $2,379 (64%) when averaged over 2007-2009 and 2010-2015, respectively, and median groundfish vessel net revenue increased by 36% from $150K to $204K when averaged over the pre- and post-catch share time periods, respectively. Median net revenue increased, on average, for each vessel size class during the post-catch share time period, most notably for the smallest vessel size class where average median vessel net revenue increased by 1181%. This increase was most likely driven by smaller vessels with low or even negative net revenues exiting the fishery during the post-catch share time period. An average of 5% of groundfish trips incurred negative net revenues when averaged over both the 2007-2009 and 2010-2015 time periods. The average percent of groundfish vessels with negative net revenues decreased from 6% to 5% over the pre- and post-catch share time periods, respectively. An average of 2% of vessels in the <30’ size class incurred negative net revenues in both the 2007-2009 and 2010-2015 time periods. Further, an average of 3% of vessels in the 30’ to <50’ size class incurred negative net revenues when averaged over both periods. Notably, ~0% of vessels in the 2 largest vessel size

[1] Groundfish fishing years start on May 1st and end on April 30th such that the pre-catch share period includes data from May 1, 2007, to April 30, 2010, and the post-catch share period includes data from May 1, 2010, to April 30, 2016.

classes—50’ to <75 and >75’—earned negative net revenues in both time periods. The Gini coefficients suggest a relatively high concentration of net revenue among groundfish trips and vessels, with average Gini coefficients of 0.70 and 0.53 for trips and vessels, respectively, when averaged over 2007-2009. When averaged over the post-catch share time period, the level of concentration remains relatively high for both trips and vessels with average Gini coefficients decreasing to 0.68 (-1%) for trips and increasing to 0.55 (3%) for vessels. The economic metrics and measures provided in this report, along with other published works, may be used to evaluate the progress made in reference to economically focused goals and objectives set by Amendment 16 to the Multispecies FMP. Lastly, more robust and consistent economic data are needed to enhance the evaluation of the economic performance of the groundfish fleet.

II. INTRODUCTION

In recent years, the Northeast Multispecies Fishery, also known as the groundfish fishery, has undergone major shifts in management. One of the most notable changes to the fishery was the implementation of the catch share program under Amendment 16 to the Multispecies Fishery Management Plan (FMP) in 2010 (NEFMC 2009). This amendment shifted the fishery from effort controls (i.e., Days at Sea [DAS] and trip limits) to output controls in the form of hard quotas (Annual Catch Limits [ACLs]). Amendment 16 also expanded the sector allocation program, allowing for vessels to join "sectors" within which vessels can self-organize, manage, and lease/trade quota. This management plan was implemented to meet the requirements of the Magnuson-Stevens Act (Sustainable Fisheries…1996), which includes measures to decrease mortality targets within groundfish stocks while mitigating economic impacts on fishing communities. More specifically, Amendment 16 contains 15 goals and objectives which can be assessed, to varying degrees, both before and after catch share implementation. Objective 8 of Amendment 16 to the Northeast Multispecies FMP aims to, "Develop biological, economic, and social measures of success for the groundfish fishery and resource that insure accountability in achieving fishery management objectives" (NEFMC 2009). To partially achieve this objective, this report assesses various economic trends and indicators with a focus on net revenue within the groundfish fishery both before and after the implementation of Amendment 16. This analysis largely follows the analytical framework suggested by NOAA's Guidance for Conducting Review of Catch Share Programs (Morrison 2017). Additionally, this report evaluates metrics from different tiers of groundfish-related businesses to establish a holistic view of economic performance. This work, along with others, can aid in assessing the economic trends and performance measures within the groundfish fishery over time as they relate to the implementation of the catch share program.

III. METHODS AND ANALYTICAL APPROACH

In this analysis, economic trends and indicators are evaluated from 3 business perspectives: the groundfish trip-, vessel-, and entity-level. Broadening the definition of a groundfish fishing unit allows for a more holistic view of the businesses which depend, to varying degrees, on groundfish species. The period of analysis covers the 3 fishing years prior to and 5 years post-sector implementation (i.e., May 01, 2007-April 30, 2016). This time period is consistent with NOAA's guidance and was selected by the New England Fisheries Management Council for purposes of the program review (Swasey et al. 2021). When possible, the economic performance metrics were averaged over FY 2007-2009 and compared to those averaged over 2010-2015. In this study, a groundfish trip is defined as any commercial fishing trip meeting the following criteria:

i) at least 1 pound of any of the regulated large-mesh groundfish species was landed using groundfish gear (e.g., otter trawl, gillnet, bottom longline, hook and line), and
ii) the trip took place in either state or federal waters.[2]

[2] Identifiable Northwest Atlantic Fisheries Organization (NAFO) trips were excluded.

Any vessel that took at least 1 groundfish trip, as previously defined, during a specific groundfish fishing year (FY) is classified as an "active" groundfish vessel. The groundfish entity perspective broadens the scope of the analysis to include costs and revenues from the entire business, such that a single entity can include multiple vessels and multiple owners. This broader analysis includes revenues and costs from both groundfish and non-groundfish vessels that still contribute to the overall business operation. Groundfish entities were established by linking permits and individuals based on a business identification number.[3] For example, if 2 vessel owners are associated with the same business, all of their vessels are considered a single "entity" or ownership group. To be considered a groundfish fishing entity, the ownership group must be affiliated with at least 1 active groundfish vessel. Table 2 depicts how ownership groups are defined and the criteria for being considered a member of a groundfish entity in this analysis.[4] Although ownership information is required on the permit application, this information has only been databased for scallop and groundfish permits from 1996-2009 and was not databased for all permits until 2010. For this reason, entity-related information regarding total affiliated groundfish and non-groundfish vessels, landings, net revenues, etc., are only reported for years following permit year 2009 (i.e., FY 2010-2015).

The framework for this analysis is primarily shaped the by the economic goals and objectives of Amendment 16 to the multispecies FMP, specifically goals 2 and 8 and Objective 7, along with NOAA's guidance for conducting economic analyses and catch share reviews (NEFMC 2009; NMFS 2007; Morrison 2017). Given this guidance, topics such as harvest capacity, fleet composition and consolidation, and landings trends are assessed within this report. Trends in trip costs, revenues, and net revenues (revenues less fishing trip-related costs) along with measures of net revenue concentration and distribution are also examined. In this report, "net revenues" are defined as the revenues earned from landings after deducting trip costs. Net revenues are an important metric as they are typically split amongst the vessel owner, captain, and crew members. "Trip costs" are those associated with fishing operation at-sea and, in this report, include the following components: the cost of supplies, crew groceries, bait, fuel, ice, water, and oil. Due to data limitations, this analysis does not consider additional quota leasing costs or revenues, sector membership fees, general fixed costs, or additional business costs. Despite these limitations, the methods provided in this section are consistent with those described by NOAA's Guidance for Conducting Review of Catch Share Programs and National Marine Fisheries Service's (NMFS) Economic Guidelines (Morrison 2017; NMFS 2007).

In this analysis, the term "consolidation" refers to a shift toward fewer vessels or entities but of larger size as a proportion of the groundfish fleet. The term "concentration," on the other hand, is used in multiple contexts in this report but generally relates to the relative unevenness of a particular metric. For example, the Herfindahl-Hirschman index (HHI) is used to measure the change landing shares derived from different fish species. The HHI ranges in increasing concentration from 0.0 to 1.0. In this example, concentration may increase either because of a decrease in the number of species landed, an increase in the share of specific species, or both. In this analysis, concentration in terms of net revenues refers to the relative unevenness in the

[3] Groundfish entities are created based on the guidance of the Regulatory Flexibility Act (RFA) definition such that entities are based on unique ownership groups.

[4] Note that the criteria applied for defining ownership groups are limited to so-called "valid permits" that were not in the Confirmation of Permit History (CPH) program. Once a vessel permit has been placed in CPH, there is no annual renewal requirement, which means that annual changes in affiliated ownership can no longer be tracked.

distribution of net revenues among groundfish trips, vessels, and entities measured using net revenue quantile assessments and Gini coefficients. Where possible, the metrics described in this section are gauged at each business level (i.e., trip-, vessel-, and entity-level) to lend insight into fleet-level economic performance, distributional impacts, and trends in economic efficiency.

IV. DATA

A variety of data sources, economic models, and computational methods were used in generating the datasets used in this analysis. Databases were accessed to acquire data for 3 specific bodies of work: trip cost estimation; trip-level revenues and revenue approximation; and the classification of groundfish trips, vessels, and entities. Operating cost data (i.e., trip costs) are collected on commercial fishing trips by onboard observers from 2 programs: the Northeast Fisheries Observer Program (NEFOP) and the At-Sea Monitor (ASM) Program. Onboard observers collect cost information incurred on a specific trip, including the cost of supplies, water, groceries, bait, and oil. The price and quantity of ice and fuel is also collected by onboard observers. For this analysis, these 7 trip cost components are summed to create a composite value for at-sea operational costs incurred on each trip. The trip costs collected by onboard observers from the NEFOP and ASM programs were queried from the Observer Database (OBDBS) and merged into a full account of commercial fishing trips[5] from calendar year 2007-2016, acquired from the Vessel Trip Report (VTR) database. Trip costs, however, are only collected from a small sample of the total population of annual commercial fishing trips (~4%). For this reason, the remaining trips without trip costs (i.e., any trip without an OBDBS record in the VTR master dataset) were estimated using econometric modeling, where separate models are developed for the major gears used on observed trips and for trip duration (i.e., single vs. multiday trips). Because observer coverage is stratified to fulfill biological data needs rather than economic, some trip cost estimation models suffer from selection bias (Werner et al. 2020). To test and correct for this bias, trip costs were modeled using the Heckman Selection method. In cases where selection bias was not statistically significant, a log transformed Ordinary Least Squares (OLS) model was used instead. Based on statistical testing for sample selection bias, the Heckman selection modeling technique was used to estimate trip costs for the following gear and trip durations: trawl multiday trips, dredge day and multiday trips, gillnet multiday trips, longline multiday trips, seine trips, and pot and trap multiday trips. OLS models are used to estimate trip costs for the remaining gears at the day-trip level: trawl, gillnet, longline, and pot and traps. Harpoon, hand line, and less commonly used gear types (i.e., dive gear) were grouped together and also modeled using OLS. This allowed for estimation of trip costs for the full profile of trips taken during FY 2007-2015.

Commercial fishing trip revenue data are recorded in the Commercial Fisheries Database System (CFDBS), commonly referred to as “dealer data.” To estimate revenue, the VTR trip data were merged with dealer data using the VTR serial number which has been included as a data element in the mandatory dealer reporting systems since 2004. However, 44% of VTR trips did not have an exact dealer record match. For these records, trip revenue was estimated by multiplying an imputed species price[6] by the quantity of each species kept on the VTR record. Federal Vessel Permit Data were used to identify groundfish ownership groups. All monetary values are presented

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[5] Landings and trips were only accounted for if the vessel submitted a VTR record.

[6] Species prices were calculated using dealer data landings and revenues. To allocate a price to each species and trip, prices were imputed using a hierarchical algorithm (Table 3).

in 2015 constant U.S. dollars and were adjusted using the Gross Domestic Product Implicit Price Deflator[7].

V. RESULTS

i. Harvest Capacity and Fleet Structure

a. Harvest Capacity and Fleet Structure Overview

Prior to catch share implementation, excess capacity was identified in the multispecies fishery (Terry 2008). A portion of Goal 2 of Amendment 16 to the groundfish FMP aims to balance fleet capacity with the resource to enhance economic efficiency. Although Terry (2008) defines harvest capacity in terms of the maximum output derived from a set of inputs, measuring harvest capacity is difficult to replicate. It is common for catch share reviews to focus on changes in fleet size and often report initial decreases in fleet size post-catch share implementation (GMFMC 2013; Agar et al. 2014; Sigler et al. 2001; NEFMC 2017). The number of groundfish trips, active vessels, and entities are examined both before and after catch share management to track changes in fleet size over time. Additionally, average vessel characteristics are summarized for each fishing year to evaluate changes in vessel composition within the groundfish fleet.

b. Fleet Size and Structure

Decreases in fleet size occur both before and after catch share implementation (Figure 1). From FY 2007-2015, the number of groundfish trips decreased by 69% (22,413 to 6,849 trips), the number of active groundfish vessels decreased by 55% (610 to 276 active vessels), and the number of groundfish fishing entities decreased by 57% (544 to 235 entities). Trips, vessels, and entities incurred larger average percent decreases in numbers post-catch share compared to the pre-catch share period with average percent decreases of 1%, 8%, and 9% from 2007-2009 and average percent decreases of 22%, 10%, and 10% from 2010-2015 for groundfish trips, vessels, and entities, respectively. The largest year-to-year decrease occurred between FY 2009 and FY 2010, where the number of trips, vessels, and entities declined by 52%, 23%, and 21%, respectively. When percent decreases from 2009-2010 are omitted from the calculation, the number of vessels and entities decrease, on average, by 7% and 8%, respectively, while trips decrease by 14% over the post-catch share time period. The large decreases in fleet size over 2009-2010 may suggest progress on Goal 2 of Amendment 16; however, the continual decline in fleet size may be driven by a combination of internal and external factors.

All vessel size classes decrease in number of active vessels when comparing numbers averaged over 2007-2009 to those averaged over 2010-2015. During 2007-2009, an average of 27, 297, 178, and 63 active vessels operated within the <30’, 30’ to <50’, 50’ to <75’ and >75’ vessel size class categories, respectively. When averaged over 2010-2015, the number of active vessels decreased to 17, 165, 106 and 54 active vessels for each of the respective vessel size categories. Each vessel size class generally decreased in the number of active vessels over 2007-2015. However, the 75’+ and 50’ to <75’ size classes increased in number of active vessels after the implementation of the catch share program in 2011 and in 2012 (Figure 2). The <30’ size class also increased in active vessels during certain fishing years, once in 2009 and again in 2013. When considering average percent changes, the 2 smallest vessel size classes incurred larger percent

[7] Accessible at: https://fred.stlouisfed.org/series/GDPDEF

decreases when averaged over 2010-2015 relative to 2007-2009 while the 2 larger vessel size classes incurred lower average percent decreases over 2010-2015 compared to 2007-2009. On average, the <30' vessel size class incurred a 9% increase over the pre-catch share period while the 30' to <50', 50' to <75' and 75'+ vessel size classes incurred average decreases of 6%, 16%, and 5%. All vessels size classes incurred average decreases over the 2010-2015 time period, with decreases of 14%, 13%, 6%, and 4% for each vessel size class, respectively. The smallest vessel size group incurred the largest percent decrease in number of vessels compared to other vessel size groups both before and after the implementation of the catch share program.

From 2007-2008 the smallest vessel size group (<30') decreased by 11% and then increased by 29% from 2008-2009 (Figure 3). From 2009-2010, this size class incurred the largest decrease (29%) which decreased further over 2011-2012 by an additional 20%. From 2012-2013 the number of <30' sized vessels increased by 13% but decreased by 17% and 20% over 2013-2014 and 2014-2015, respectively. This resulted in a 9% average increase during the pre-catch share period and an average decrease of 14% of during the post-catch share time period for the <30' vessel size class. The 30' to <50' vessel size class also incurred larger decreases in number of vessels over 2010-2015, with an average decrease of 13% compared to a 6% decrease over 2007-2009. Conversely, the 50' to <75' and 75'+ vessel size classes had higher average percent decreases in number of vessels during the pre-catch share period compared to the post-catch share time period. The 50' to <75' size class incurred an average decrease of 16% in number of vessels before catch share implementation compared to a 6% average decrease post-catch share management, while the 75'+ size group had an average decrease of 5% in number of vessels pre-catch share and a 4% average decrease post-catch share implementation. The 75'+ size class had the overall lowest average percent decreases in number of vessels in both the pre- and post-catch share time periods compared to other vessel size classes. Each size class experienced maximum decreases in numbers of vessels from 2009-2010, with decreases of 29%, 26%, 21%, and 10% for the <30', 30' to <50', 50' to <75', and 75'+ size groups, respectively.

c. Active Vessel Characteristics

The relative proportion of each vessel size class changed over time for some size categories when comparing averages from before and after catch share implementation. On average, the <30' vessel size class comprised 5% of the fleet over both the 2007-2009 and 2010-2015 time periods (Figure 4). The relative abundance of vessels in the <30' size class fluctuated post-catch share, slightly increasing from 2008-2009. The average share of 30' to <50' sized vessels within the fleet decreased from 53% to 48% over the pre- and post-catch share time periods, respectively. Moreover, the proportion of 30' to <50' sized vessels increased over 2007-2009 but continuously declined from 2010-2015. The 50' to <75' vessel size class contained 31% of the groundfish fleet both pre- and post-catch share implementation while the 75'+ vessel size category increased from 11% to 16% of active vessels when comparing averages from pre- and post-catch share management. The percent of 50' to <75' sized vessels within the fleet decreased over 2007-2009 but then mostly increased over 2010-2015. The largest vessel size category slightly increased over the pre-catch share time period but increased from 14% to 17% over 2010-2015. An increase in the proportion of larger vessels is an indication that larger vessels may be more likely to continue to be active in the post-catch share environment relative to smaller vessels.

Groundfish vessel length, tonnage, and horsepower followed an overall increasing trend from 2010-2015. When comparing pre- and post-catch share averages, vessel length (ft.) increased by 4%, gross tonnage by 11%, and horsepower by 6% (Figure 5). Moreover, the average vessel age followed a decreasing trend from 2010-2015, decreasing by 6% when comparing averages from pre- and post-catch share enactment. The changes in fleet characteristics are a reflection of the changes in the composition of the active fleet, as previously noted. The change in vessel characteristics could also indicate that smaller, less efficient vessels may be exiting the fishery in greater numbers than larger vessels during 2010-2015.

The number of active, non-groundfish fishing vessels affiliated with groundfish entities decreased over 2010-2015 (Figure 6). There were 77 active, non-groundfish fishing vessels associated with groundfish entities in 2010; this number decreased to 47 non-groundfish fishing vessels in 2013. The number of affiliated non-groundfish fishing vessels increased in 2014 to 59 vessels but decreased to an all-time low of 46 vessels in 2015. Overall, this result suggests that groundfish entities may be exiting the groundfish fishery rather than diversifying permits across non-groundfish vessels over the post-catch share time period.

The average number of vessels associated with a groundfish entity generally decreased over the 2010-2015 time period with an average of 1.87 vessels affiliated with a groundfish entity in 2010 decreasing to an average of 1.70 affiliated vessels in 2015 (Figure 7). The median number of vessels associated with groundfish entities stayed constant at 1 over the 2010-2015 time period. The differences between the mean and median number of vessel affiliates highlights the skewed distribution of entity size classes where the majority are single-vessel entities but the average entity size is impacted by the maximum vessels per entity, which is greater than 15 vessels in each of the years assessed.

d. Groundfish Entity Size and Structure

There are marginal changes in the relative number of each entity size class over the 2010-2015 period. Overall, the proportion of single-vessel entities increased from 61% to 64% from 2010-2015 (Figure 8). The increase in the percent of single-vessel entities was mostly driven by the decrease in the largest entity size class, (i.e., entities affiliated with 5 or more vessels) which decreased from 5% to 3% when comparing percentages from 2010-2015. Entities affiliated with 2 and 3 vessels saw little change over the 2010-2015 period. Two-vessel entities comprised about 23% of all groundfish entities in both 2010 and 2015 while entities affiliated with 3 vessels decreased from 8% to 7% of entities from 2010-2015. Though the relative proportion of entity size classes changed marginally, each entity size class followed an overall decreasing trend in the number of entities over the 2010-2015 time period.

ii. Landings Trends and Compositions

a. Landings Overview

Landings trends (all species) were assessed across the 3 groundfish business-level perspectives. First, an overview of median landings is presented and assessed in relation to exogenous factors. Landings per unit effort (LPUE) was also assessed at the trip-level to gauge how output per hour changes before and after the catch share program. Gross landings, including both groundfish and non-groundfish species, were evaluated individually for groundfish trips, vessels, and entities along with changes in landings composition.

Median landings of all species landed on groundfish trips and groundfish vessels were higher post-catch share compared to pre-catch share management. Median groundfish trip landings over 2010-2015 were more than twice as high as average landings from 2007-2009, increasing from 1,128 lbs. to 2,284 lbs., a 102% increase (Figure 9). Further, the highest median landings occurred in 2014 and the least in 2009 (2,983 lbs. and 1,075 lbs., respectively). Median landings at the vessel-level, averaged over 2010-2015, were 1.4 times greater than median landings averaged over 2007-2009, increasing from an average of 147,000 lbs. to 203,000 lbs., a 38% increase. Entity-level median landings fluctuated post-catch share implementation, but no comparison can be drawn to 2007-2009 due to database limitations.

LPUE is a metric which can be used to track trends in output levels given a standardized unit of effort. Average LPUE follows an increasing trend post-catch share implementation compared to the pre-catch share time period. When comparing groundfish trip landings per hour during 2007-2009 and 2010-2015, average landings increased by 22% from 176 lbs./hour to 215 lbs./hour (Figure 10). In addition, all average LPUE measurements were higher in every year post-catch share compared to all values from the pre-catch share management years. By contrast, median LPUE measures were constant in value when averaged over 2010-2015 and compared to those averaged over 2007-2009. Lastly, there was a larger range of LPUE values overall during 2010-2015 compared to 2007-2009, which is skewed in the positive direction.

b. Trip-Level Landings Trends and Compositions

Average gross landings from groundfish trips (all species) decreased after catch share management (Figure 11). From 2007-2009, gross landings from groundfish trips averaged about 83.5 million lbs. compared to an average of 63.6 million lbs. when averaged over the 2010-2015 period, a 24% decrease. On average, 61.3 million lbs. of groundfish species were landed per year over 2007-2009 compared to an average of 46.4 million lbs. of groundfish species when averaged over 2010-2015, such that average gross landings of groundfish species decreased by 24% after the implementation of the catch share program.

In addition to decreases in gross landings, landings compositions also changed between the pre- and post-catch share time periods. The mean and median number of non-groundfish species landed on groundfish trips increased over the 2010-2015 period (Figure 12). The average number of non-groundfish species landed per trip increased from 2.32 to 2.94 when averaged over 2007-2009 and 2010-2015, respectively. Median non-groundfish species trip landings increased from 2.00 to 2.67 species when averaged over 2007-2009 and 2010-2015, respectively. The average number of non-groundfish species landed per trip decreased from 2007-2009 then rose steadily from 2010-2015. The median number of non-groundfish species landed per trip was static at 2 from 2007-2011 then rose to 3 in 2012 where it remained through 2015. The increase in number of species landed post-catch share suggests that i) vessels may be actively diversifying catch or ii) vessels which targeted a lower diversity of species exited the fishery after implementation of the catch share program.

The changes in trip-level landings compositions were further assessed using the Herfindahl and inverse Herfindahl indices. The Herfindahl index (also known as Herfindahl–Hirschman Index or HHI) is a measure commonly used to estimate market concentration based on the squared sum of each firm competing in a particular market. The HHI ranges from 1/N to 1 where N is the number of firms within the industry. An HHI closer to 0 would represent highly diversified industry with many small firms. By contrast, an HHI closer to 1 is indicative of an industry dominated by a few, large firms. One can interpret a decrease in an HHI as movement toward a more dispersed market, and an increase may suggest that the industry is becoming more consolidated. Here, groundfish species were estimated as a single species to understand their total "share" in groundfish trip landings relative to landings shares for all other species on groundfish trips. The average Herfindahl index value decreased from 0.59 to 0.51 when averaged over 2007-2009 compared to those averaged over 2010-2015 (Figure 13). Median Herfindahl indices decreased from 0.54 to 0.46 when comparing averages derived from the same time periods, respectively. Overall, the values from the pre-catch share time period suggest that for any one trip, there is a relatively low number of species landed and in relatively uneven proportions. For example, if an average of 4 species is landed per groundfish trip and each species is caught in relatively equal proportions, one would expect the HHI to be around 0.25. As the average and median index values are initially 0.59 and 0.54, this indicates that some species may be caught in higher abundances relative to other species on the trip-level. The average and median indices decrease post-catch share, suggesting that there is not only an increase in the number of different species being landed (as shown in Figure 12), but the relative abundance of these species may be more even. The inverse Herfindahl index demonstrates the number of "effective competitors" or the number of species that would need to be landed in equal amounts to produce the same HHI value. The mean and median inverse Herfindahl index values, when averaged over 2007-2009, are lower than values averaged over 2010-2015, with a mean and median value of 2.11 and 1.85 for 2007-2009, and 2.44 and 2.19 for 2010-2015. The increase in the inverse Herfindahl index values suggests that a larger number of various species would need to be landed in order to produce the same HHI in the post-catch share time period. These results suggest that a greater variety of species may be playing larger roles in the compositions of groundfish trip landings during the post-catch share time period.

c. Vessel-Level Landings Trends and Compositions

Gross landings from groundfish vessels, including landings from both groundfish and non-groundfish trips, decreased by 10% when comparing gross landings averaged over 2007-2009 to gross landings averaged over 2010-2015. An average of 144.3 million lbs. were landed over 2007-2009 compared to an average of 129.5 million gross lbs. from 2010-2015 (Figure 14). The largest inter-annual decrease in gross landings occurred over 2011 to 2012 when gross landings decreased by 14%. Gross landings peaked in 2008 and 2011 at 151 million gross lbs. The lowest gross landings occurred in 2015 with only 114 million landed lbs.

On average, the average number of non-groundfish species landed per groundfish vessel increased after catch share management. When averaged over 2007-2009, an average of 8.9 and a median of 6.7 non-groundfish species were landed compared to an average and a median of 11.1 and 8.8 when averaged over 2010-2015 (Figure 15). Further, the average number of non-groundfish species landed per groundfish vessel decreased over 2007 to 2009 but rose for 6 consecutive years to an all-time high of 12.0 non-groundfish species per vessel in 2015.

Herfindahl indices were calculated to further investigate landings compositions at the vessel-level.[8] Both mean and median Herfindahl index values were lower post-catch share when comparing averages of the 2007-2009 and the 2010-2015 time period (Figure 16). The mean Herfindahl index value, when averaged over 2007-2009, was 0.58 and decreased to 0.55 when averaged over the 2010-2015 period. The median Herfindahl index, when averaged over the pre-catch share time period, was 0.55 and decreased to 0.50 when averaged over the post-catch share time period. The HHI values suggest that a few species are more abundant in vessels' overall landings given that there is an average of 9 to 12 species landed per vessel across fishing years, as previously discussed (Figure 15). For example, if there are 10 species landed per fishing vessel and each is caught in equal proportions, the HHI would reflect a value closer to 0.1. On average, the HHI decreased post-catch share, which indicates a decrease in the dominance of a single/few species in the total vessel catch composition and a more equal proportion of catch landed. The inverse HHI increased post-catch share overall, with an average mean value of 2.19 (median 1.81),

[8] An explanation of the calculation and interpretation of the Herfindahl and Inverse Herfindahl can be found in Section ii. Landings Trends and Compositions under sub-section b. Trip-Level Landings Trends and Compositions.

which increased to 2.32 (median 1.99) when averaged over the pre- and post-catch share period, respectively. This indicates that the number of species landed would need to increase in order to produce the same HHI value during the 2010-2015 time period, further supporting that the groundfish vessel landings compositions are becoming more even and rich.

d. Entity-Level Landings and Catch Compositions

"Gross landings from groundfish entities" are defined as the total landings (all species) from all vessels affiliated with a groundfish entity. The added contribution of landings differs from the vessel-level analysis by incorporating non-groundfish vessels that still contribute to a groundfish business entity. Gross landings from groundfish entities fluctuated over the 2010-2015 period. Gross landings increased during 2010-2011 from 148 million to 179 million gross lbs. Gross landings decreased for 3 consecutive years to a minimum value of 132 million gross lbs. in 2014 but rebounded slightly in 2015 to 138 million lbs. (Figure 17). Further, gross entity landings peaked in 2011 (179 million gross lbs.). Entity-level gross landings increased the most from 2010-2011, increasing by 21%, and decreased the most from 2011-2012 with a 15% decrease. The fluctuation during the 2010-2015 time period was consistent with the vessel-level analysis, highlighting the large contribution of landings from groundfish vessels to the groundfish businesses as a whole.

The mean and median number of non-groundfish species landed per entity followed an overall increasing trend over 2010-2015. The average number of non-groundfish species landed per groundfish entity is 10.4 species in 2010. The average number of non-groundfish species increased for 4 consecutive years to 13.2 species per entity in 2014, which decreased slightly to an average of 13.0 non-groundfish species landed per entity in 2015 (Figure 18). The median number of non-groundfish species landed at the entity-level increased from 9 to 10 species from 2011 to 2012; the median number of non-groundfish species landed decreased in 2013 to 9 but increased and leveled off at 11 species in 2014 and 2015.

Here, the Herfindahl index is used to explore the relative abundance of each species landed at the entity-level. Average Herfindahl indices, describing the relative share of each species landed per groundfish entity, fluctuated marginally over the 2010-2015 time period, ranging from 0.54 to 0.52 (Figure 19).[9] Median Herfindahl indices were also relatively consistent over this time period, with an index value of 0.48 from 2010 to 2013, which decreased to 0.46 over 2013 to 2014 and increased slightly to 0.49 in 2015. The minor differences between HHI mean and median values across years, along with the relatively stable interquartile ranges, suggest that the relative abundance was similar over time where fewer species are more abundant relative to other species. The average and median inverse Herfindahl values also suggest marginal differences in relative species shares, where the average inverse HHI was 2.4 from 2010-2013 and increased slightly to 2.5 in 2014 but decreased to 2.4 in 2015. The median HHI value followed a similar trend, with values of 2.1 for 2010-2014 which increased to 2.2 in 2014 and decreased to 2.0 in 2015. These values support that of the ~10 species landed by groundfish entities (Figure 18), some are landed in higher abundances relative to other species.

[9] An explanation of the calculation and interpretation of the Herfindahl and Inverse Herfindahl can be found in section ii. Landings and Catch Compositions under sub-section b. Trip-Level Landings and Catch Compositions.

iii. Cost, Revenue, and Net Revenue Analysis

a. Cost, Revenue, and Net Revenue Analysis Overview

Trip costs, or expenses incurred during the at-sea operation of individual commercial fishing trips, were calculated at the trip and vessel level both before and after the implementation of catch share management. Entity operating costs are calculated for FY 2010-2015. In this analysis, the trip-related operating costs include the cost of supplies, groceries, bait, fuel, ice, water, and oil. The trip-level analysis includes a summary of operating costs incurred on groundfish fishing trips and a calculation of trip costs per hour. Trip costs at the vessel-level equal the sum of all operating costs incurred on any vessel that took at least 1 groundfish trip during a single fishing year. Entity-level operating costs are equal to the sum of all trip costs from all vessels within the groundfish entity for each fishing year, including all groundfish and non-groundfish operations. Revenues are also assessed at the groundfish trip-, vessel-, and entity-level. Revenues per trip, vessel, and entity include revenues earned from all species, unless otherwise stated. A summary of the percent of revenues earned from groundfish species, as a proportion of total revenues, is also assessed. Net revenues equal total revenues less trip costs and are assessed at the trip-, vessel-, and entity-level. These measures highlight economic performance of the groundfish fleet before and after the implementation of the catch share system.

b. Trip-Level Cost, Revenue, and Net Revenue Analysis

Average and median trip costs per hour change marginally across the pre- and post-catch share time period. The average cost of a trip per hour, in terms of variable costs such as fuel, ice, bait, supplies, food, water, and oil was $40.9/hour pre-catch share and $43.4/hour post-catch share when averaged over the 2 time periods, respectively (Figure 20). Median trip costs were slightly lower than average trip cots per hour with rates of $34.1/hour and $33.3/hour when averaged over the pre- and post-catch share period, respectively. Average and median trip costs per hour were largely influenced by average fuel prices, as this is a dominant component of at-sea operation (Das 2014). Trends in average hourly trip costs closely followed trends in average New England fuel prices with both average fuel prices and average trip costs per hour peaking in FY 2012 ($50.1/hour and 3.8/gallon, respectively) and decreasing to their lowest values in 2015 ($32.1/hour and 2.4/gallon, respectively).[10] Median trip costs per hour were also lowest in 2015 but peaked in 2007 with a median rate of $39.2/hour. This may suggest that vessels with low fuel efficiency, possibly driven by older, non-upgraded vessels, were more active during the pre-catch share period. This is further supported by the trends in fleet characteristics, which show a decline in average vessel age post-catch share enactment, which suggests possible increases in fleet efficiency post-catch share (see Figure 5). The difference between the average and median hourly trip costs demonstrate a skewed distribution with fewer trips incurring higher hourly costs than the majority of trips taken, which may be driven by large, less fuel-efficient vessel operation. Overall, trip costs per hour changed marginally over the pre- and post-catch share time period and mirrored trends in average New England fuel prices.

[10] Monthly New England PADD 1A retail gasoline prices in dollars per gallon (all grades and formulations) were accessed via the U.S. Energy Information Administration website and averaged by groundfish years. Values reflect non-adjusted US dollars.

Average operating costs per trip were 1.7 times higher post-catch share compared to pre-catch share with trip costs averaging $1.6K from 2007-2009 and $2.7K over 2010-2015 (Figure 21). Average trip costs per trip decreased over 2007-2009, reaching a minimum value of $1.2K per trip in 2009. Average trip costs almost doubled, increasing by 99% to $2.4K in 2010. Trip costs slightly increased from 2010 to 2013 where average trip costs peaked at $3.2K. Trip costs dropped to $3.0K and $2.2K in 2014 and 2015, respectively. Median trip-level operating costs were substantially lower than average costs but were also generally higher post-catch share compared to the pre-catch share time period. Median trip costs, when averaged over 2007-2009, equaled $311 and increased to $417 when averaged over 2010-2015. Median trip cost increased over 2009-2010 by 42% and continually rose to $526 where median costs peaked in 2013. Median trip costs decreased to $476 and $375 in 2014 and 2015, respectively. Overall, the cost of taking a trip was higher post-catch share. The increases in trip costs are most likely driven by longer trips which increased from an average of 27.0 hours in 2015 to 48.7 hours in 2019 (Table 4). Most notably, the average trip durations increased from 2009 to 2010 where the average trip duration increased from 24.2 hours to 37.9 hours, a 56% increase. The relatively large difference between mean and median trip costs highlights the skewed distribution of costs where some trips incur much higher costs than the majority of trips. The range of trip costs was also wider post-catch share compared to the pre-catch share time period.

Average and median trip revenues were also higher after catch share implementation. Average groundfish trip revenues were 1.9 times higher post-catch share compared to pre-catch share revenues. Specifically, when averaged over 2007-2009 and 2010-2015, average trip revenues equal $5.2K and $9.8K, respectively, an 88% increase. Average trip revenues decreased over 2007-2009 from $5.6K to $4.8K (Figure 22). Average trip revenues more than doubled from 2009 to 2010, increasing from $4.8K to $10.2K. Average revenues decreased from 2010-2012 to $8.2K but increased from 2012 to a maximum of $10.8K in 2015. Average revenues were about 2 to 3.6 times higher than median trip-level revenues; however, median revenues followed a pattern similar to average revenue values. Median revenue increased by 61% post-catch share compared to median revenues averaged over the pre-catch share period. Median trip revenues equaled $2.9K and $1.8K when averaged over 2007-2009 and 2010-2015, respectively. Median revenues decreased over 2007 to 2009 from $2.0K to $1.6K then increased by 94% to $3.1K over 2009 to 2010. Median revenues decreased from 2010 to 2012, increased in 2013 and 2014, and then slightly decreased to $3.0K in 2015. Overall, both average and median trip revenues are higher post-catch share. The range of trip revenue values was also wider post-catch share when compared to the pre-catch share time period. This is further supported by the difference between average and median revenues, which increased during the 2010-2015 period.

The percent of revenue earned from groundfish species as a proportion of total revenues earned on a groundfish trip was lower during 2010-2015 compared to 2007-2009. Average groundfish species revenue as a percent of total trip revenues decreased from 80.9% to 71.5% when comparing 2007-2009 and 2010-2015 percentages (Figure 23). Revenue from groundfish species make up 76.9%-86.1% of total trip revenues during 2007-2009. The percentage of groundfish species revenue decreased continuously after 2009 to a minimum of 62.9% in 2015. The median percent revenue resulting from groundfish species is overall higher than average revenue percentages, ranging from 76.4% to 97.3% over 2007-2015. Median groundfish revenue as a percent of total revenues is also higher during 2007-2009, with a median of 94.7% of revenues when averaged over the time series compared to 2010-2015, with an average median of 85.8% of revenues. The highest median percent of groundfish species revenue occurred in 2009 (97.3% of revenues) and the lowest occurred in 2015 (76.4% of revenues). Lastly, the distribution of percentages of groundfish revenue was widest over 2013-2015. The overall decrease in the percentage of revenue earned from groundfish species may support that catch compositions are becoming more diversified at the trip-level or those who remained in the fishery are those who are less reliant on groundfish revenue, overall.

Net revenues, assessed at the trip-, vessel-, and entity-level, can reflect changes in economic efficiency within the fleet (Murphy et al. 2018). Average and median groundfish trip net revenues were higher after catch share implementation. Average net revenues for the 2010-2015 period (ranging from \$5.5K to \$8.6K per trip) were almost 2 times those averaged over 2007-2009 (ranging from \$3.5K to \$3.8K per trip) (Figure 24). Average groundfish trip net revenues more than doubled from 2009 to 2010 to \$7.8K then declined over 2011 and 2012 to \$5.5K but increased for 3 consecutive years to \$8.6K per trip in 2015. Median net revenues were also higher during the 2010-2015 time period but are notably lower than average net revenue values. Median net revenues, averaged over 2010-2015, are 1.6 times larger than median revenues averaged over 2007-2009. Median net revenues ranged from \$2.0K to \$2.7K over 2010 to 2015 compared to \$1.3K to \$1.6K over 2007-2009. The percent differences between the mean and median revenue values are higher post-catch share implementation, ranging from 93-107% over 2010-2015 compared to 81-91% in 2007-2009. The highest average and median net revenue values per trip were earned in 2015 and 2010 (\$8.6K and \$2.7K, respectively). Further, there was a notable increase in the range of trip-level net revenues during the 2010-2015 period comparatively to the 2007-2009 period.

Negative net revenues occur when the cost of operating exceeds the revenues earned. A trip that does not cover costs is referred to as a “busted trip.” Over a longer time period, negative net returns may be a signal that operations should be halted as costs such as fuel, ice, bait, and other variable trip costs cannot be covered. When assessing net revenues at the trip-level, average negative net revenues did not change when comparing averages from pre- and post-catch share implementation. Specifically, an average of 5% of trips earned negative net revenues during the 2007-2009 and the 2010-2015 time periods. The percent of trips with negative net revenues ranged from 2007-2015 from 3-6% (Figure 25). The highest percent of trips with negative net revenues occurred in FY 2007, 2008, and 2013 (6% of trips). Lastly, the lowest percent of trips earning negative net revenues (3%) occurred in 2015.

c. Vessel-Level Cost, Revenue, and Net Revenue Analysis

Operating costs were also calculated at the vessel-level by summing all trip costs per groundfish vessel for each fishing year. This calculation includes costs incurred on both groundfish and non-groundfish fishing trips. Average operating costs per vessel were 1.2 times higher during the post-catch share time period compared to the pre-catch share time period (Figure 26). Vessel operating costs or total trip costs equal \$103K when averaged over 2007-2009 compared to \$121K when averaged over the 2010-2015 time period. From 2007 to 2009, vessel operating costs decreased from \$117K to \$83K. From 2009 to 2010, average vessel operating costs increased by 30% to \$108K and increased by another 32% from 2010-2011 to \$143K. From 2011 to 2015, average vessel operating costs followed a generally decreasing trend to \$91K in 2015. Median vessel operating costs were about half the value of average vessel operating costs, highlighting a skewed distribution of vessel-level costs. Median costs were about the same when comparing values from the pre- and post-catch share periods. Median vessel operating costs are about \$57K when averaged over the 2007-2009 and 2010-2015 periods. From 2007-2009, median vessel trip/operating costs decreased from \$64K to \$44K. Median trip costs increased by 13% over 2009-

2010 and by another 40% from 2010 to 2011where median costs peaked at $69K. After 2011, median vessel operating costs decreased for 4 consecutive years to $45K in 2015. Lastly, the variation in vessel operating costs was greater during the post-catch share time period.

Trends in vessel-level revenues were assessed both before and after the implementation of the catch share system. Vessel revenues were higher in every year post-catch share compared to the 3 years analyzed before catch share implementation. Average vessel revenues were 1.4 times higher when averaged over the post-catch share time period than revenues averaged over the pre-catch share time period. Moreover, average vessel revenues equaled $313K when averaged over 2007-2009 compared to revenues averaged over 2010-2015, which equaled $446K, a 43% increase between the 2 time periods (Figure 27). From 2007-2009, the average vessel revenue was relatively stable, only slightly decreasing from $315K to $307K. Average vessel revenues increased by 38% from 2009 to 2010 to $424K, the largest percent increase of the time series. Average vessel revenues increased by an additional 19% from 2010 to 2011 where revenues peaked at $504K. Average revenues decreased by 15% over 2011-2012 to $431K then rose after 2012 to $455K in 2015. Median vessel revenues were also higher over 2010-2015 compared to median values from 2007-2009. When averaged over 2007-2008, median vessel revenues equaled $211K and $265K when averaged over 2010-2015, a 26% increase between the 2 time periods. Median vessel revenues were fairly consistent over 2007-2009, ranging from $2087K to $214K. Median vessel revenues increased by 19% from 2009 to 2010 from $211K to $251K and rose by an additional 13% from 2010 to 2011 to $285K. After peaking in 2011, median revenues decreased over 2012 and 2013 to $244K then increased over 2014 and 2015 to $282K. The difference between the median and average revenues increased post-catch share, highlighting the increase in the range of revenues over the 2010-2015 time period.

The revenue earned from groundfish species as a percent of total vessel revenues was higher during 2007-2009 compared to 2010-2015, despite higher gross vessel-level revenues during the post-catch share time period. About 51.3% of average vessel revenues were derived from groundfish species when averaged over 2007-2009 (Figure 28). Comparatively, only an average of 42.5% vessel-level revenues were derived from groundfish species when averaged over 2010-2015. There was a sharp decrease in the percentage of revenue earned from groundfish species over 2009-2010, decreasing from 54.8% to 46.0% of average vessel revenues. The median vessel revenue earned from groundfish species was somewhat higher than average percent revenue. Median percent revenue from groundfish species, however, was also higher pre-catch share when compared to post-catch share percentages, with median values of 56.0% and 36.3% when averaged over the respective time periods. Median values incurred a large decrease over 2009-2010, decreasing from 62.6% to 43.5% of revenues derived from groundfish species. Median groundfish revenue as a percent of total revenues was lowest in 2015 where only 25.2% of median the revenue was derived from groundfish species. These results suggest that though individual vessel revenues increased post-catch share, the majority of vessel-level revenues were derived from species other than groundfish.

Similar to groundfish trips, groundfish vessel net revenues were also generally higher after the enactment of catch share management. Average net revenues per vessel ranged from $199K to $224K (an average of $210K) over 2007-2009 to $283K to $364K (an average of $325K) over 2010-2015 (Figure 29). The largest inter-annual increase in average net revenues occurred over 2009-2010 (a 41% increase) and average net revenues continued to rise to $361K in 2011. After 2011, average vessel net revenues decreased for 2 consecutive years to $283K in 2013, but increased to an all-time high in 2015 ($364K). Median net revenues at the vessel-level were, again, higher during 2010-2015, ranging from $180K-$231K compared to $138K-$162K in 2009-2007. More specifically, average median vessel net revenues increased by 36% when comparing average median values from before to after catch share management. Median vessel net revenues followed a similar trend to average net revenues, rising in 2011 ($213K), decreasing from 2012-2013 ($180K), and then rising to an all-time high of $231K in 2014-2015. There was higher variability in net revenues over 2010-2015 compared to 2007-2009, and interquartile ranges increased in the positive direction when comparing the values from pre- and post-catch share time periods.

Further, the percent differences between mean and median net revenue values were greater during 2010-2015 (42%-52%) compared to 2007-2009 (32%-36%) but did not follow consistent trends post-catch share implementation.

Across all vessel size groups, median net revenues were higher when comparing values averaged over 2007-2009 to those averaged over 2010-2015 (Figure 30). All vessel size groups earned minimum median net revenue values prior to catch share implementation (either in FY 2007 or 2008). Further, all vessel size classes earned maximum median net revenues post-catch share implementation in either FY 2011 or 2015. The only vessel size class to have negative median net revenues in any year is the <30' vessel size group. Median net revenues increased for all vessel size classes from 2009-2011 with the exception of the smallest size class where median net revenues decreased from $1.5K to -$347 from 2010 to 2011. Median net revenues decreased for all vessel size classes from 2011 to 2012. Finally, median net revenues increased for all vessel size classes from 2014 to 2015. Overall, most vessel size classes had relatively stable median net revenues over 2007-2008 followed by increases in median net revenues from 2009-2011, but median net revenues decreased during 2012, and sometimes decreased further in 2013 and 2014. The decreases were followed by an increase in median net revenues from 2014-2015 for all size classes. Generally, all vessel size classes incurred large percent increases in median net revenues from 2008 to 2009, 2009 to 2010, and 2010 to 2011, while median net revenues changed marginally across vessel size classes from 2007-2008.

There was little change in the percentage of vessels operating below their shutdown point (i.e., incurring net revenues < $0.00) when comparing averages from before and after the catch share program. Pre-catch share implementation, an average of 6% of vessels operated below their shutdown point, ranging from 4-7% of vessels during the 2007-2009 period (Figure 31). From 2010-2015, an average of 5% (ranging from 2-9%) of vessels operated below their shutdown point. The highest percent of vessels earning negative net revenues occurred in 2011 (9%) and the lowest in 2015 (2%). The number of vessels with negative net revenues decreased most from 2008 to 2009 by 3 percentage points, but increased by 5 percentage points from 2010 to 2011. The percent of vessels with negative net revenues decreased from 9-4% from 2011 to 2012 and increased in 2013 to 6%, but decreased for 2 consecutive years to an all-time low point in 2015 (2%).

There was no change in the percent of vessels earning negative net revenues by vessel size class when comparing averages from pre- and post-catch share implementation. Vessels incurring negative net revenues were almost always in the <30' or 30' to <50' size classes (Figure 32). An average of 2% of vessels in the <30' size class operated below their shutdown point during both the 2007-2009 and 2010-2015 time periods. Similarly, an average of ~3% of vessels in the 30' to <50' size class incurred negative net revenues when averaged over 2007-2009 and 2010-2015. The percent of vessels with negative net revenues in the <30' size class remains relatively stable, around 2-3%, but the 30' to <50' size class fluctuated more dramatically over time, ranging from 1-7%, over the course of 2007-2015. The percent of vessels operating below their shutdown point increased in both the <30' and 30' to <50' vessel size classes over FY 2010-2011. Trends in negative net revenues among the smaller vessel size classes may have been driven by increases in average New England fuel prices, which increased from $2.41/gal. $3.78/gal. from 2009 to 2012.[11] The combination of factors, such as increasing variable costs (i.e., trip costs) and decreasing ACLs, may have contributed to smaller vessels to falling below their shutdown points as they are inherently more susceptible to shifting supply curves. These vessels may have exited the fishery or halted operations resulting in a decrease in fleet size and a decrease in the number of vessels operating with negative net revenues during the latter half of the analysis.

d. Entity-Level Cost, Revenue, and Net Revenue Analysis

Operating costs were also evaluated at the entity-level to assess how costs changed during this time period from a broader business perspective. Overall, costs fluctuated over the 2010-2015 time period. Average operating costs at the entity-level increased by 31% from 2010 to 2011 ($150K to $197K, respectively; Figure 33). Average entity operating costs decreased to $182K and $183K in 2012 and 2013, respectively, then deceased further to $163K and reached an all-time low of $125K in 2015. Mean entity operating costs were about 3 times the median cost values. Median trip cost values, like average trip costs, also increased from 2010-2011, increasing by 45% from $52K to $75K. After 2011, median entity operating costs decreased continuously and reached a minimum value of $43K in 2015. There was a highly skewed distribution of operating costs at the entity-level, with few entities incurring relatively high costs compared to the general population of groundfish entities.

Entity-level revenues fluctuated slightly over the 2010-2015 time period and followed similar trends to those at the vessel-level. From 2010-2011, average entity-level revenues increased by 22% from $641K to $780K then decreased over 2012 and 2013 to $592K, increased over 2014 to $673K, then fell again in 2015 to $662K (Figure 34). Mean entity revenues were more than twice as large as median values. Median values ranged from $243K-$292K over 2010-2015. From 2010-2011, median entity revenues increased by 14% from $257K to $292K then decreased over 2012 and 2013 to $243K. Median entity revenues rose over 2014 and 2015 to $257K and $270K, respectively. The difference between mean and median entity-level revenues highlights the positively skewed range of entity-level revenues over the 2010-2015 time period.

Groundfish species revenues, as a percent of total entity revenues, were lower than vessel-level percentages and generally followed a decreasing trend over the post-catch share time period. Average groundfish revenues as a percent of total entity revenues increased by a tenth of a percent from 42.6% to 42.7% over 2010-2011 (Figure 35). From 2011 to 2012 the percent of revenues earned from groundfish species decreased to 40.4% and held constant over 2013. From 2013, the percentage earned from groundfish species decreased to 36.1% and 34.9% for 2014 and 2015, respectively. Median groundfish revenues as a percent of total entity revenues were lower than average values, suggesting that there are few entities which earn relatively higher percentages from groundfish species comparatively to the majority of groundfish entities which rely more heavily on revenues from other species. Median groundfish revenues as a percent of total entity revenues increased from 2010-2011 from 34.1% to 39.7%. After 2011, the proportion of revenue earned from groundfish species decreased for 4 consecutive years to 22.8% in 2015.

The minimum median and average percent of revenues earned from groundfish species occurred in 2015 with 34.9% and 22.85%, respectively, decreasing by 7.7 and 11.3 percentage points from 2010 percentages. Entities trends were similar to those in the vessel-level assessment,

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[11] New England (PADD 1A) retail gasoline prices for all grades and all formulations in nominal dollars per gallon was obtained from the [U.S. Energy Information Administration Website.]

where groundfish entities earned less from groundfish species relative to other species over the course of the time series.

Groundfish entity net revenues varied during the post-catch share implementation time period. Average entity net revenues peaked in 2011 ($583K), decreased for 2 consecutive years to $409K in 2013 but increased again over 2014 and 2015 to $537K (Figure 36). Median net revenues increased from 2010 to 2011 ($213K), decreased to an all-time low in 2013 ($180K), and rose again to a maximum value of $231K in 2015. The variation in net revenues is greatest in 2011 and 2015 and least in 2010. The skewed distribution of entity net revenues is evident in all years post-catch share implementation, similar to the trip- and vessel-level analyses. Further, the percent differences in mean and median net revenues ranged from 78-93% over 2010-2015.

The trends and magnitudes of net revenues were assessed by entity size class and compared across 2010-2015 (Figure 37). On average, median net revenues earned from entities with 2 vessel affiliates were 0.7 times larger than median net revenues earned by single-vessel entities. Entities associated with 3 vessels earned median net revenues that were, on average, 1.5 times higher than those of entities comprised of 2 vessels. On average, entities with 4 vessels earned median net revenues that were about 1.2 times greater than those of entities with 3 vessel associates, on average. Notably, entities with 5 or more vessels earned median net revenues that were, on average, 5.7 times larger than those of 4-vessel entities over 2010-2015. In addition, the differences in net revenue earnings between entity size groups increased over 2010-2015 for most comparisons. For example, entities with 2 vessels earned 0.5 times as much as single vessel entities in 2010, but this increased to 0.8 times by 2015. The difference in net revenues between vessel size classes also increased for entities affiliated with 4 and 5+ vessels; however, the magnitude of this difference was greater among the larger entities. For example, entities with 4 vessels made double the median net revenues of entities with 3 vessels in 2010, but this difference increased to 1.8 times median net revenues in 2015. Entities affiliated with 5 or more vessels earned about 2 times the median revenues earned by entities affiliated with 4 vessels in 2010 which increased to 9.8 times in 2015. Almost all entity size classes incurred higher median net revenues during 2014 and 2015 compared to 2010 net revenues. In addition, all but 1 entity size class (entities associated with 3 vessels), earned maximum median net revenues in 2014 or 2015. Overall, there was no clear trend in inter-annual increases across vessel size classes over 2010-2015. The largest entity size class had the most consistent upward trend in median net revenues, only decreasing once in 2013. Median net revenues for entities associated with 5 or more vessels increased by almost 600% from 2010 to 2015, with median net revenues increasing from $805K to $5.5M. Smaller entities incurred higher variations in median net revenues over the 2010-2015 period, but of smaller magnitudes, with percent changes ranging from 1-60% across the 4 smallest entity size classes. Over 2010-2015, median net revenues for single-vessel entities ranged from $127K to $194K, median revenues for entities affiliated with 2 vessels ranged from $185K to $269K, and median net revenues for entities affiliated with 3 vessels ranged from $319K to $430K. Vessels affiliated with 4 vessels earned median revenues which ranged from $296K to $564K. Lastly, entities affiliated with 5 or more vessels earned anywhere from $805K to $5.5M in median net revenues over 2010 to 2015.

At the entity-level, only 2 entity size classes, those affiliated with either 1 or 2 vessels, operated with negative net revenues over 2010-2015 (Figure 38). On average, 8% of single-vessel entities operated below their shutdown point over 2010-2015, which increased over 2010 to 2011 from 7% to 14%, but this percentage eventually decreased to only 3% of single vessel entities with negative net revenues in FY 2015. An average of 3% (2-4%) of entities affiliated with 2 vessels operated below their shutdown point over 2010-2015. Notably, 0% of entities affiliated with 3, 4, or 5+ vessels earned negative net revenues over the time series analyzed. The fluctuations in the number and percentage of entities earning negative net revenues may have been driven by rising operating costs (e.g., fuel) and changes in the maximum potential output (i.e., potential landings dictated by Annual Catch Limits and Sector Annual Catch Entitlements). These and other factors could have caused smaller entities, who are more susceptible to these changes, to shut down, such that the number of entities with negative net revenues decreased over time.

iv. Concentration and Distribution of Net Revenues

a. Concentration and Distribution of Net Revenues Overview

The concentration and distribution of net revenues were assessed at the trip-, vessel-, and entity-level to highlight disproportional impacts and trends that can affect fleet diversity and therefore Goal 2 and Objective 7 of Amendment 16. Net revenues were highly skewed in the groundfish fishery and have maintained a similar level of skewness over the duration of the analysis period, with the majority of trips, vessels, and entities earning lower net revenues and a few earning extremely high net revenues. Cumulative earnings distributions were assessed at the trip-, vessel-, and entity-level by ordering net revenues from smallest to largest and dividing the ranked values into equal quartiles, each approximately 25% of gross net revenues for each business level. This process allows for the quantification and visualization of the number of trips, vessels, and entities earning the lowest and highest percentages of gross net revenues.

Gini coefficients were used to quantify the level of inequality in the distribution of net revenues across the population of trips, vessels, and entities. Gini coefficients range from 0 to 1, where 0 represents perfect equality and 1 is perfect inequality, in terms of the distribution of income or in this case net revenues, among a population. Gini coefficients can be graphically represented by a Lorenz curve, which demonstrates how net revenues are distributed across a population. The calculation of the Gini coefficient, graphically described, requires the cumulative percentage of the population, ordered by net revenues from least to greatest (i.e., the Lorenz curve), to be plotted on the horizontal axis and the cumulative share of net revenues on the vertical axis. The Lorenz curve is plotted in the same graphical space as the line of equality, a 45-degree line from the origin representing a perfectly even distribution of net revenues across the population. Gini coefficients are calculated using the area below the line of equality but above the Lorenz curve, divided by the total area under the line of equality and Lorenz curve. Lorenz curves and Gini coefficients were generated for each fishing year from 2007-2015. The metrics were averaged over FY 2007-2009 and compared to averages from 2010-2015 to identify changes from pre- and post-catch share implementation.

b. Trip-Level Concentration and Distribution of Net Revenues

An average of 79% of trips fell into the first quartile of the distribution of net revenues both pre- and post-catch share management (Figure 39). Further, in 2007-2009 and 2010-2015, an average of only 2% and 3% of trips fell in the top earning quantile (Q4: Top 25%) of net revenues, respectively. The inner 2 quartiles changed slightly from 2007-2009 to 2010-2015, with the percent of trips earning 25%-50% of gross net revenues, decreasing from 15% to 12% on average between the 2 periods. Those earning within the 50%-75% quartile increased from 4% to 5% when comparing averages from pre- and post-catch share management. Overall, at the trip-level, there was little change in the percent of trips which fell within each quantile when assessed over the pre- and post-catch share time periods, changing by only a few percentage points over the duration of the entire analysis. Overall, the distribution of net revenues was consistent but highly skewed over the 2007-2009 and 2010-2015 time periods.

The Gini coefficients suggest an uneven distribution of net revenues across groundfish trips, ranging from 0.68 to 0.7 over 2007-2015 (Figure 40). These coefficients suggest relatively high levels of unevenness in the distribution of net revenues over this time. The average Gini coefficient decreased from 0.70 to 0.69 when comparing averages from the pre- and post-catch share time periods. These results support those of the net revenues quartile assessment, which also suggests high levels of concentration in net revenues which vary marginally at the trip-level between the 2007-2009 and 2010-2015 time periods.

c. Vessel-Level Concentration and Distribution of Net Revenues

Net revenues were highly concentrated at the vessel-level where about 6% of vessels earned the top 25% of gross net revenues both before and after the implementation of catch share management (Figure 41). The level of concentration, in terms of percentage of vessels per quartile, changed marginally when assessed both before and after the enactment of catch share management. On average, the lowest quartile of net revenues (Q1: Bottom 25%) was earned by 63% of groundfish vessels during 2007-2009. This percentage increased when averaged over 2010-2015 to 65% of vessels. The percent of vessels that encompassed the inner quartiles (Q2 and Q3) only changed by a percentage point when comparing averages from before and after the catch share program. The percent of vessels within the 25%-50% quartile decreased from 19% to 18%, and the percent of vessels within the 50%-75% quartile decreased from 12% to 11%, when comparing the pre- and post-catch share averages, respectively.

Similar to the distribution of trip-level net revenues, the Gini coefficient was used to quantify the concentration of net revenues at the vessel-level (Figure 42).[12] Net revenues were less concentrated at the vessel-level compared to the trip-level, with Gini coefficients ranging from 0.51 to 0.57 over the 2007-2015 FY period. The average Gini coefficient value increased from 0.53 to 0.55 when comparing averages from 2007-2009 to 2010-2015. Net revenues are most concentrated in 2011 and 2013 where the Gini coefficient peaked at 0.57. The Gini coefficient reached a minimum in 2009 with a value of 0.51. Overall, the distribution of vessel net revenues was moderately skewed and varied marginally between the pre- and post-catch share time periods.

d. Entity-Level Concentration and Distribution of Net Revenues

At the groundfish entity-level, net revenues were highly concentrated with only 1-2% of entities (3 to 4 entities) earning the top 25% of gross net revenues and about 76% (270 to 173) of entities earning the lowest 25% of gross net revenues (Figure 43).[13] The lower middle quantile (25%-50%) of gross net revenues were earned by 17% of entities for all years except for 2011 which decreased to 16% of entities. Anywhere from 4-7% of entities earned 50%-75% of gross net revenues, increasing to 6-7% during 2013-2015. The top 25% of net revenues were earned by 1% of entities from 2010-2013, but this increased slightly to 2% of entities in 2014 and 2015.

[12] For a detailed description of the calculation and interpretation of Gini coefficients and Lorenz curves, refer to Section V.iv.b. Trip-Level Net Revenue Concentration and Distribution of Net Revenues

[13] Total net revenues earned by each groundfish entity were ordered from smallest to largest and divided into equal quartiles, each approximately 25% of the gross net revenues earned by all groundfish entities by groundfish year. This was such that the proportion of entities earning the lowest and highest percentages of gross net revenues could be identified.

Lastly, though the total number of entities decreased over the analysis period, the percent of entities within each earning quartile stayed relatively consistent over time.

Gini coefficients, measured at the entity-level, quantified the distributional unevenness of net revenues earned over time. Gini coefficients ranged from 0.66 to 0.73 during the 2010-2015 post-catch share time period. These Gini coefficients suggest relatively high levels of unevenness in the distribution of net revenues during this period (Figure 44). The highest Gini coefficient, 0.73, occurred in 2011 while the lowest Gini coefficient, 0.66, occurred in 2015. The greatest inter-annual changes occurred from 2010-2012, where the Gini coefficient increased from 2010 to 2011 from 0.69 to 0.73 then decreased to 0.69 in 2012. The only other decrease in the Gini coefficient occurred from 2014 to 2015, decreasing from 0.69 to 0.66.

VI. SUMMARY AND CONCLUSION

In this report, trends and indicators are assessed from various business-level perspectives to investigate the economic performance of the groundfish fleet before and after the enactment of catch share management. Where possible, data were analyzed over FY 2007-2009 and compared to those of 2010-2015 to understand how measures have changed over these 2 distinct time periods. The analytical framework for this report is shaped by the economic goals and objectives of Amendment 16 to the multispecies FMP (Goal 2, 8, and Objective 7) and follows NOAA’s Guidance for Conducting Review of Catch Share Programs (Morrison 2017). Specifically, harvest capacity and fleet structure, landings trends and compositions, operating costs, revenues, and net revenues were assessed. The distribution and concentration of net revenues and negative net revenues were also analyzed. These assessments can be used to track the economic performance of the groundfish fleet both before and after the implementation of the catch share system.

Fleet size decreased in terms of the number of trips, vessels, and entities operating post-catch share implementation, with the <30’, 30’ to <50’, 50’ to <75’ and 75’+ size classes decreasing in average numbers by 37%, 45%, 40%, and 16%, respectively. Each size class decreased most from 2009-2010. The 2 smallest vessel size classes (the <30’ and 30’ to <50’ size classes) had relatively greater average percent decreases post-catch share management (-14% and -13%, respectively) compared to average decreases over the 2007-2009 period (9% and -6%, respectively). The converse was true for the two largest vessel size categories, (50’ to <75’ and 75’+ size classes) which incurred smaller average percent decreases after the catch share program (-6% and -4%) rather than before (-16% and -5%).

Active groundfish vessels post-catch share implementation demonstrate possible increases in harvesting capacity and fleet efficiency, as suggested by increases in average vessel length, gross tons, and horsepower along with decreases in average vessel age. The changes in vessel characteristics and the higher percent decreases in the number smaller sized vessels may have been driven by two interrelated factors: (1) a shift toward increasing fleet efficiency and/or (2) shifting supply curves (e.g., changing input prices, alterations in the fishery management plan) which may have disproportionately impacted smaller businesses and forced smaller vessels to exit the fishery.

LPUE demonstrated no change when comparing values from pre- and post-catch share management; however, the average LPUE measure increased when compared across these 2 time periods. In addition, median landings per trip/vessel increased post-catch share by a factor of 2 and

1.4, respectively.[14] These results may be driven by less efficient vessels exiting the fishery after catch share implementation.

Overall, gross landings at the trip- and vessel-level were lower during the post-catch share time period. Gross landings from groundfish trips and vessels decreased when comparing gross landings averaged over the pre- and post-catch share time periods, decreasing by 24% and 10% for trips and vessels, respectively. The number of non-groundfish species landed increased and the relative share of each landed species became more even at the trip- and vessel-level after the enactment of the catch share program, as suggested by the HHI index values. The increase in species richness and evenness of landed species may be driven by (1) those remaining in the fishery post-catch share may have actively diversified their targeted species or (2) the exit of those who depend more heavily on lower diversities of species landings. Gross landings were lowest in 2014 and 2015 when assessed at the entity-level, and the number of non-groundfish species landed generally increased over 2010-2015. Overall, gross landings decreased after the implementation of the catch share system from each of the business-level perspectives assessed. Additionally, those who remained in the fishery were landing less groundfish species as a proportion of their total landings while harvesting a wider variety of non-groundfish species.

Trip and vessel-level operating costs were 1.7 and 1.2 times higher, respectively, when comparing costs averaged over 2007-2009 to those averaged over 2010-2015. Trip and vessel revenues were also higher during the post-catch share time period. Average trip revenues are 1.9 times higher and vessel revenues are 1.4 times higher when comparing revenues averaged over 2007-2009 to those averaged over 2010-2015. Net revenues per trip/vessel were also overall higher during 2010-2015 when compared to the pre-catch share time period. The increase in net revenues post-catch share may be reflecting increases in economic efficiency within the remaining fleet. Trip and vessel-level net revenues vary more during 2010-2015 compared to 2007-2009, which may be partially explained by trends in ACLs and fuel prices along with additional exogenous factors. There is little to no change in the percent of trips and vessels operating below their shutdown point when comparing average percentages from 2007-2009 to 2010-2015. Notably, only the smallest vessel size class consistently contains vessels which operate with negative net revenues when assessed over time. At the entity-level, only entities affiliated with 1 or 2 vessels incurred negative net revenues over 2010-2015.

Net revenues are highly concentrated in the groundfish fishery both pre- and post-catch share implementation. The top 25% of gross net revenues were earned by only 2-4% of trips and 56% of vessels. At the trip- and vessel-level, there was little to no change in the concentration of net revenues when comparing 2007-2009 to 2010-2015 average quartile percentages and Gini coefficients. In addition, only 1-2% of entities (3-4 entities) earned the top 25% of net revenues over 2010-2015. Overall, each groundfish business-level had skewed net revenue distributions that remained relatively consistent over the pre- and post-catch share time periods.

In conclusion, results suggest possible decreases in overcapacity and possible increases in economic efficiency post-catch share implementation. Higher landings and net revenues per trip and vessel were captured post-catch share management as fleet size and gross landings continuously declined. In addition, there were higher percent decreases in the number of smaller, active vessels post-catch share enactment, which was most likely due to the reduction of less efficient vessels in the groundfish fleet but also the disproportional impacts of shifting supply curves on smaller groundfish businesses. Although net revenues were higher at the trip- and vessel-

[14] Median landings were averaged over the 2 time periods for this comparison.

level for 2010-2015 compared to 2007-2009, an uneven distribution of net revenues and a trend toward fleet consolidation (i.e., fewer vessels/entities but of larger size as a proportion of the groundfish fleet) persisted after the implementation of groundfish catch share management.

TABLES

Table 1. Summary of major report metrics, averaged over fishing year 2007-2009 and 2010-2015.

Performance Metrics		Pre Catch Share (Averaged over 2007-2009)	Post Catch Share (Averaged over 2010-2015)	Percent Change (%)
Number of Groundfish Trips		22224	9559	-57%
Number of Groundfish Vessels		565	341	-40%
Number of Vessels Per Vessel Size Class	<30’	27	17	-37%
	30’ to <50’	297	165	-45%
	50’ to <75’	178	106	-40%
	75’+	63	54	-16%
Number of Groundfish Entities		498	297	-40%
Vessel Characteristics	Length (ft.)	51	53	4%
	Gross Tons	56	62	11%
	Horsepower (VHP)	403	427	6%
	Age (Years)	33	31	-6%
Gross Landings (All Groundfish Trips in Millions of lbs.)		83	64	-24%
Gross Landings (All Groundfish Vessels in Millions of lbs.)		144	130	-10%
Gross Landings (All Groundfish Entities in Millions of lbs.)		--	150	--
Median Landings Per Groundfish Trip (lbs.)		1128	2284	102%
Median Landings Per Groundfish Vessel (lbs.)		147,027	202,550	38%
Median Landings Per Groundfish Entity (lbs.)		--	208,063	--
Median Trip Landings Per Unit Effort (lbs./hr)		123	123	0%
Median Number of Non-Groundfish Species Landed / Trip		2	3	33%
Median Number of Non-Groundfish Species Landed / Vessel		7	9	33%
Median Number of Non-Groundfish Species Landed / Entity		--	10	--
Median Trip Species Shares Herfindahl–Hirschman (HHI)		0.5	0.5	-15%
Median Vessel Species Shares Herfindahl–Hirschman Index (HHI)		0.6	0.5	-9%
Median Entity Species Shares Herfindahl–Hirschman Index (HHI)		--	0.5	--

Median Trip-Level Operating Costs (2015 Constant Dollars)		311	417	34%
Median Vessel-Level Operating Costs (2015 Constant Dollars)		56,827	56,708	0%
Median Entity-Level Operating Costs (2015 Constant Dollars)		--	56,307	--
Median Trip-Level Revenues (2015 Constant Dollars)		1799	2896	61%
Median Vessel-Level Revenues (2015 Constant Dollars)		211,332	265,380	26%
Median Entity-Level Revenues (2015 Constant Dollars)		--	261,577	--
Median Percent Revenues Earned from Groundfish Species on Groundfish Trips (%)		95	86	-9%
Median Percent Revenues from Earned from Groundfish Species on Groundfish Vessels (%)		56	36	-35%
Median Percent Revenues from Earned from Groundfish Species within Groundfish Entities (%)		--	30	--
Median Trip-Level Net Revenues (2015 Constant Dollars)		1,452	2,379	64%
Median Vessel-Level Net Revenues (2015 Constant Dollars)		150,077	204,001	36%
Median Vessel-Level Net Revenues By Vessel Size Class (2015 Constant Dollars)	<30’	93	1,196	1181%
	30’ to <50’	103,403	127,419	23%
	50’ to <75’	220,698	333,437	51%
	75’+	410,062	662,622	62%
Median Entity-Level Net Revenues (2015 Constant Dollars)		--	203,105	--
Median Entity-Level Net Revenues by Entity Size (Millions of 2015 Constant Dollars)	1 Affiliate	--	0.2	--
	2 Affiliates	--	0.2	--
	3 Affiliates	--	0.3	--
	4 Affiliates	--	0.4	--
	≥5 Affiliates	--	2.6	--
Percent of Trips with Negative Net Revenues (%)		5	5	-16%
Percent of Vessels with Negative Net Revenues (%)		6	5	-17%
Percent of All Vessels with Negative Net Revenues Summarized by Vessel Size Class (%)	<30’	2	2	0%
	30’ to <50’	3	3	0%
	50’ to <75’	0	0	0%
	75’+	0	0	0%
Percent of Entities with Negative Net Revenues (%)		--	6	--
Percent of All Entities with Negative Net Revenues Summarized by Entity size (%)	1 Affiliate	--	8	--
	2 Affiliates	--	3	--
	3 Affiliates	--	0	--
	4 Affiliates	--	0	--

≥ 5 Affiliates	--	0	--
Trip Net Revenue Gini Coefficient	1	1	-1%
Vessel Net Revenue Gini Coefficient	1	1	3%
Entity Net Revenue Gini Coefficient	--	1	--

Note: Groundfish fishing years start on May 1st and end on April 30th such that the pre-catch share period includes data from May 1, 2007, to April 30, 2010, and the post-catch share period includes data from May 1, 2010, to April 30, 2016. All monetary values have been adjusted to 2015 constant U.S. dollars. Changes in percentages are calculated as changes in percentages.

Table 2. Groundfish Entity Requirements and Decision Rules

Year	Vessel Permit Number	Entity Identification	Groundfish Permit?	Included in Groundfish Enterprise Analysis?
2015	121	1	Yes	Yes
2015	177	1	No	
2015	153	1	No	
2010	552	2	No	No
2010	577	2	No	
2007	944	3	Yes	No*
2007	995	3	Yes	
2007	(Not Databased)	(Not Databased)	(Not Databased)	

Note: Ownership information for 2007 to 2009 was only databased for scallop and groundfish permits such that entity sizes and economic data are only partial assessments and therefore are excluded from the analysis.

Table 3. Average Species Price Algorithm Levels.

Price Level	Criteria				
1	Year	Month	Day	Species	Port
2	Year	Month	Day	Species	County
3	Year	Month	Day	Species	State
4	Year	Month	Day	Species	Area
5	Year	Month	Day	Species	Region
6	Year	Month	Week	Species	
7	Year	Month	Species		
8	Year	Species			
9	Species				

Table 4. Average and Median Trip Durations over Fishing Year.

Fishing Year	Mean Hours per Groundfish Trip	Median Hours per Groundfish Trip
2007	27.0	10.5
2008	26.3	10.0
2009	24.2	9.0
2010	37.9	11.3
2011	36.3	11.3
2012	38.4	12.2
2013	45.6	13.5
2014	48.5	13.5
2015	48.7	13.8

FIGURES

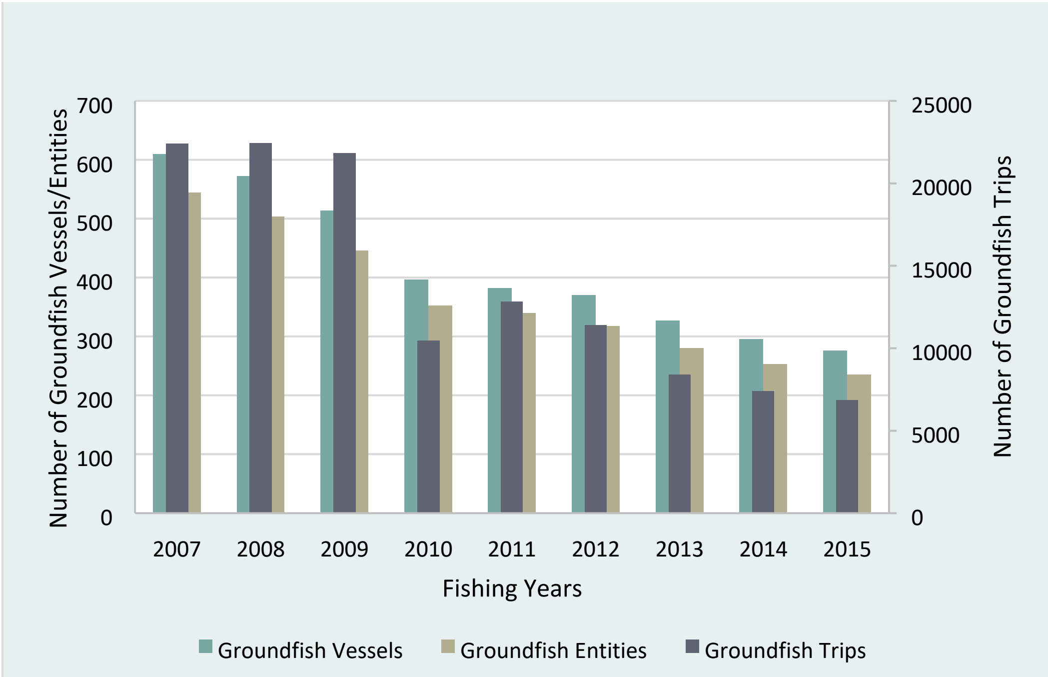


Figure 1. Number of Groundfish Trips, Active Vessels, and Entities by Fishing Year.

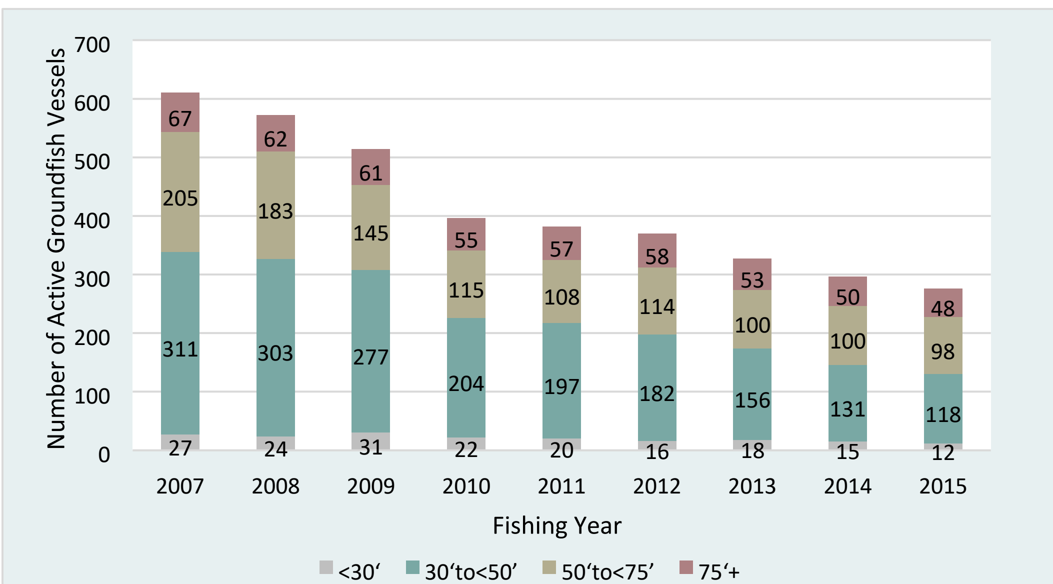


Figure 2. Number of Active Groundfish Vessels by Size Class and Fishing Year.

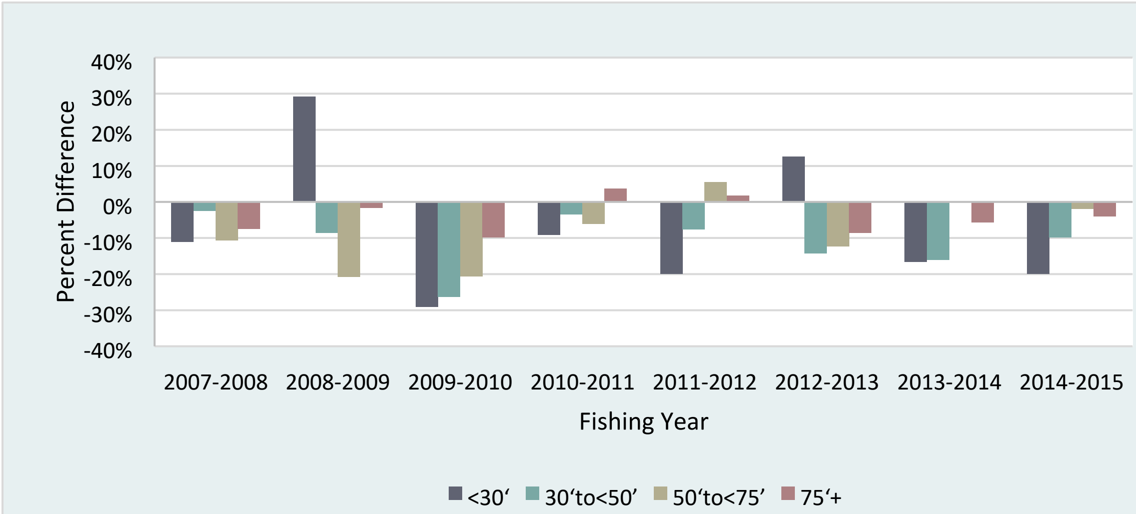


Figure 3. Percentage Increase/Decrease in Number of Vessels by Vessel Size Class between Fishing Years.

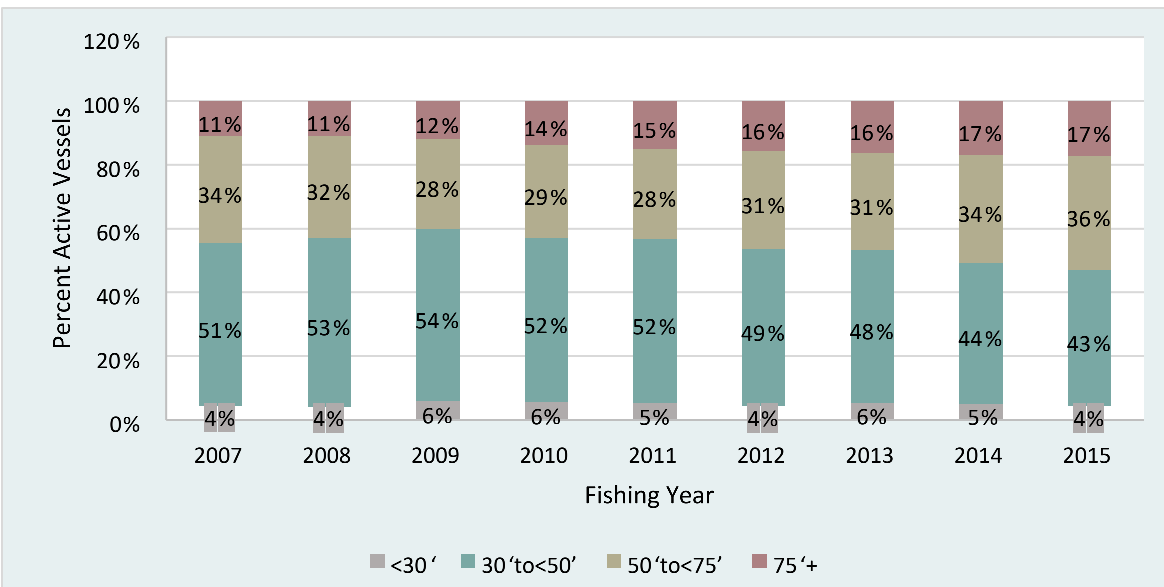


Figure 4. Percent of Active Vessels in the Groundfish Fleet by Vessel Size Class and Fishing Year.

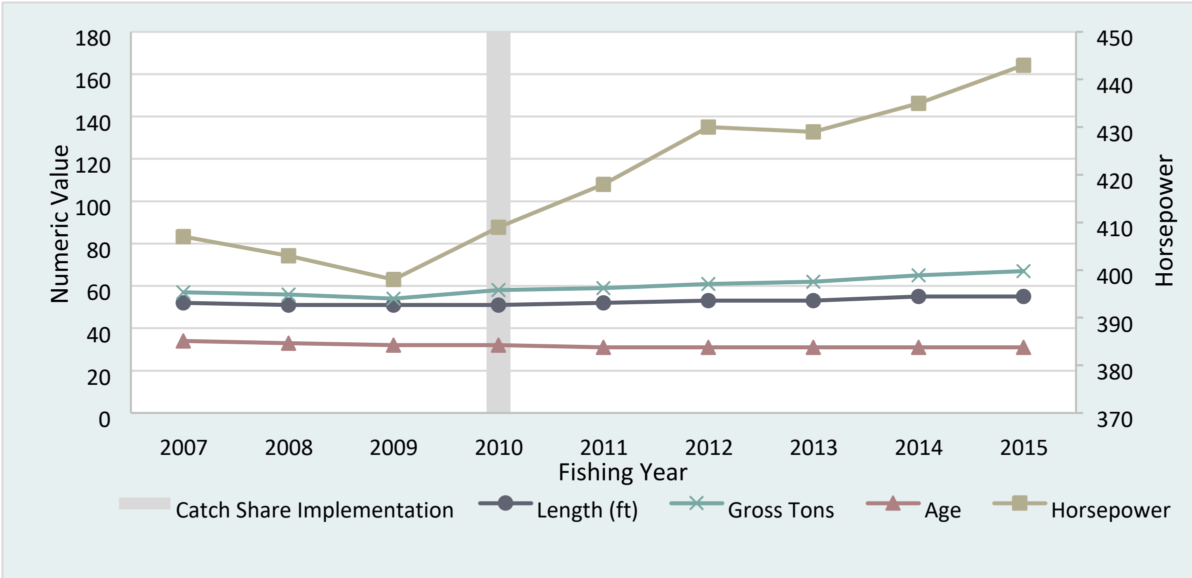


Figure 5. Average Groundfish Vessel Characteristics by Fishing Year.

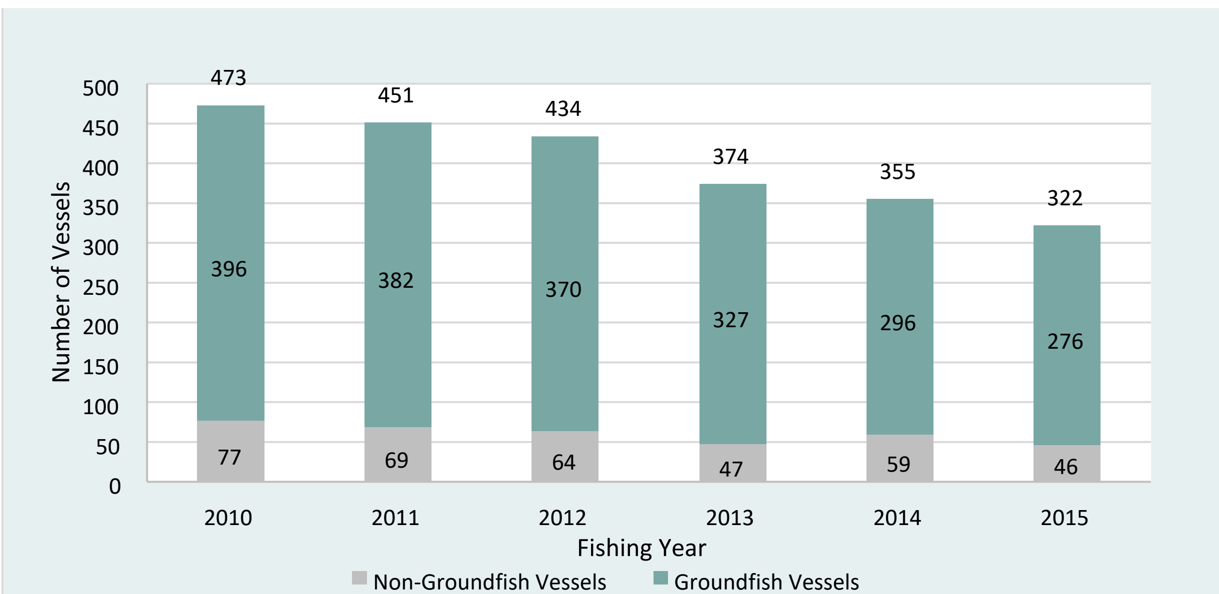


Figure 6. Total Number of Vessels Affiliated with a Groundfish Entity by Fishing Year.

Note: Affiliate data were not fully databased prior to FY 2010.

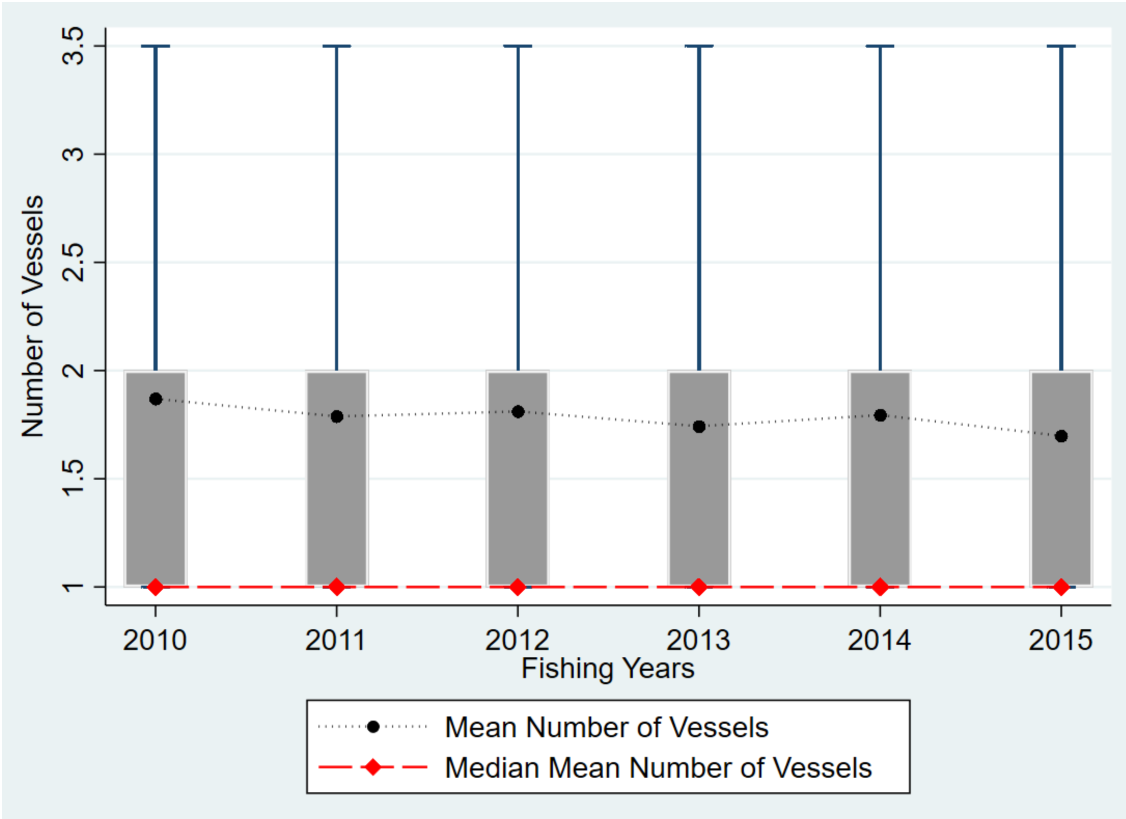


Figure 7. Box and Whisker Plot of Number of Active Vessels per Groundfish Entity by Fishing Year.

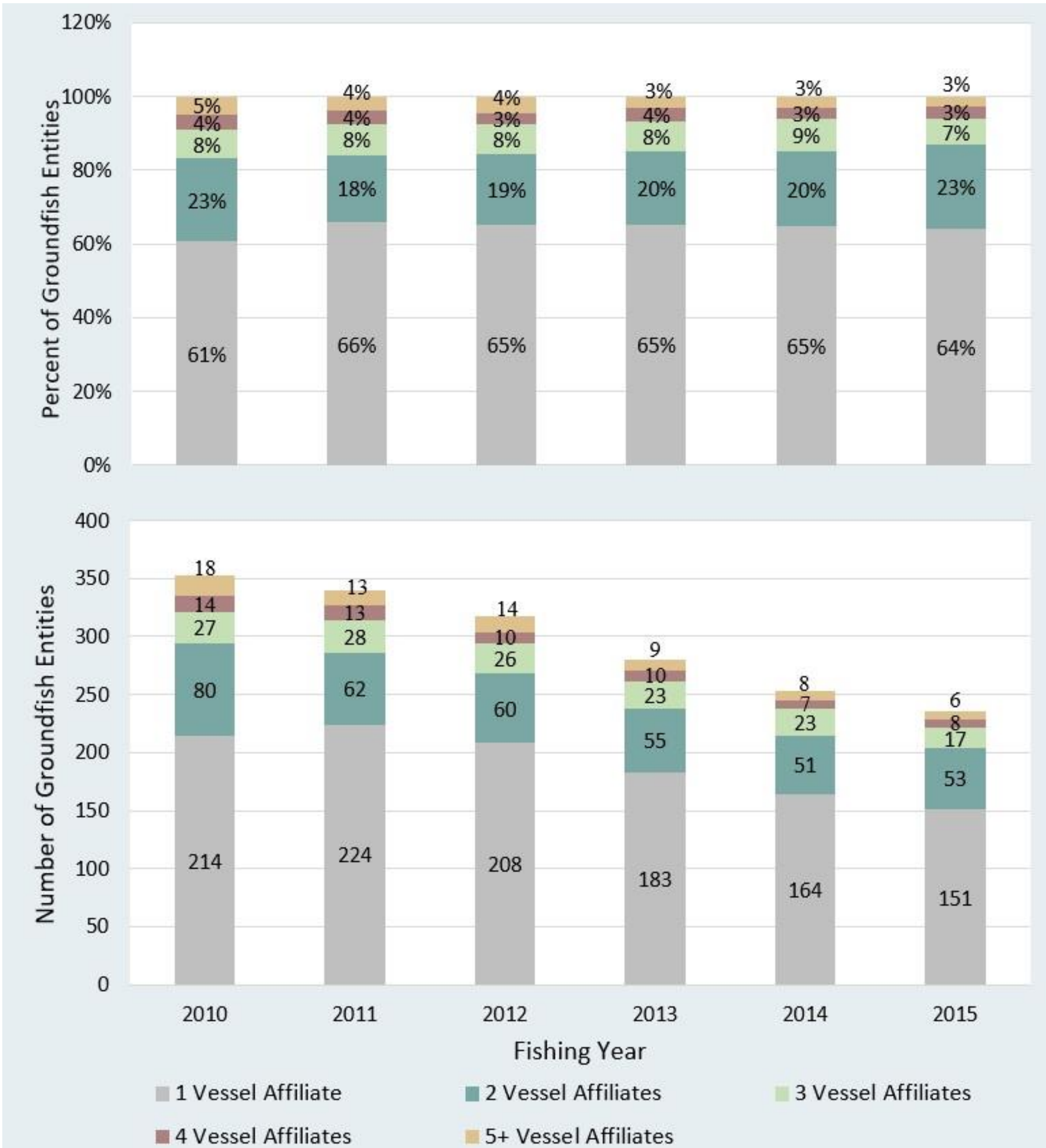


Figure 8. Percent and Number of Entities by Vessel Affiliation Size Group and Fishing Year.

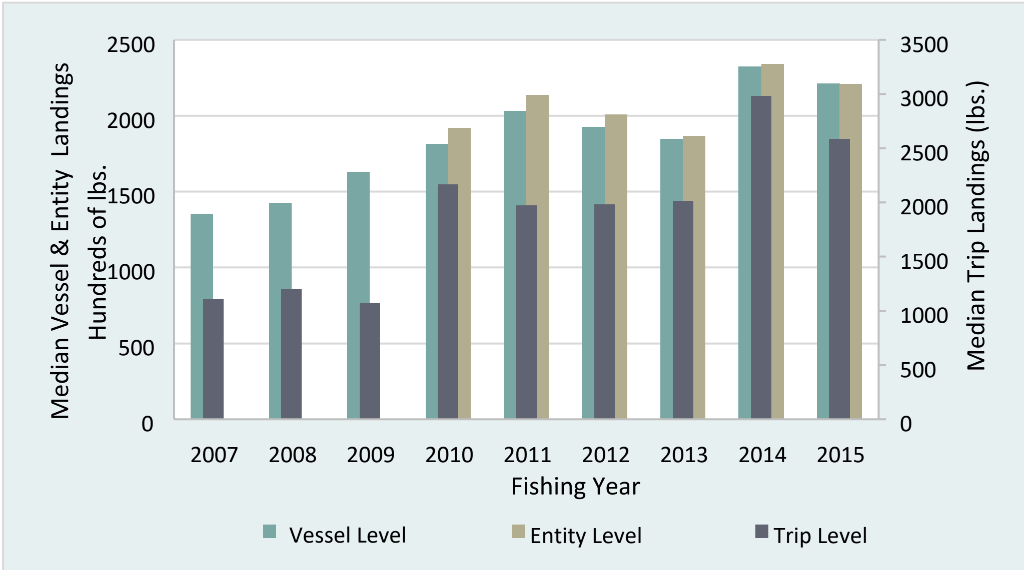


Figure 9. Median Landings (All Species) from Groundfish Trips, Vessels, and Entities.

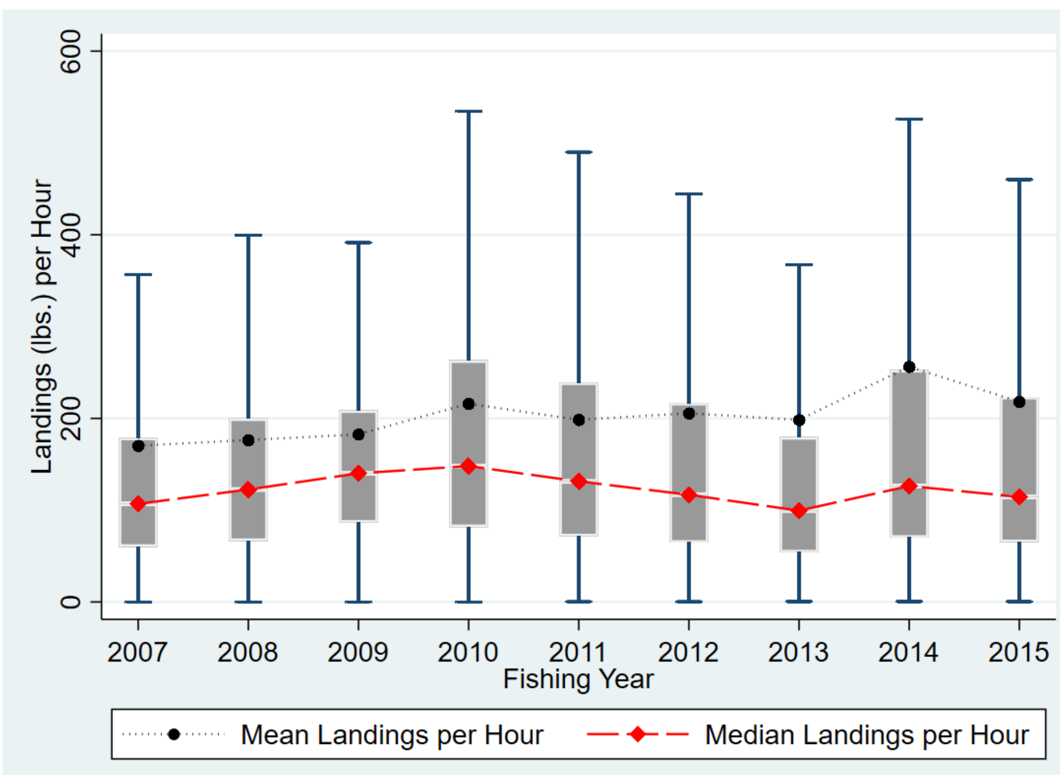


Figure 10. Groundfish Trip Landings per Hour Box and Whisker Plot (All Species) by Fishing Year.

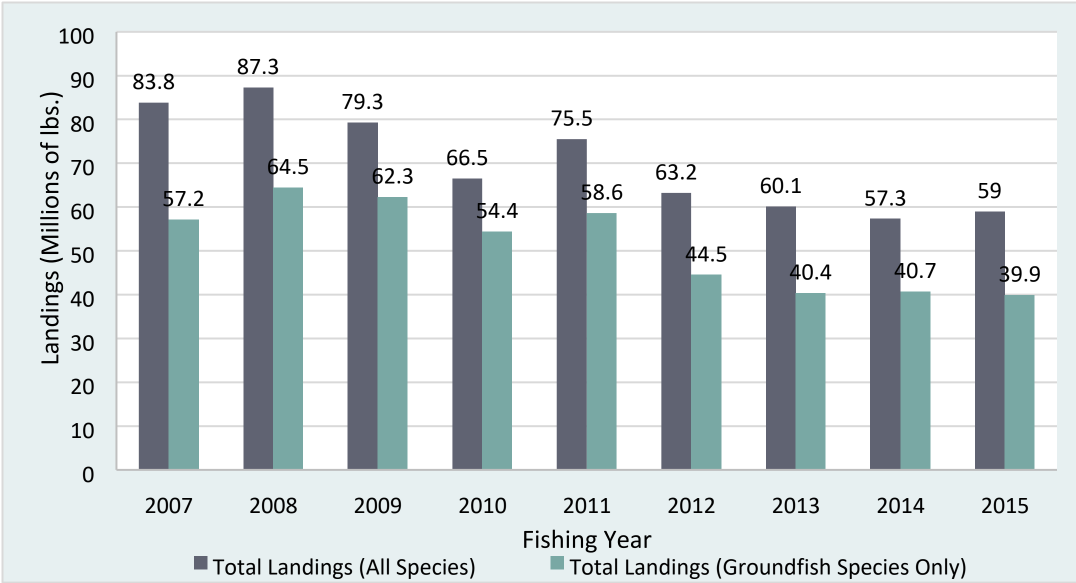


Figure 11. Gross Groundfish Trip Landings (All Species and Groundfish Species) by Fishing Year.

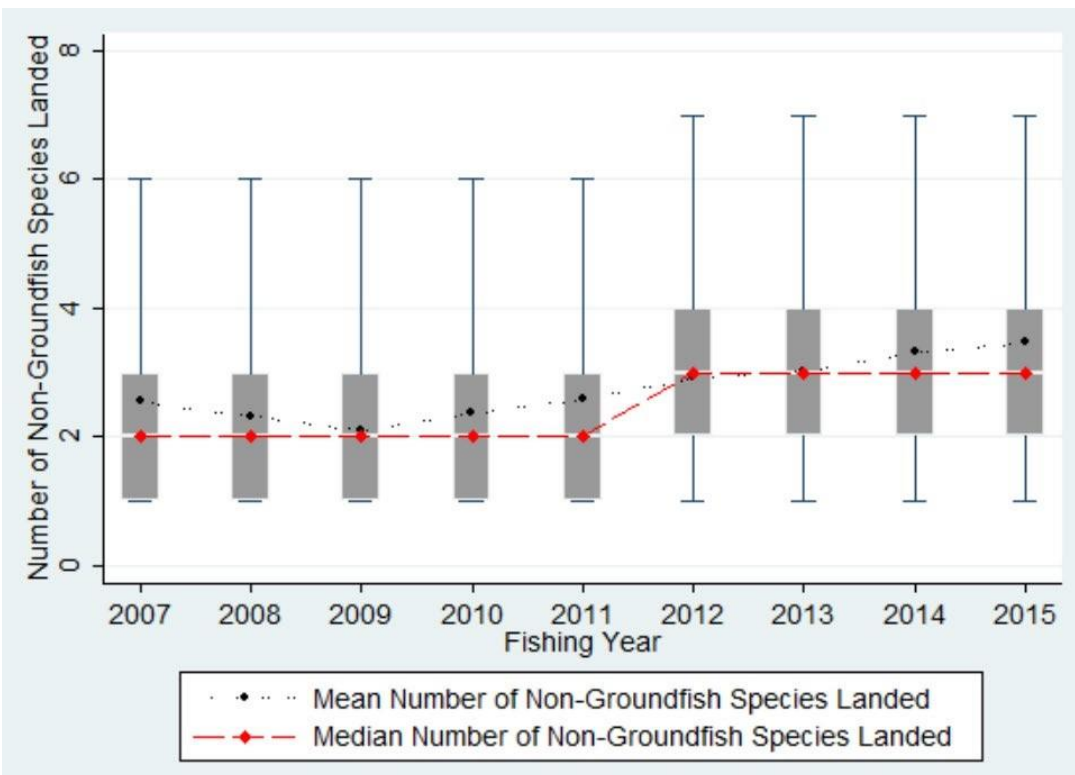


Figure 12. Number of Non-Groundfish Species Landed per Groundfish Trip Box and Whisker Plots by Fishing Year.

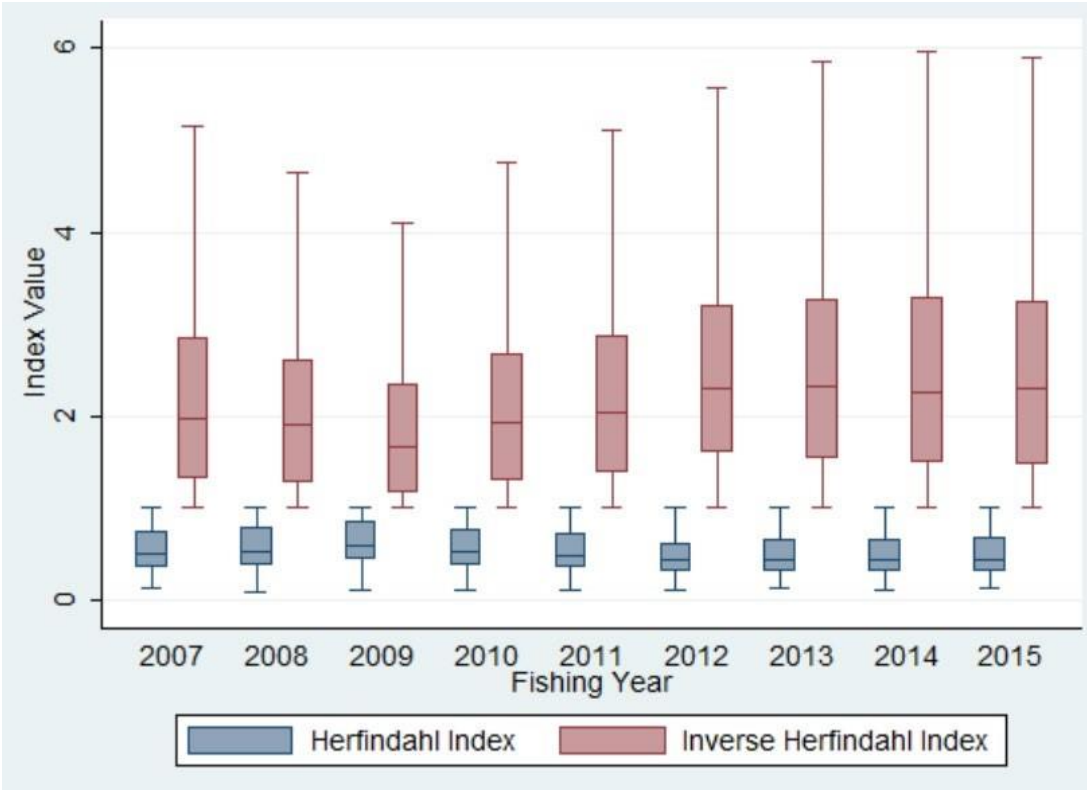


Figure 13. Trip-Level Herfindahl and Inverse Herfindahl Indices Box and Whisker Plots by Fishing Year.

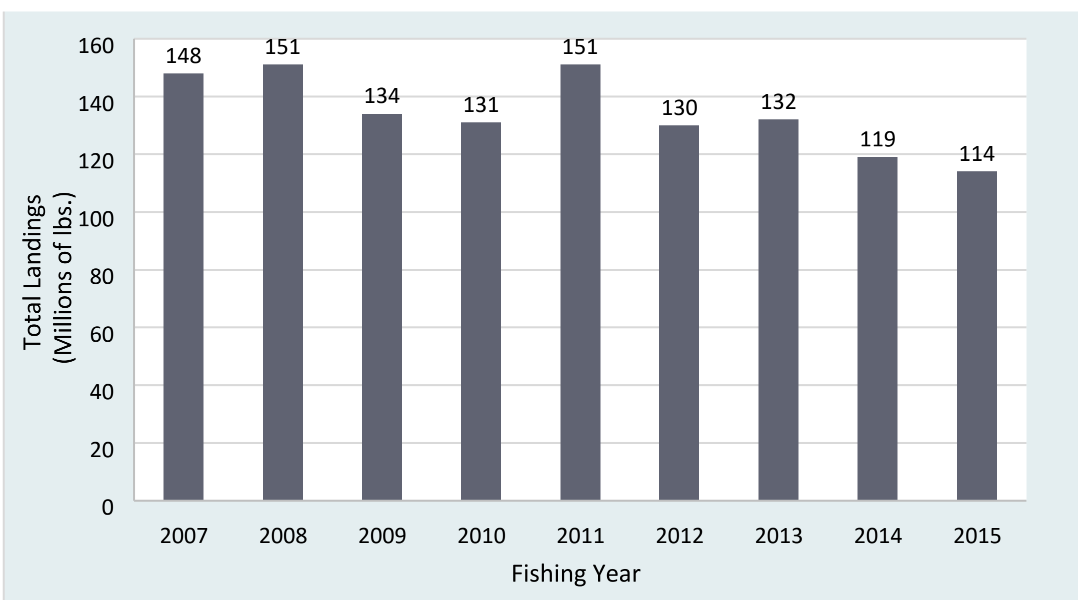


Figure 14. Gross Groundfish Vessel Landings by Fishing Year (All Species).

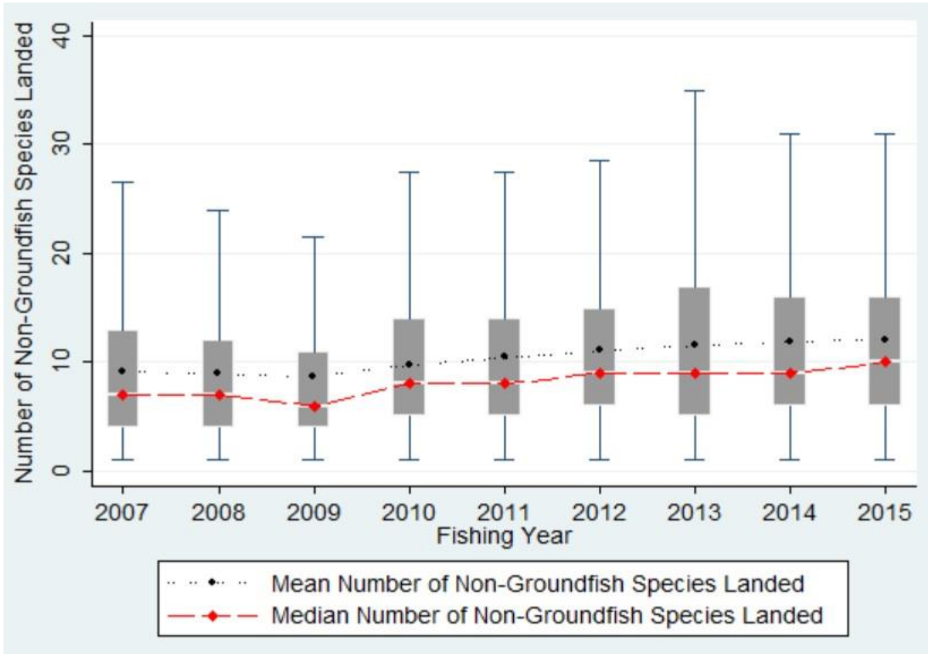


Figure 15. Number of Non-Groundfish Species Landed per Vessel Box and Whisker Plots by Fishing Year.

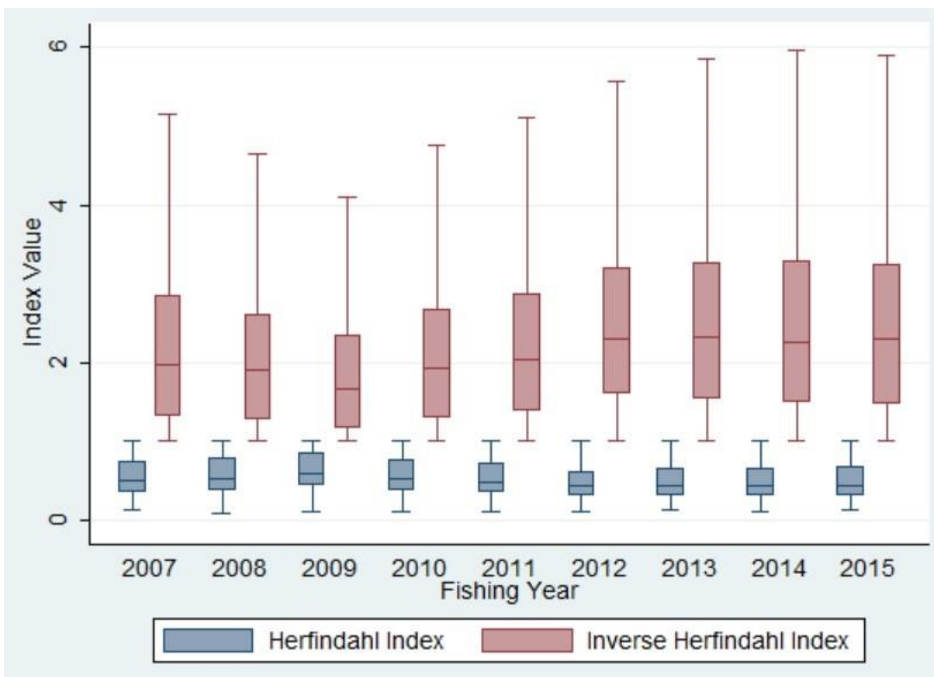


Figure 16. Vessel-Level Herfindahl and Inverse Herfindahl Indices Box and Whisker Plots by Fishing Year.

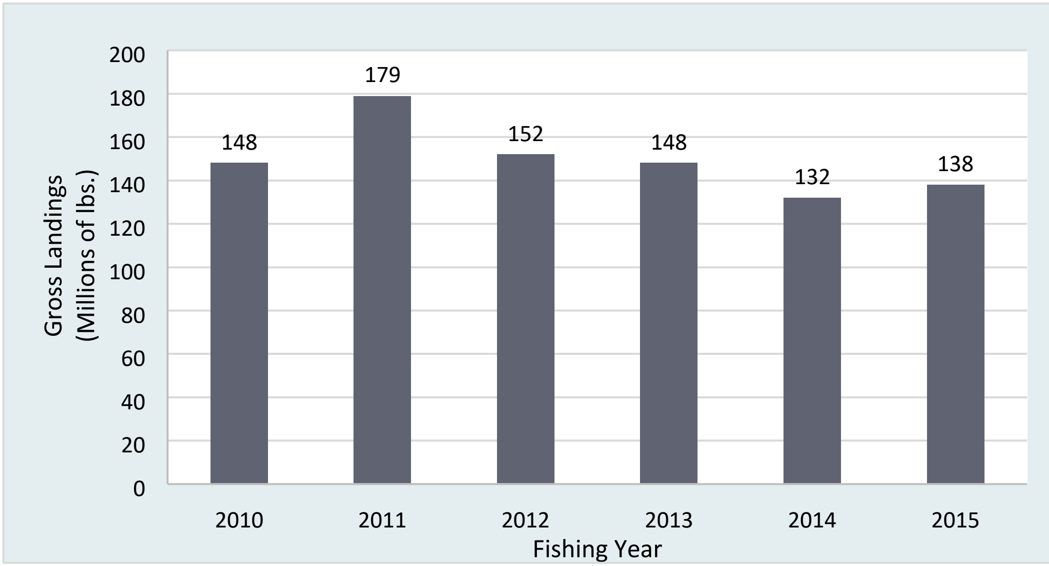


Figure 17. Gross Landings by Groundfish Entities by Fishing Year (All Species).

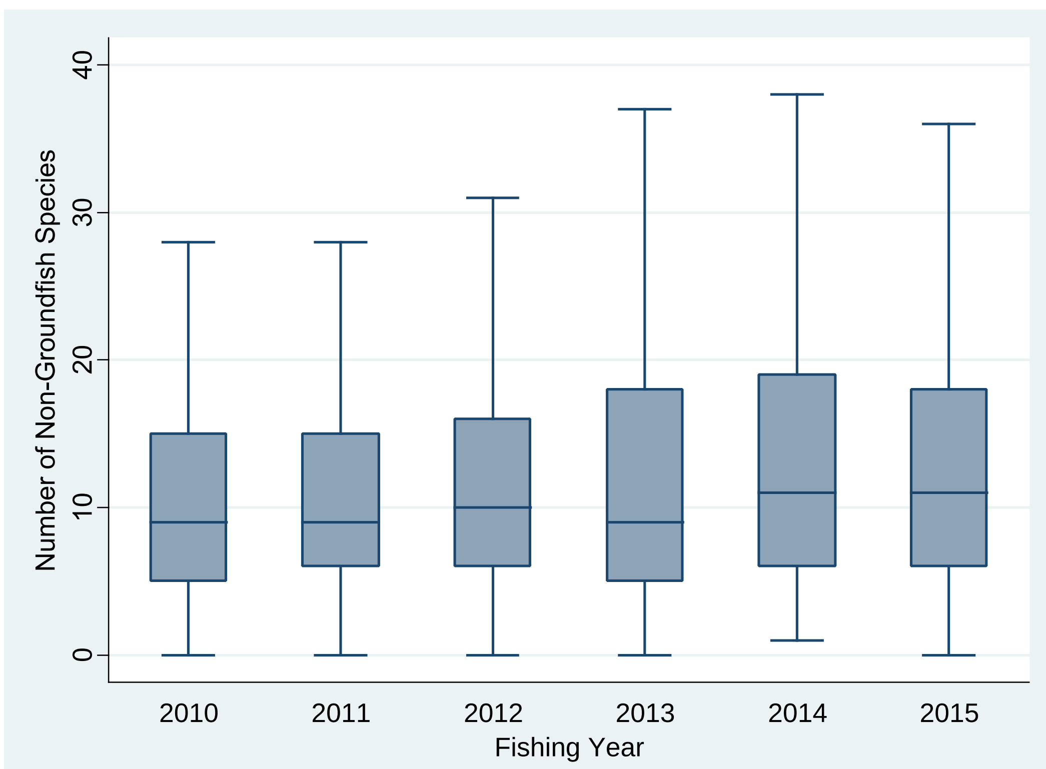


Figure 18. Number of Non-Groundfish Species Landed per Groundfish Entity Box and Whisker Plots by Fishing Year.

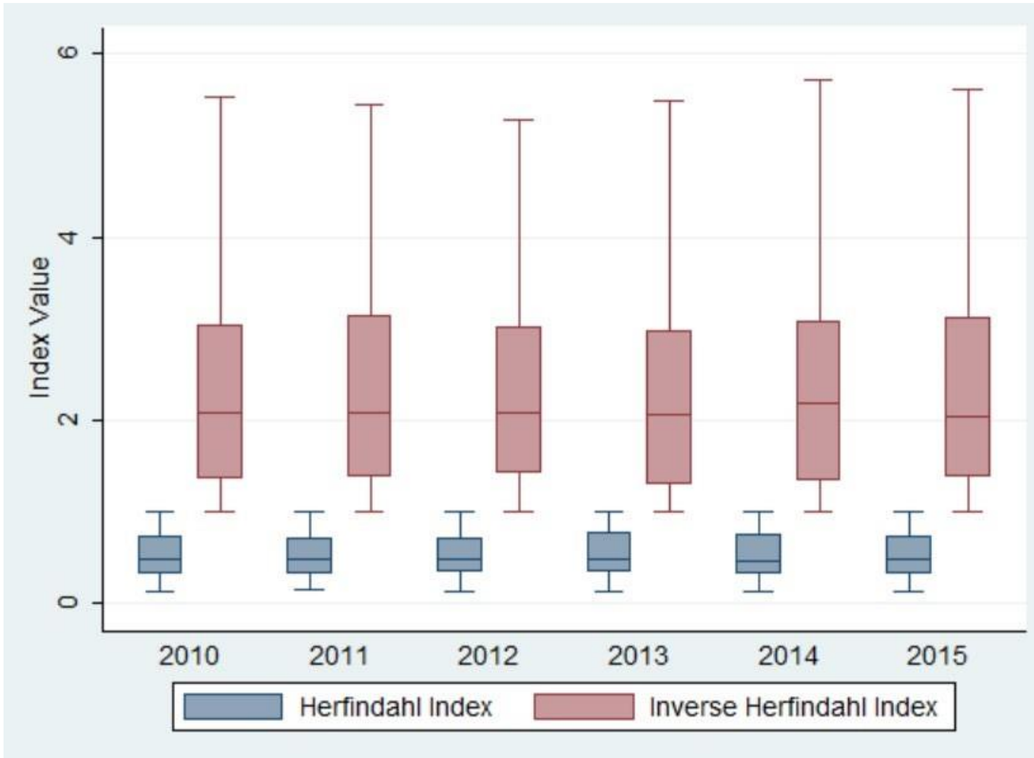


Figure 19. Entity-Level Herfindahl and Inverse Herfindahl Index Box and Whisker Plots by Fishing Year.

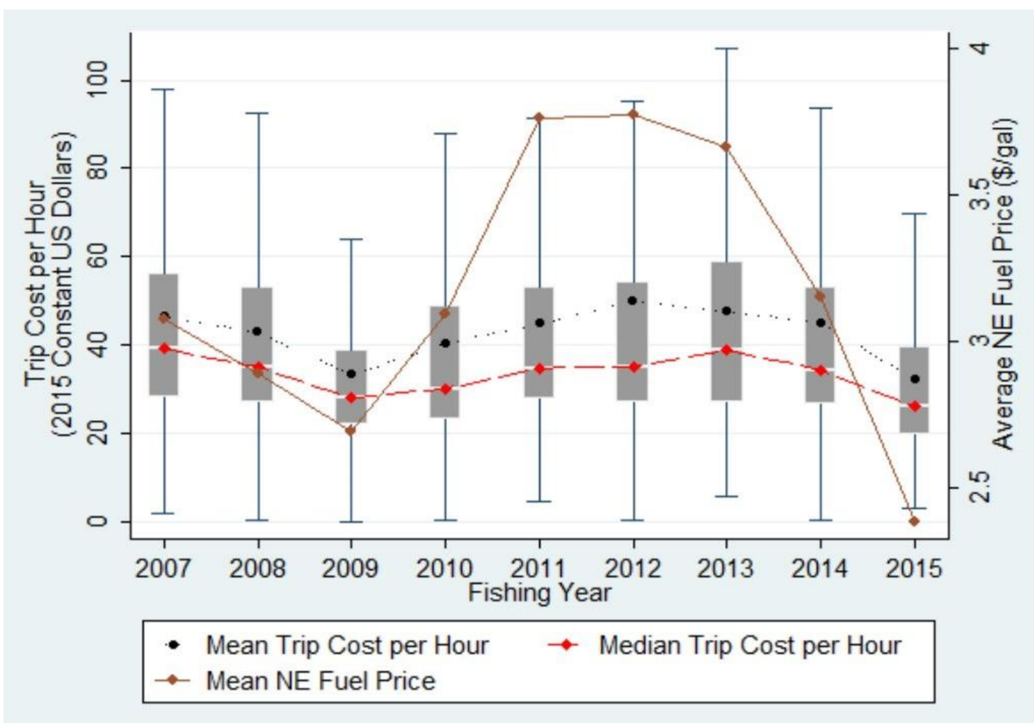


Figure 20. Trip Costs per Hour Box and Whisker Plots and Average New England Fuel Prices by Fishing Year (2007-2015).

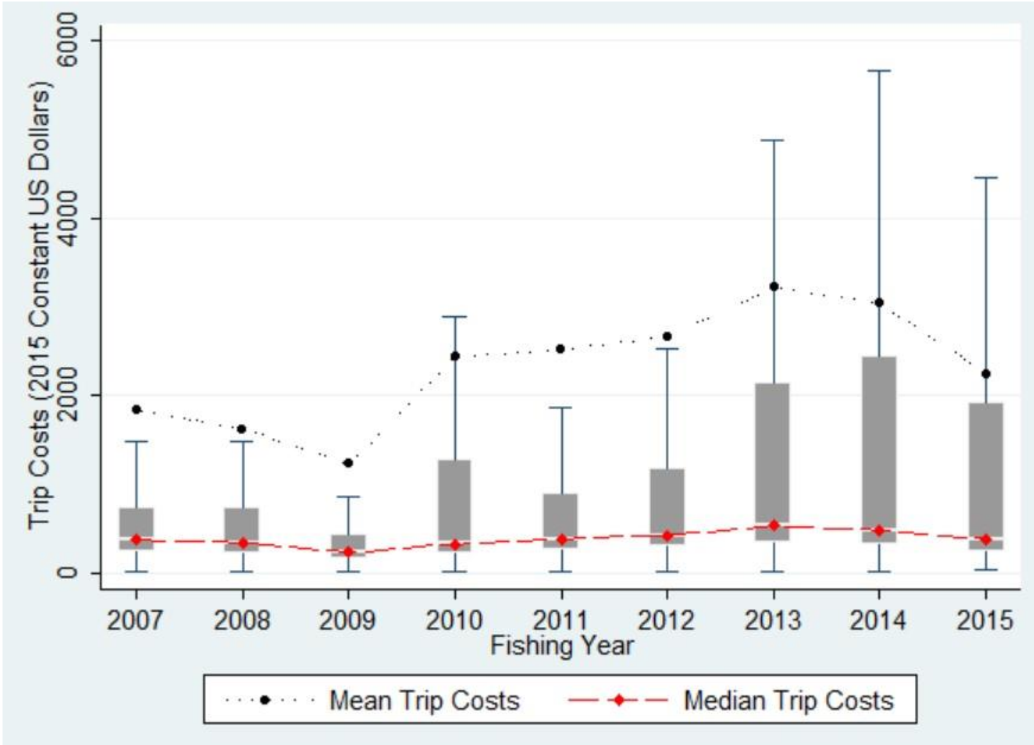


Figure 21. Groundfish Trip Costs Box and Whisker Plots by Fishing Year.

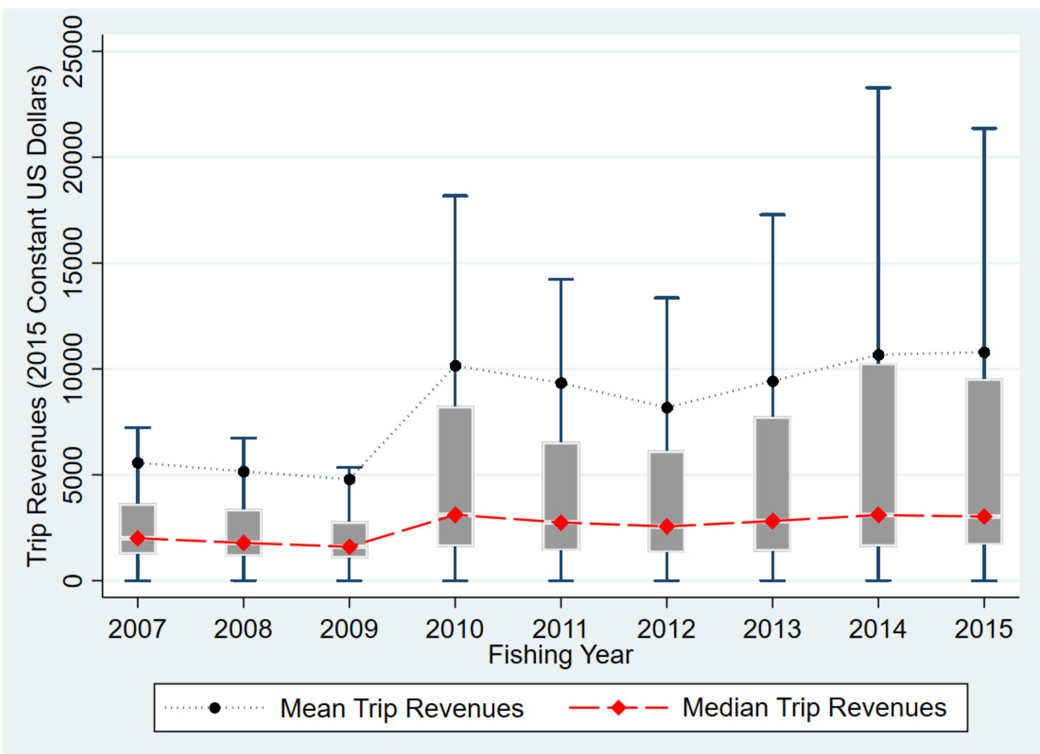


Figure 22. Groundfish Trip Revenues (All Species) Box and Whisker Plots by Fishing Year.

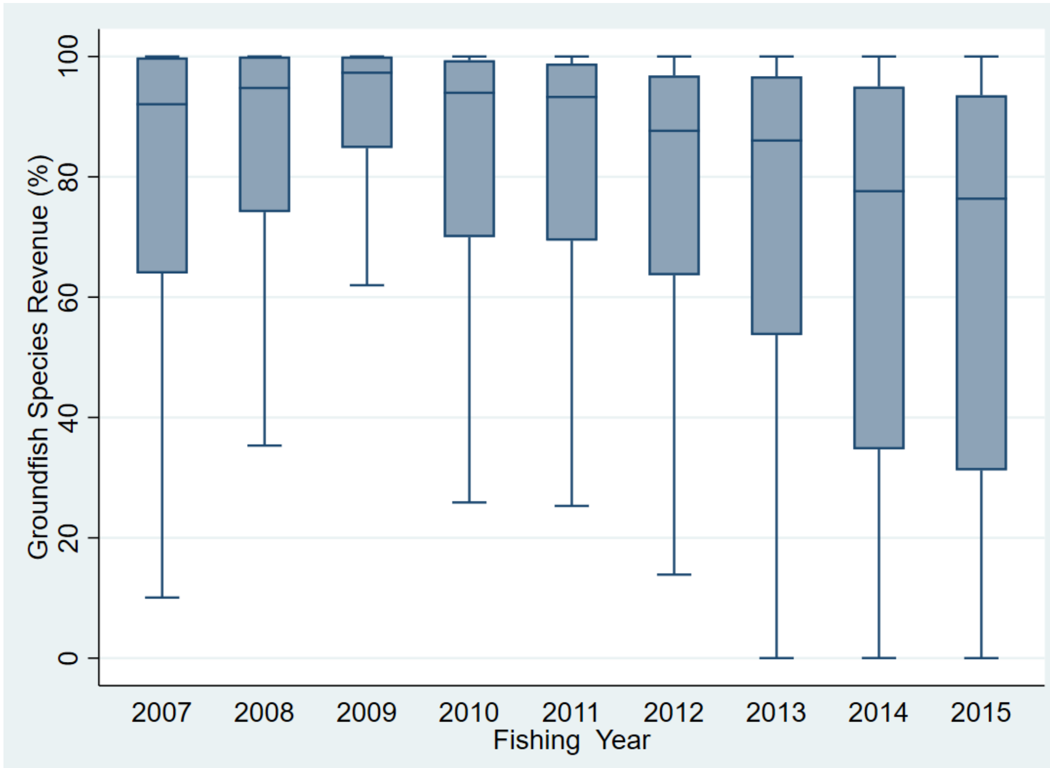


Figure 23. Groundfish Species Revenues as a Percent of Total Groundfish Trip Revenues Box Plots by Fishing Year.

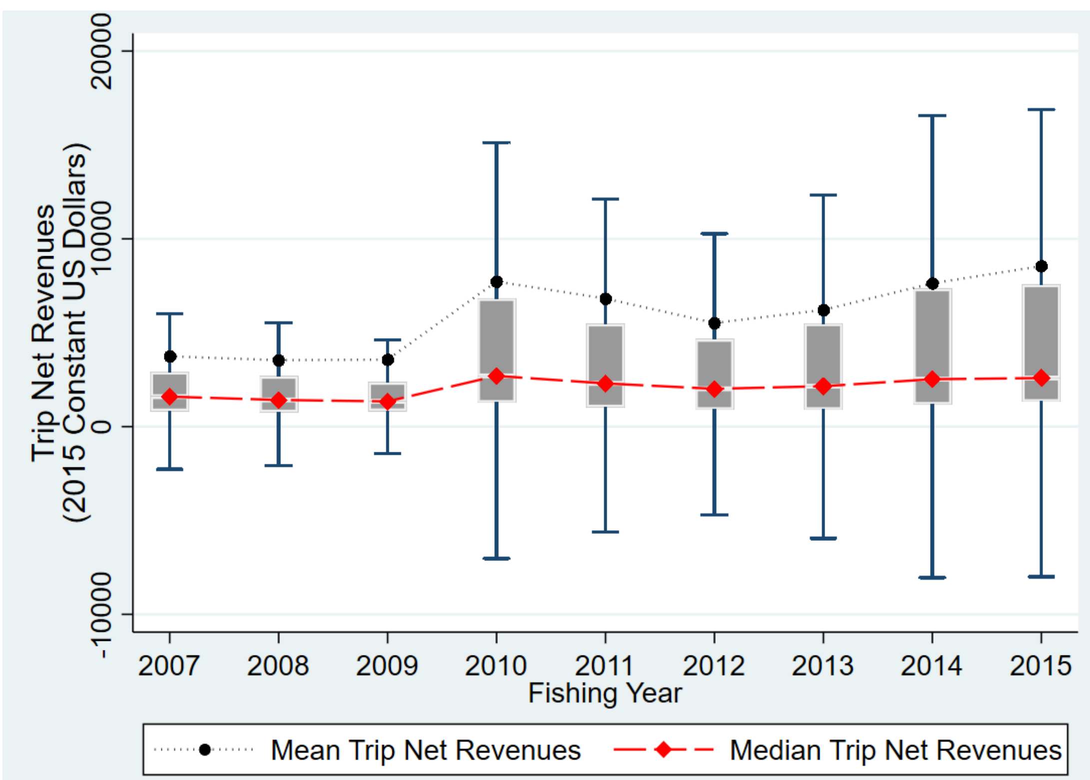


Figure 24. Groundfish Trip Net Revenues Box and Whisker Plots by Fishing Year.

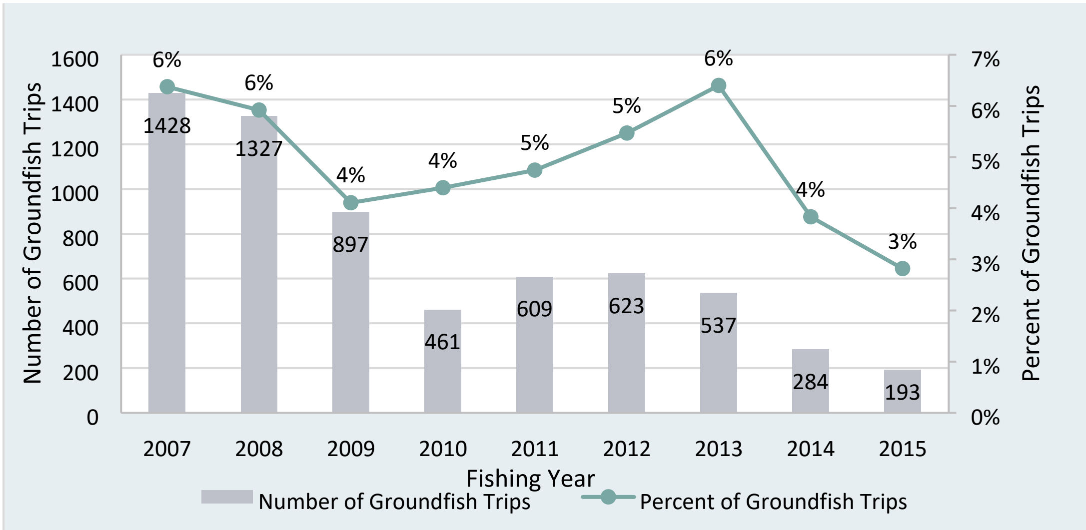


Figure 25. Number and Percent of Groundfish Trips with Negative Net Revenues over Fishing Year.

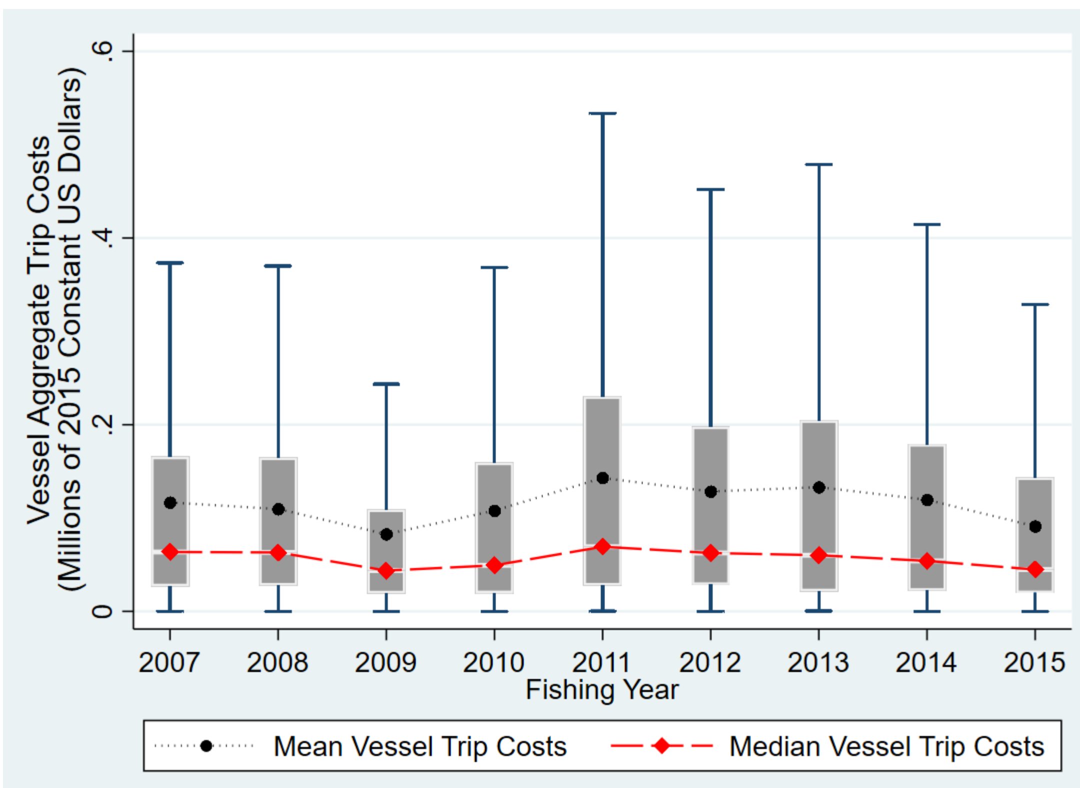


Figure 26. Groundfish Vessel Aggregate Trip Costs Box and Whisker Plots by Fishing Year.

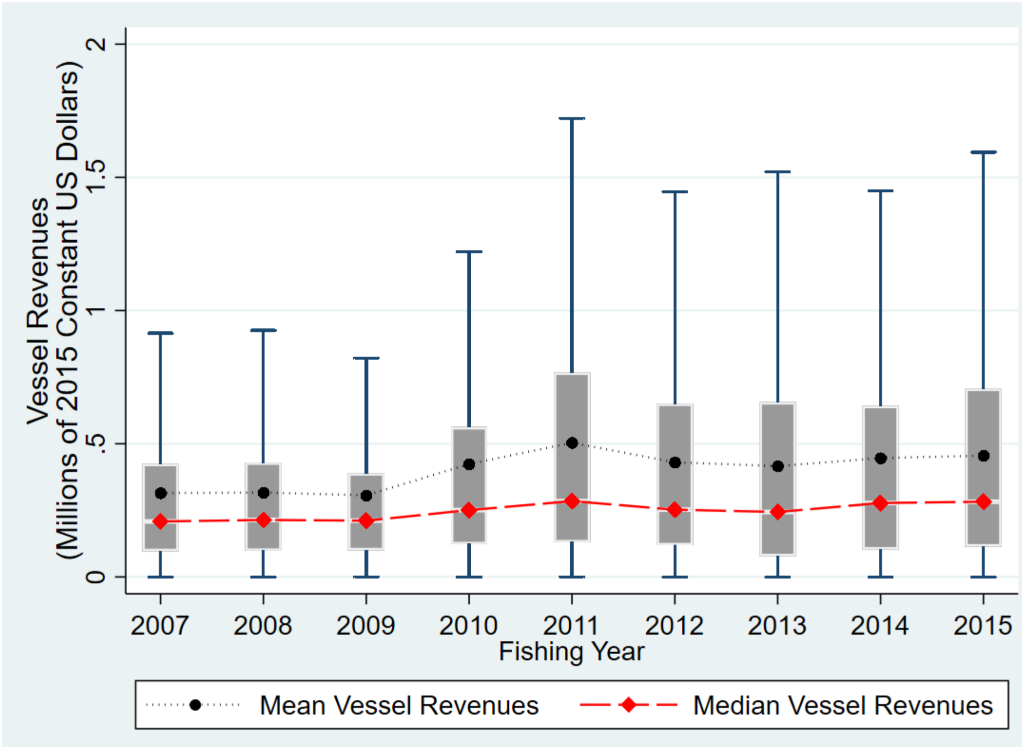


Figure 27. Groundfish Vessel Revenues Box and Whisker Plots by Fishing Year (All Species).

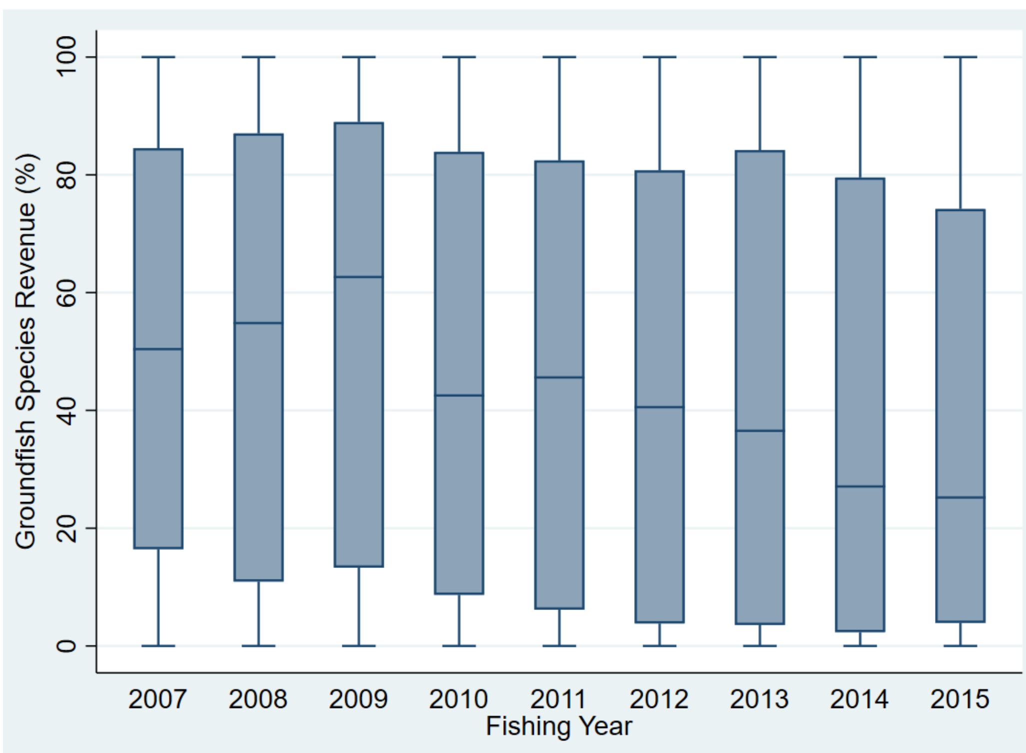


Figure 28. Box and Whisker Plots of Groundfish Species Revenues as a Percent of Total Vessel Revenues by Fishing Year.

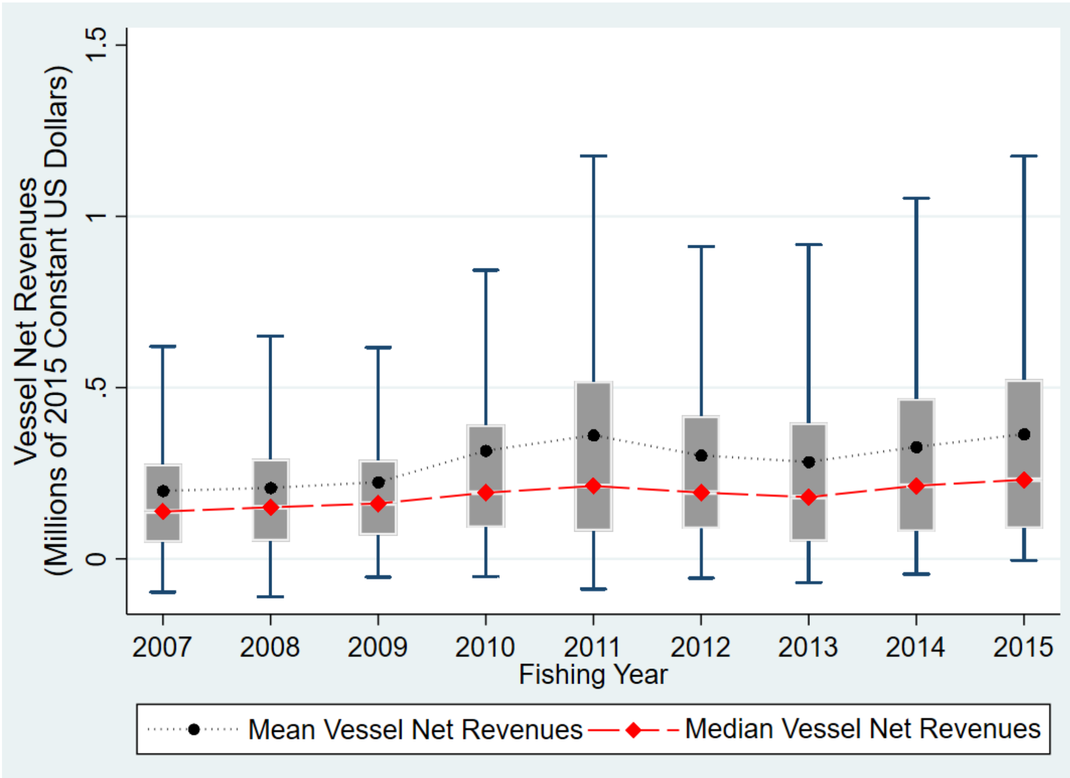


Figure 29. Groundfish Vessel Net Revenues Box and Whisker Plots by Fishing Year.

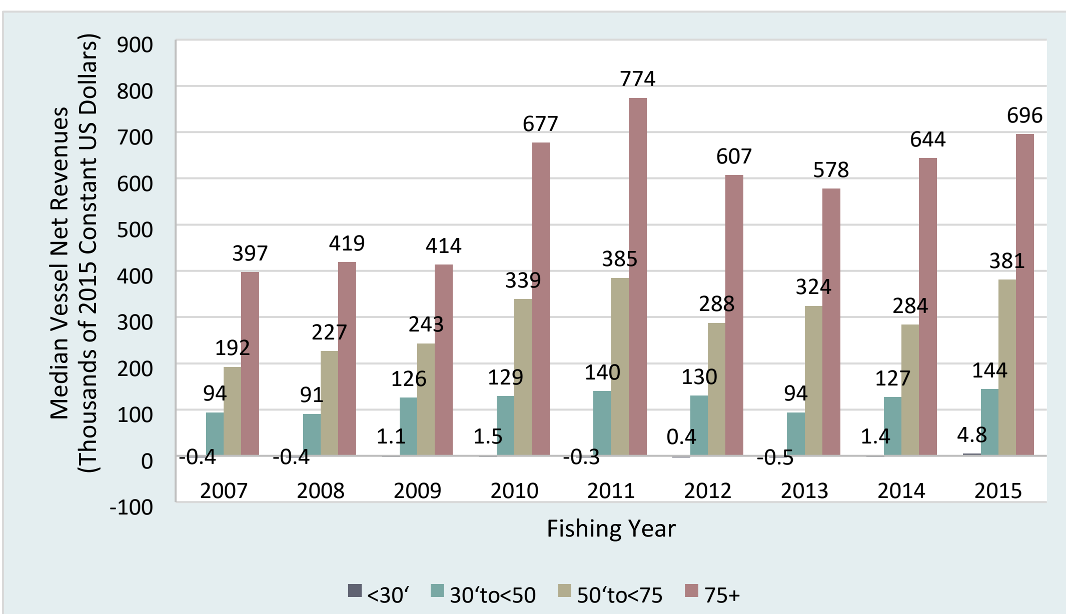


Figure 30. Median Net Revenues by Vessel Size Class over Fishing Year.

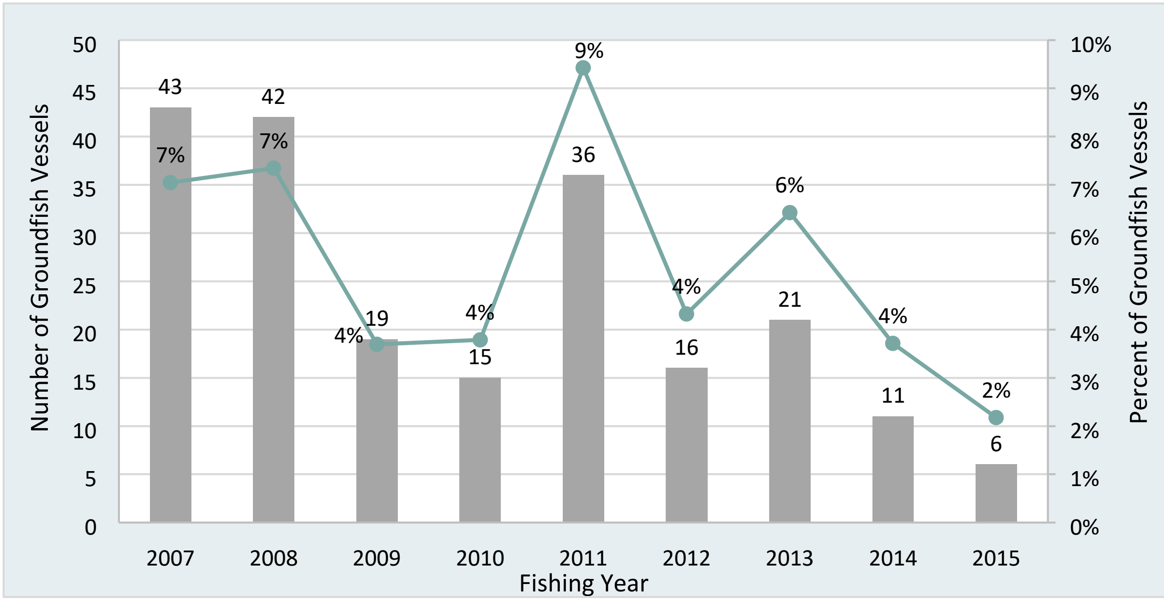


Figure 31. Number and Percent of Groundfish Vessels with Negative Net Revenues over Fishing Year.

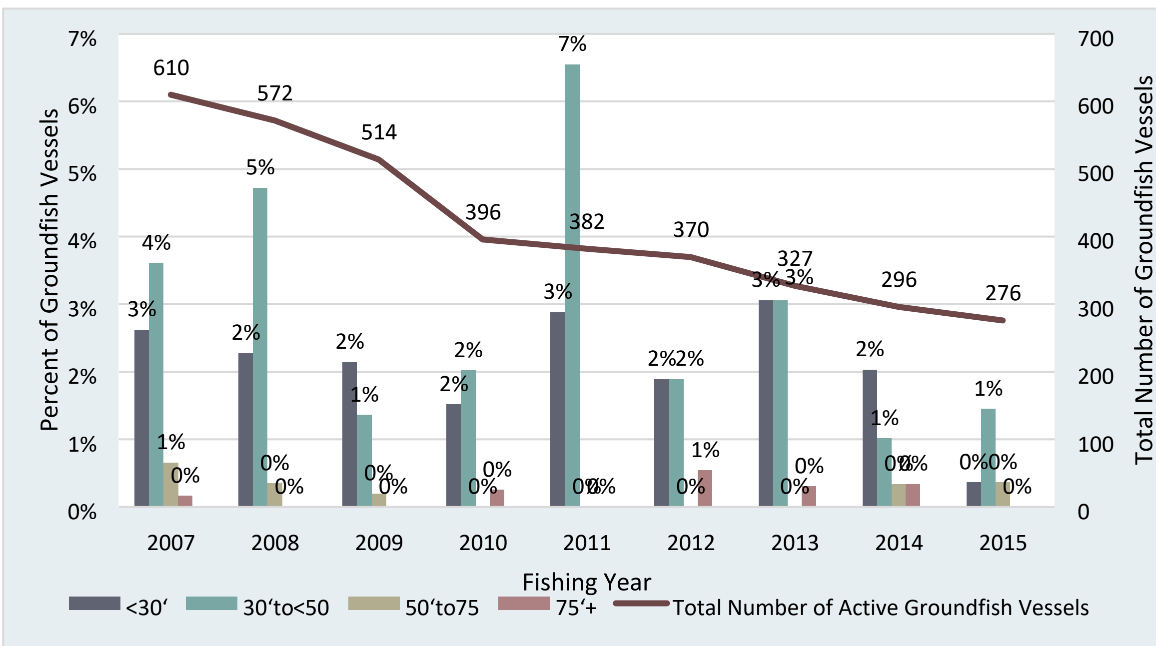


Figure 32. Percent of Total Groundfish Vessels with Negative Net Revenues by Vessel Size Class over Fishing Year.

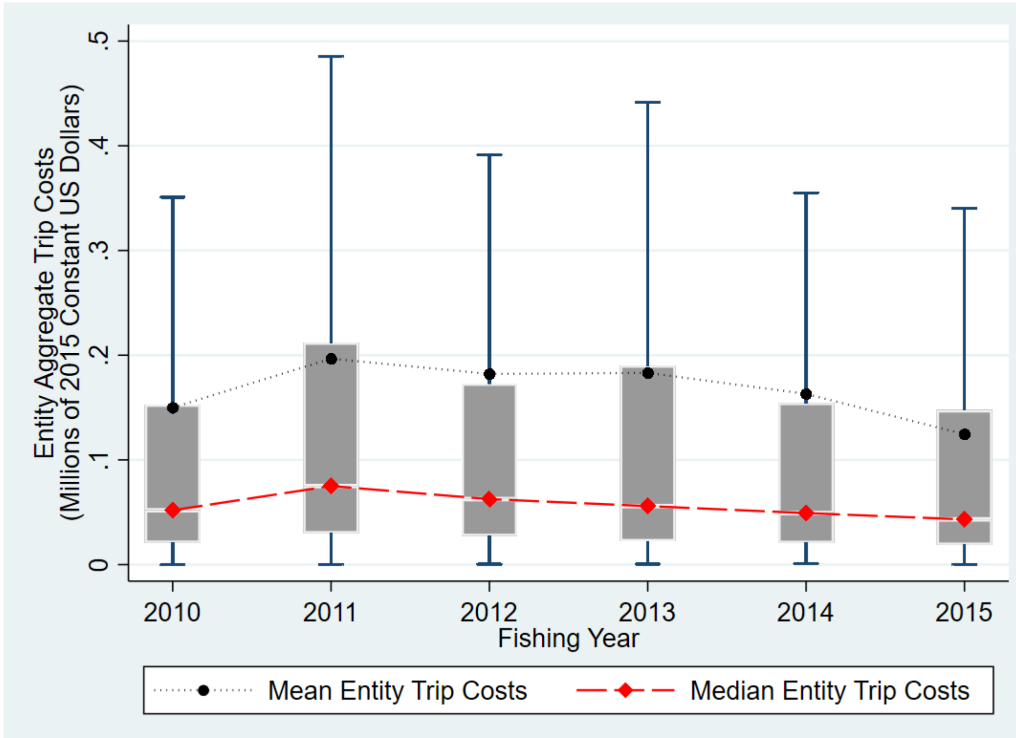


Figure 33. Groundfish Entity Aggregate Trip Costs Box and Whisker Plots by Fishing Year.

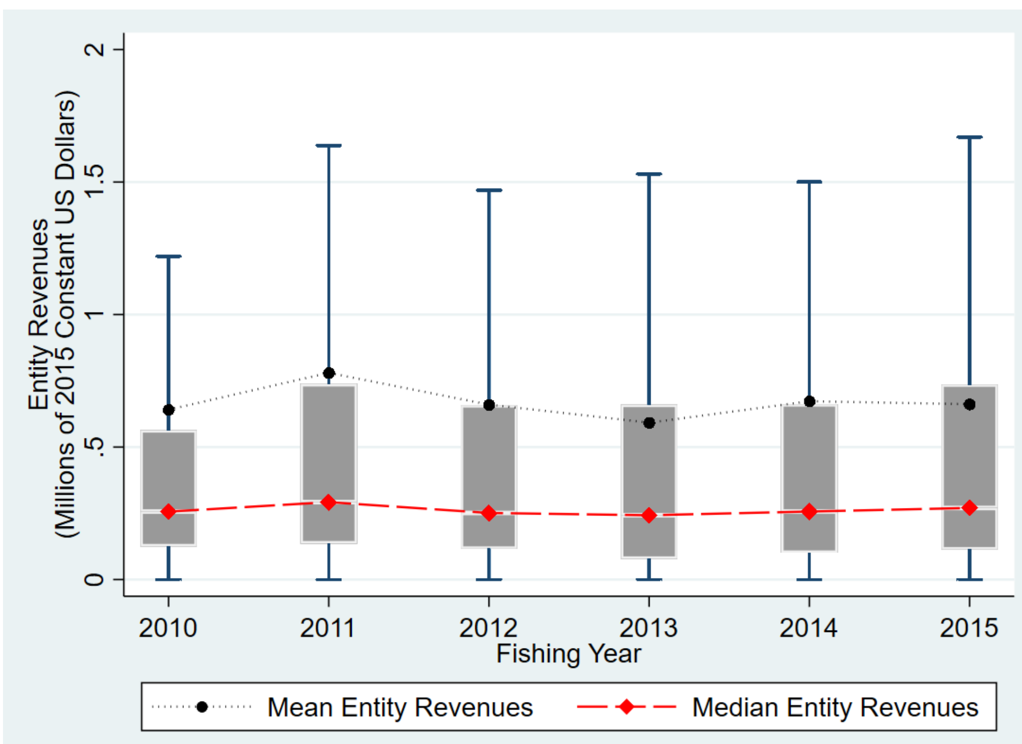


Figure 34. Groundfish Entity Revenues (All Species) Box and Whisker Plots by Fishing Year.

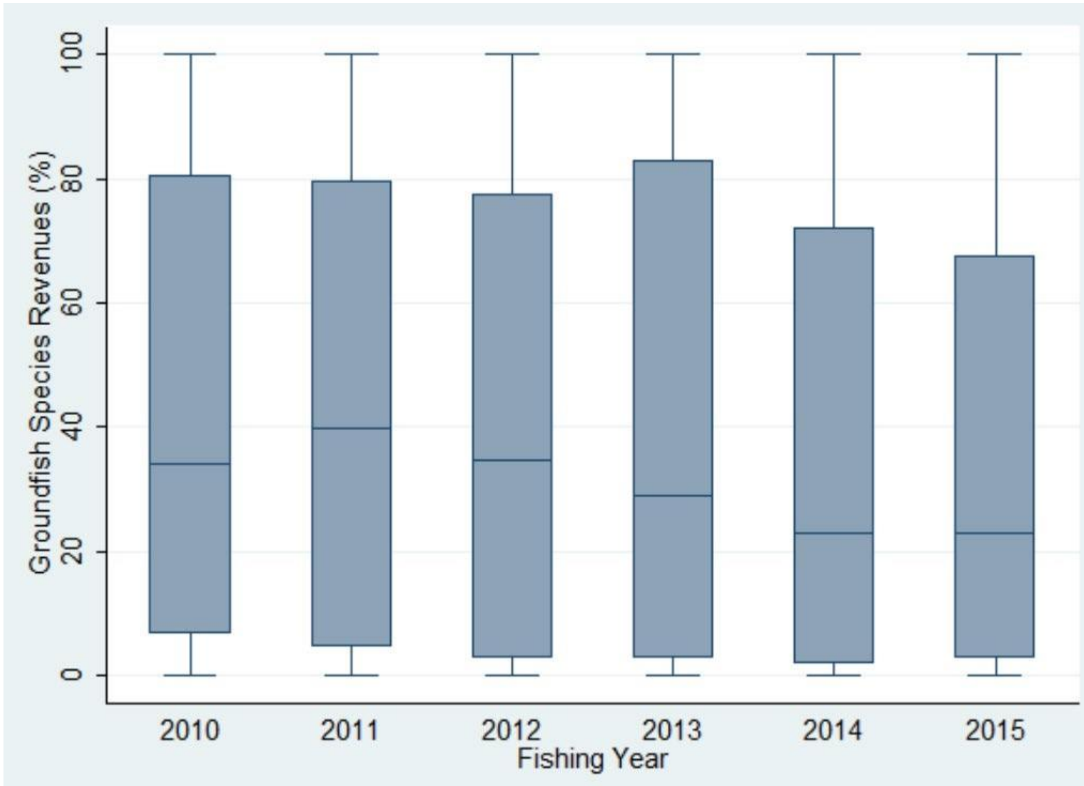


Figure 35. Box and Whisker Plots of Groundfish Species Revenues as a Percent of Total Entity Revenues.

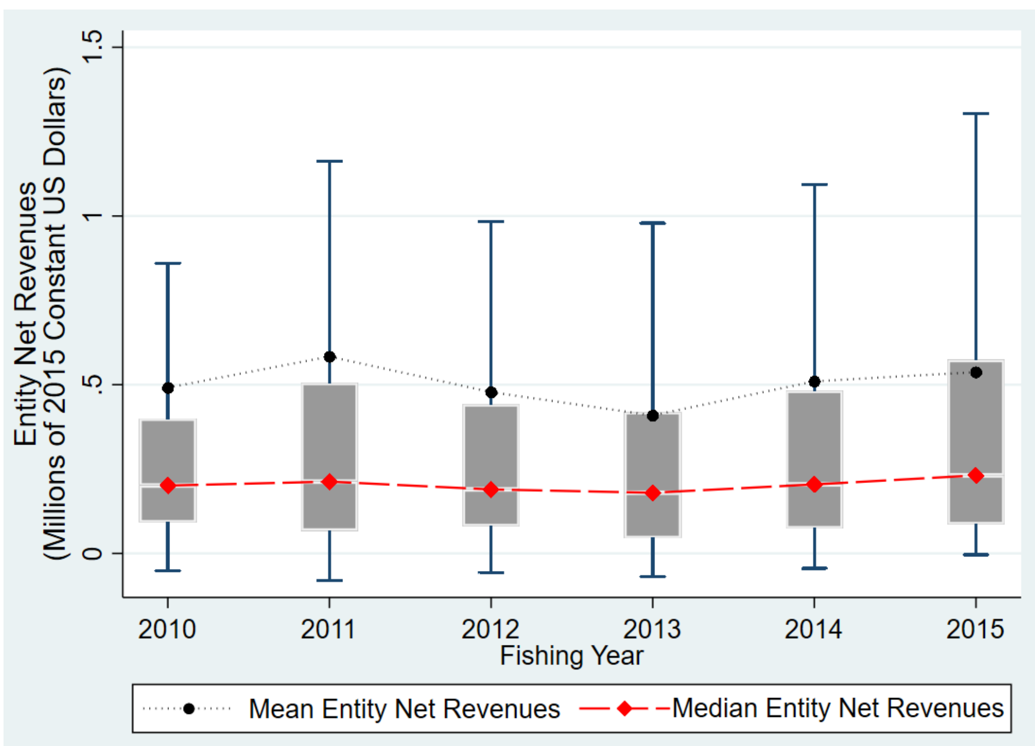


Figure 36. Groundfish Entity Net Revenues Box and Whisker Plot by Fishing Year

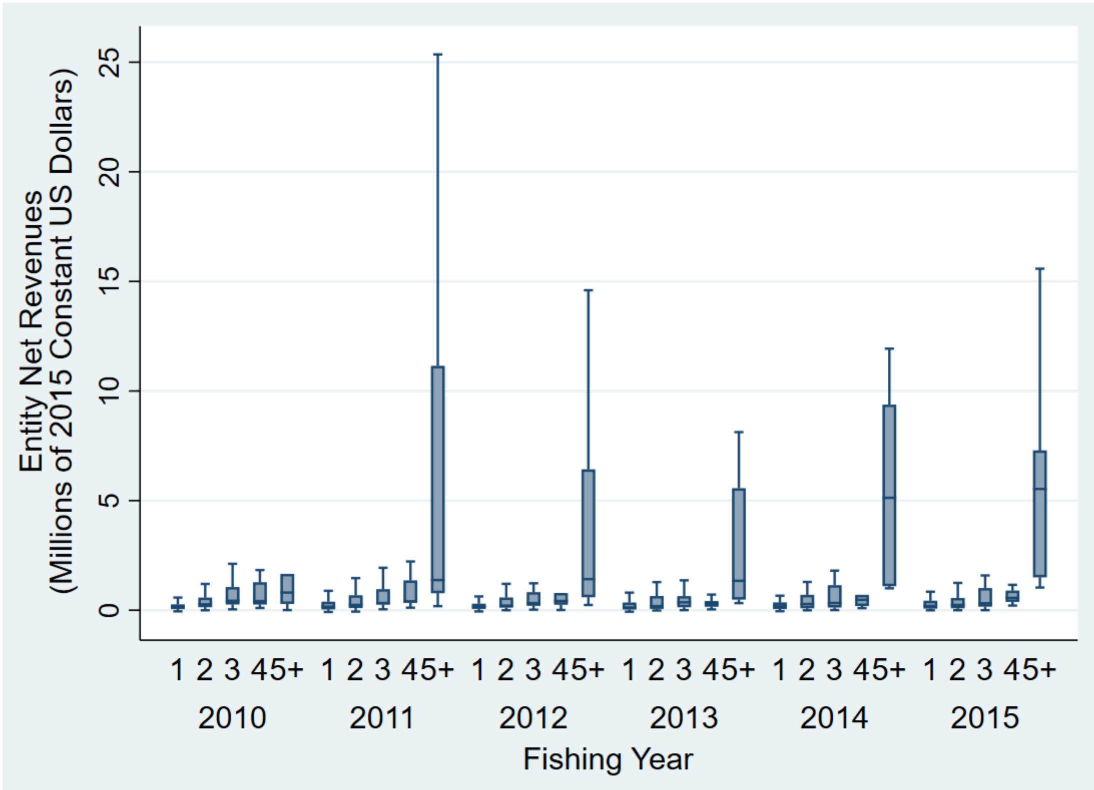


Figure 37. Groundfish Entity Net Revenues Box and Whisker Plots by Groundfish Entity Size Class and Fishing Year.

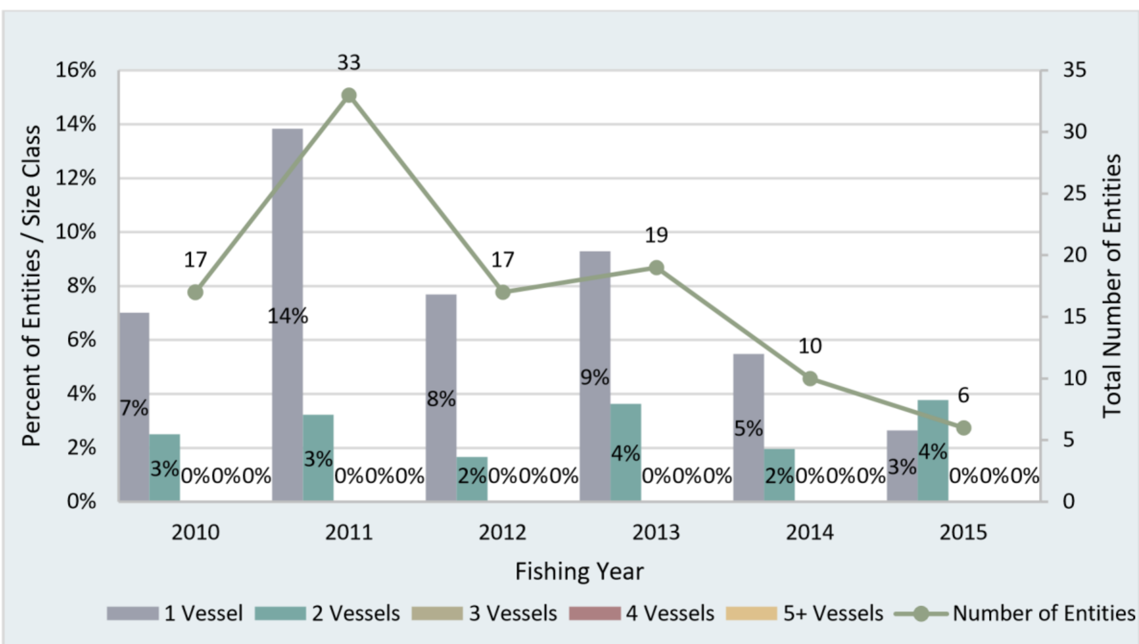
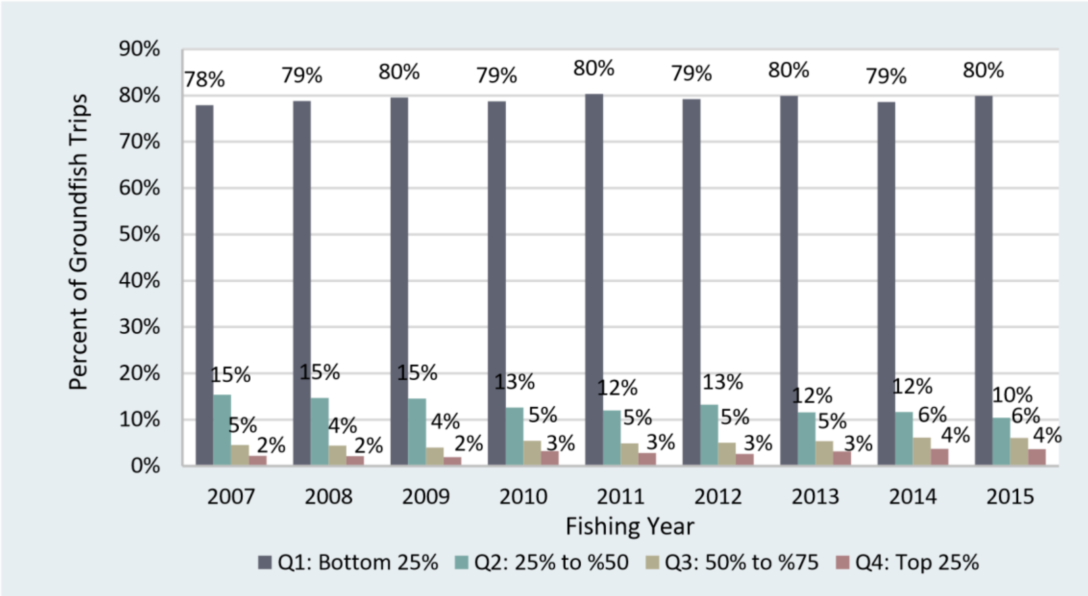


Figure 38. Percent and Number of Entities with Negative Net Revenues by Entity Size Class over Fishing Year.



Fishing 39. Percent of Trips by Net Revenues Quartiles over Fishing Year.

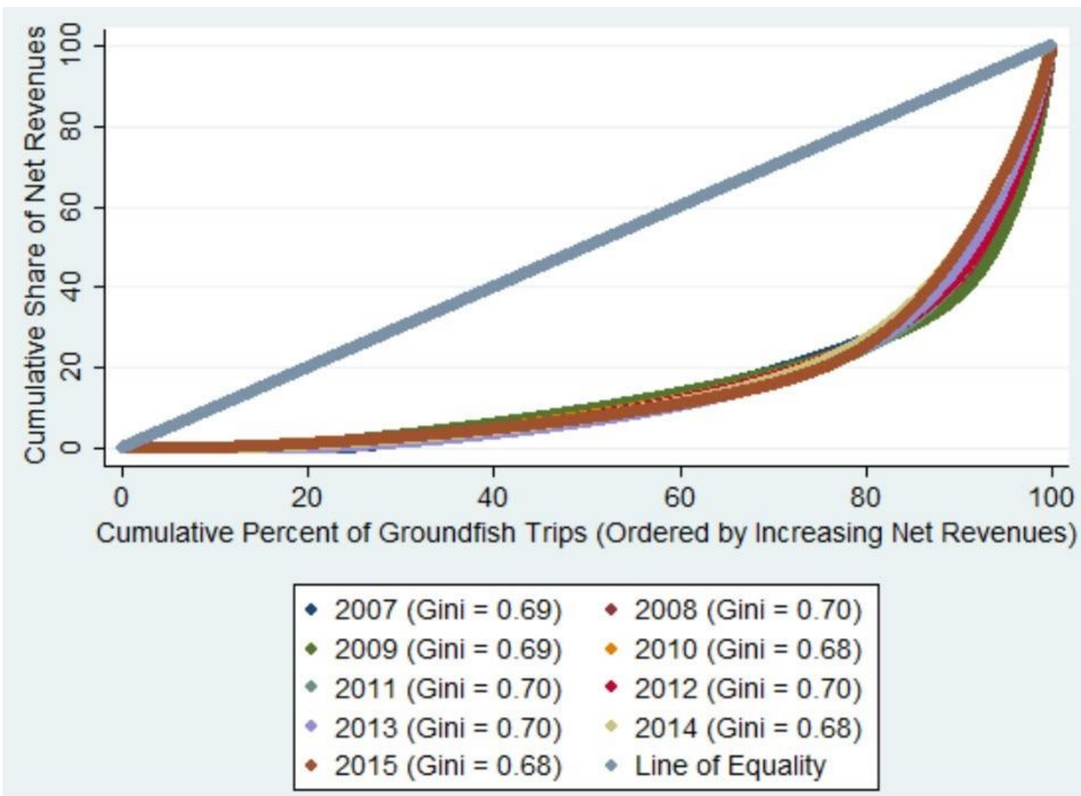


Figure 40. Lorenz Curves and Gini Coefficients by Cumulative Groundfish Trips, Ordered by Increasing Net Revenues.

Note: Lorenz curves presented for groundfish years 2007-2015 overlap due to similarities in values.

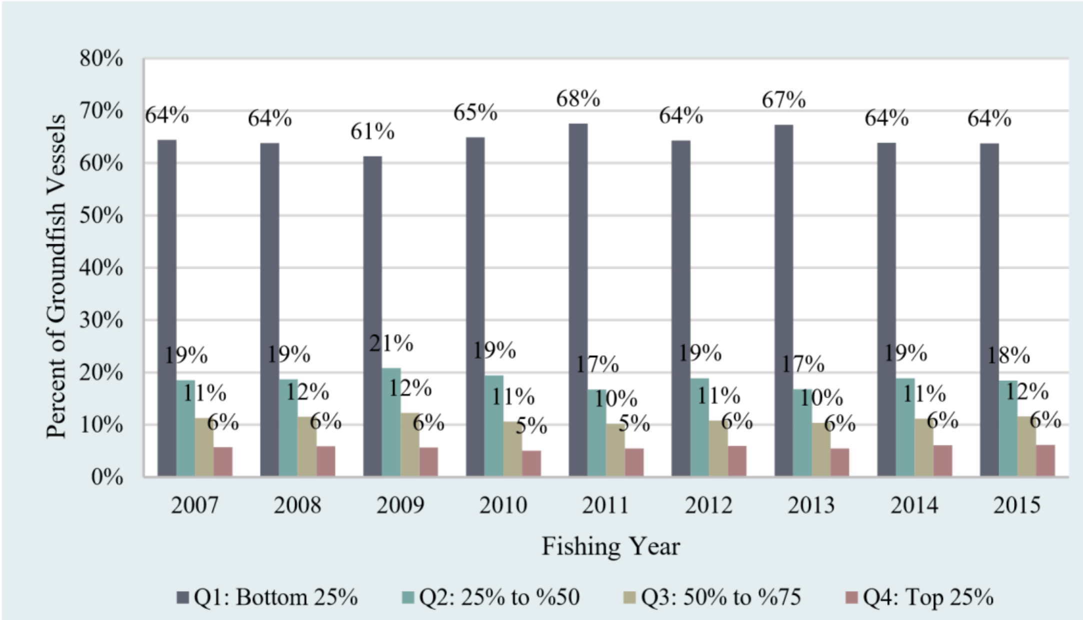


Figure 41. Percent of Vessels by Net Revenues Quartiles over Fishing Year.

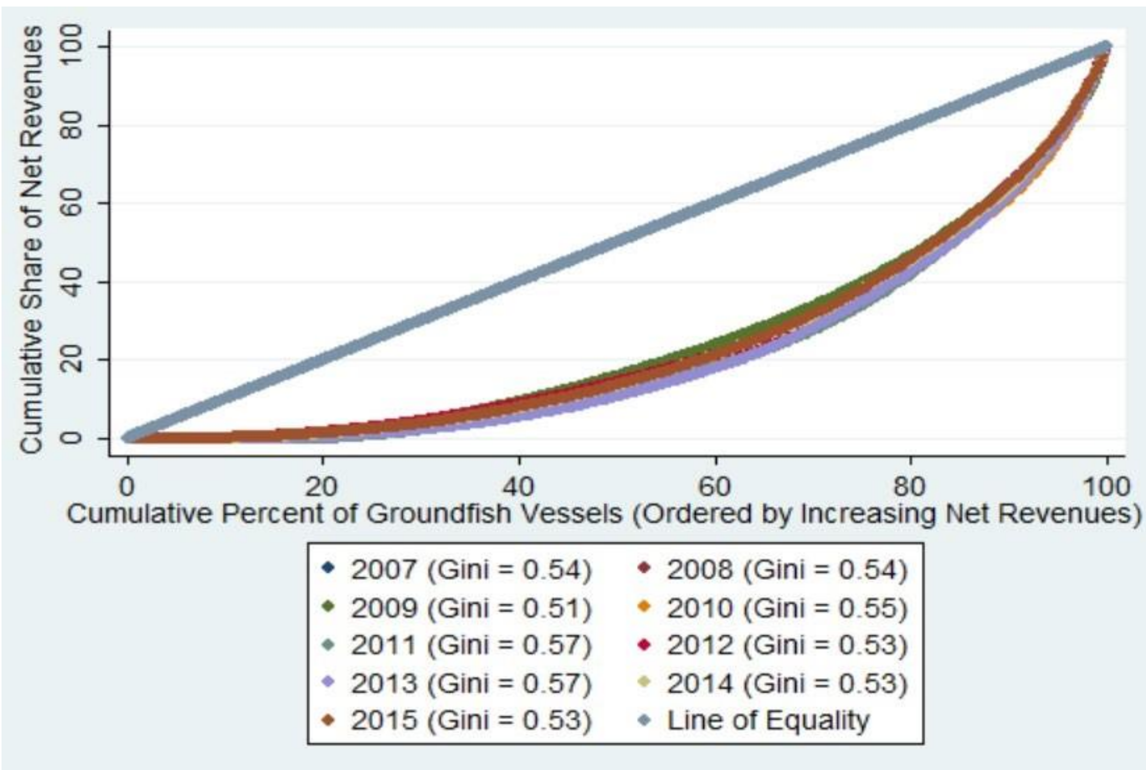


Figure 42. Lorenz Curves and Gini Coefficients by Cumulative Groundfish Vessels, Ordered by Increasing Net Revenues.

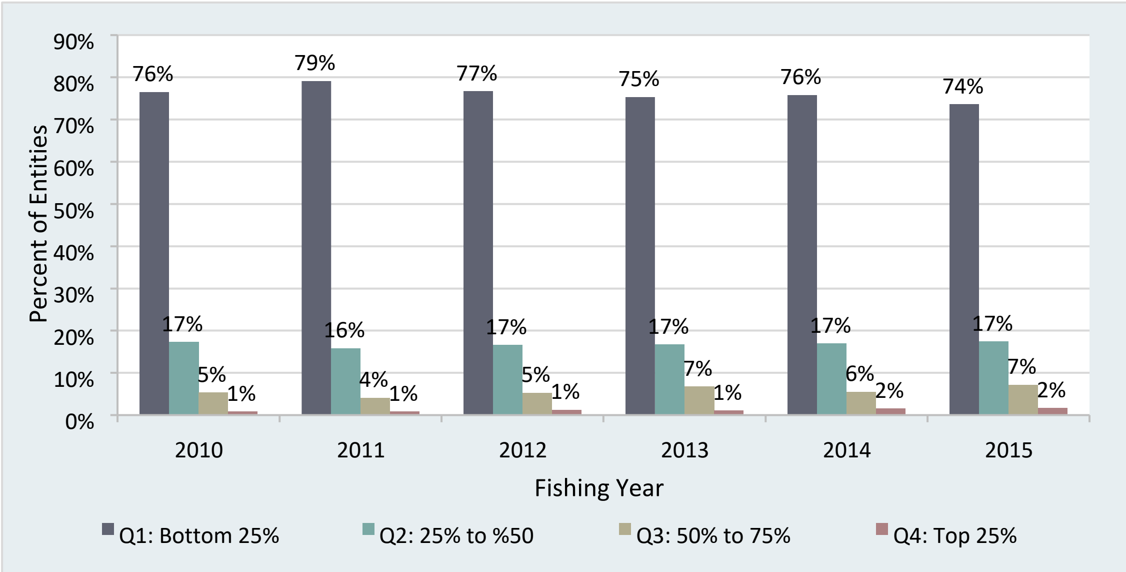


Figure 43. Percent of Entities by Net Revenues Quartiles over Fishing Year.

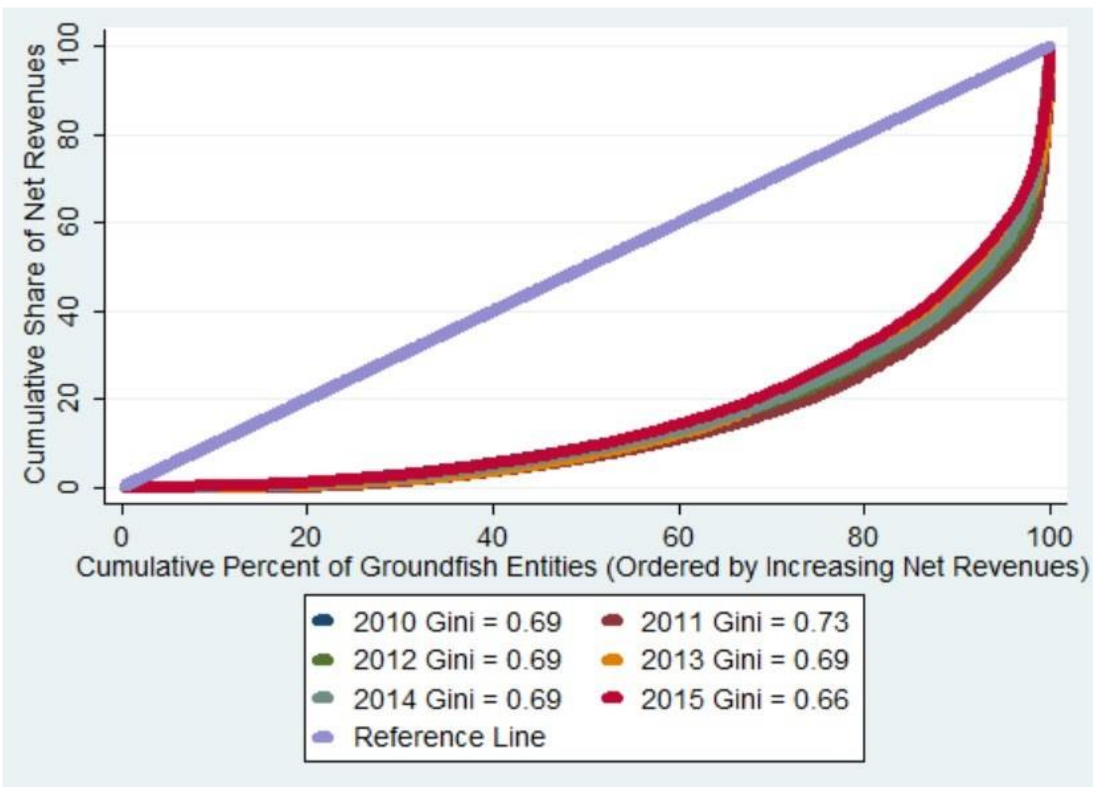


Figure 44. Lorenz Curves and Gini Coefficients by Cumulative Groundfish Entities, Ordered by Increasing Net Revenues.

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July 8, 2022

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

Dear Mr. Pentony:

I am writing you on behalf of the Massachusetts Marine Fisheries Advisory Commission (MFAC), as its Chair. This letter is addresses the MFAC's concerns regarding delays in federal rule making process during recreational groundfish for the 2022 Fishing Year (May 1, 2022 – April 30, 2023). The MFAC last met on June 16, 2022, and at this business meeting numerous concerns were raised about these delays, the impact the delays may have on achieving conservation objectives, and how such delays negatively impact the Commonwealth's recreational fishing public.

Of specific concern were the delays in NOAA Fisheries implementation of Georges Bank (GB) cod regulations approved by the New England Fishery Management Council in Framework Adjustment 65 to the Groundfish Fishery Management Plan. If implemented at the start of the 2022 Fishing Year, these proposed regulations would have closed the recreational Georges Bank cod fishery from May 1 – July 31; this corresponds to a time-of-year when MRIP data demonstrates catch and effort are elevated. Accordingly, a significant amount of the conservation needed for GB cod was to be achieved through this early season closure.

As of today, the closure has not been implemented and it appears nearly all related potential conservation may be forgone for 2022. Accordingly, we also anticipate it will be likely that catch targets will likely be exceeded this fishing year. The MFAC is very concerned about how such an exceedance may affect management in the coming years, and that recreational and commercial fishing opportunities may be further limited due to the failure to achieve conservation objectives during the current fishing year, driven principally by the inability of NOAA Fisheries to enact timely regulations.

The MFAC is also concerned about delays in NOAA Fisheries implementing the New England Fishery Management Council's recommendations for Gulf of Maine haddock. Consistent with catch limits for the current fishing year, the Council recommended increasing the recreational bag limit from 15-fish to 20-fish. As of today, NOAA Fisheries has not implemented this recommended change. Accordingly, our recreational fishing public have not been able to take advantage of this liberalization and our recreational fishers will potentially forego about three months of improved fishing access. This delay in rule making is negatively impacting our recreational fishing community, including those 786 for-hire permit holders who rely on bag limits as a marketing tool to book trips and conduct their economic enterprise.

The impact of delays in rule making are not strictly limited to the quantities of fish caught and harvested. Such delays also undermine public faith in the fisheries management process. It is critical to implement regulations in a timely manner to demonstrate that the conservation obtained through limitations on catch and effort are both critical and necessary, and that should necessary conservation be obtained, limits will be liberalized to the benefit of the fishery participants.

In closing, as a partner in managing New England's cod and haddock resources, we also request you work closely with the Massachusetts Division of Marine Fisheries when implementing these regulations. In order for the Commonwealth to adopt complementary regulations, it is necessary for the state agency to be able to timely anticipate when the federal regulations will be adopted. Delays between state and federal rule making only serve to further delay and complicate implementation, undermine the conservation and management objectives of the proposed regulations, and reduce confidence in the management process.

Sincerely,

Raymond W. Kane

Raymond Kane
Chairman

cc:
Marine Fisheries Advisory Commission
Tom Nies, Executive Director of New England Fishery Management Council
Daniel McKiernan, Director of Massachusetts Division of Marine Fisheries
Ronald Amidon, Commissioner of Massachusetts Department of Fish and Game
Pat Keliher, Commissioner of Maine Department of Marine Resources
Cheri Patterson, Chief of New Hampshire Department of Fish and Game, Marine Division
Jason McNamee, Deputy Director of Rhode Island Department of Environmental Management, Bureau of Natural Resources
Jason Davis, Assistant Director of Connecticut Department of Energy and Environmental Protection, Fisheries Division

New England Fishery Management Council
50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
Eric Reid, *Chair* | Thomas A. Nies, *Executive Director*

July 22, 2022

Dr. Christopher Moore
Executive Director
Mid-Atlantic Fishery Management Council
Suite 201, 800 N. State Street
Dover, DE 19901

Dear Chris:

The Council initiated Framework Adjustment 65 (FW65) to the Northeast Multispecies (Groundfish) fishery management plan at its April 2022 meeting. As part of the framework, the Council is considering adopting additional measures to promote rebuilding of Southern New England/Mid-Atlantic (SNE/MA) winter flounder. The Council may develop a sub-annual catch limit (ACL) and establish an accountability measure (AM) for other federal fisheries catching SNE/MA winter flounder.

At its meeting on June 29, 2022, the Council agreed by consensus to the following motion:

> *That the Council write a letter to the Mid-Atlantic Fishery Management Council informing them of our intention to consider a Southern New England/Mid-Atlantic (SNE/MA) winter flounder sub-ACL for the small mesh fisheries and inquire if they would like to consult on establishing the AM for those small mesh fisheries under their purview.*

The recent 2022 management track assessment of this stock suggests it may not be overfished, but its official status has not yet been changed. Even if it is, Amendment 16 states that: *for the category described as "other non-specified", catches will be monitored and if the catch rises above five percent accountability measures will be developed to prevent the overall ACL from being exceeded*. GARFO's year-end catch reports indicate catches of SNE/MA winter flounder from the squid fishery have exceeded 5% of total catches in recent years, FY2017-FY2020, and increased over this time period (Table 1 and Table 2).

Table 1- SNE/MA winter flounder catch (mt) in the squid and squid/whiting categories of the other federal fisheries sub-component. Groundfish fishery catch shown for comparison. Source: GARFO year-end catch reports FY2017-FY2020.

Fishing Year	Groundfish Fishery	SQUID	SQUID/ WHITING
2017	409.3	35.2	2.9
2018	250.7	47.9	3.2
2019	143.8	66.4	4.8
2020	103.2	57.2	4.8

Table 2- SNE/MA winter flounder percentage of total catch (%) in the squid and squid/whiting categories of the other federal fisheries sub-component. Groundfish fishery shown for comparison. Source: GARFO year-end catch reports FY2017-FY2020

Fishing Year	Groundfish Fishery	SQUID	SQUID/ WHITING
2017	74.3	6.4	0.5
2018	63.0	12.0	0.8
2019	48.7	22.5	1.6
2020	44.2	24.5	2.1

Based on this information, the Council may consider a SNE/MA winter flounder sub-ACL for small mesh fisheries in FW65. If a sub-ACL is established, an AM will also be necessary. As a result, we would like to invite the MAFMC to consult with us on establishing the AM for small mesh fisheries under their purview.

Please contact me if you have questions.

Sincerely,

Thomas A. Nies

Thomas A. Nies
Executive Director

clf
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For a thriving New England

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August 1, 2022

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

Submitted via comments@nefmc.org

Dear Mr. Reid and Mr. Neis:

Conservation Law Foundation (CLF) submits this letter for consideration by the Scientific and Statistical Committee (SSC) at its meeting on August 4, 2022. The meeting agenda states that the SSC will "[p]rovide feedback to the Council's Groundfish Plan Development Team (PDT) on possible rebuilding approaches for Gulf of Maine cod and on the basis for the range of alternative rebuilding strategies under development[.]"[1] Regarding this agenda item, CLF is concerned that the PDT's rebuilding approaches/range of rebuilding strategies, understandably limited by the directions provided to them, are insufficient to successfully rebuild Gulf of Maine (GOM) cod as mandated by the Magnuson-Stevens Fishery Conservation and Management Act. **We ask the SSC to urge the New England Fishery Management Council (Council) to prioritize increased spawning protections for GOM cod for inclusion in the new rebuilding plan.**

In August 2021, the National Marine Fisheries Service (NMFS) notified the Council that GOM cod is making inadequate progress towards rebuilding.[2] In response, the Council is now developing the **third rebuilding plan for GOM cod** since 2004 (two plans have now failed) under Framework Adjustment 65 to the Northeast Multispecies Fishery Management Plan ("Framework 65"). In making its decision, NMFS relied on the 2017 and 2019 stock assessments for GOM cod, which showed that the stock was only 5-9% of its spawning stock biomass with a truncated age structure, limited signs of incoming recruitment, and considerably decreased spatial distribution.[3] Furthermore, analyses based on the 2019 assessment indicated that GOM

[1] *See* Agenda for the Scientific and Statistical Committee (SSC) Meeting Webinar, Aug. 4, 2022. https://s3.us-east-1.amazonaws.com/nefmc.org/220804_SSC_Mtg_Notice.pdf.
[2] *See* Letter from Regional Administrator Pentony to Council Chairman Reid regarding Rebuilding Progress Reviews dated Aug. 13, 2021. https://s3.us-east-1.amazonaws.com/nefmc.org/6_Correspondence_210920_093318.pdf.
[3] *See* NEFSC. *Gulf of Maine Atlantic cod 2017 Assessment Update Report.* Compiled August 2017. https://apps-nefsc.fisheries.noaa.gov/saw/sasi/uploads/Gulf_of_Maine_Atlantic_cod_Update_2017_08_21_072733.pdf; *See* NEFSC. *Gulf of Maine Atlantic cod 2019 Assessment Update Report.* Compiled August 2019. https://apps-nefsc.fisheries.noaa.gov/saw/sasi/uploads/Gulf_of_Maine_Atlantic_cod_Update_2019_08_23_080524.pdf.

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cod only had a one percent chance of rebuilding on schedule.[4] The most recent assessment shows that GOM cod is still only 5% of its spawning stock biomass, and it confirms the poor state of the stock including limited signs of incoming recruitment.[5] In short, GOM cod continues to be overfished with overfishing occurring – as it has been for decades – despite reductions in fishing mortality.[6]

In recognition of GOM cod's seriously poor status, NMFS provided clear advice to the Council on developing a new rebuilding plan. The agency suggested "that the Council should consider measures in its revised rebuilding plan beyond setting a new F target to enable the rebuilding of GOM cod. Specifically, **the Council should consider additional spawning protections such as time/area closures**, and selective gears or other measures that could foster increased spawning success to increase the probability of improvements in recruitment."[7] The scope of Framework 65 includes adopting additional measures to promote stock rebuilding for GOM cod, but the Council has yet to further develop these measures. The Council is expected to take final action on Framework 65 in December, which means the clock is ticking. The SSC is weighing in on GOM cod rebuilding strategies at a crucial time, and we hope that the SSC expresses the urgent need for increased spawning protections for the stock.

Time and area closures have long been utilized in New England,[8] but have proven insufficient in size or duration to protect cod. The current GOM Cod Protection Closures[9] developed under Framework Adjustment 53 to the Northeast Multispecies Fishery Management Plan ("Framework 53") (implemented in 2015) are based on a comprehensive set of analyses of

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[4] Memorandum from Groundfish Plan Development Team Development to Scientific and Statistical Committee regarding "Candidate Groundfish OFLs and ABCs for fishing years 2020 to 2022" dated Oct. 10, 2019 & revised Oct. 15, 2019, at 7. https://s3.amazonaws.com/nefmc.org/A.8-GF-PDT-memo-to-SSC-re-FY2020-FY2022-Groundfish-OFLs-ABCs20191001-REVISED.pdf.

[5] *See* NEFSC. *Gulf of Maine Atlantic cod 2021 Assessment Update Report.* Compiled October 2021. https://apps-nefsc.fisheries.noaa.gov/saw/sasi/uploads/2021_COD_GOM_ASSESSMENT_v3.pdf.

[6] *Id.;* Fishing mortality has been reduced at least on paper. Based on analyses completed for Amendment 23 to the Northeast Multispecies Fishery Management Plan, there is a discarding problem in New England's groundfish fishery, which impacts the understanding of cod catch.

[7] *See* Letter from Regional Administrator Pentony to Council Chairman Reid regarding Rebuilding Progress Reviews dated Aug. 13, 2021. https://s3.us-east-1.amazonaws.com/nefmc.org/6_Correspondence_210920_093318.pdf. (emphasis added).

[8] Armstrong MP, Dean MJ, Hoffman WS, Zemeckis DR, Nies TA, Pierce DE, Diodati PJ, McKiernan DJ. 2012. "The application of small scale fishery closures to protect Atlantic cod spawning aggregations in the inshore Gulf of Maine." *Fisheries Research* 141:62-69. ("In 1668 the Massachusetts legislature, in recognition of the importance of nearshore winter spawning aggregations, issued the following law: "….that no man shall henceforth kill any codfish, hake, haddock, or pollack to dry for sale in the month of December or January because of their spawning tyme…" see Claesson et al., 2010).").

[9] *See* NOAA Fisheries, "Northeast Multispecies Closed Area Regulations: Gulf of Maine." https://www.fisheries.noaa.gov/new-england-mid-atlantic/commercial-fishing/northeast-multispecies-closed-area-regulations-gulf. Three of these closures apply to both sector and common pool vessels, two apply to only common pool.

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all available information on cod spawning in the region and provide protection for many known cod spawning times and locations. At the time of development, however, the PDT recommended for consideration a broader suite of seasonal closures to "provide the needed protection for both remaining spawning components (winter and spring) for the GOM cod stock. …[and] to ensure that the low SSB of this stock [would have] the opportunity for successful spawning events which is essential to prevent failures in future classes through recruitment success."[10] The former Regional Administrator attempted to include this broader suite of closures for consideration in Framework 53 and provided the following rationale:

> We've continually reiterated there are two important steps to cod rebuilding: (1) controlling fishing mortality, (2) protecting their remaining spawning aggregations from disruption and depletion. In order for spawning to be effective, closures must be relatively large to ensure that fishing activity does not disrupt spawning behavior. …[T]he PDT's analysis relied on multiple data sources. The body of evidence provided in the PDT's analysis suggests that some of the current options being discussed would miss key areas and times that are important for cod spawning. At such low biomass levels for Gulf of Maine cod, spawning measures adopted in this action must give *maximum* chance possible for increased spawning success. Framework 53 should take a conservative approach for spawning protections. These protections are critical to rebuilding. There is only a small window of opportunity. Any further declines in biomass or disruption of spawning behavior will reduce the chances for rebuilding.[11]

Despite the agency's position, the Council voted against even considering these closures as an option in Framework 53. **Now, even though nearly eight years have passed, the PDT's 2014 analysis[12] remains robust as does the recommendation for the broader suite of closures to protect cod spawning times and locations in the Gulf of Maine, given the failure of the stock to rebuild.**

The presence of multiple biological stocks of cod within the current GOM cod management unit further drives home the importance of adopting spawning protections as an additional measure to promote rebuilding the stock in Framework 65. The Atlantic Cod Stock Structure Working Group stated nearly two years ago:

[10] Memorandum from Groundfish Plan Development Team Development to Groundfish Committee regarding "Development of Framework Adjustment 53 (FW 53) to the Multispecies (Groundfish) Fishery Management Plan" dated Nov. 5, 2014, at 13. https://s3.us-east-1.amazonaws.com/nefmc.org/8_141105_GF-PDT-memo-to-GF-Committee-re-FW-53-FINAL-2-with-Appendicies.pdf.

[11] Audio from November 2014 Council meeting around 2:11:00, https://s3.us-east-1.amazonaws.com/nefmc.org/10_141119_GF_FW53_contd.MP3. (emphasis in original).

[12] See Attachment #1. CLF acknowledges that these analyses may need to be updated to reflect any new data collected since 2014.

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> Declining populations of cod have occurred despite substantially reduced fishery catch and a series of management actions over decades. This has led to concerns that existing cod management units have not adequately captured cod's biological stock structure, contributing to delays in rebuilding . . . .[13]

Failure to account for stock structure can lead to extirpation of spawning components,[14] such as what happened in coastal Maine waters,[15] and what must be prevented in coastal Massachusetts waters. In the face of misalignment between biological and management stock units, Kerr et. al. (2017) suggests that spatial and temporal closures can be a good option when spatial structure is known but full alternation of stock boundaries is not possible.[16] This is the case for the Western Gulf of Maine winter spawners and Western Gulf of Maine spring spawners – two separate biological stocks that overlap spatially and that the Research Track Working Group has preliminarily decided to combine into one unit.[17] Given this spatial overlap and differences in the degree to which the populations contribute to the fishery, decreases in fishing mortality alone are insufficient and must be complemented with spawning protections to support recruitment success of both spawning groups.

Recent analyses demonstrate the need to protect winter and spring spawners more fully in the Western Gulf of Maine. Winter spawners currently contribute the vast majority of overall recruitment relative to spring spawners.[18] Compared to spring spawners, though, winter spawners have experienced higher mortality in recent years due to less protection from seasonal and year-round closed areas.[19] At a minimum, there should be a focus on measures to protect these winter spawners to facilitate recruitment success, as they are the likely engine of future rebuilding of the overall Western Gulf of Maine stock. The closures developed by the PDT in 2014 expand protections for winter spawners in both space and time to do just that. [20] The closures also expand needed protection for spring spawners;[21] this population is likely the most vulnerable to

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[13] McBride RS and Kent Smedbol R. *An Interdisciplinary Review of Atlantic Cod (Gadus morhua) Stock Structure in the Western North Atlantic Ocean.* NOAA Technical Memorandum NMFS-NE-XXX at 6. ("Working Group Report").
[14] *Id.* at 6-7.
[15] Ames EP. 2004. "Atlantic cod stock structure in the Gulf of Maine." *Fisheries* 29(1):10–28.
[16] Kerr LA, Hintzen NT, Cadrin SX, Clausen LT, Dickey-Collas M, Goethel DR, Hatfield EMC, Kritzer JP, and Nash RDM. 2017. "Lessons learned from practical approaches to reconcile mismatches between biological population structure and stock units of marine fish," *ICES Journal of Marine Science* 74(6): 1708-1722.
[17] CLF does not object to the research track working group's decision.
[18] Dean MJ, Elzey S, Hoffman, WS, and Buchan N. 2019. "The relative importance of sub-populations to the Gulf of Maine stock of Atlantic cod." *ICES Journal of Marine Science* 76(6):1626-1640.
[19] *Id.*
[20] *See* NEFMC. *Framework Adjustment 53 to the NE Multispecies FMP, Appendix II: Analytic Techniques: GOM Cod and Other Groundfish Analysis.* https://s3.amazonaws.com/nefmc.org/150115FW53AppendixIIAnalyticTechniques.pdf.
[21] *Id.*

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ocean warming under climate change and hence in need of protection to foster recruitment and prevent extirpation of the sub-stock.

Lastly, we eagerly await the results of the cod research track assessment and are optimistic about the ongoing process considering its accounting for the new understanding of stock structure. Nonetheless, there is no reason to wait for the assessment's results to protect winter and spring spawners because any protections adopted in Framework 65 would fit within the current GOM cod management unit and the proposed Western GOM cod unit. Even if the rebuilding plan adopted in Framework 65 will need to be revised following the research track assessment, the current focus should be on how to provide GOM cod with the most support possible to lead to successful rebuilding. Initial PDT discussions around preliminary rebuilding projections for GOM cod signal that measures in addition to controlling overall fishing mortality will be necessary to rebuild and support GOM cod.[22,23]

The third rebuilding plan for GOM cod should be its last rebuilding plan. We hope the SSC does everything it can to encourage the Council to expand spawning protections for GOM with a focus on measures that protect both winter and spring spawners. Thank you for considering our comments.

Sincerely,

Allison Lorenc

Allison Lorenc
Senior Policy Analyst
Conservation Law Foundation

[22] Initial rebuilding analyses show a "very optimistic buildup of biomass" for the stock, but there is great uncertainty about the stock's ability to rebuild as projected given lack of recruitment in the fishery. The PDT discussed approaching the rebuilding projections as "theoretical" exercises. And as one PDT member stated, "You should not overinterpret rebuilding projections." *See* Audio from July 11, 2022 PDT Meeting from 2:30:00 to end, https://nefmc.sharefile.com/share/view/s3c1d7bcb76c7418693ce9afa4364f8e6/fobf323b-188f-4e49-abbc-11ef652fb5db;

[23] CLF shares concerns about lack of recruitment in the fishery, but we are encouraged by the abundance and biomass increases seen in the most recent spring survey for GOM cod (pers. comm.). These positive signs of rebuilding should be protected.

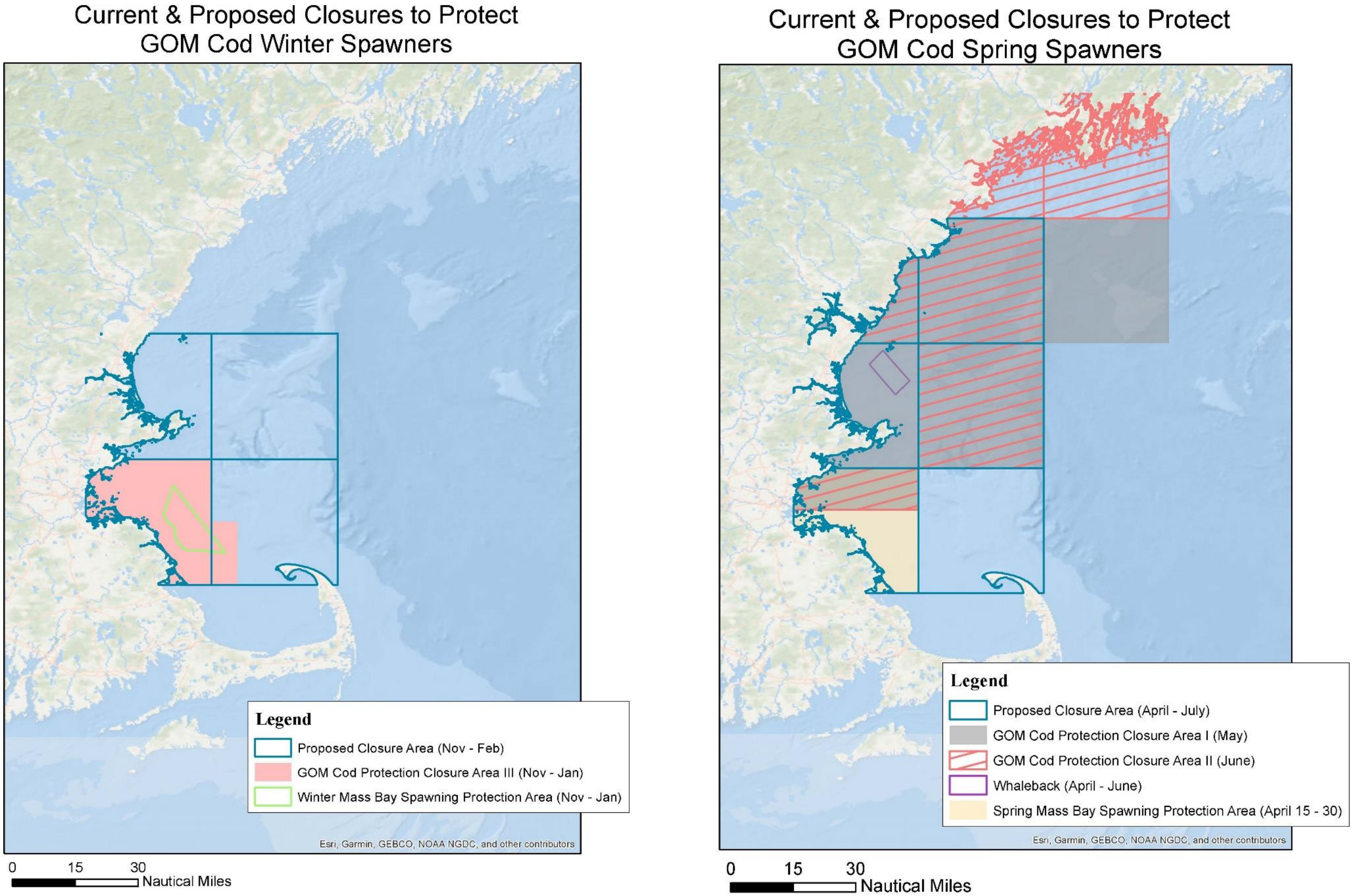

Figure 1. Maps of current and proposed closures (for sectors and common pool) to protect GOM cod winter and spring spawners. The proposed closure areas reflect the those developed by the PDT in 2014. These maps do not include the GOM Cod Protection Closure Areas for October and March because these areas apply to common pool only. Map data downloaded from GARFO's website.

Framework Adjustment 53

To the

Northeast Multispecies FMP

Appendix II: Analytic Techniques:

Gulf of Maine Cod and Other Groundfish Analysis

Identifying location and times of spawning for Gulf of Maine cod

Micah Dean and Steven J. Correia, Massachusetts Division of Marine Fisheries
October 31, 2014

Introduction:

At its September/October meeting, the Council tasked the Groundfish Plan Development Team (PDT) with evaluating the biological impacts of spawning closure options for GOM cod in draft Framework Adjustment 53 (FW 53) to the Multispecies (Groundfish) fishery management plan. Two options were identified at the Council meeting, and the PDT requested that it work with the Committee after the September/October Council meeting to further evaluate the efficacy of those time/areas for protecting spawning GOM cod. The options in FW 53 include 30 minute blocks that would be closed for specific months to protect spawning cod. Several independent data sources and methods were used to examine the time-area blocks with high concentrations of spawning cod.

Cod spawning biology:

The GOM stock of Atlantic cod is comprised of two genetically distinct groups whose spawning activity overlaps in space, but not in time (i.e., “winter” and “spring” spawners) (Kovach et al., 2010; Zemeckis et al., 2014). Within these broad groups are several smaller sub-components that form spawning aggregations at predictable times and locations. At one time, numerous aggregations of spawning cod could be found all along the GOM coast (Ames 2004). Unfortunately, most of these spawning grounds are now vacant, and current cod spawning activity appears restricted to a narrow range of coastline from NH to MA. Cod exhibit high fidelity to their spawning sites, and recent studies on spring spawning GOM cod have shown that tagged females are capable of returning to the same precise spawning location (within <10m) over multiple years (Dean et al., 2014; Zemeckis et al., 2014). This spatial and temporal predictability makes individual spawning groups particularly vulnerable to depletion, and there is little indication that once a site-specific spawning component is lost that the area can be recolonized.

Some of the remaining GOM cod spawning aggregations are well documented and small seasonal fishery closures have been implemented in an attempt to protect them from disruption and depletion (Armstrong et al., 2013). However, these examples as well as similar experiences in other cod stocks have pointed to a need for broader-scale measures (i.e., at the scale of 30-min blocks) to prevent further loss of population structure and enhance the potential for recruitment success in the future (Zemeckis et al., 2014).

Trawl surveys:

We examined the spatial distribution of spawning cod from 5 trawl surveys in the Gulf of Maine: NEFSC spring, NEFSC fall, MADMF spring, MADMF fall, and the Industry-based cod survey (IBS). The NEFSC and MADMF surveys have narrow seasonal coverage, limiting their applicability to spawning cod (Figure 1). Additionally, because these surveys were designed to provide information on a wide variety of species, they have relatively low catches of cod and even smaller sample sizes of sex and maturity data.

The IBS cod survey was specifically designed to study stock distribution and demographics of cod in inshore Gulf of Maine waters (< 75 fathoms) from Cape Cod to the Bay of Fundy. The IBS survey gathered detailed information on the spawning condition of captured animals (see section *Spawner CPUE*). The IBS was a cooperative research effort that employed 4 industry vessels to simultaneously survey the entire study area with high intensity over five back-to-back cruises starting in mid-November and continuing through May:

Cruise	Dates	Season
1	Nov 14 - Dec 31	Winter
2	Jan 1 - Feb 12	Winter
3	Feb13 - Mar 17	Winter
4	Mar 18 - Apr 19	Spring
5	Apr 20 - May 31	Spring

Each vessel used an identical net equipped with a mensuration system to ensure equivalent net geometry and fishing power among vessels. The survey used a systematic fixed station design (standardized grid) as well as a random stratified sampling design for areas that fishermen designated as "hot spots" with traditionally high catch rates. Due to its singular focus on Atlantic cod, the IBS provided an order of magnitude more biological samples (i.e., sex, maturity) from this species than the other surveys (NEFSC, MADMF). The broad seasonal overlap with cod spawning, high spatial resolution and large sample sizes make the IBS an invaluable source for describing the spawning activity of cod in the GOM.

The August 2008 peer-review of the Cod IBS acknowledged its utility for this purpose:

> *"The Cod IBS provides valuable information on cod in the Gulf of Maine when no other sources of data are available. The Cod IBS is a good example of a cooperative project."*
>
> *"The survey provides high resolution information on the spatial and temporal distribution, size composition, maturity and potentially age of cod and augments existing surveys."*
>
> *"Survey data are useful in determining the location and timing of cod in spawning condition as well as the coincidence of spawning cod with rolling closures."*
>
> *"The utility of the Cod IBS data relative to the fishery closure areas (rolling closures) lies mostly in the identification of the areas containing spawning fish during specific times of the year. Generally, the monthly closed areas matched well with the areas where the highest catches of spawning fish could be found. In that respect, the survey data are useful to determine the location and timing of cod in spawning condition."*

Trawl survey data were used in two separate ways to identify areas of cod spawning activity:

1) CPUE of cod in spawning conditions, and;
2) Presence of significantly skewed sex ratios

Spawner CPUE:

Cod were considered "spawning" if they were classified as ripe, running, or spent using standard macroscopic maturity criteria. While it is possible to find cod in spawning condition some distance from the specific spawning sites, a high abundance of spawning cod is typically seen as a reliable indicator of spawning location. In particular, females in spawning condition are likely to be near the spawning area as hydrated eggs (i.e., "ripe") are typically released within 36 hours and ovulated eggs (i.e., "running") within 5 hours (Kjesbu et al., 1990).The CPUE (kg/tow) of cod in spawning condition was calculated for each survey tow (Figure 2) and summarized by 30-min square ("block") and season, using the arithmetic mean (Figure 3). For the purpose of identifying blocks with spawning activity, the mean's sensitivity to outliers is a useful property that can help indicate the presence of cod spawning aggregations. Each 30-min block was classified into low (<1 kg/tow), medium (1-8 kg/tow) or high (>8 kg per tow) categories.

For the winter cruises, only Massachusetts Bay (Block 125) was assigned to the "high" category, with the neighboring blocks of 124, 132, 133, as well as 123 and 139 falling into the "medium" category. A very low level of spawning fish was detected in nearly all other sampled blocks, but these areas were dominated by zero catches.

In the spring (see above table), blocks covering Massachusetts Bay (Block 125), Ipswich Bay (Block 133) and Jefferies Ledge (Block 132) were identified as having "high" CPUE of spawning cod. Stellwagen Bank (Block 124), Bigelow Bight (Block 139), and the offshore ledges of Platts (Block 138), Fippennies (Block 130) and Cashes (Block 129) all fell into the "medium" category. Notably, the backside of Cape Cod was identified as having either "high" (Block 123) or "medium" (Block 114) CPUE of spawning cod; however, these areas are technically part of the Georges Bank stock area.

Despite the intensive sampling and broad seasonal footprint of the IBS, this survey did not completely encompass the entire spawning periods of GOM cod. In particular, the beginning of the winter spawning season (before November 15) and the end of the spring spawning season (after May 31) were not sampled. Furthermore, the short time series (2004-2007) provides a recent "snapshot" of spawning activity, and some areas that formerly may have been quite important to the reproductive capacity of the stock may have been depleted when these data were collected. As such, the areas identified by the IBS should be seen as a subset of where cod spawning occurs.

For the draft FW 53 GOM cod spawning area closure alternatives (in section 4.2.1), Sub-Option A appears to have good overlap with the areas identified as having high CPUE of spawning cod from the IBS for the months of November - May. However, as there are no IBS data for June and July, and adequacy of proposed closures for these months should be evaluated using other data sets (see sections *ichthyoplankton surveys* and *acoustic telemetry*). Also, several blocks with "medium" abundance of spawning cod would be vulnerable under this option. Sub-Option B appears to provide only partial protection of spawning cod, particularly in the spring.

Skewed sex ratios:

During spawning, males and females segregate themselves on the spawning ground, with males exhibiting higher activity over a larger area. This causes males to become more vulnerable to capture, leading to predominantly male-skewed sex ratios in survey or fishery catches (Dean et al., 2014). This phenomenon can be utilized to identify specific locations where spawning behavior occurs. When not spawning, the ratio of females to males[1] is expected to be 1:1. Therefore, identifying survey tows with a sex ratio (SR) that is significantly different from 1:1 indicates spawning activity. All bottom trawl survey tows with a sufficient sample size (n>=5 sex observations) were evaluated for the presence of a significant SR skew using a two-tailed exact binomial test (α=0.05). The resulting probabilities were further adjusted for multiple comparisons by controlling the false discovery rate.

The IBS was the most relevant dataset for this approach, given the broad temporal overlap with spawning and generally high sample sizes. Of the IBS tows conducted in winter, significantly skewed sex ratios were detected in blocks 124, 125 and 139 (Figure 5). For the spring cruises, blocks 124,125,132,133 were found to contain significantly skewed SRs. Only a handful of tows from the NEFSC surveys were found to have a significant SR skew (Blocks 124 and 125 in both spring and fall), but this survey is not well suited for this method given the low number of sex observations and limited coverage of inshore areas (Figure 6). Because the MADMF fall survey does not occur at a time of year when cod are typically spawning, it is not surprising that none of the 3,200+ tows were found to have a significant SR skew. However, within the limited survey area of the MADMF spring survey, the same precise locations of spawning activity were identified as in the IBS dataset (Figure 7 - near Cape Ann, in blocks 124 and 133).

Ichthyoplankton surveys:

The MARMAP ichthyoplankton survey (1977-1987) provides a unique picture of GOM cod spawning, because it is the only data source that offers a measure of spawning activity in every month of the year.

Once released, cod eggs are generally pelagic and their distribution is largely influenced by oceanographic currents. The duration of this incubation period is strongly temperature dependent (Marteinsdottir et al., 2000) and given the average water temperature in the GOM over the course of a spawning season, the expected time to hatch is 15 days in winter and 9 days in spring. A study of the dispersal of cod eggs and larvae in the GOM using a highly-resolved hydrodynamic model found that the maximum dispersal over 15 days was approximately 100 km (Churchill et al., 2011). Assuming an egg mortality rate of 10% per day estimated from MARMAP data (Mountain et al., 2003), the median age of eggs at peak spawning would be

[1] Cod hatch in equal numbers of males and females as evidenced by the equal sex ratio of juveniles in survey data. As they mature, the higher activity level and space use of spawning males causes a male-skewed sex ratio in catches made on a spawning ground. This sexually-dimorphic behavior also causes mature males to be removed from the population at a faster rate (by the fishery), leading to female dominated older ages. However, due to the relative abundance of juveniles, the overall sex ratio of the population is likely very close to 1:1. The sex ratio of cod catches from surveys that occur in non-spawning times (MADMF Fall; NEFSC Shrimp), there are essentially no tows that are significantly different from 1:1 (Dean et al., in prep).

approximately 6 days in winter and 4 days in spring. Therefore, we conclude that the maximum dispersal (distance from the spawning location) of the typical egg would be ~40 km in winter and ~25 km in spring. Therefore, it is reasonable to assume that quarter-degree blocks (~40 km x 55 km) with elevated egg densities correspond to spawning locations.

Maps of cod egg density from MARMAP surveys (1977-1987) were examined from Berrien and Sibunka (1999) and used to assign a maximum observed egg density to each 30-min block for each month (Figures 9-11). These data both corroborate and complete the seasonal profile of spawning activity provided by the IBS (Figure 12). Specifically, the winter spawning season spans the months of November-February, whereas the spring season encompasses the months of April-July. It appears that very limited spawning occurs in the months of August, October and March, with a complete absence of spawning in September.

The MARMAP data represent spawning areas during the 1970's and 1980s and may capture spawning aggregations that have since been depleted or extirpated. Regardless, the areas of spawning activity indicated by this method are similar to those described by sex ratio and spawner CPUE data from trawl surveys. For the winter months, elevated egg densities were found most consistently in blocks 124, 125, 132, 133 and 139, with the highest levels observed in Massachusetts Bay (block 125). As with the IBS dataset, the backside of Cape Cod (blocks 123, 114) was also identified as a spawning area; however, it should be noted that these blocks are technically part of the Georges Bank cod stock. For the spring spawning season, blocks 124, 125, 132, 133, 139, and 140 all achieved the highest level of observed egg density. These data provide some indication of a latitudinal progression of spawning activity, with peak egg density occurring earlier in Massachusetts Bay than in Ipswich Bay. However, it should be noted that the timing of the shift in closure areas under the FW53 Sub-options do not align well with the available data.

Acoustic telemetry:

Several acoustic telemetry experiments have been conducted recently on groups of spring spawning cod in the GOM (Dean et al., 2012, 2014; Zemeckis et al., 2014; Siceloff and Howell, 2013 – all occurring in blocks 125 and 133). While narrow in scope, each study provides direct empirical evidence from individual spawning aggregations. Given the high resolution and the multi-year observational capabilities of this technology, tagged fish were documented returning to the same precise spawning location year after year. A spring spawning aggregation was observed to be intact for over 100 days, corroborating other sources of data on the temporal span of the spawning season. Significant spawning activity was observed from acoustically tagged cod in June and July, which is in agreement with the MARMAP surveys of cod egg density.

Of note, a similar acoustic telemetry study is currently underway to describe the activity of winter spawning cod in Massachusetts Bay (blocks 125 and 124). The finding of this project will be subject to a peer review upon completion and in the interim early information is being provided for informational purposes only. Preliminary data from this project are only relevant for the end of the winter spawning season (surviving tagged fish will return to the spawning ground this winter), but the departure of spawning fish from the study area by mid-February corroborates the IBS and MARMAP datasets.

Passive acoustic monitoring

The mating system of cod involves vocalizations (i.e., "grunts"), primarily arising from agonistic interactions between males competing over mating territories. Cod spawning grunts are sufficiently distinct that they can be discerned from other fish and marine mammal sounds, and the frequency of their occurrence has been used as a proxy for the intensity of spawning activity (Hernandez et al., 2013). Arrays of moored underwater hydrophones have successfully recorded cod spawning grunts from both the winter (blocks 124, 125, 133) and spring (blocks 125, 133) spawning groups. While use of this technology is limited by a relatively narrow detection range and a labor intensive analytical process, the peaks in vocal activity correspond well with the other measures of the seasonal distribution of cod spawning activity: Winter = late November to early December; Spring = late May to early June. It should be noted that while the passive acoustic observations of spring pawning GOM cod have been published in a peer-reviewed journal (Hernandez et al., 2013), the data from winter spawning cod are preliminary observations from an ongoing project and should be considered accordingly.

Conclusions:

Alternatives in FW 53[2]:

<u>Sub-Option A</u>

All commercial and recreational groundfish fishing would be prohibited:

Year-round in the WGOM Closed Area and;

Seasonally in the following 30-minute blocks during these months:

- May: 124, 125, 132, 133, 139, 140
- June: 132, 133, 139, 140, 147
- November – January: 124-125
- March-April: 124, 125, 132, 133

<u>Sub-Option B</u>

All commercial and recreational groundfish fishing would be prohibited in the following 30-minute blocks:

- May: 125, 133
- June: 133
- November – January: 124 with an eastern boundary defined at 70-15, 125
- March-April: 125, 133

Multiple independent data sources and analytical approaches were used to identify the areas important to spawning cod in the GOM, at the scale of the 30-min month-block. Notable discrepancies exist between these analyses and the FW53 spawning closure sub-options (Sub-Option A and Sub-Option B), including:

1) Significant spawning occurs in February and July, both of which are absent from sub-options A and B

[2] Sub-Option A and Sub-Option B documented here were the versions developed by the Council at their September 2014 meeting. The final versions of the sub-options in this action from the November Council meeting reflected the use of Appendix II to further refine the sub-options, notably, to remove March and the WGOM from consideration as spawning closures.

2) March appears to be a time with limited spawning, yet is included in both sub-option A and B
3) The northward shift in closure areas (from May to June) under both sub-option A and B does not match existing data on the latitudinal progression of spawning. Blocks 124 and 125 continue to be important in June.
4) Sub-option B would protect a small fraction of the area that is import to spring spawning cod

An alternative Sub-option C should be considered that will more fully protect spawning cod, while at the same time allow access to areas that do not support aggregations of spawning cod. Based on these analyses, we recommend the closure of blocks 124, 125, 132, 133 for the months of November through February, and blocks 124, 125, 132, 133, 139, 140 for the months of April through July.

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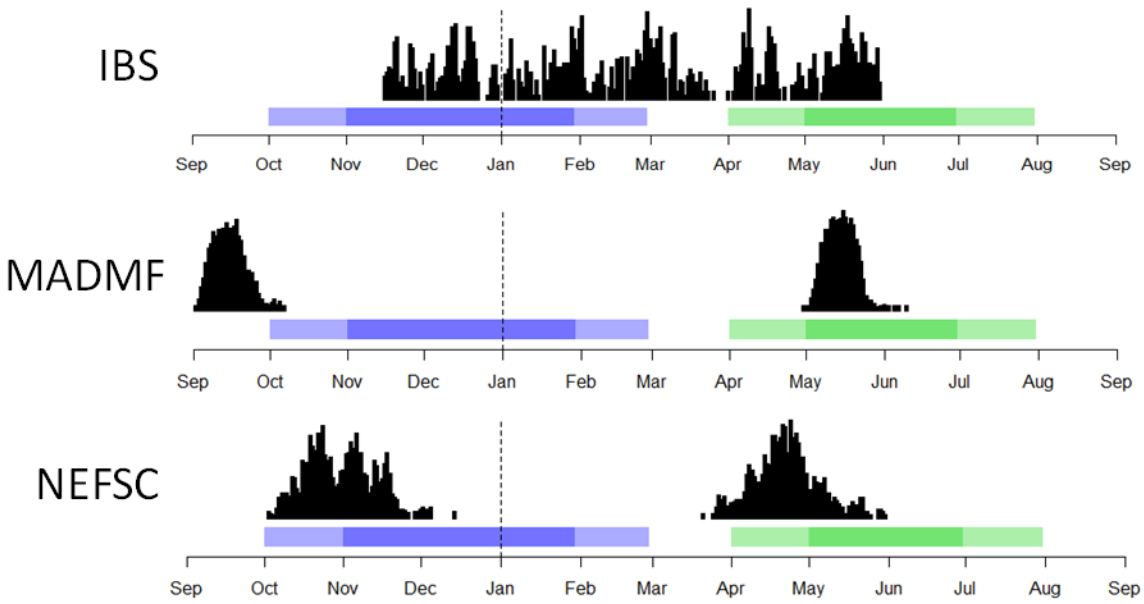


Figure 1- Histogram of tow dates for the IBS, MADMF and NEFSC bottom trawl surveys, in relation to cod spawning seasons in the GOM (blue = “winter”; green = “spring”).

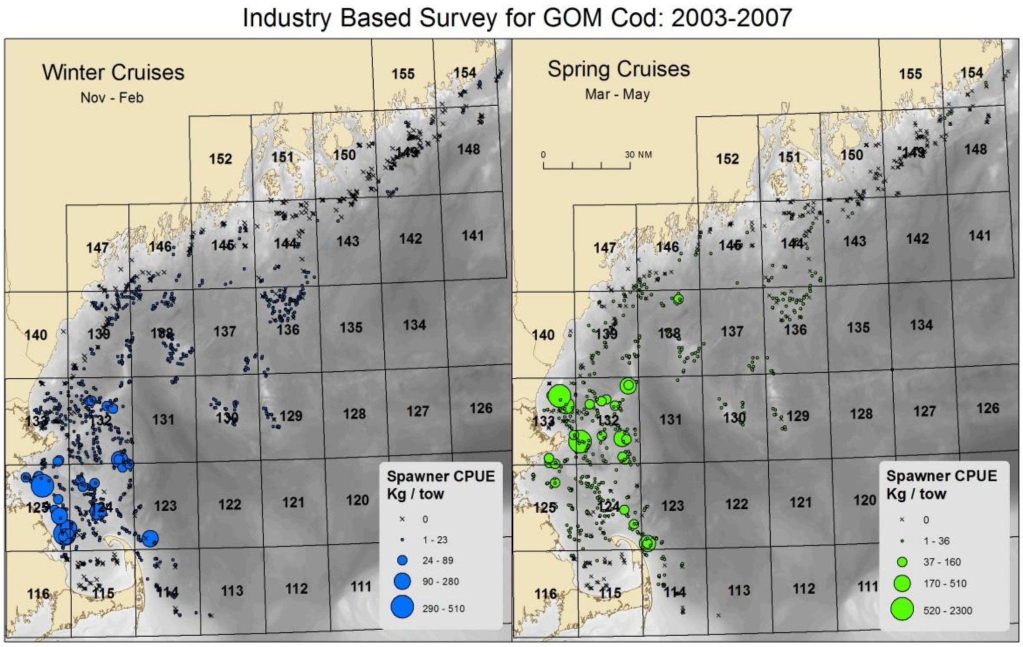


Figure 2- Distribution of weights of ripe, ripe and running and spent cod (kg) for winter and spring period in the IBS survey (2003-2007).

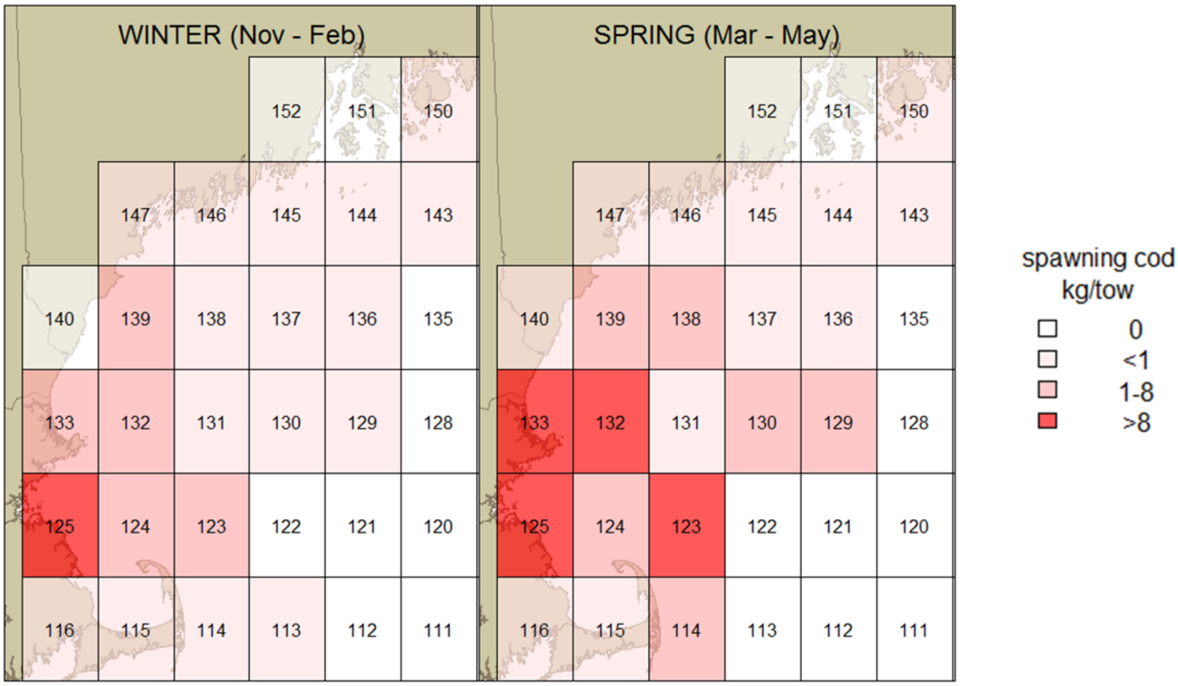


Figure 3- Mean CPUE of spawning cod from the IBS by block and season.

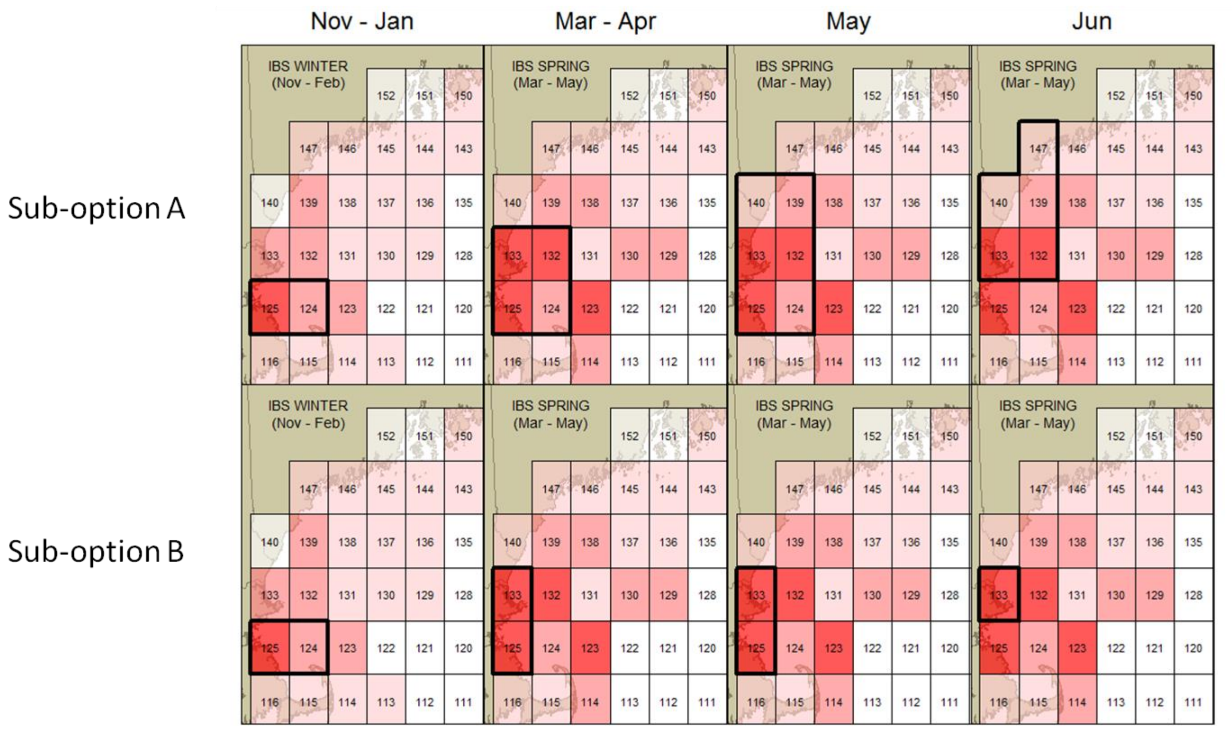


Figure 4- Mean CPUE of spawning cod by season from the IBS, as compared to the two sub-options identified in FW 53. Blocks under consideration for closure are outlined in bold. It should be noted that IBS did not operate in June, and data from all spring cruises (March-May) are shown for comparison.

GOM Cod IBS Survey (2003-2007)

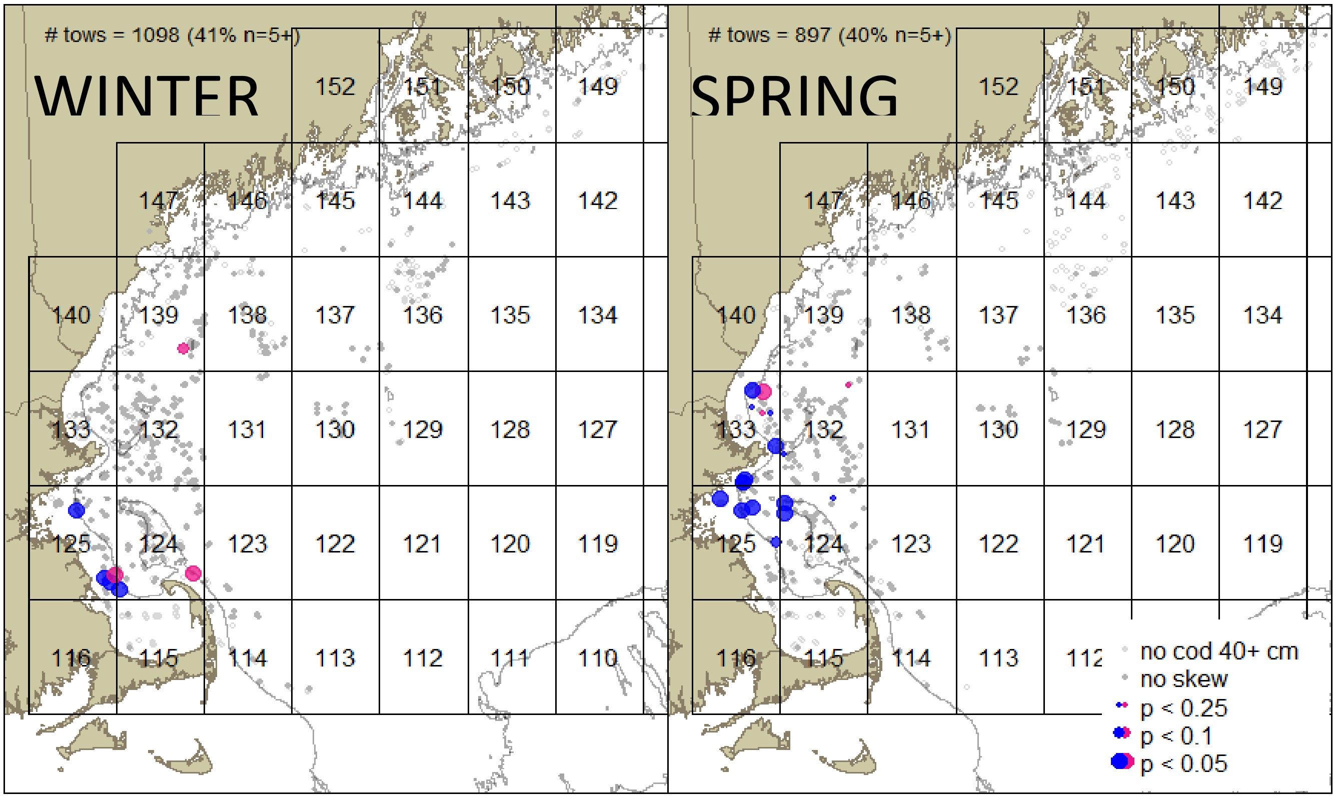


Figure 5- Location of tows with significantly skewed cod sex ratios in the IBS survey, indicating the presence of spawning behavior. Blue dots represent a significant male skew, whereas pink dots represent a significant female skew. The size of the dot is proportional to the *p*-value of the significance test (i.e., larger dots indicate a stronger sex ratio skew).

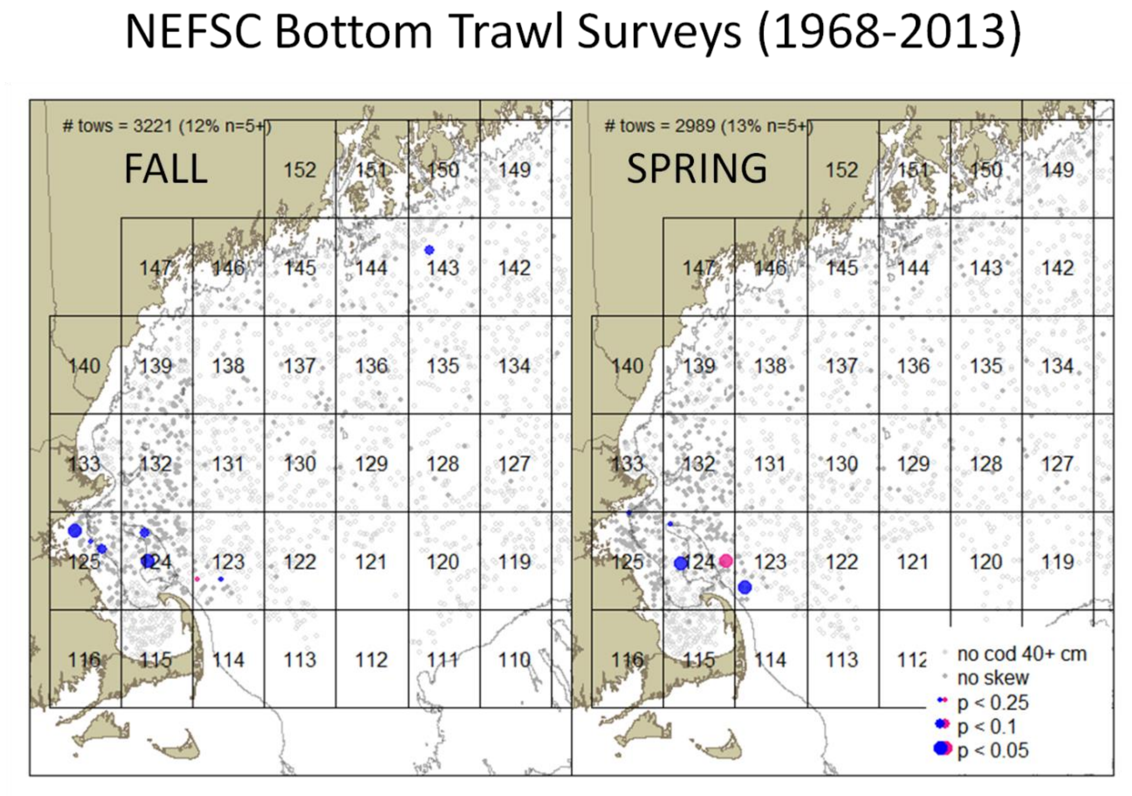


Figure 6- Location of tows with significantly skewed cod sex ratios in the NEFSC bottom trawl surveys, indicating the presence of spawning behavior. Blue dots represent a significant male skew, whereas pink dots represent a significant female skew. The size of the dot is proportional to the *p*-value of the significance test (i.e., larger dots indicate a stronger sex ratio skew).

MADMF Bottom Trawl Surveys (1978-2013)

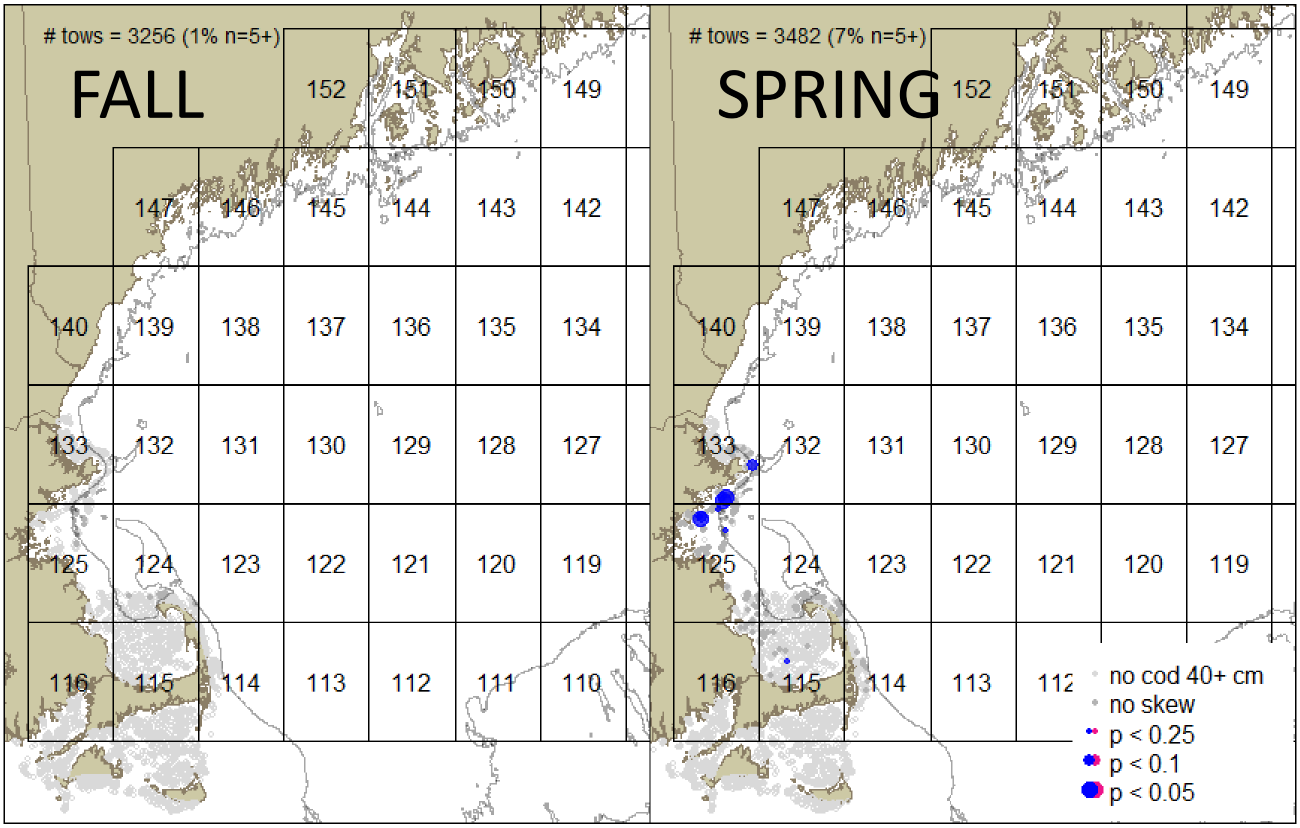


Figure 7- Location of tows with significantly skewed cod sex ratios in the MADMF bottom trawl surveys, indicating the presence of spawning behavior. Blue dots represent a significant male skew, whereas pink dots represent a significant female skew. The size of the dot is proportional to the *p*-value of the significance test (i.e., larger dots indicate a stronger sex ratio skew).

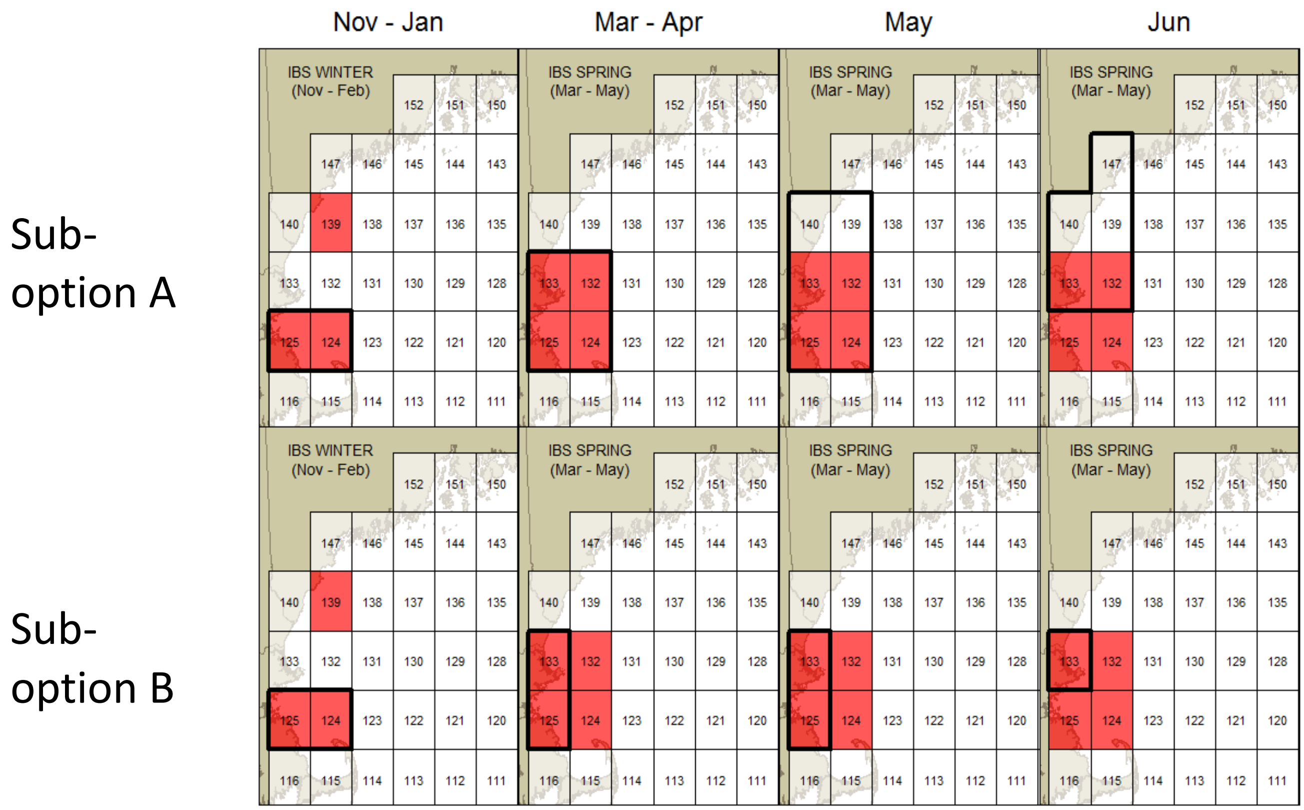
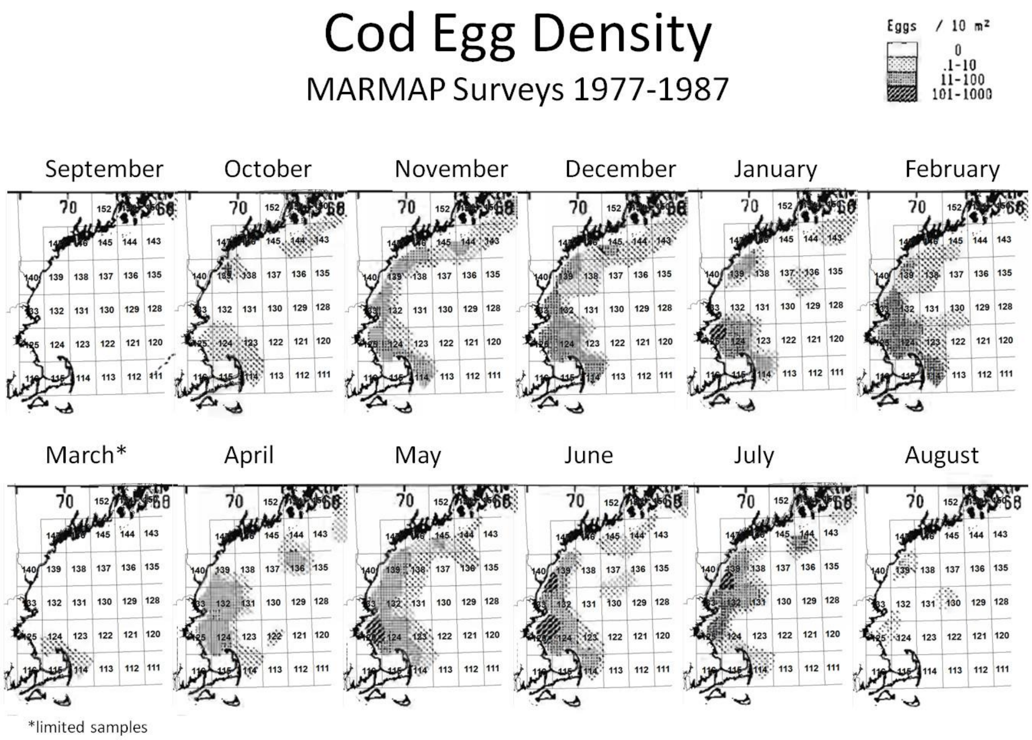


Figure 8- Blocks containing tows from the IBS with significantly skewed cod sex ratios, indicating spawning behavior. Blocks under consideration for closure under the FW 53 sub-options outlined in bold. It should be noted that IBS did not operate in June, and data from all spring cruises (March-May) are shown for comparison.



Reproduced from Berrien and Sibunka, 1999

Figure 9- MARMAP cod egg densities by Month in relation to 30-min blocks. Figures were reproduced from from Berrien and Sibunka (1999). Note that the scale of egg density bins represent increasing orders of magnitude.

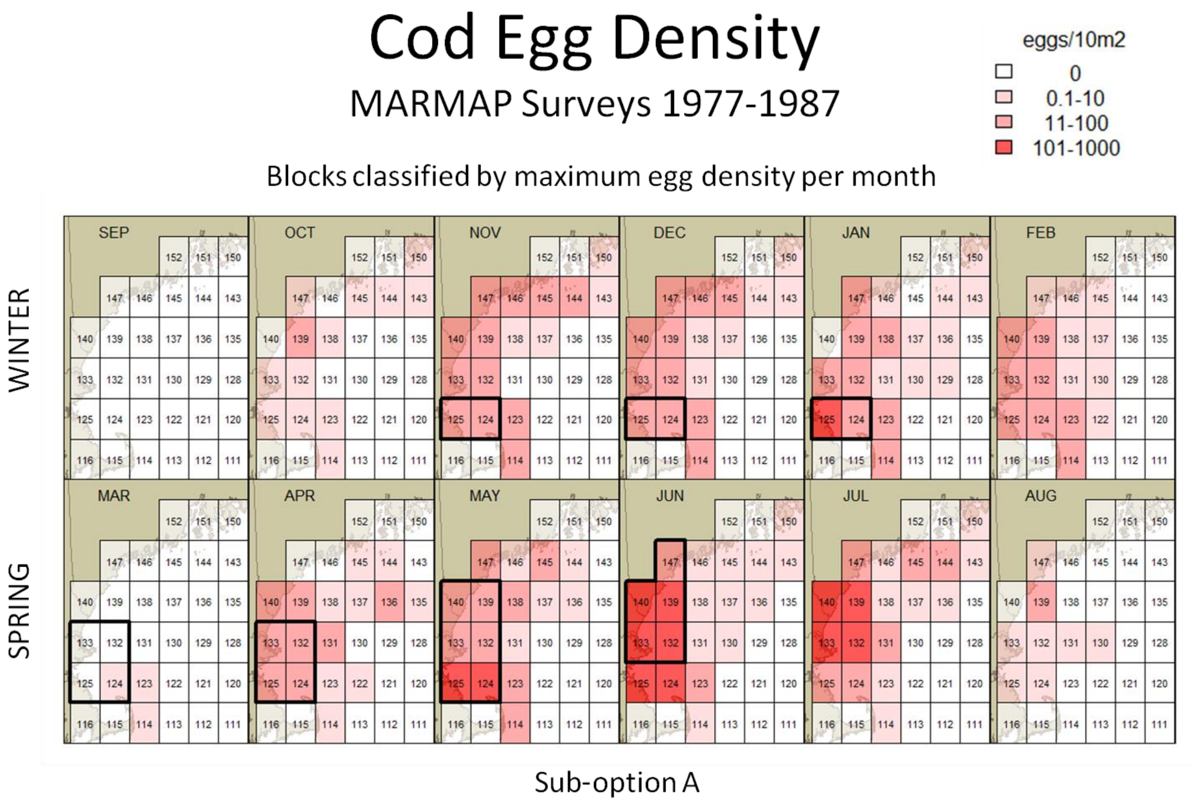


Figure 10- Maximum observed cod egg density per block from the MARMAP ichthyoplankton survey. Blocks under consideration for closure under the FW 53 sub-option A are outlined in bold. Note the presence of significant spawning activity in February and July.

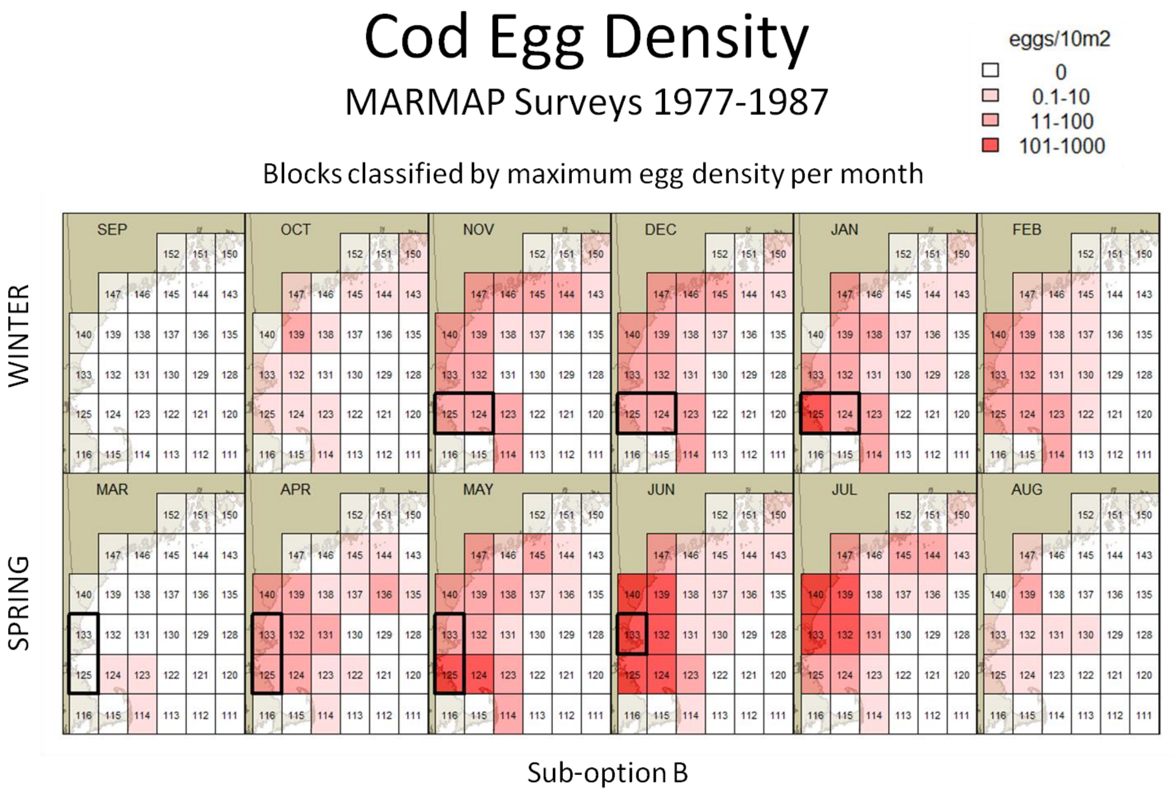


Figure 11- Maximum observed cod egg density per block from the MARMAP ichthyoplankton survey. Blocks under consideration for closure under the FW 53 sub-option B are outlined in bold. Note the presence of significant spawning activity in February and July.

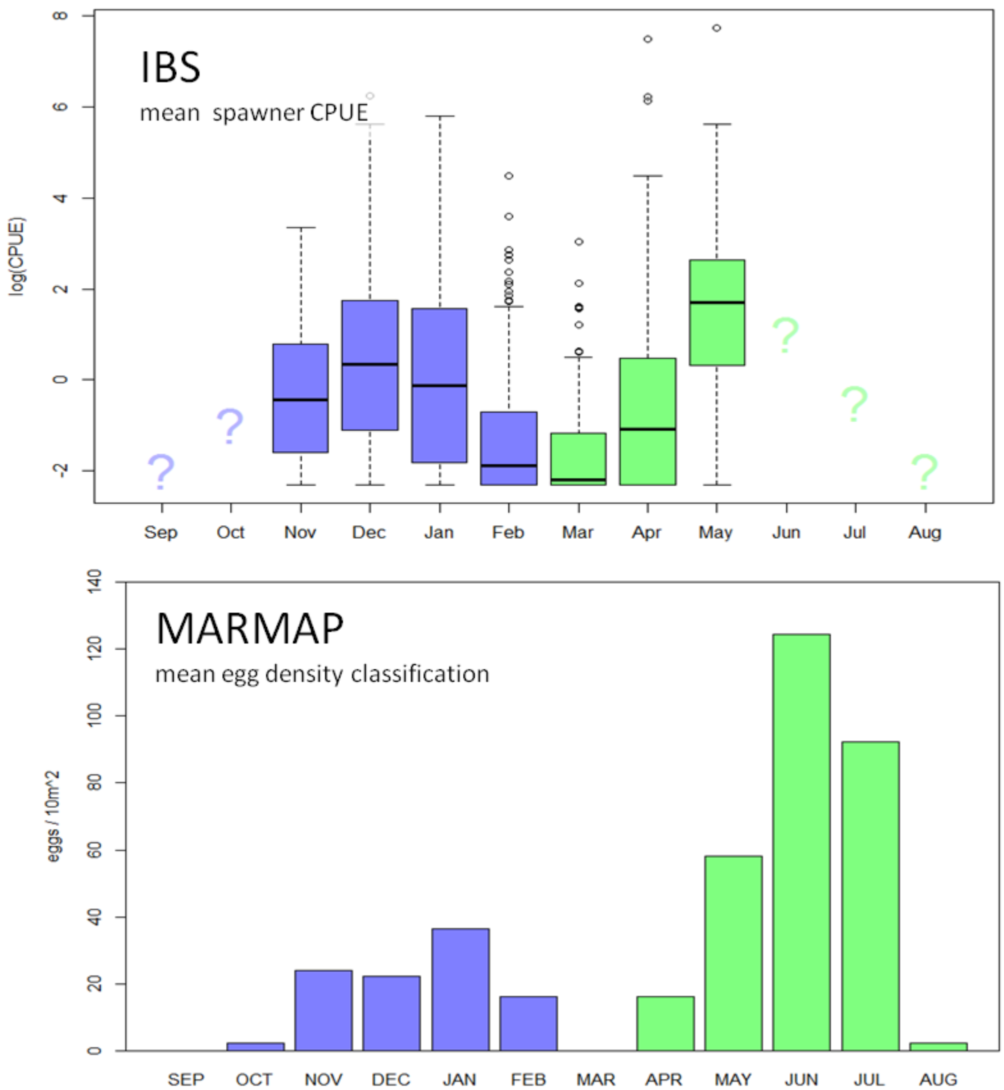


Figure 12- Seasonal distribution of cod spawning activity in the GOM, as evidenced by the IBS trawl survey (above), and the MARMAP ichthyoplankton survey (below). The IBS did not operate between the months of June and October, while MARMAP had very few samples from the GOM in March. “Winter” spawning months are shown in blue and “spring” spawning months are shown in green.

Estimating the Conservation Benefit of Gulf of Maine (GOM) Cod Protection Measures- Revised Commercial Groundfish Fishery Rolling Closures- to Spawning Cod

Micah Dean – December 15, 2014

Purpose: Framework Adjustment 53 (FW53) includes an option to modify the existing Gulf of Maine (GOM) sector and common pool rolling closures with *GOM Cod Protection Measures (Preferred Alternative).* These GOM Cod Protection Measures were evaluated with respect to the protection offered to spawning cod, relative to *No Action* (current GOM rolling closures).

The GOM cod stock is comprised of two genetically distinct spawning components: winter spawners and spring spawners (Kovach et al., 2010; Zemeckis et al., 2014). Spatial management measures may prevent the depletion and loss of individual stock components, thereby sustaining spawning diversity and increasing the chance of recruitment success. As such, the relative conservation benefit of the *Preferred Alternative* relative to the *No Action* was evaluated for each spawning component separately.

Methods: The only available dataset that provides a measure of the abundance and distribution of spawning cod for the months and areas under consideration comes from the Industry Based Survey for GOM Cod (IBS) (Figure 1). The IBS dataset was well-suited for evaluating the relative conservation benefit of FW53 alternatives due to the cod-focused design, intensive sampling effort, and the broad seasonal coverage. The cod IBS employed a two-stage survey design, allocating approximately two-thirds of its survey effort (145 tows per cruise) to a systematic grid encompassing all US waters of the GOM from 10 to 75 fathoms (~ 20 to 140 meters). The remaining one-third of survey effort (80 tows per cruise) was assigned to a stratified random sample of areas that were previously identified by fishermen as having a high abundance of cod. The purpose of this unique design was to ensure a "baseline" level of coverage for the whole survey area, yet achieve higher sampling intensity in the areas most important to cod. The 2006 peer review acknowledged that the cod IBS was particularly useful for evaluating the adequacy of rolling closure areas for protecting spawning cod. However, reviewers also pointed out that the IBS design presents difficulties in describing uncertainty, because it does not lend itself well to typical variance estimators. While uncertainty in biomass estimates was not addressed in this paper, it could be described through a geostatistical approach or post-stratification methods.

For the purpose of this analysis, the largest drawbacks to the IBS dataset are the short time series (2003-2007) and lack of data from June, a month known to be important to spring spawning cod in the GOM (Dean et al., 2014; Siceloff and Howell, 2013). However, despite only operating for four years, the entire study area was surveyed on five consecutive cruises per year (Nov-May), with the distribution of survey effort optimized for describing the spatial and temporal distribution of cod. Furthermore, emphasis was placed on collecting biological and demographic information from cod, and as a result the IBS dataset includes far more maturity observations (i.e., spawning condition) than other surveys that operate in the

GOM. For the purpose of this analysis, the abundance and distribution of spawning cod in June were assumed to be similar to that of May (i.e., June closures were compared to May IBS data).

A compilation of federal and state commercial groundfish fishery closures was assembled to represent the *No Action* in federal waters with respect to FW 53 and *Status Quo* in state waters (Table 1; Figure 2). Some of these closures overlapped in time and space because of differing management bodies or regulatory objectives; however, all current closures prohibit commercial groundfishing for all vessels. For the sake of simplicity, the rolling closures that apply to only common pool vessels were not considered because of the relatively small size of their cod harvest (~2% of the commercial ACL). Furthermore, only closures for the months of Nov-June were considered, because closures that occur at other times of year remain unaffected by the *Preferred Alternative*. As compared to the *No Action*, FW53 results in a decrease in total closure area in April and June, with an increase in total closure area in November, December, January, and May (Figure 3).

The IBS data were summarized by calculating the mean catch per unit effort (CPUE – kg per standard tow) of spawning cod (i.e., ripe, running or spent) per 30-minute block per month. The mean CPUE per block was then multiplied by the survey area within each block (depths from 20m to 140m) to provide an index of the biomass of spawning cod in each block. As with most fisheries data, the distribution of IBS catches has a long right tail. The influence of outliers is often listed as a reason for not using the mean as the measure of central tendency; however, in this case we don't want to disregard the outliers because they indicate spawning aggregations, exactly the phenomenon we are trying to capture the 'signal' of. These index values were then summed across all blocks to achieve an estimate of the entire spawning stock per month (Table 3). Note that the units here are arbitrary, as the area swept of a standard tow was not considered. The goal of this analysis was to determine the amount of protection afforded to spawning cod of the *Preferred Alternative* relative to the *No Action* closures. For this reason, it is only necessary to calculate the proportion of total spawners affected by area closures, not the absolute biomass.

The amount of spawning cod that occurred inside closed areas was estimated by multiplying the mean CPUE per month/block inside the closure by the closed survey area in that month/block (Tables 3 and 4). These values were then summed across all closed areas and compared to the estimate of the total to achieve a proportion of the spawning stock protected by area closures in each month (Table 5). To evaluate the net effect on each spawning component (i.e., winter vs. spring spawners), the estimates of protected spawners were summed across months for each season and compared to the equivalent measure from the entire IBS survey area.

Results: The results of this analysis indicate that the *Preferred Alternative* closures offer additional protection to winter spawners in all months November through January, with the largest increase in December. Across the entire season, the *Preferred Alternative* protects 35% more winter spawning biomass than the *No Action*. For the spring spawning component, the *Preferred Alternative* offers additional protection in May and June, but decreases protection in April. When aggregated across all three months, 8% less of the spring spawning biomass receives protection under the Preferred Alternative as compared to the *No Action*.

Interestingly, the IBS observed more spawning cod biomass in the spring than in winter, despite less coverage of the spring spawning season. If we assume that spawner biomass in June is roughly equal to that of May, the spring spawning component appears to be more than double the size of the winter pawning component.

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Table 1. Current closures that prohibit commercial groundfish fishing by all vessels in federal and state waters.

Closure	Type	Dates
GOM Cod Spawning Protection Area ("Whaleback")	Federal	June
WGOM Closed Area	Federal	All Year
Cashes Ledge Closed Area	Federal	All Year
Apr Sector Rolling Closure (blocks 125, 124, 132,133)	Federal	April
May Sector Rolling Closure (blocks 132, 133, 138, 139, 140)	Federal	May
Jun Sector Rolling Closure (blocks 139, 140, 146, 147)	Federal	June
Nov State Waters Rolling Closure (blocks 123, 124, 125)	Massachusetts	November
Apr State Waters Rolling Closure (blocks 123, 124, 125, 133)	Massachusetts	April
May State Waters Rolling Closure (block 133)	Massachusetts	May
Spring Cod Conservation Zone	Massachusetts	Apr 16 - Jul 21
Winter Cod Conservation Zone	Massachusetts	Nov 15 - Jan 31

Table 2. Calculation of the monthly spawner biomass index for the entire IBS survey area.

	Area	Number of Tows						Spawner CPUE (kg / tow)						Biomass Index (CPUE x Area)					
BLOCK	(km^2)	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*
154	567		8	6	3	6	6		0.5	0.0	0.2	0.0	0.0		292	0	139	0	0
151	214			1	1					0.0	0.0					0	0		
150	954		10	4	6	15	15		0.1	0.0	0.0	0.0	0.0		124	2	20	0	0
149	1439		14	15	11	39	39		0.2	0.0	0.1	0.0	0.0		233	63	107	0	0
148	671		5	4	6	9	9		0.0	0.0	0.1	0.0	0.0		15	0	75	0	0
147	303		6	3	3	3	3		0.1	0.0	0.4	0.0	0.0		32	4	114	13	13
146	1076		18	7	8	21	21		0.3	0.1	0.1	0.2	0.2		342	132	126	268	268
145	1643		7	8	4	19	19		0.9	0.1	0.0	0.2	0.2		1473	124	0	298	298
144	1787		17	2	17	40	40		0.5	0.1	0.0	0.1	0.1		959	141	85	113	113
143	497		7	3	2	14	14		0.1	0.0	0.0	0.0	0.0		68	0	0	7	7
140	285		1	1	1	1	1		0.0	0.0	0.0	0.1	0.1		0	0	0	26	26
139	1633	17	28	34	30	35	35	1.7	1.5	1.3	0.0	4.7	4.7	2698	2490	2133	77	7673	7673
138	771	2	49	14	17	32	32	10.7	0.6	0.6	0.1	4.4	4.4	8240	458	434	78	3424	3424
137	153		5	5	3	6	6		0.2	0.3	0.0	0.9	0.9		34	39	2	135	135
136	663		49	8	17	27	27		0.2	0.2	0.1	0.4	0.4		122	102	48	243	243
133	1012	44	10	29	44	26	26	0.6	1.2	2.3	12.0	112.9	112.9	619	1245	2331	12146	114265	114265
132	1959	53	55	78	66	60	60	3.0	5.0	7.8	38.4	23.3	23.3	5827	9705	15370	75205	45675	45675
131	28		2	2		1	1		0.6	1.4		0.6	0.6		16	40		16	16
130	271		10	9	7	8	8		1.5	1.0	1.0	6.2	6.2		397	265	260	1685	1685
129	270		8	7	5	5	5		0.9	0.4	0.7	2.0	2.0		248	109	186	533	533
125	1088	18	18	33	16	23	23	6.9	56.1	29.5	8.3	9.9	9.9	7556	61082	32145	9019	10756	10756
124	2087	41	51	46	45	55	55	1.8	12.2	6.2	4.9	8.2	8.2	3824	25390	12932	10257	17061	17061
123	277	3	9	4	8	11	11	0.7	1.9	3.7	34.2	6.7	6.7	186	530	1033	9481	1860	1860
116	38	4	1	4	3	4	4	0.3	0.6	0.1	0.0	1.5	1.5	13	22	3	0	58	58
115	626	12	12	12	21	11	11	0.0	0.1	0.0	0.0	0.1	0.1	5	32	5	4	39	39
114	1138	7	19	7	14	18	18	0.0	0.9	0.2	2.4	0.9	0.9	0	1048	196	2723	1005	1005
113	150	1	1		1			0.0	0.0		0.0			0	4		0		
Total =	21600	202	420	346	359	489	489							28967	106361	67603	120154	205152	205152

** IBS did not operate in June; data from May tows were used to represent June.*

Table 3. Calculation of the spawner biomass index for IBS tows that occurred inside current closures.

	Closure Area (km2)						Number of Tows						Spawner CPUE (kg / tow)						Biomass Index (CPUE x Area)					
BLOCK	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*
147						306						3						0.0						13
146						1081						21						0.2						269
145						1704						19						0.2						309
140					285	285					1	1					0.1	0.1					26	26
139	324	324	324	324	1633	1634	10	8	8	6	35	35	2.7	4.5	2.9	0.2	4.7	4.7	878	1457	940	68	7673	7678
138	50	50	50	50	770	51	2	2	2	1	32	4	10.7	6.0	1.4	0.6	4.4	10.1	534	300	69	31	3419	515
137		71	71	71	71	71		2	2	1	3	3		0.4	0.2	0.0	1.2	1.2		27	15	1	85	85
136		23		23	23	23		1		1	2	2		0.0		0.0	0.8	0.8		0		0	19	19
133				1014	1014	453				44	26	14				12.0	112.9	199.2				12170	114490	90238
132	939	939	939	1971	1972	940	10	25	32	66	60	35	4.5	6.0	14.9	38.4	23.3	28.9	4272	5638	13954	75666	45978	27206
130		246	246	246	246	246		9	8	6	7	7		1.3	0.9	0.5	7.0	7.0		320	226	131	1714	1714
129		190	190	190	190	190		4	4	2	2	2		0.6	0.6	0.9	2.3	2.3		120	119	170	435	435
125	587	219	219	1092	587		10	4	9	16	12		10.5	28.1	72.0	8.3	13.0		6149	6151	15764	9052	7613	
124	936	512	512	2087	937	512	14	3	7	45	13	8	2.9	2.4	19.9	4.9	2.5	3.0	2690	1217	10203	10257	2310	1555
123			18	38	38	18			1	1	1	1			1.1	0.5	0.6	0.6			20	21	22	10
114					0						2						5.8						0	
Total =	2836	2574	2569	7106	7766	7514	46	58	73	189	196	155							14523	15229	41308	107566	183784	130072

** IBS did not operate in June; data from May tows were used to represent June.*

Table 4. Calculation of the spawner biomass index for IBS tows that occurred inside Framework 53 Preferred Alternative closures.

	Closure Area (km2)						Number of Tows						Spawner CPUE (kg / tow)						Biomass Index (CPUE x Area)					
BLOCK	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*	Nov	Dec	Jan	Apr	May	Jun*
147						306						3						0.0						13
146						1081						21						0.2						269
145						0						19						0.2						0
140					285	285					1	1					0.1	0.1					26	26
139	324	324	324	324	1633	1634	10	8	8	6	35	35	2.7	4.5	2.9	0.2	4.7	4.7	878	1457	940	68	7673	7678
138	50	50	50	50	770	51	2	2	2	1	32	4	10.7	6.0	1.4	0.6	4.4	10.1	534	300	69	31	3419	515
137		71	71	71	71	71		2	2	1	3	3		0.4	0.2	0.0	1.2	1.2		27	15	1	85	85
136		23		23	23	23		1		1	2	2		0.0		0.0	0.8	0.8		0		0	19	19
133				342	1014	453				11	26	14				0.8	112.9	199.2				280	114490	90238
132	939	939	939	940	1972	1972	10	25	32	22	60	60	4.5	6.0	14.9	28.4	23.3	23.3	4272	5638	13954	26662	45978	45978
130		246	246	246	246	246		9	8	6	7	7		1.3	0.9	0.5	7.0	7.0		320	226	131	1714	1714
129		190	190	190	190	190		4	4	2	2	2		0.6	0.6	0.9	2.3	2.3		120	119	170	435	435
125	1091	1091	1091	587	806	559	18	18	33	12	16	12	6.9	56.1	29.5	10.1	12.4	14.7	7577	61250	32234	5955	9979	8230
124	1048	742	742	936	937	513	21	12	17	15	13	8	2.4	1.9	10.4	1.6	2.5	3.0	2541	1401	7717	1453	2310	1558
123			18	38	38	18			1	1	1	1			1.1	0.5	0.6	0.6			20	21	22	10
114					0						2						5.8						0	
Total =	3452	3676	3671	3747	7985	7402	61	81	107	78	200	192							15802	70513	55292	34771	186150	156768

** IBS did not operate in June; data from May tows were used to represent June.*

Table 5. Index of spawner biomass observed by the IBS from inside closed areas (No Action- Federal andStatus Quo State vs. Framework 53 Preferred Alternative), as compared to the total observed by the survey.

Winter Spawners

Month	All IBS	No Action/ Status Quo Closures		FW53 Closures		Change	
November	28967	14523	50%	15802	55%	1278	+4%
December	106361	15229	14%	70513	66%	55284	+52%
January	67603	41308	61%	55292	82%	13984	+21%
Total	202932	71061	35%	141607	70%	70546	+35%

Spring Spawners

Month	All IBS	No Action/ Status Quo Closures		FW53 Closures		Change	
April	120154	107566	90%	34771	29%	-72795	-61%
May	205152	183784	90%	186150	91%	2366	+1%
June*	205152	130072	63%	156768	76%	26696	+13%
Total	530457	421113	79%	377689	71%	-43733	-8%

** IBS did not operate in June; June closures were compared to May IBS data*

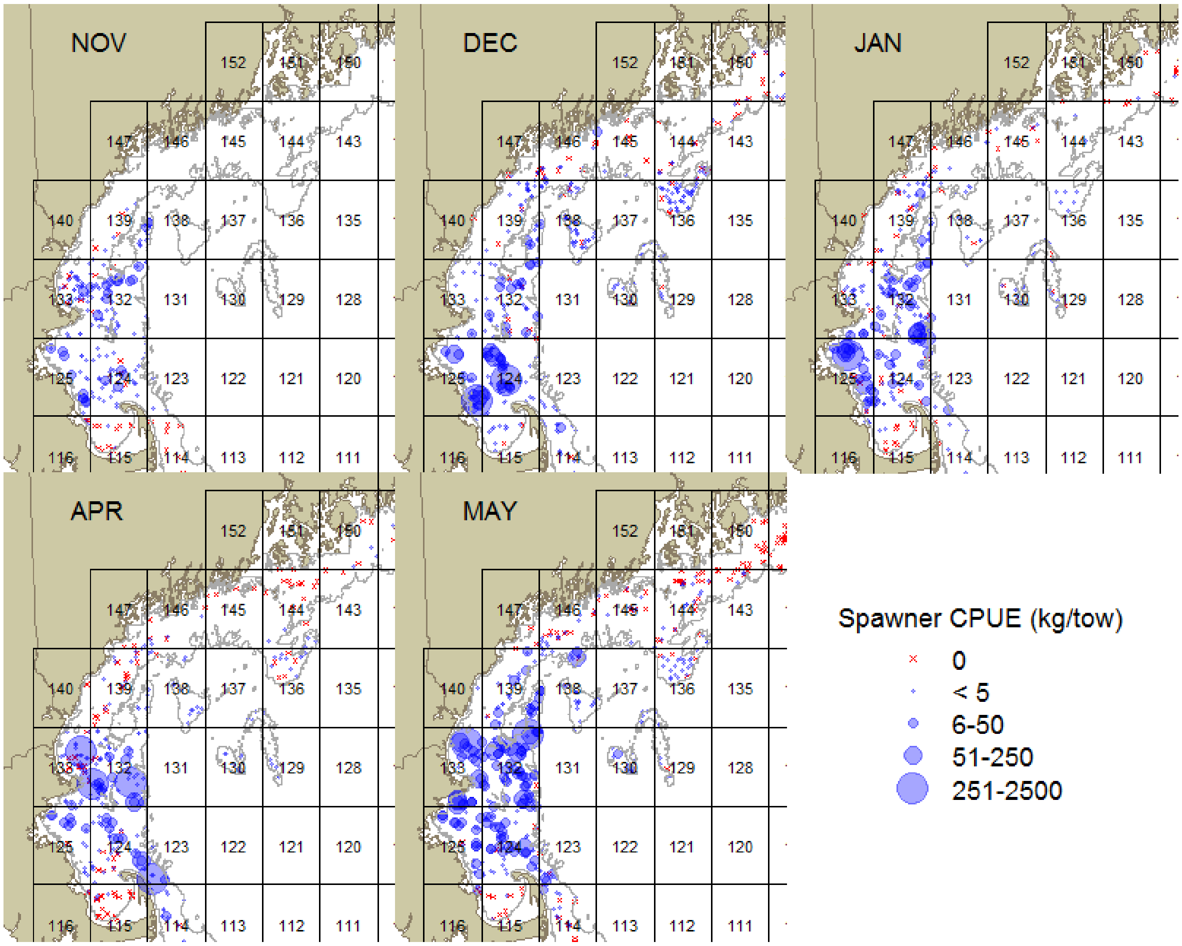


Figure 1. Catch per unit effort (CPUE) of cod in spawning condition (ripe, running or spent) by the Industry Based Survey (IBS) for Gulf of Maine Cod. The gray line indicates the limits of the IBS survey area (20-140m depths).

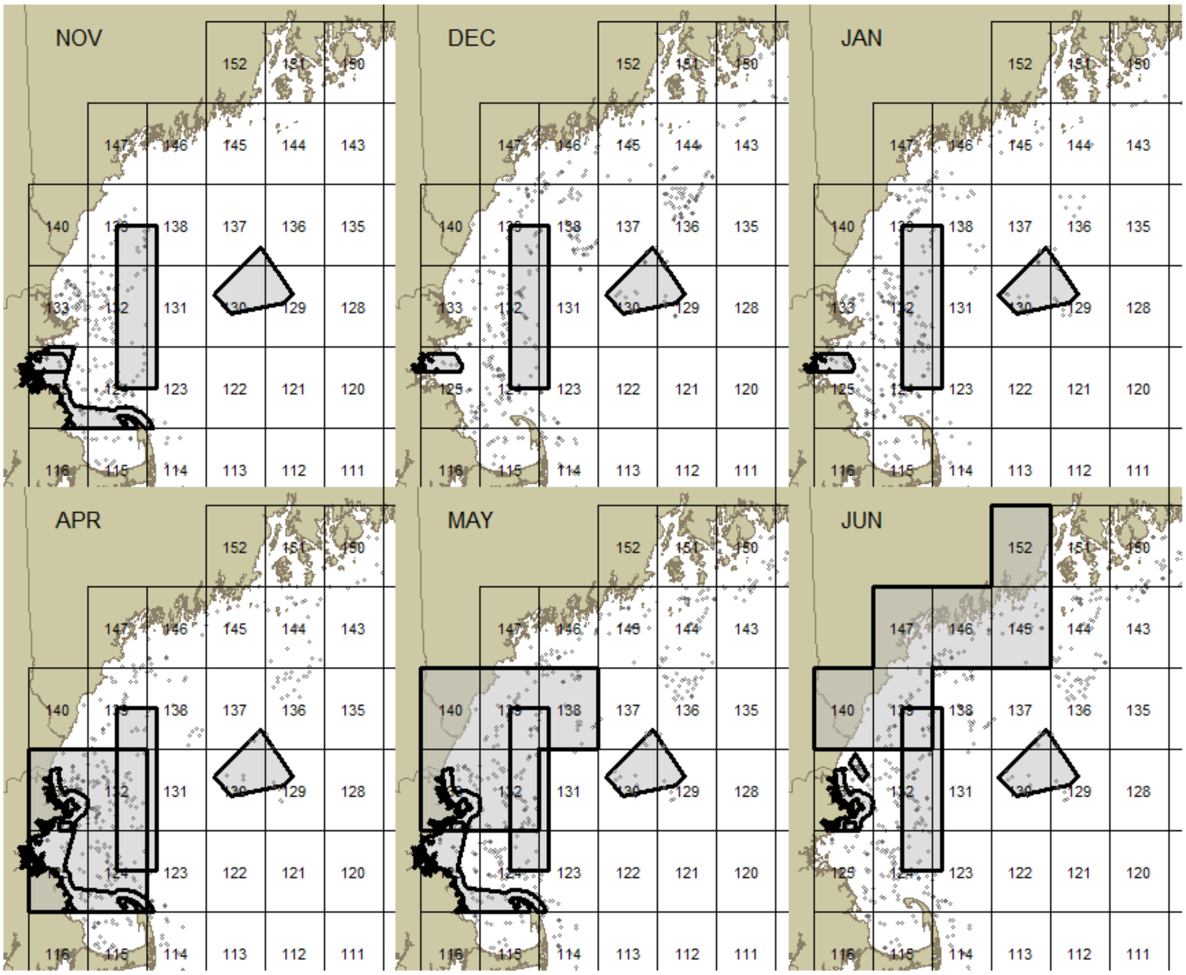


Figure 2. No Action (federal) and Status Quo (state) closures that prohibit commercial groundfishing are shown in gray. Gray points identify IBS tow locations in each month. Note that May tows are shown in comparison to June closures, due to a lack of survey coverage in June.

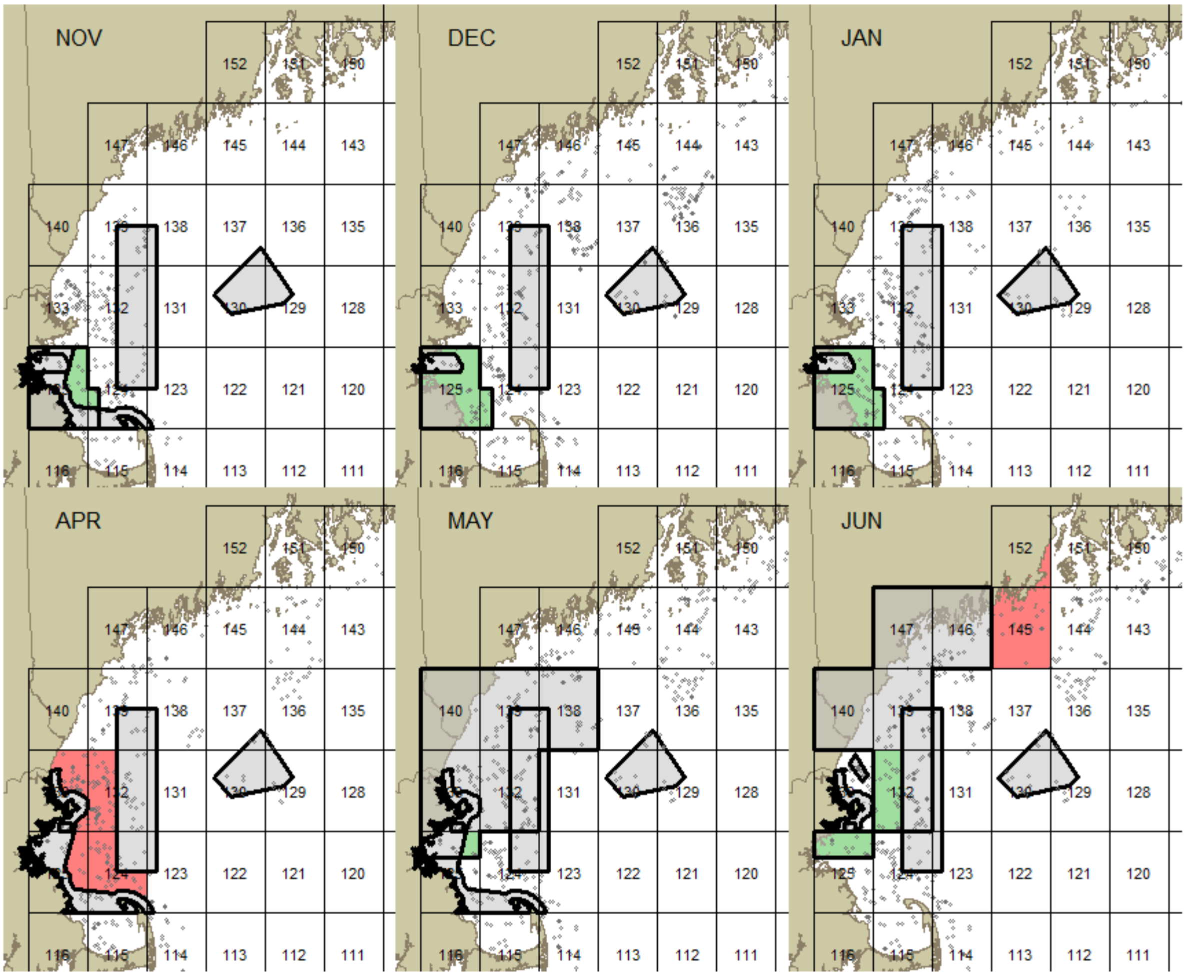


Figure 3. Changes to No Action closures under FW53 as the Preferred Alternative. Green areas are additional closures, whereas red areas would be open under the FW53 Preferred Alternative. Grey areas are No Action (federal) and Status Quo (state) closures that would remain unaffected by the measures in FW53. Gray points identify IBS tow locations in each month. Note that May tows are shown in comparison to June closures, due to a lack of survey coverage in June.

Examining Gulf of Maine (GOM) Cod Spawning Activity in the Coastal Waters of Maine and New Hampshire

Sally Sherman and Jamie Cournane– January 7, 2014

Background: Established in the fall of 2000, the Maine/New Hampshire (MENH) trawl survey covers the nearshore component of the Gulf of Maine waters along the coasts of Maine and New Hampshire. It operates on a random stratified sampling scheme and follows published standard protocols. A total of 20 strata are distributed over four depths: 5-20 fathoms, 21-35 fathoms, 36-55 fathoms, and >56 fathoms roughly bounded by the 12-mile limit, and contains five longitudinal regions. The current survey objective is to complete 120 stations. The number of random stations per stratum is proportional to the area of the stratum. Twenty minute standard bottom trawls are performed using a sample net specifically designed to sample bottom populations while not targeting any specific species. A survey consists of 25 sea days over a 5-week period conducted in the spring, typically from the first full week of May through the first week of June and in the fall from the last week of September through the month of October. The survey contracts a commercial fishing vessel, the Robert Michael, a 54' stern trawler, each year to accomplish the work. In order to evaluate management measures under consideration in Framework Adjustment 53, an examination of Atlantic cod data from the MENH survey is presented.

Data and Methods: An examination of biological information on spawning Atlantic cod begins with stratifying the survey data into two time periods (Spring: 2001-2007 and 2008-2014; Fall: 2000-2007 and 2008-2013) and by month (Spring-May and Fall-October). Figures illustrate survey locations with Atlantic cod present and absent (number/tow) based on this stratification (Figures 1 and 4). Next, maps display survey locations with the number of Atlantic cod per tow equal to or greater than 31 cm, which is the L50 (i.e., length in which 50% of the females are considered mature) for cod in the MENH survey (Figures 2 and 5). For mature cod examined, maps display the locations of individual cod collected at different maturity stages, using a standard classification scheme (as described in Burnett et al. 1989) (Figures 3 and 6). The MENH data was interpreted based on the presence/absence of cod in 30-minute blocks, and the relative number of cod within each classification and time period. An overlay of 30-minute blocks in each map provides a reference for comparing management measures under consideration in Framework Adjustment 53.

Results:

Summary of spatial (30-minute blocks) and temporal patterns in the cod data from the MENH surveys, based on visual inspection of Figures 1-6:

- Areas of relative cod abundance, based on the number of cod per tow in these surveys, regardless of time period (Figure 1 and Figure 4):
    - In the spring (May): waters off NH (132 and133), Southern ME (139), Midcoast ME (145,146,150,151) and Downeast ME (153 and 154), and
    - In the fall (October): waters off NH (132 and 133), Midcoast Maine (144,150, and 151), and Downeast Maine (153 and 154).

- Areas of cod caught in developing or ripe spawning condition,, regardless of time period (Figure 1 and Figure 4):
    - In the spring (May): waters off NH (132 and133), Southern ME (139, 147), Midcoast ME (145 and 146) and Downeast ME (153), and
    - In the fall (October): waters off Southern Maine (138 and 139).
- When comparing between the two time periods, in the more recent period:
    - Fewer locations with relatively high fish per tow for the spring and fall surveys observed (Figure 1 and Figure 4), and
    - More frequently observed fish greater than 31 cm in spring but less frequently in the fall surveys (Figure 2 and Figure 5). Of note, the percent of larger fish by year and in Southern ME and NH has remained stable, but in recent years has declined in Downeast ME.

<u>Conclusions</u>:

The GOM Cod protections closures being considered in FW 53 for the commercial fishery modify existing rolling closures in May for all vessels, closing blocks 132, 133, 138, 139, 140 and 125 north of 42° 20'. This configuration expands the overall closure area for sector vessels by adding the northern half of block 125, and contracts the number of blocks closed to the common pool, primarily in the central GOM. October closures apply only to common pool vessels and remain unchanged in both the GOM cod protection closures and the No Action alternatives, with blocks 124 and 125 closed during that month. Under the No Action for May, sector rolling closures include blocks 132,133,138,139, and 140, and common pool rolling closures in blocks 124, 125, 129, 130, 131, 132, 133, 135, 136, 137, 138, 139, 140. The MENH surveys do not cover blocks 124, 125, 129, 130, 131, 136, and 137, so this information cannot be used to examine the potential impact of modifying the time/area closures for those blocks in May and October.

Based on the survey coverage, the proposed GOM cod protection closures in May and October would continue to provide the same protection for aggregating and spawning cod that is currently afforded by the sector rolling closures provided these animals continue to exhibit behavior observed in the recent period. The impact of opening common-pool rolling closures in areas that would not be closed under the alternative cannot be discerned from the MENH data as the survey does not cover these blocks. In addition, waters down in Downeast Maine (blocks 153 and 154) do not have federal spatial management measures in place, but appear to be important areas for cod. In the fall (October), impacts are expected to be neutral. Overall in May and October, the No Action and the GOM cod protection closure alternative would continue to provide positive benefits for cod. However, this information cannot be used to examine the impact of April being open under Option 2 compared with closed under Option 1/No Action.

Figures:

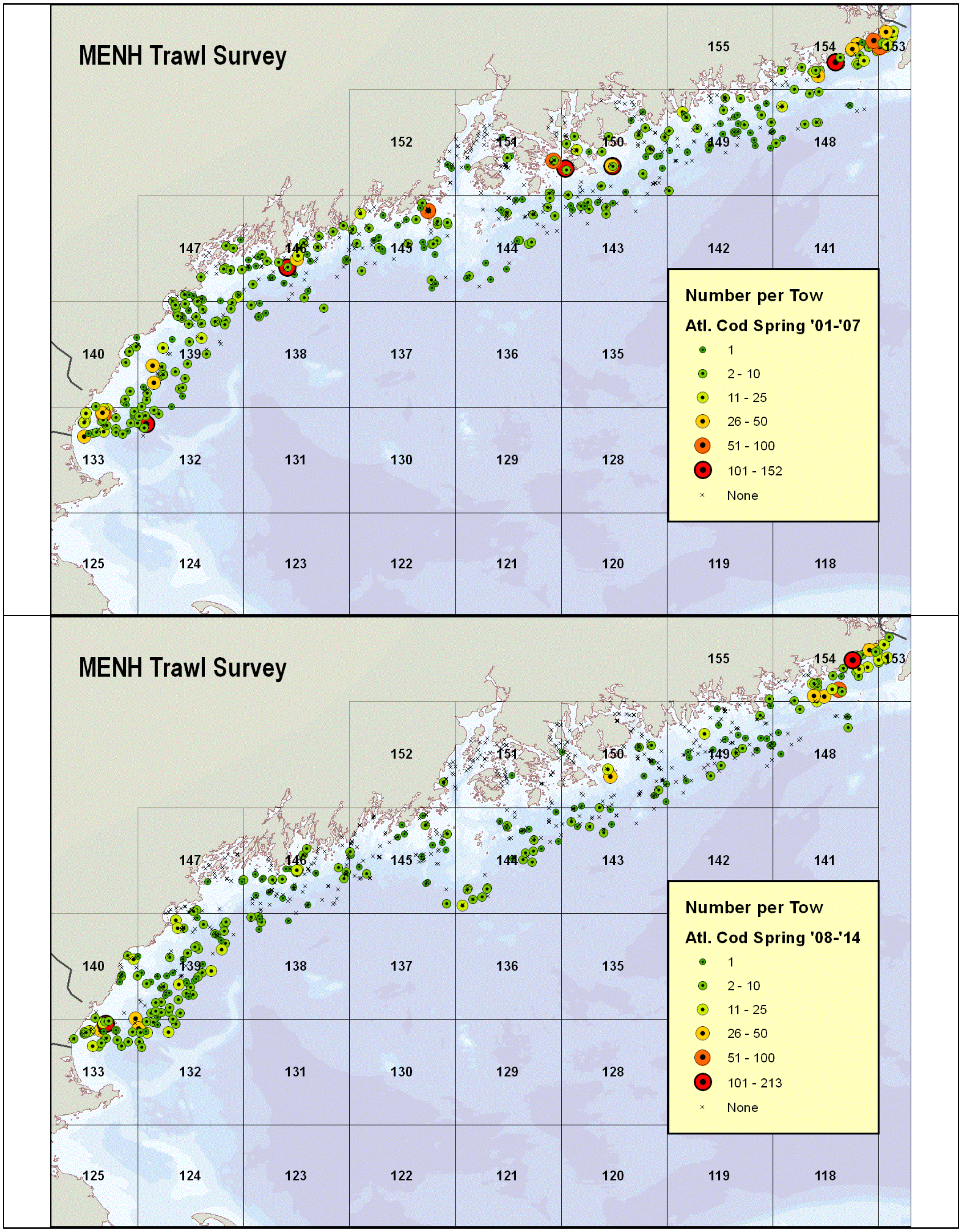


Figure 1 - Spring survey locations identified with the number of Atlantic cod per tow (circles of increasing size) and presence (circles) or absence (x's) indicated, for 2001-2007 (top) and 2008-2014 (bottom). Data source: ME/NH trawl survey, May 2001-2014, ME DMR.

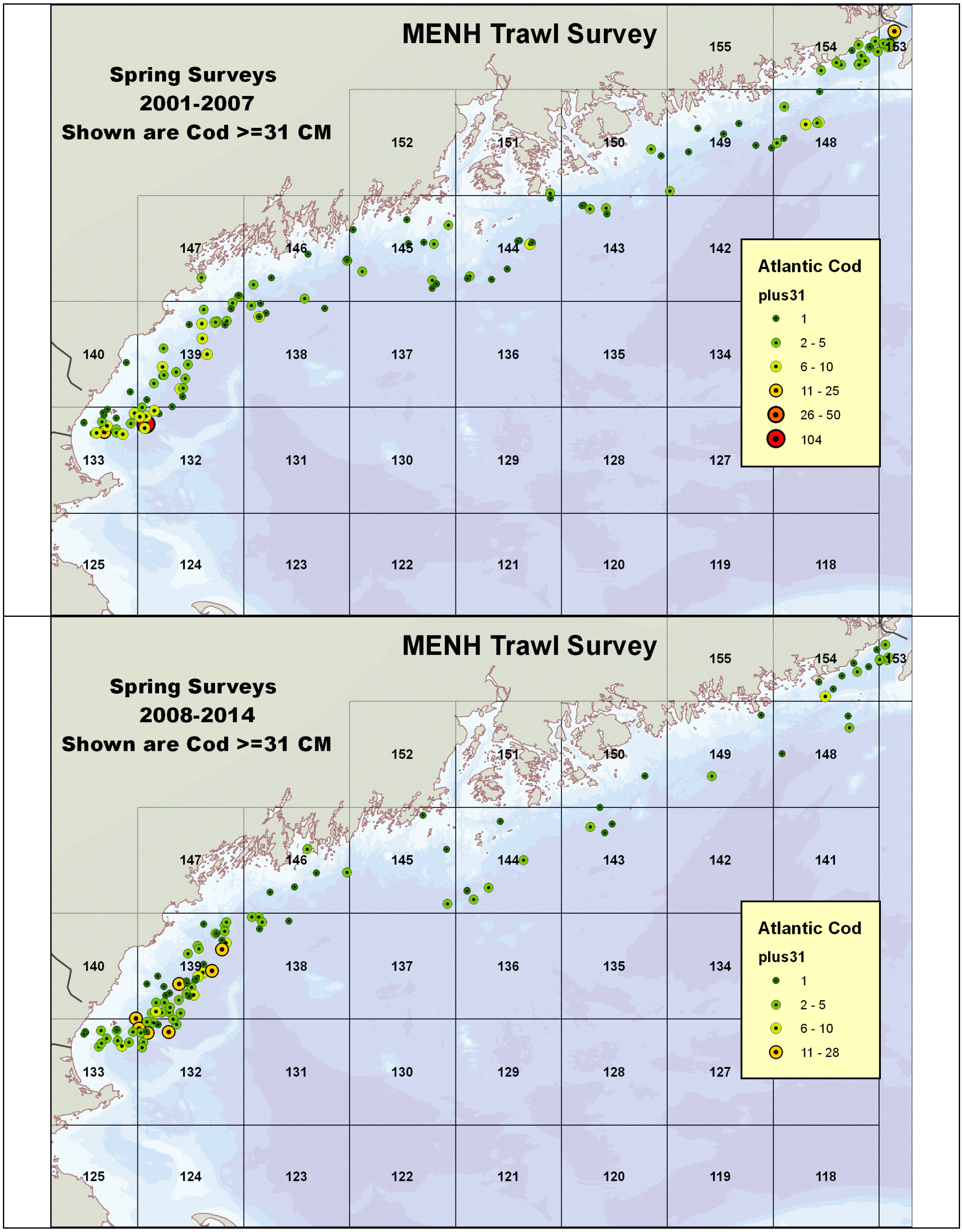


Figure 2- Spring survey locations identified with the number of Atlantic cod per tow (circles of increasing size) present equal or greater than 31 cm, for 2001-2007 (top) and 2008-2014 (bottom). Data source: ME/NH trawl survey, May 2001-2014, ME DMR. Total fish are 475 and 523 respectively.

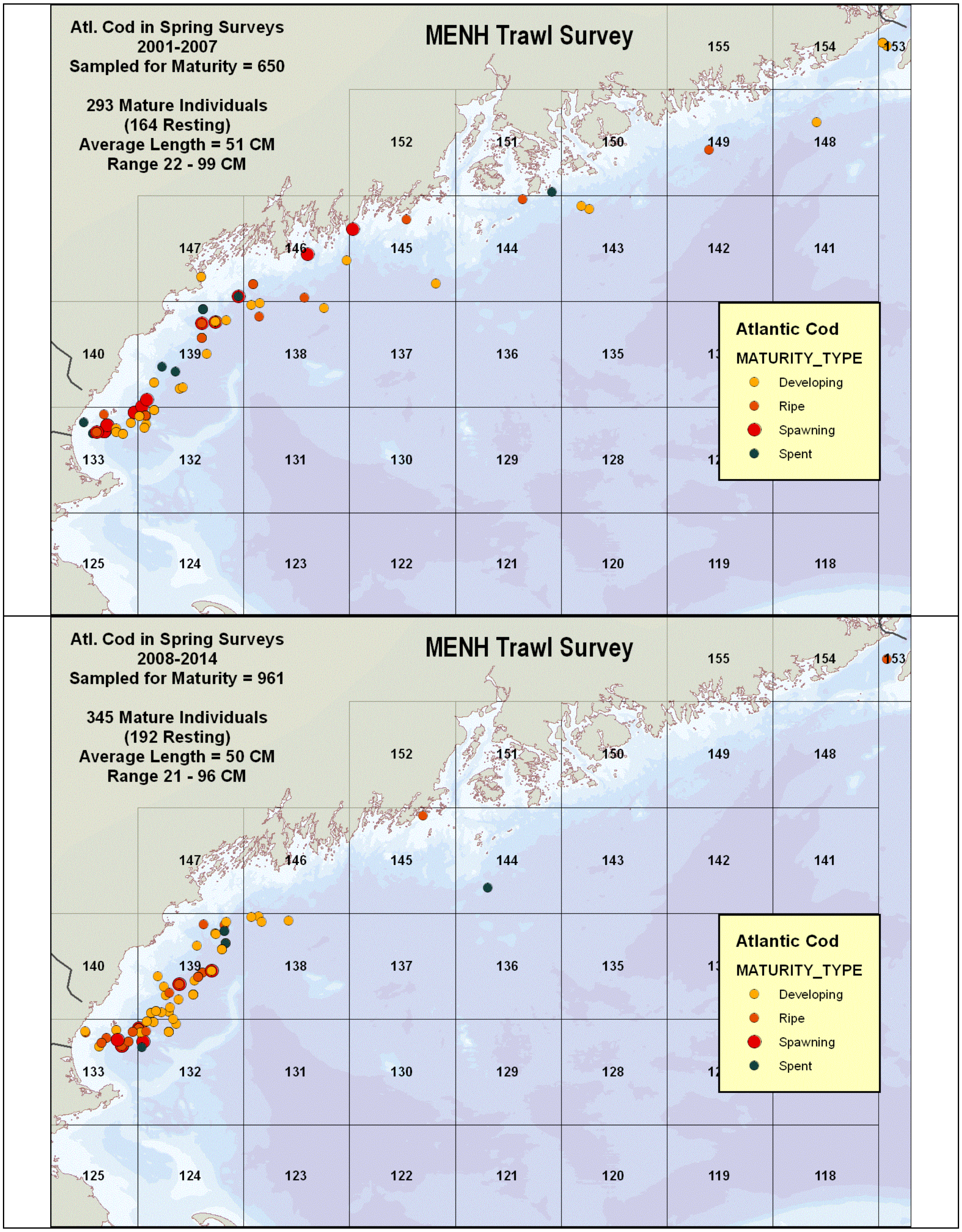


Figure 3- Spring survey locations identified with Atlantic cod for mature individuals and their spawning condition, for 2001-2007 (top) and 2008-2014 (bottom). Data source: ME/NH trawl survey, May 2001-2014, ME DMR.

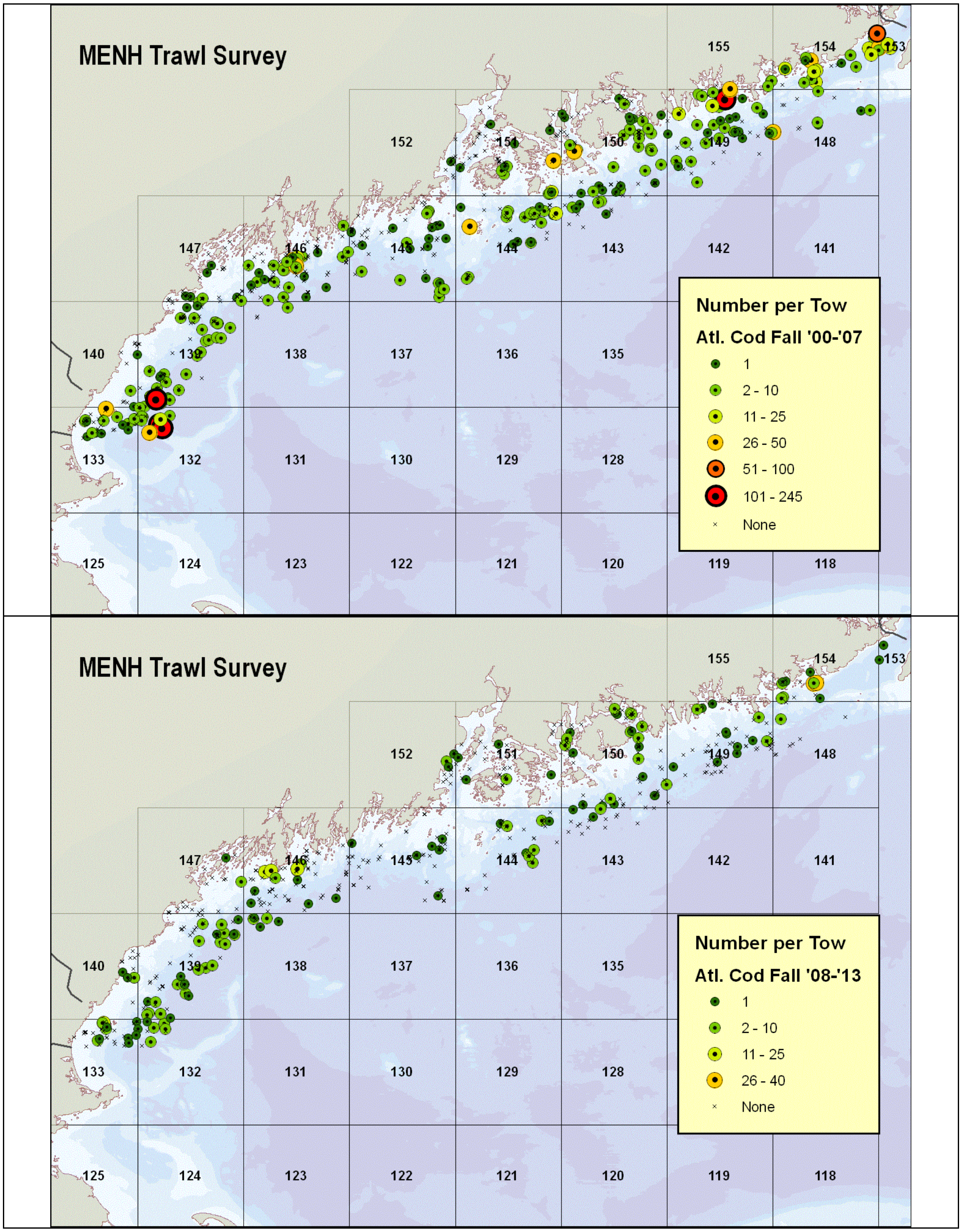


Figure 4 - Fall survey locations identified with the number of Atlantic cod per tow (circles of increasing size) and presence (circles) or absence (x's) indicated, for 2000-2007 (top) and 2008-2013 (bottom). Data source: ME/NH trawl survey, October 2000-2013, ME DMR.

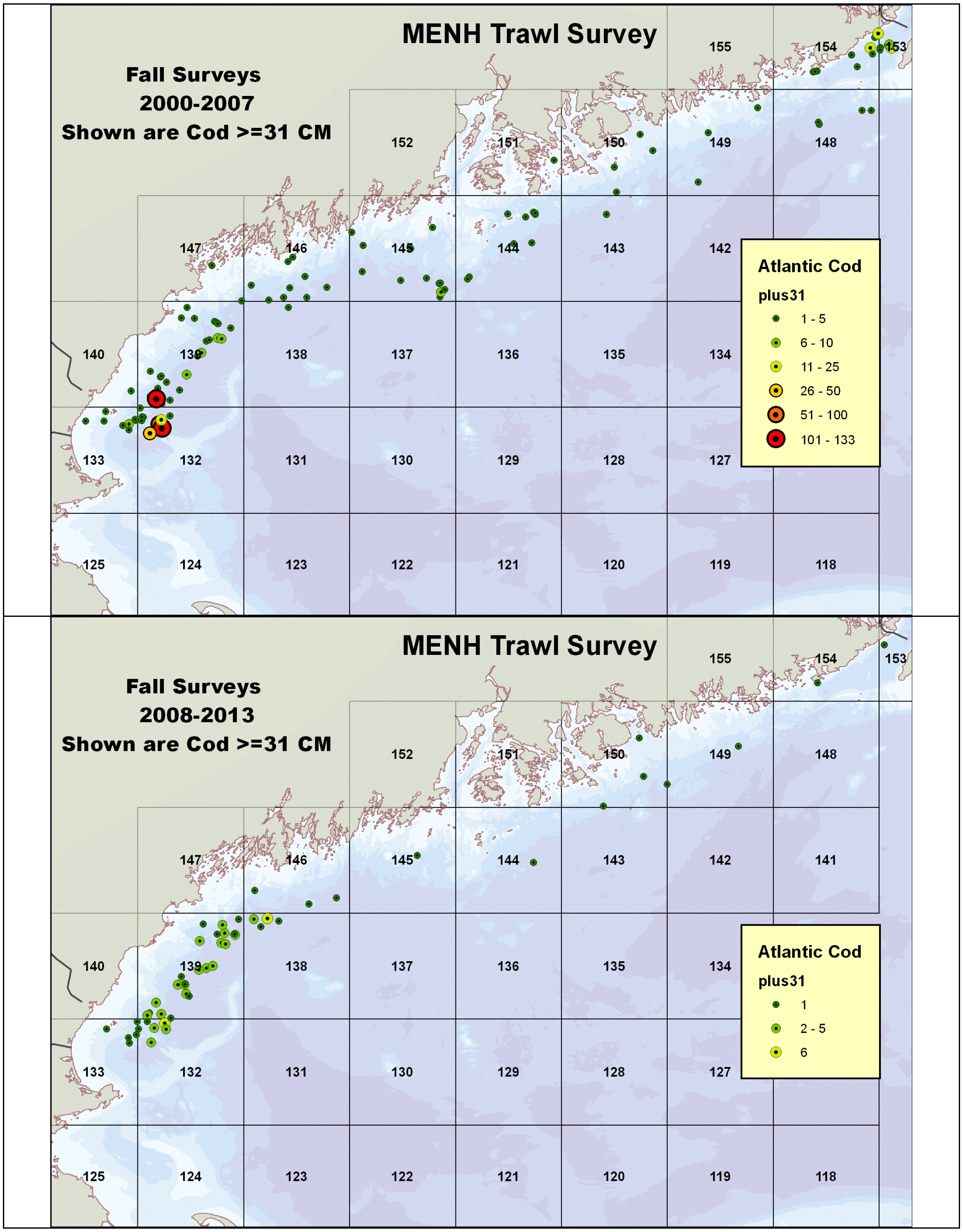
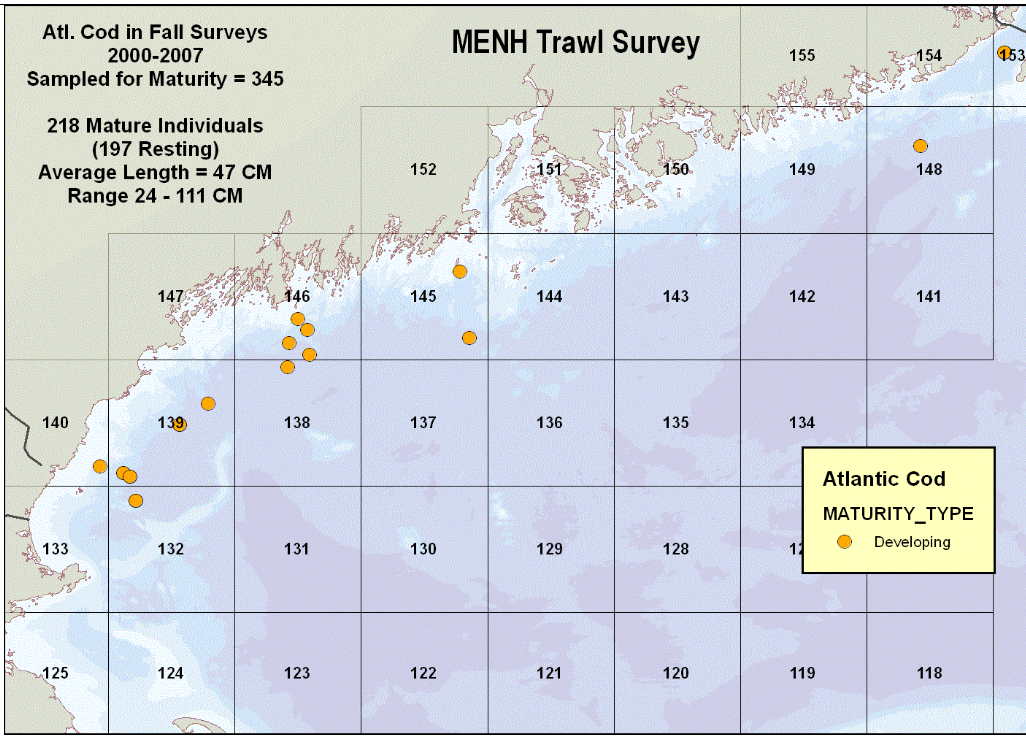


Figure 5- Fall survey locations identified with the number of Atlantic cod per tow (circles of increasing size) present equal or greater than 31 cm, for 2000-2007 (top) and 2008-2013 (bottom). Data source: ME/NH trawl survey, October 2000-2013, ME DMR. Total fish are 838 and 427 respectively.



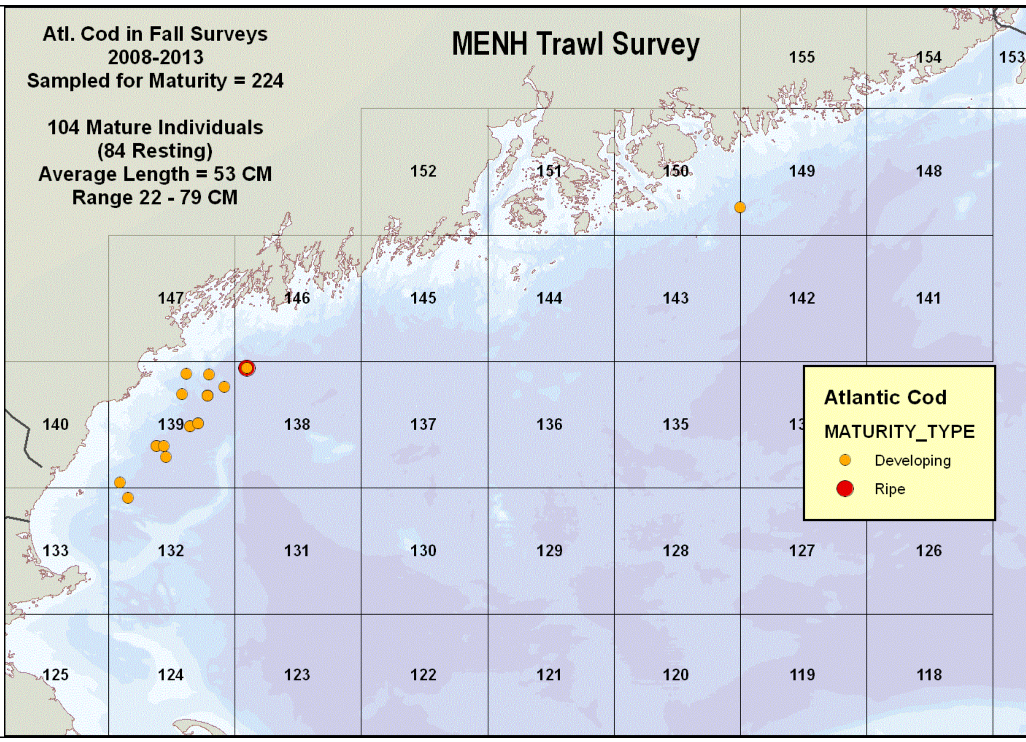


Figure 6- Fall survey locations identified with Atlantic cod for mature individuals and their spawning condition, for 2000-2007 (top) and 2008-2013 (bottom). Data source: ME/NH trawl survey, October 2000-2013, ME DMR.

Examination of seven spring spawning groundfish stocks in the NEFSC bottom trawl survey for comparison to spatial management measures under consideration in Framework Adjustment 53

Paul Nitschke and Jamie Cournane – January 7, 2015

Overview:

The Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey was examined for evidence of spawning activity for seven groundfish stocks that spawn in the spring (cod, winter flounder, yellowtail flounder, American plaice, witch flounder, windowpane flounder and haddock) for comparison to the proposed changes in mortality/spawning closures for Gulf of Maine (GOM) cod in Framework Adjustment 53. This is not a full quantitative analysis of the survey data, but rather a visual inspection of the spatial/temporal patterns for mature and spawning condition fish observed in the NEFSC spring bottom trawl survey.

The suite of GOM cod protection closures (*Preferred Alternative*) includes the removal of time/area closures during the month of April, and modifies the existing rolling closures in the month of May.

Dataset and Data Selection:

The NEFSC spring survey has covered GOM survey strata during April and May since 2009, when the FSV Bigelow was used to conduct the bottom trawl survey (i.e, sampling coverage for inshore GOM improved with the transition from the Albatross to the Bigelow). The majority of tows in the western Gulf of Maine are completed in the last two weeks of April and the first two weeks of May. Therefore, the combination of data collected throughout April and May was considered a single temporal block for this analysis. An examination for each month separately was not possible due to low sample size.

To obtain adequate spatial coverage, 2009 and 2011 through 2014 surveys were combined in the analysis. The 2010 survey was omitted because inshore Massachusetts strata, which can be important for detecting spawning, were not completed for this survey year and therefore inconsistent with other years sampled. Only sampling locations (starting latitude and starting longitude) intersecting Broad Stock Area 1 - which is identical to the GOM cod stock area - were used in the analysis, for a total of 364 survey tows.

Mature and Spawning Fish Indicators:

Survey tows were examined for fish abundance greater than L50 (i.e., length in which 50% of the females are considered mature) and for abundance of fish in spawning condition. Evidence of spawning was defined as maturity stages ripe, ripe and running and spent following a similar approach to what was done for the GOM cod industry-based survey (IBS) analysis (see Dean and Correia in this Appendix). Fish abundance greater than L50 was calculated as the "Mature Fish Index" for each stock. Then, an estimate of spawning abundance was calculated for each tow as the proportion of fish in spawning condition multiplied by the numbers of fish greater than L50 since only a subsample of fish caught on each tow is staged for maturation. This assumes the likelihood of spawning does not change considerably with sizes greater than L50, since maturation subsampling protocols are done at length. This is referred to as the “Spawning Fish Index.”

The L50’s used in this analysis were based on female fish (and was applied equally to males and females) using information from either the most recent stock assessment (Palmer, 2014) or from O’Brien et al. (1993) (Table 1). Peak spawning was compiled from Omnibus Habitat Amendment 2, Appendix B (Table 2). Note that previous PDT work on spawning cod in the GOM suggests a peak spawning period slightly later (May-June) (see Dean and Correia in this Appendix). The PDT analysis also found little evidence of cod spawning in March. Windowpane flounder has a peak spawning period in the summer but this species is known to have a very protracted spawning season from May to November, which is why it was included in this analysis.

Table 1- Summary of stocks examined in the analysis including length (cm) when 50% of females would be mature fish (L50s).

Stock	L50s
Cod	43 cm
Winter flounder	30 cm
Yellowtail flounder	31 cm
American plaice	27 cm
Witch flounder	30 cm
Windowpane flounder	23 cm
Haddock	38 cm

Plots for the combination of each species and index were developed using ArcGIS (Figures 1-7).

Results:

Comparison of abundance of fish greater than L50 (Mature Fish Index) with abundance of fish in spawning condition (Spawning Fish Index) for each stock is shown in Figures 1 through 7. Circles of increasing size indicate the magnitude of the value at the center of the sampled location. Break points were determined by using examining the distribution of the data for each species and each index, parsing it into quintiles (i.e., break points at 20%, 40%, 60%, and 80% of the data) using ArcGIS. Note that that scale changes when comparing maturity abundance plots with spawning condition plots.

Table 2 - Spawning periods for regulated groundfish stocks in the Gulf of Maine (Source: Omnibus Essential Fish Habitat Amendment 2; Appendix B).

spawning months

peak spawning months

Species	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Notes*
American Plaice			spawning	peak	peak	spawning							
GOM Atlantic Cod	peak	peak	peak	peak	peak	spawning	spawning				spawning	spawning	
Atlantic Halibut	spawning	spawning	spawning	spawning							peak	peak	Atlantic Canada waters
GOM Haddock		peak	peak	peak	spawning								
Ocean Pout								spawning	peak	peak	spawning	spawning	
Pollock	spawning	spawning									spawning	peak	
Redfish				spawning	spawning	spawning	spawning	spawning					copulation from Oct-Jan; fertilization from Feb-April; no peak times evident
GB-GOM White Hake													no evidence of spawning in the GOM
Windowpane			spawning	spawning	spawning	spawning	spawning	spawning	spawning				
GOM Winter Flounder		spawning	spawning	peak	spawning								*peak spawning is from Press et al. 2014
Witch Flounder				spawning	peak	peak	peak	peak	spawning	spawning	spawning		
CC-GOM Yellowtail Flounder			spawning	peak	peak	peak	spawning	spawning					

* Press, Y. K., M. J. Wuenschel, and R. S. McBride. 2014. Time course of oocyte development in winter flounder (Pseudopleuronectes americanus) and spawning seasonality for the Gulf of Maine, Georges Bank, and Southern New England stocks. J. Fish Biol. 85:421-445.

Table 3- Summary of the average mature and spawning fish indices (in numbers of fish). The percentage of the spawning index relative to the mature index is also shown. May and April are lumped into a single time block for this analysis. Spatial patterns are shown in the figures and are not summarized in this table.

Stock	Mature Fish Index	Spawning Fish Index	Spawning Index percentage of Mature
Cod	5.99	0.647	11%
Winter flounder	3.23	1.69	52%
Yellowtail flounder	15.08	10.88	72%
American plaice	12.62	6.43	51%
Witch flounder	3.03	0.53	18%
Windowpane flounder	0.29	0.05	16%
Haddock	3.01	0.99	33%

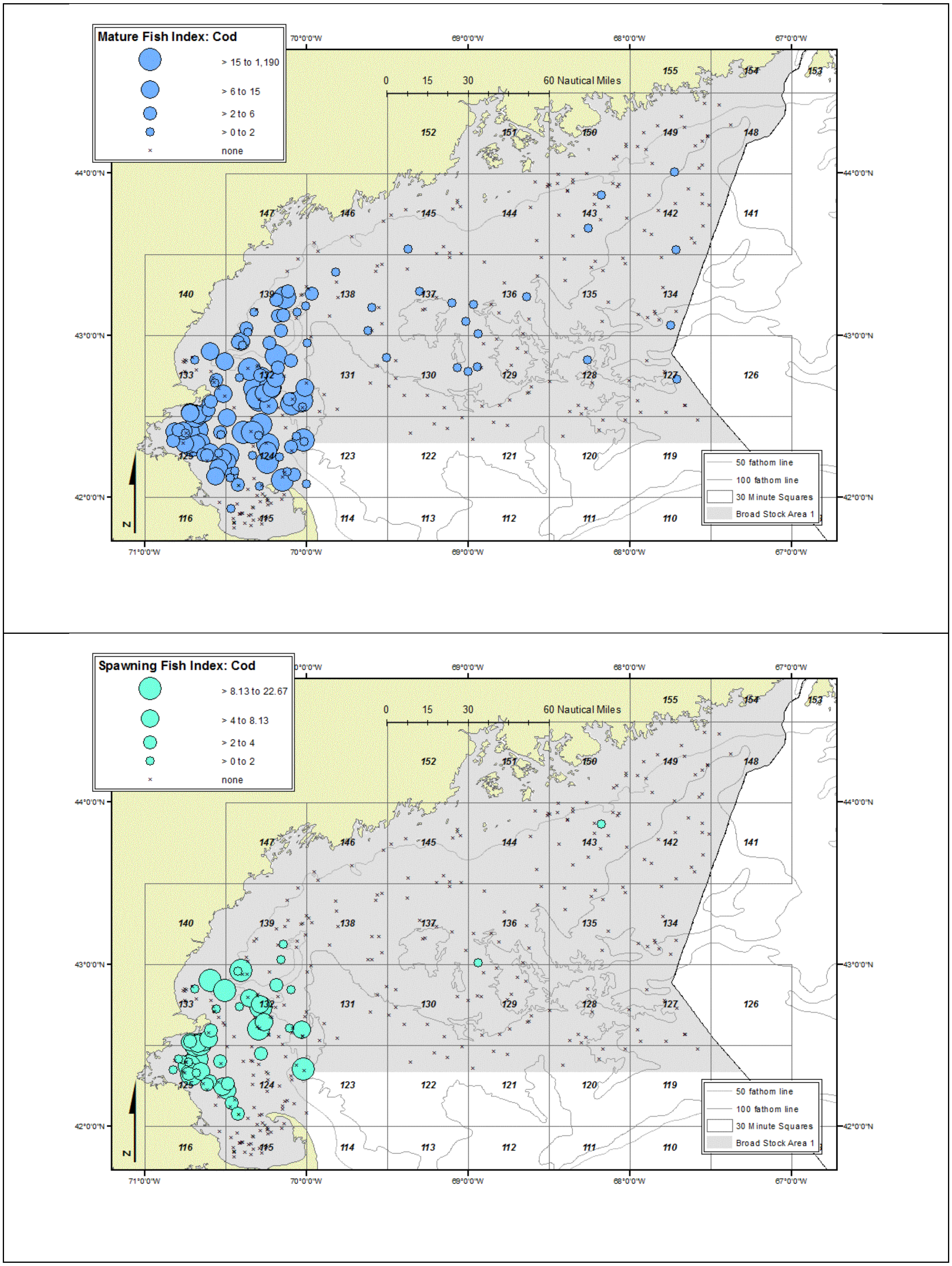


Figure 1- Mature Fish Index (above) and Spawning Fish Index (below) for Atlantic cod.

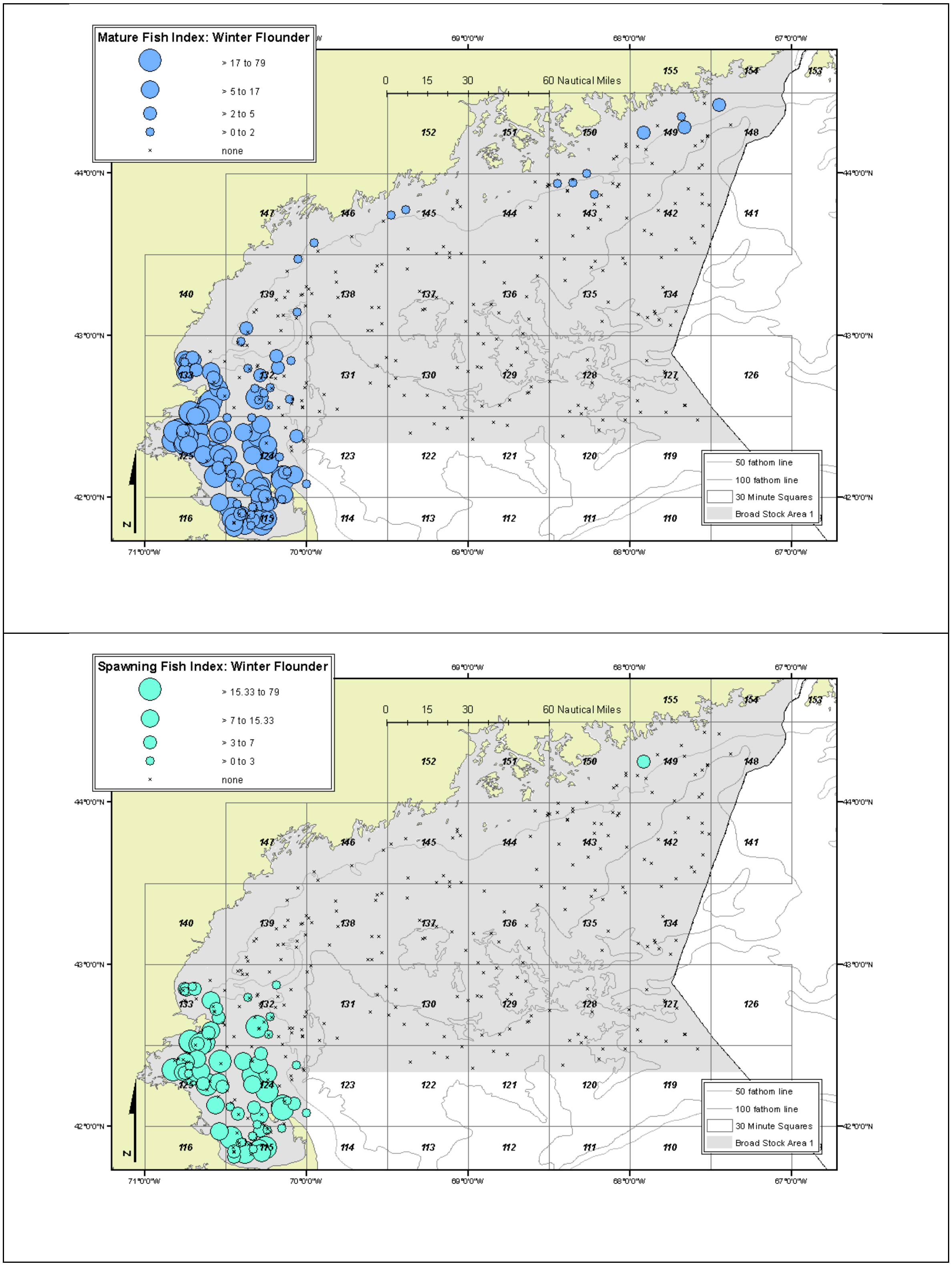


Figure 2- Mature Fish Index (above) and Spawning Fish Index (below) for winter flounder.

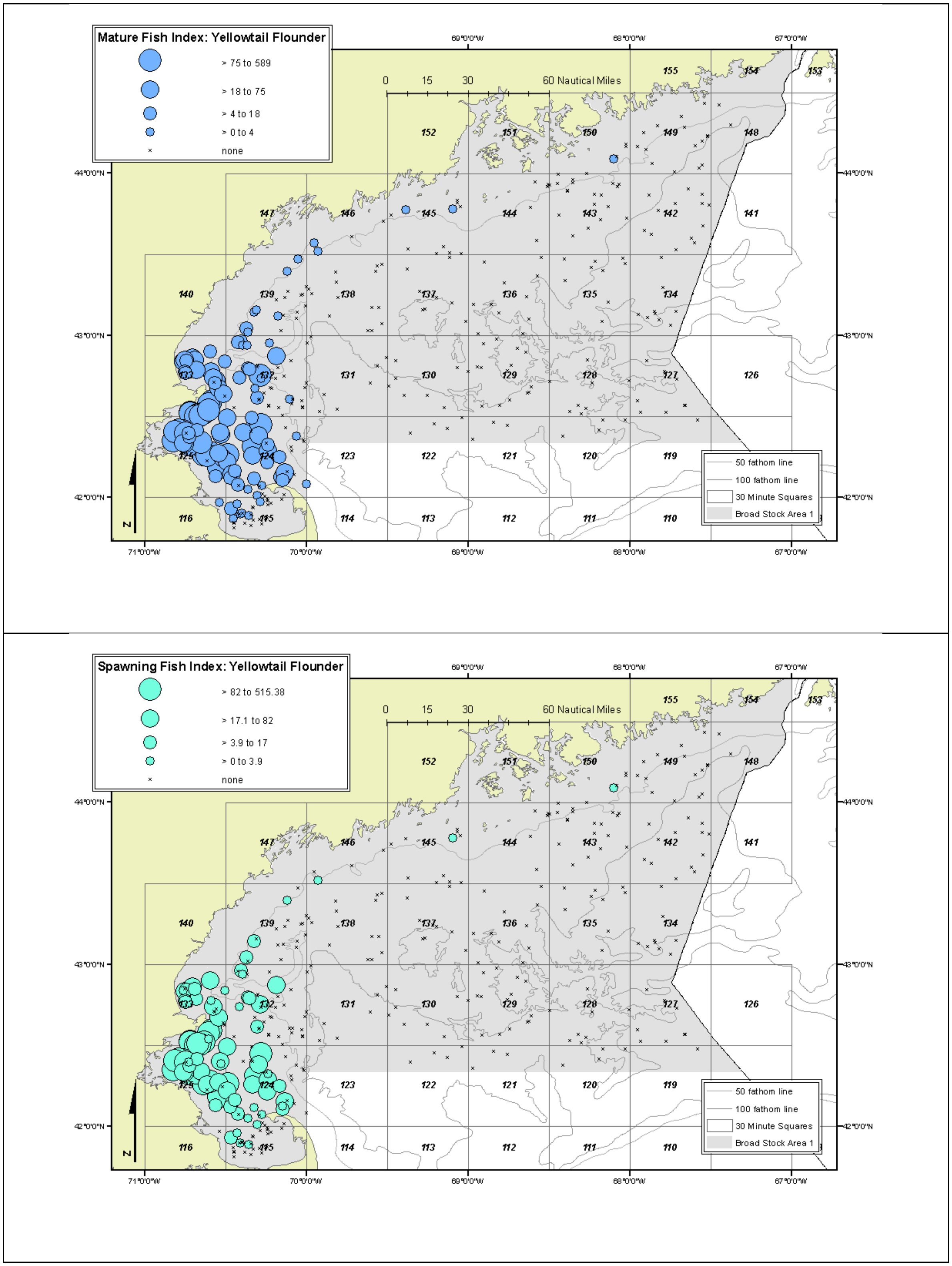


Figure 3- Mature Fish Index (above) and Spawning Fish Index (below) for yellowtail flounder.

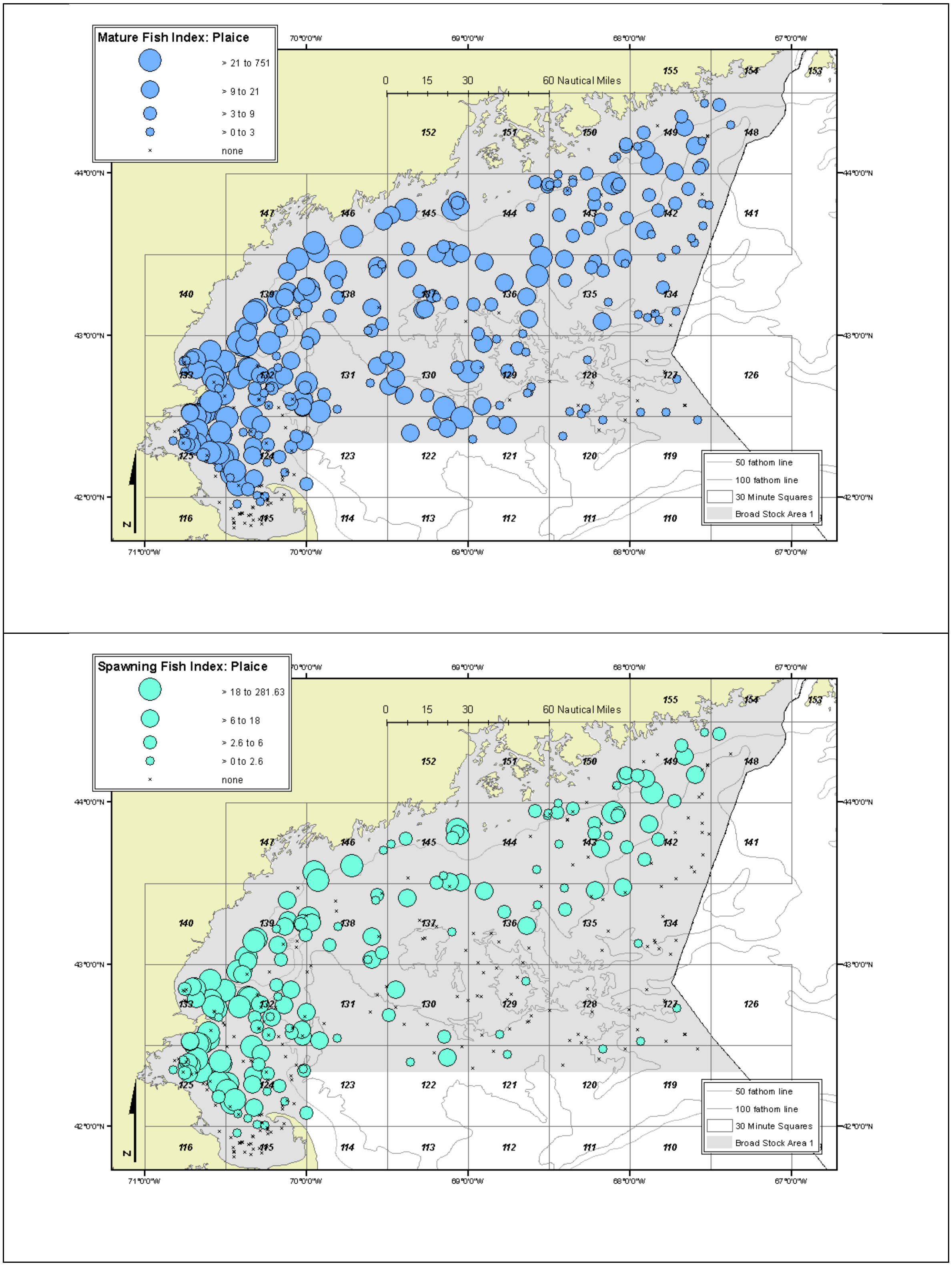
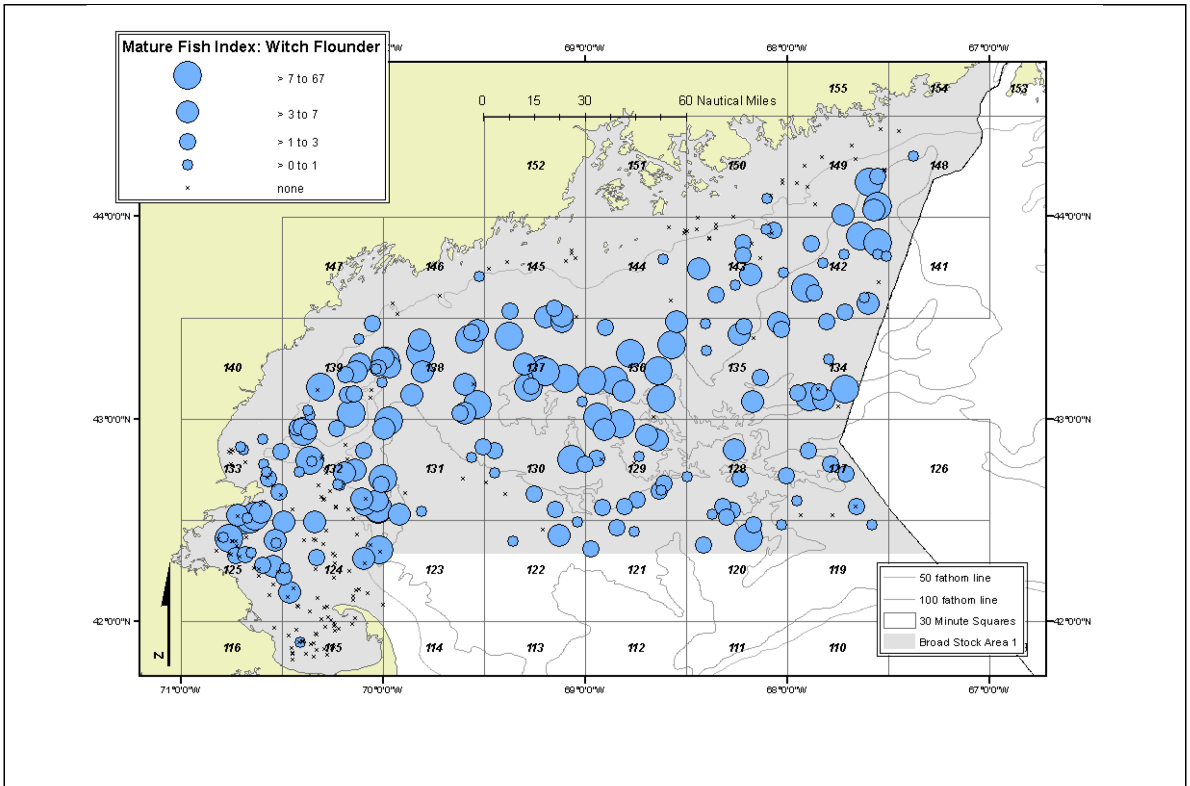


Figure 4- Mature Fish Index (above) and Spawning Fish Index (below) American plaice.



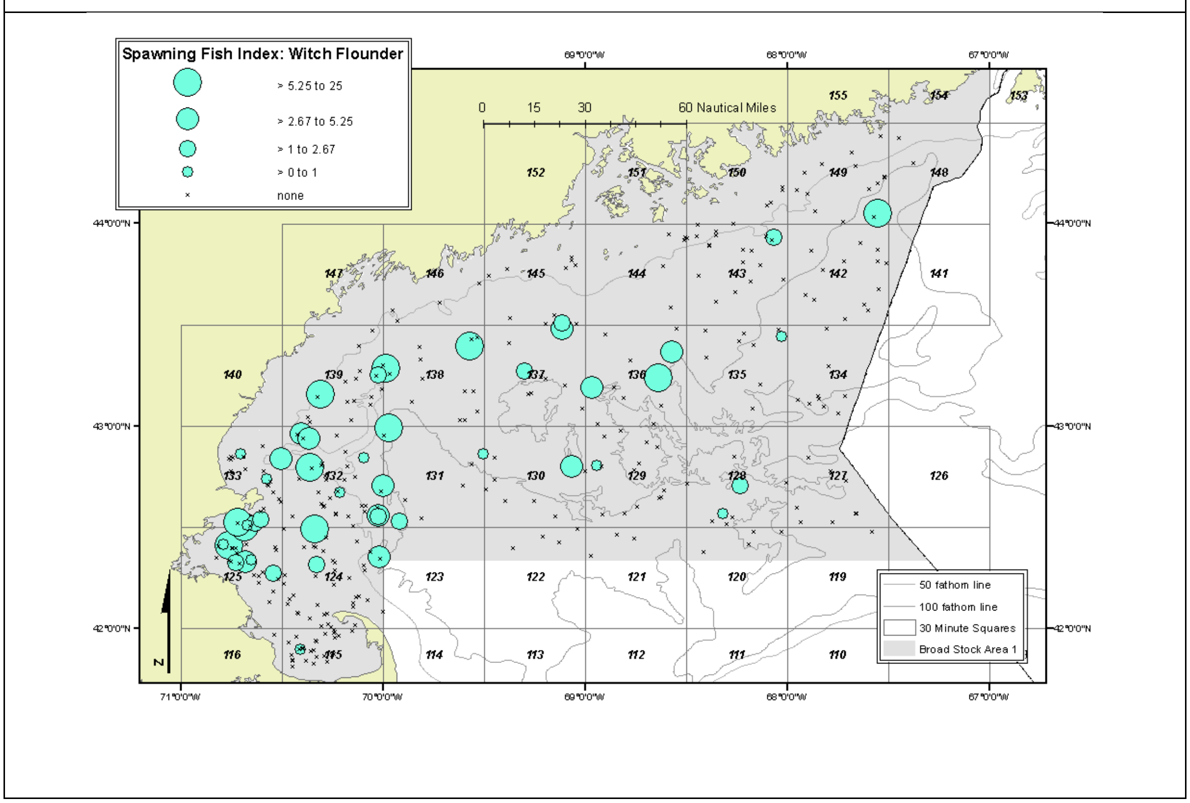


Figure 5- Mature Fish Index (above) and Spawning Fish Index (below) for witch flounder.

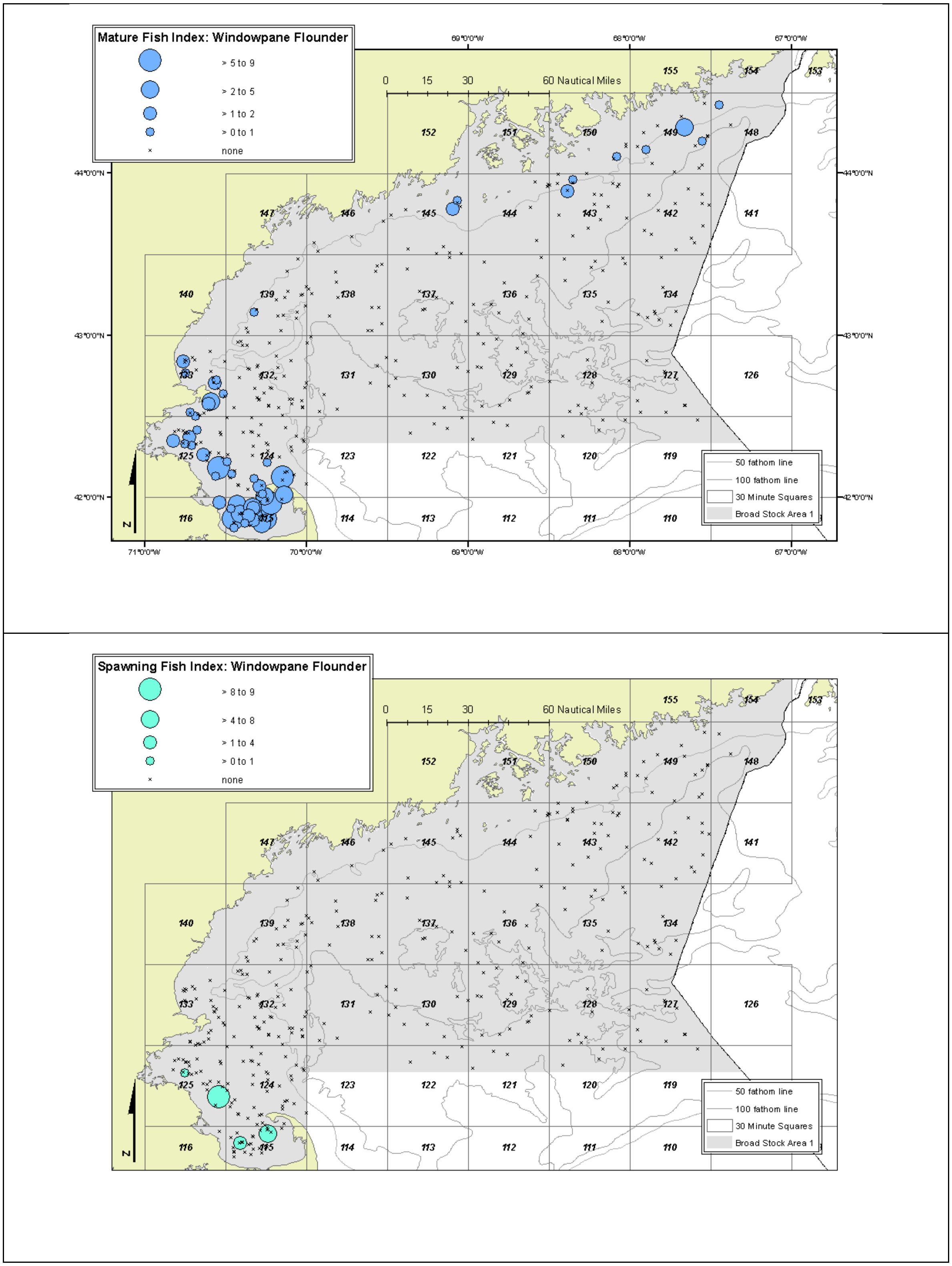


Figure 6- Mature Fish Index (above) and Spawning Fish Index (below) for windowpane flounder.

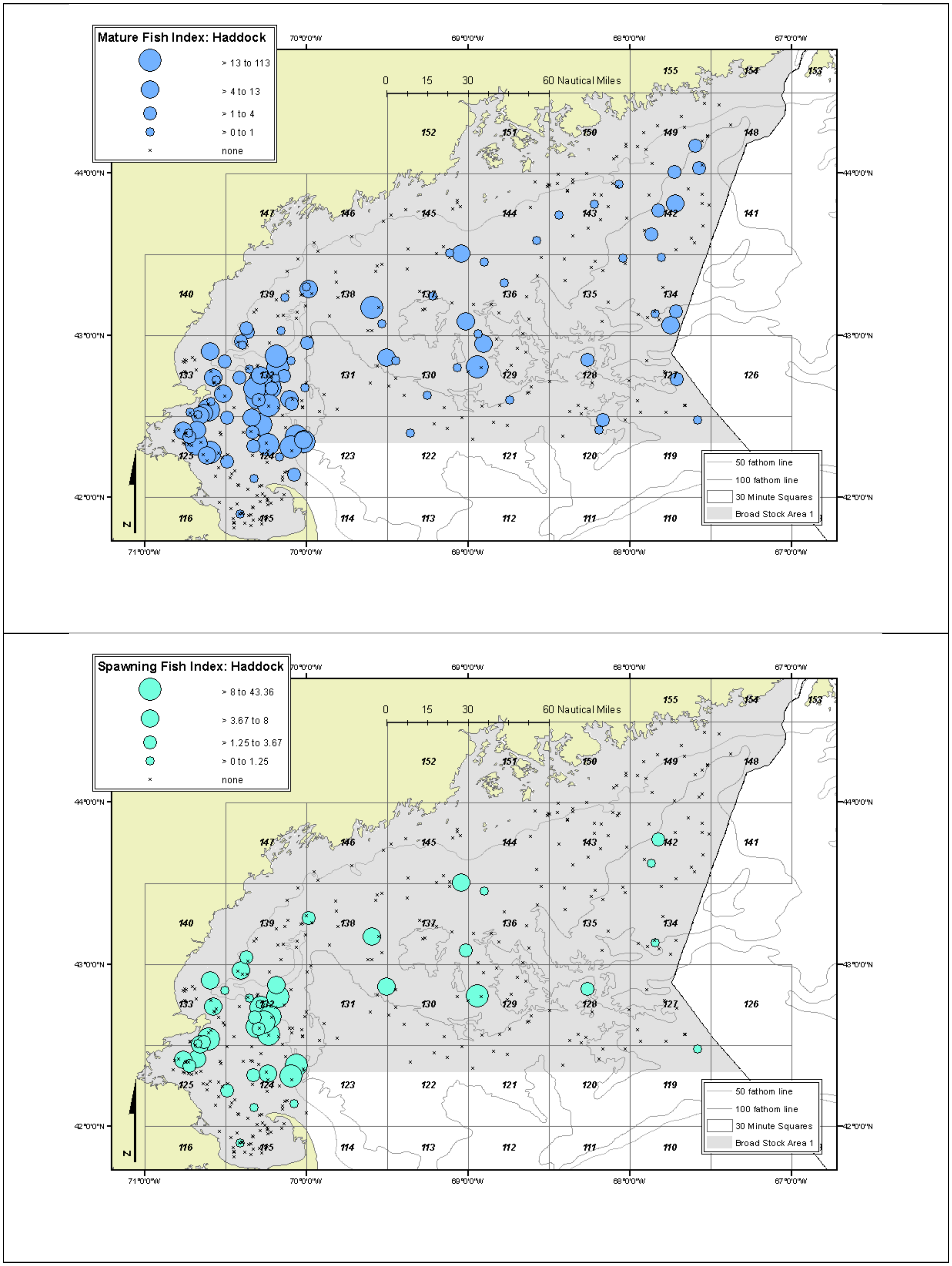


Figure 7- Mature Fish Index (above) and Spawning Fish Index (below) for haddock.

Conclusions:

The raw index (average numbers of fish/tow) for cod was relatively low in comparison to the maturity index (Table 3). This could be due to tows being conducted at the beginning of the spring spawning season. However the cod that were observed in spawning condition were within blocks 124, 125, 132, 133. The proportion of the index in spawning condition was relatively high for groundfish stocks of winter flounder, yellowtail flounder, American plaice, and haddock. Higher concentrations of spawning condition fish can be seen in blocks 124, 125, and 133 for winter flounder, and yellowtail flounder. For haddock, it appears all four blocks (124, 125, 132, and 133) are important for spawning. These blocks also appear to be important spawning blocks for American plaice. However, American plaice in spawning condition appear to be more widely distributed across the Gulf of Maine. Witch flounder and windowpane flounder showed relatively few fish in spawning condition. Additionally, witch and windowpane flounder that were observed in spawning condition did not appear to be as highly concentrated in blocks 124, 125, 132, and 133.

Comparison to the Alternatives in FW 53:

No Action

Under the No Action, the Sector Rolling Closures in April include 124, 125, 132, 133 and in May include 132, 133, 138, 139, 140. The Common Pool Rolling Closures include these additional areas in April 121, 122, 123, 129, 130, and 131 and in May 124, 125, 129, 130, 131, 136, and 137. In April and May, the No Action alternative in blocks 124,125,132, and 133 provides spawning protection for cod, winter flounder, yellowtail flounder, American plaice, and haddock and to a lesser extent witch flounder and windowpane flounder.

Preferred Alternative

Under the Preferred Alternative, there would be no Sector or Common Pool rolling closure in April. In May, the closures for both Sector and Common Pool would be May: 132, 133, 138, 139, 140, and 125 north of 42° 20'. Compared to the No Action alternative, the Preferred Alternative would negatively impact spawning fish in April with the opening of blocks 124,125,132, and 133, and in May in blocks 124 and 125 south of 42° 20' for cod, winter flounder, yellowtail flounder, American plaice, and haddock and to a lesser extent witch flounder and windowpane flounder.

References:

O'Brien, L., J. Burnett, and R. K. Mayo. 1993. Maturation of Nineteen Species of Finfish off the Northeast Coast of the United States, 1985-1990. NOAA Tech. Report. NMFS 113, 66 p.

Palmer M. C. 2014. 2014 Assessment update report of the Gulf of Maine Atlantic cod stock. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 14-14; p. 84 Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/publications/. Accessed on December 18th, 2014.

Examining the mortality objective of the Gulf of Maine cod protection measures using fishery-dependent data

Paul Nitschke, Michael Palmer, and Jamie Cournane

January 8, 2015

Overview:

The *Preferred Alternative* in Framework Adjustment (FW 53) for the Gulf of Maine (GOM) cod protection measures would modify the existing groundfish rolling closures for the commercial groundfish fishery, and prohibit possession of GOM cod by the recreational fishery. These GOM cod protection measures have three objectives: 1) to protect spawning GOM cod, 2) reduce mortality of GOM cod in the identified times and areas, and 3) minimizing impacts to fishing fleets by allowing for opportunities to fish for healthy groundfish stocks. The mortality objective (2) of the GOM cod protection measures was examined using vessel trip reports (VTRs) submitted between January 2010 and August 2014 for commercial and recreational landings.

Alternatives in FW 53:

Figure 1 depicts 30 minute squares in the GOM. The following blocks apply No Action/status quo:

Sector Rolling Closures (30-Minute Blocks):

- May: 132, 133, 138, 139, 140
- June: 139, 140, 145, 146, 147, 152
- April: 124, 125, 132, 133

Common Pool Rolling Closures (30-Minute Blocks):

- May: 124, 125, 129, 130, 131, 132, 133, 136, 137, 138, 139, 140
- June: 132, 133, 139, 140, 142, 143, 144, 145, 146, 147, 152
- October – November: 124, 125
- March: 121, 122, 123
- April: 121, 122, 123, 124, 125, 129, 130, 131, 132, 133

The GOM cod protection measures would modify the rolling closures for sector and common pool vessels (shown above) to the following time/area configuration:

GOM Cod Protection Closures for all vessels:

- May: 132, 133, 138, 139, 140, and 125 north of 42° 20’
- June: 132, 139, 140, 146, 147, and 125 north of 42° 20’

- November – January: 125, and an area of 124 defined by the following coordinates:
  - 42° 00’ N…70° 30’ W
  - 42° 00’ N…70° 24’ W
  - 42° 15’ N…70° 24’ W
  - 42° 15’ N…70° 30° W, and

Rolling closures would continue to apply to common pool vessels in the following 30-Minute Blocks:

- October: 124 and 125
- March: 121, 122, 123

Results:

No Action:

The No Action alternative maintains the existing rolling closures for sector and common pool vessels. The impact of these management measures on landings is evident in the proportion and total monthly landings plots for Gulf of Maine (GOM) cod from 2010-2014 (Figure 2 and 3). The VTR data indicates that most of the GOM cod landings were taken from blocks 124 and 132 across the year except for the months when these blocks are closed due to the rolling closures (124 in April and 132 in April and May for all vessels; 124 is closed to the common pool in April). The April rolling closures appear to have shifted fishing effort further offshore with relative increases in cod catch from the other category and block 138. Additionally, block 125 has higher relative cod catch during the winter spawning season from November to January and block 133 has higher relative catch during the spring spawn in June and July (Figure 3). These results are analogous to what was determined in the PDT spring and winter spawning area analysis (see Dean and Correia in this Appendix). Most of the recreational catch is also taken from blocks 124 and 132 (Figure 4 and 5). In addition, the recreational catch also suggests that block 133 becomes more important during the spring spawning season.

Preferred Alternative:

The removal of closure 30 minute blocks 132,133,124 and 125 in April would allow fishing effort to shift into these blocks, where cod catch has been concentrated. This additional fishing opportunity in these productive areas will likely produce an increased incentive for observer bias, and unaccounted for cod mortality under the low cod ACL if GOM cod are caught as bycatch when targeting other groundfish stocks such as winter flounder, yellowtail flounder, American plaice, and haddock in these blocks. It appears that the core of the GOM cod population is within blocks 124 and 132 throughout the year even though commercial landing information cannot be used to definitively make this conclusion since there are existing rolling closures in these areas. However, the spring survey’s positive cod tows conducted in April and May suggest that the highest cod abundance is within stratum 26 which roughly covers blocks 124 and 132 (2014 GOM cod operational assessment; Figure 1.26). Spring Gini indices and survey distribution plots from the assessment also suggest GOM cod distributions are concentrated in the western Gulf of Maine. In June, there may be some increased protection of cod from the 132 closure if this closure does not result in a shift in effort into blocks with high cod concentrations (i.e., block 124). The closure of block 125 north of 42 would likely afford minimal mortality protection since small amounts of catch come from 125 in May and June. There could be some increased protection from November to January if the displaced effort does not shift to other areas with high cod concentrations such as Stellwagen Bank or block 132 (Figure 3). Mortality reductions of the closures may not be realized with a potential shift in effort when blocks with high cod concentrations remain open (124 and 132). Mortality changes may be a tradeoff with the closure of one area and the opening of another or protection of cod from a closure may result in a shift in effort into other blocks that have relatively high cod concentrations. Therefore it is uncertain whether this action will result in a reduction in GOM cod mortality. Conversely, the opening of block 145 in June may also have minimal impact on cod since few cod were taken from this block in the past.

Summary:

This analysis suggests that should the GOM cod stock remain concentrated in the core 30 minute block areas of 124 and 132 the preferred closure areas provide little additional protection relative to the No Action. Some protection may be provided in June with the closure of 132 but in April protection of cod in the core area of 124 and 132 is lost. It is unlikely that reductions in fishing mortality will be met since displaced effort will probably shift into areas with relatively high cod concentrations (132 and 124) on unobserved trips.

Figures:

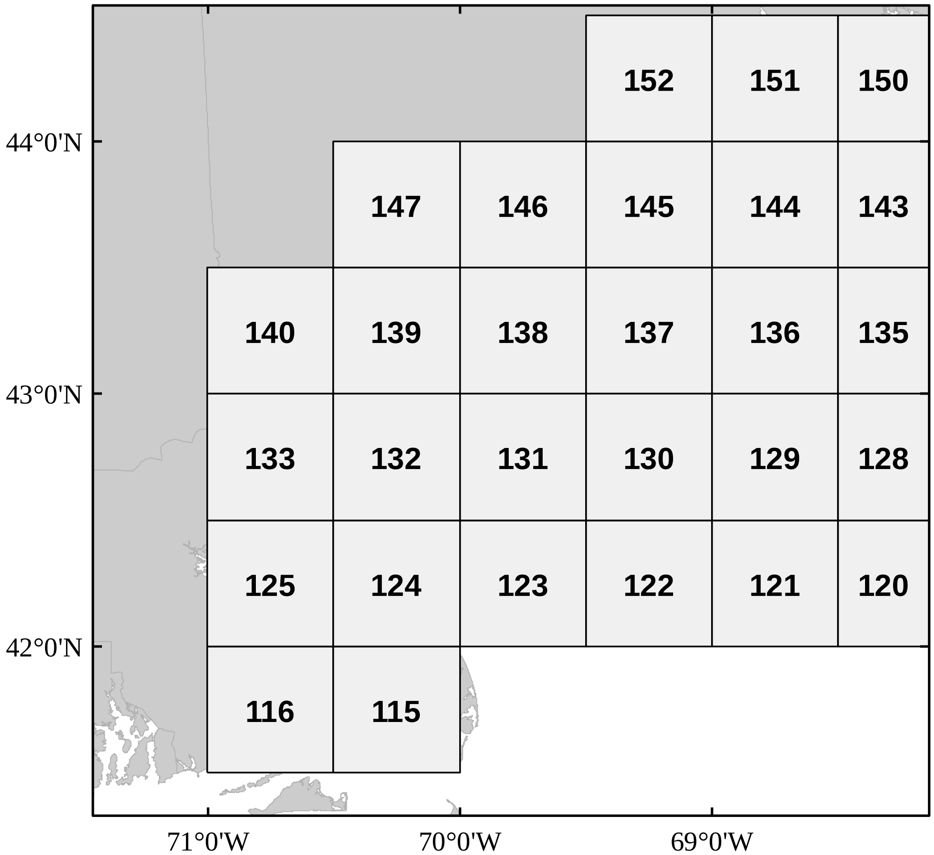


Figure 1. Map of 30 minute squares in the Gulf of Maine.

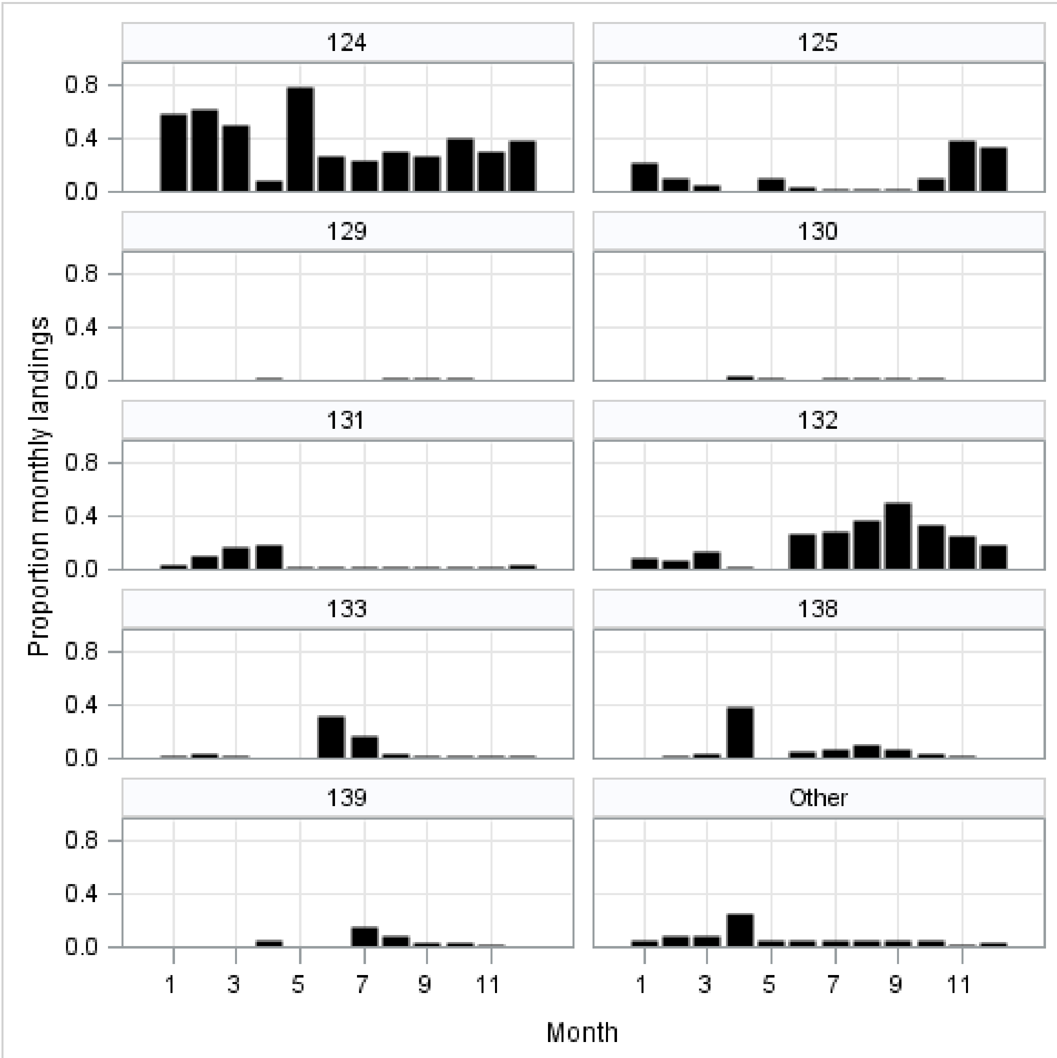


Figure 2. Proportion of commercial Gulf of Maine Cod landings by 30 minute block from 2010-2014.

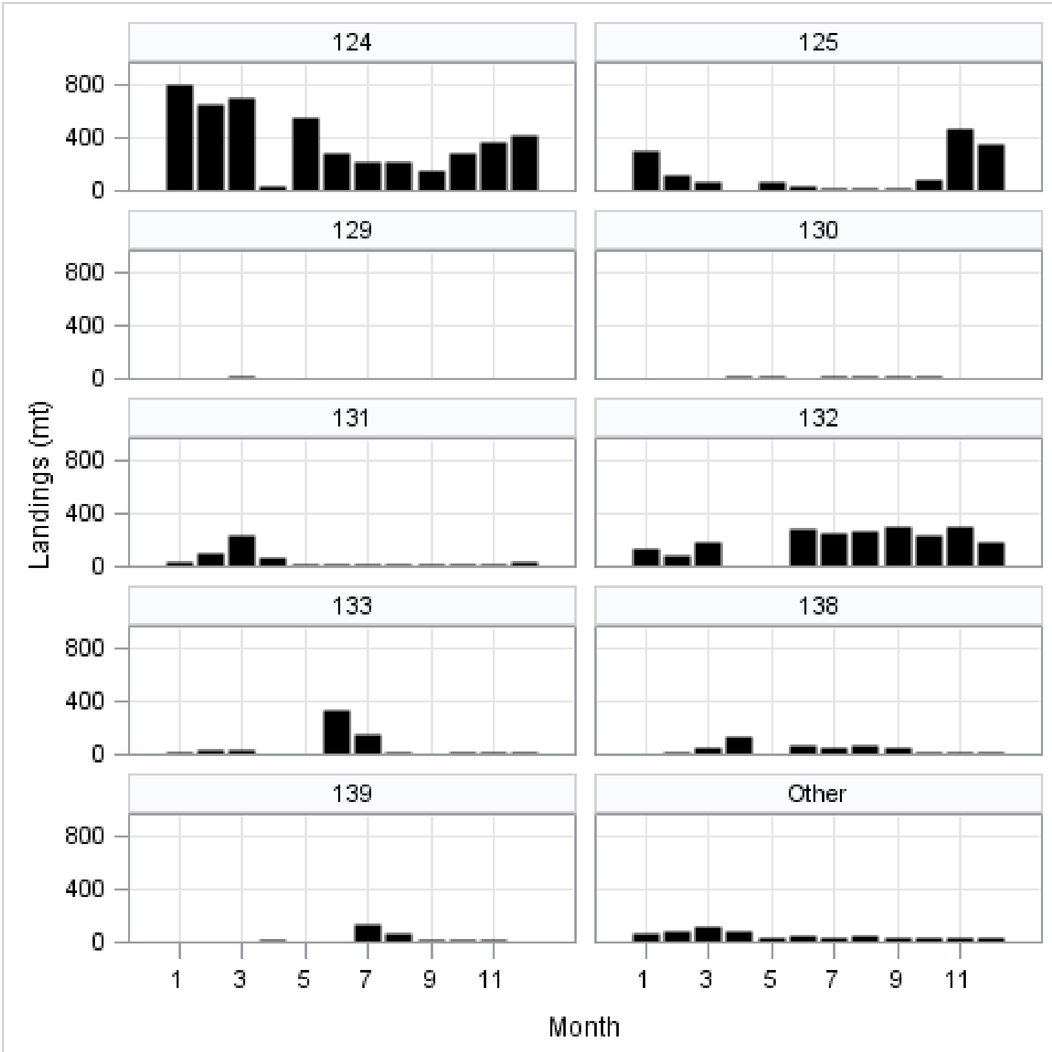


Figure 3. Total commercial Gulf of Maine Cod landings by 30 minute block from 2010-2014.

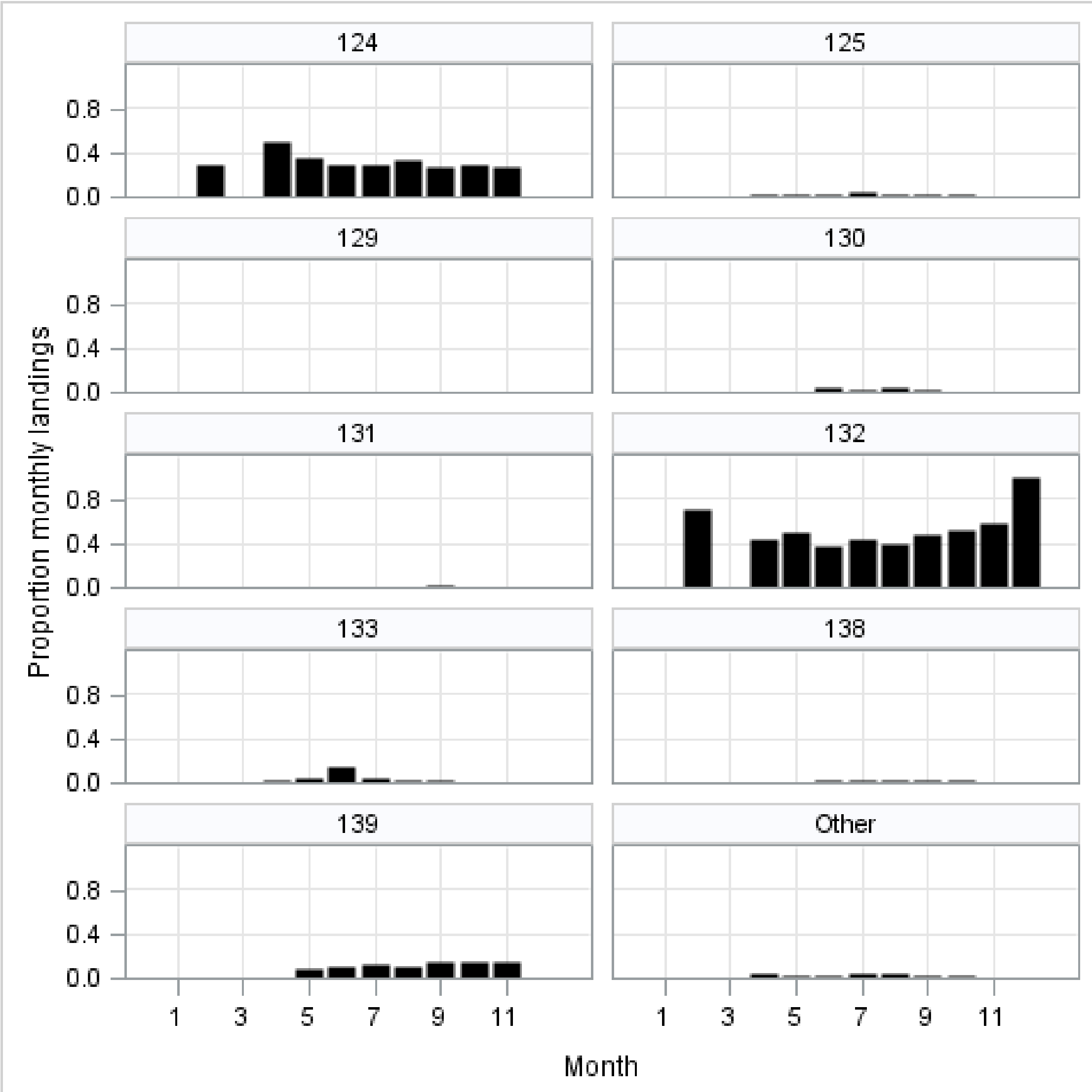


Figure 4. Proportion of VTR recreational Gulf of Maine Cod landings by 30 minute block from 2010-2014.

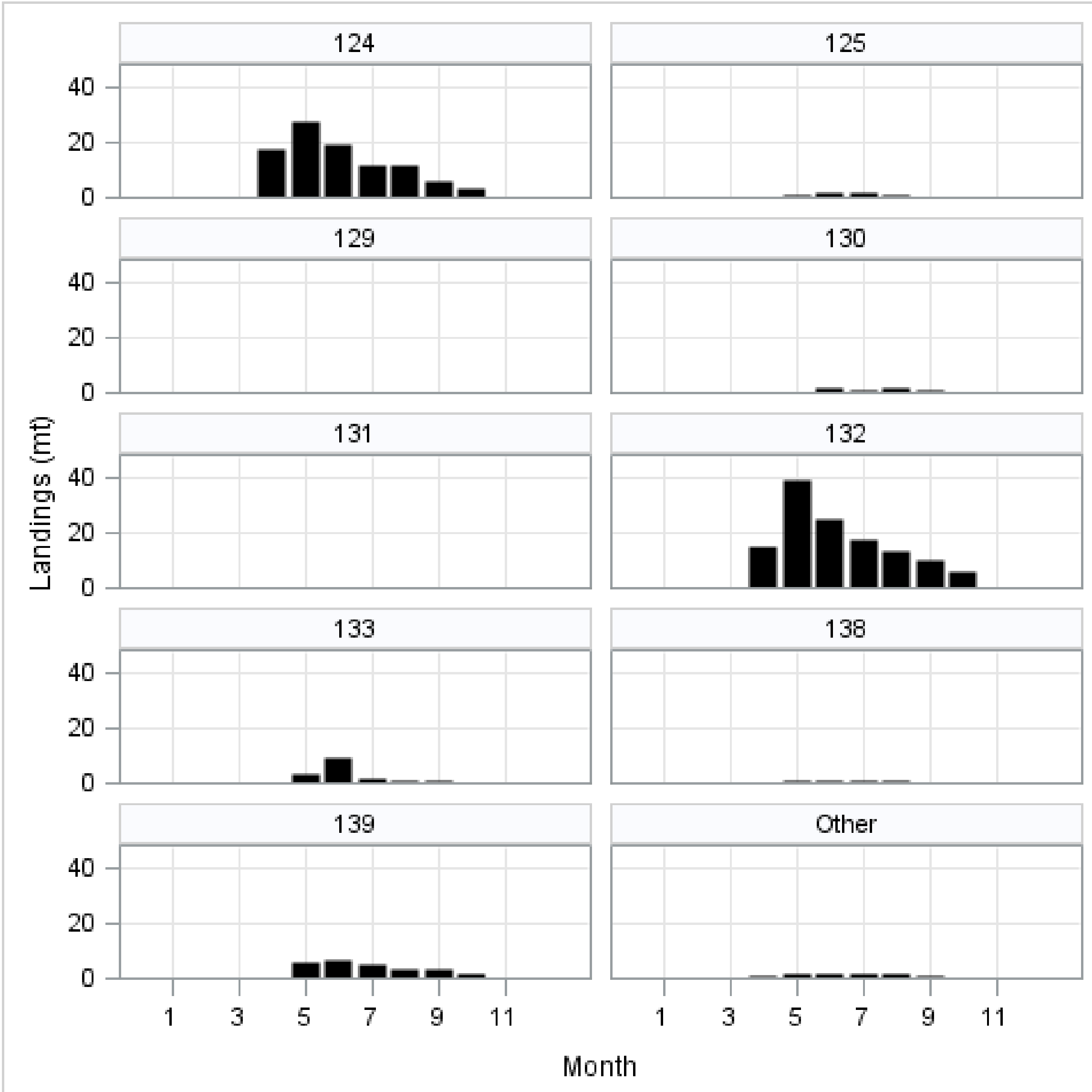


Figure 5. Total VTR recreational Gulf of Maine Cod landings by 30 minute block from 2010-2014.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

August 22, 2022

Dear Sector Managers:

Thank you for the letters from Hank Soule and Amy Morris on your behalf, concerning some of the challenges Sector Managers face. The letters note concerns with dealer reporting compliance and several data quality control issues you are experiencing on an ongoing basis. Similar concerns were also shared in your presentation at the June 2022 meeting of the New England Fishery Management Council.

We understand your concern about ensuring dealer and vessel data that inform our fisheries management decisions is as accurate and timely as possible. We agree that improvements can always be made to our data collection, processing, and quality control programs. Sector managers could also benefit from a thorough explanation of how these programs currently function and the limitations we face in administering them.

We would like to have a constructive and meaningful follow-up discussion with you. I have asked my staff from the Analysis and Program Support Division (APSD) to meet with you at a future Sector Managers meeting to provide an overview of our data collection, auditing, and compliance monitoring programs and share with you steps they are working on to improve these programs. We also would like to hear your suggestions on how we can improve our programs. An increased understanding of these programs coupled with a meaningful discussion of the issues you face as Sector Managers will provide a strong path forward for improving our data collection, auditing, and compliance programs.

I appreciate you taking the time to share your concerns and we look forward to working with you to improve our monitoring programs.

Sincerely,

Michael Pentony
Regional Administrator

Cc: David Gouveia
Sarah Bland
James StCyr
Peter Christopher

August 22, 2022

Tom Nies
Executive Director
New England Fishery Management Council
50 Water Street
Newburyport, MA 01950

Re: Scientific and Statistical Committee discussion on Georges Bank cod ABC 2023-2024

Dear Tom,

The Northeast Seafood Coalition (NSC) is writing to request the Scientific and Statistical Committee (SSC) consider a new 2023-2024 ABC for Georges Bank (GB) cod. Specifically, an ABC that attempts to reduce the significant economic impacts occurring from the present catch advice largely generated by the PlanBSmooth assessment approach, which is scheduled to be replaced by a more robust analytical assessment within the next two years.

Last year, NSC wrote to the Council (see attached letter) requesting GB cod be remanded back to the SSC for reconsideration. NSC was hopeful that the SSC with relevant information available, including 2020 catch information and more complete socio-economic information for the commercial and recreational fisheries, would reconsider the Council's Risk Policy and GB cod ABC previously recommended. NSC was also hopeful the SSC would recall its recommendation in 2017 that alternative approaches be investigated, such as capping the proportional change from year to year, when using the PlanBSmooth approach as the basis to recommend GB cod catch advice.

NSC understands that the SSC is not revisiting the PlanBSmooth assessment approach at this time. However, it is critical to highlight the scientific uncertainty that is now driving the economic harm to the commercial fishery, as indicated by the sector letter submitted to the SSC. The harm to the commercial groundfish sector program is not only caused by the GB cod quota reduction but also through the loss of yield from other allocated groundfish stocks to the commercial sector program. This is occurring now and will continue to occur in the 2023 and 2024 fishing years until such time as the Atlantic cod research track assessment and management update is complete.

The PlanBSmooth assessment approach was adopted in 2015. This approach was developed after the Rho Adjusted 2012 benchmark assessment ASAP model was rejected. The PlanBSmooth was considered *a* ***temporary assessment approach***. It has always been acknowledged that this approach, averaging survey data and using a loess smooth, may not adequately dampen the noise generated by the survey data. It is also known that there can be large changes in the multipliers and if catch is not close to the quota, there could be large changes in the quotas calculated even when the multiplier is close to one. This reality largely led to the SSC recommendation in 2017 to consider alternative approaches that cap the proportional change in catch advice.

The trawl survey does not catch GB cod consistently throughout the entire GB cod stock area, most likely due to randomly generated tow locations and seasonality of the survey. Thus, the trawl survey data does not reflect the GB cod catch occurring throughout the range from the commercial and recreational fleet. This is seen in the high 2020 catch information released by NOAA fisheries last year, that represents state and recreational catch, after the SSC deliberations.

Further, this assessment approach does not mirror the process followed by the U.S. – Canada Transboundary Resource Assessment Committee (TRAC) for the eastern portion of Georges Bank cod. The TRAC rejected the ASAP model in 2017. Since that time the TRAC has used different approaches to assess this stock and most recently have adopted the DMLtool (data limited) assessment approach as their Plan B *"temporary assessment approach" in 2021.* This inconsistency in approaches has been flagged throughout the U.S. stock assessment process.

It's critical for SSC members to realize that the ABC adopted through the SSC process is further reduced to reflect the shares negotiated through the U.S. – Canada Sharing Agreement. ***The remaining portion of the ABC left for the U.S. fishery, and groundfish sector sub-ACL in 2022, is significantly less than the amount approved by the SSC.***

Decline in US ABC from FY2021 to FY2022:
Total ABC = 754 mt
Canadian TAC = 411 mt
US ABC 2022= 343mt
US ABC 2021 = 1,308 mt
73.8% decline

The commercial groundfish sector program has been operating with high levels of monitoring and reporting requirements since the inception of the sector program in 2010. On December 14, 2021, the NOAA Fisheries Regional Administrator announced the ASM coverage for the present fishing year would be up to 99% until Amendment 23 measures, an industry funded groundfish monitoring program, is finalized.

There has been a significant reduction in effort in the commercial fishery since the inception of the sector program. The number of commercial vessels actively fishing, most notably in the offshore groundfish fishery, has been greatly reduced due to the instability in the assessments, big swings allowed in catch advice and low quotas being held constant for extended periods. In most cases, quotas that often do not adequately reflect what fishermen are seeing on the water.

Overall, the financial viability of many groundfish fishing businesses, along with their sector entities that depend upon their landings to remain functional, is in jeopardy. Many sectors have already consolidated and some have ceased operations. There is simply not enough fish in the sector program to allow for vessels, under the sector program, to actively fish in the Georges Bank cod stock area safely. Sectors and their active members are anticipating the worst, being shut down mid-season.

As you'll read from the sector manager letter, lease prices for Georges Bank cod have already skyrocketed this fishing year. While we raised these concerns last year when requesting a remand to the SSC; the severity was not captured in the analysis and models used under Framework 63. Further, the SSC was not presented with any analysis showing the impact to lease prices and the fishery when you convened last year. These extreme prices are not sustainable in light of average market price and increase in fuel expenses.

There is a high level of accountability in the groundfish sector program *that is unlike any other fishery in this region.* This not only includes monitoring but also weekly, sometimes daily, reporting requirements as well as other yearly sector reporting mandates and thorough data reconciliation process.

In light of the underlying scientific uncertainty with the PlanBSmooth assessment approach, the ongoing Atlantic cod research track work and economic constraints, NSC urges the SSC to reconsider the 2023-2024 ABC to a level that allows the sector program to remain functional. When broken down at the sector and then vessel level, the current sub-ACL for the groundfish sector program is well below any bycatch allocation for an active business fishing throughout the Georges Bank cod stock area and the loss of yield for other groundfish stocks is significant. Furthermore, critical information is being lost through commercial fisheries data that could lead to improvements in the stock assessment over the long-term. *The data being generated from the groundfish sector program is like no other.*

NSC greatly appreciates your attention to this important issue that we strongly believe is process not biomass driven. We urge the SSC to consider a recommendation that is mindful of the stock but attempts to strike a better balance with the needs of the groundfish sector program until such time as the Atlantic cod research track and management update are complete. There is a high level of accountability in the sector program that after twelve years of implementation should be yielding some positive benefits for the remaining active participants not the threat of having to cease fishing, lost opportunities to harvest other allocated stocks, and potential impacts, that could be long-term, to the U.S. market share.

Sincerely,

Jackie Odell

Jackie Odell
Executive Director

Northeast Seafood Coalition Associated Fisheries of Maine

December 3, 2021

Mr. Eric Reid, Chairman
New England Fishery Management Council
Via: Email

Dear Eric,

We are writing to support a remand of the Georges Bank cod (GB cod) Acceptable Biological Catch (ABC) back to the Council's Scientific and Statistical Committee (SSC) for reevaluation.

When the SSC met on October 25, 2021, the SSC did not have all the relevant information available when considering the ABC recommendation for GB cod. SSC members did not have socio-economic information, as outlined in the Council's Risk Policy Road Map, nor did they have final catch information from the 2020 fishing year that offers a different signal for the resource.

On November 19, 2021, a month after the SSC meeting, NOAA Fisheries Regional Office (GARFO) released the final 2020 catch report. This report states that the recreational fishery (combination of federal recreational and state waters) caught 294.4 mt of GB cod in 2020. *This 2020 catch represents roughly 85% of the 343 mt that would be made available to* ***ALL*** *U.S. fisheries in 2022-2024, based upon the recent GB cod assessment report and SSC recommendation. This high 2020 catch is occurring in areas not factored into the PlanBsmooth empirical assessment for GB cod. This is incongruent with the purported status of the resource.*

Continuing to rely upon a "noisy," "data limited" PlanBsmooth assessment which only factors in three years of Georges Bank survey strata/data, with one year missing due to the pandemic, is a serious problem. An SSC recommendation that represents an 80% reduction in the allowable catch for U.S. fisheries using this limited approach without factoring in the signal from the 2020 catch information is wrong.

During the SSC meeting, there was limited to no socio-economic (commercial and recreational) information for the SSC to evaluate the economic risks associated with the highly uncertain assessment and the ABC derived. This is not only counter to the directive offered by the Council's own Risk Policy but it is also inconsistent with how other FMPs provide socio-economic data for SSC consideration and deliberations under a Risk Policy Matrix.

To conclude, we implore the Council to offer a remand to the SSC that factors in all the relevant information available and reconsiders the ABC advice in a manner which does not result in an extended delay of Framework 63.

Specifically, the SSC should evaluate the economic and biological impacts associated with a phased in approach as outlined in the SSC minority report, whose linear decline represents a substantial conservation benefit. This request is consistent with the Council's ABC Control Rule:

> *Option d.: Interim ABCs should be determined for stocks with unknown status according to case-by case recommendations from the SSC.*

It is also consistent with prior SSC recommendations on GB cod, October 23, 2017 SSC report.

> 9. Recommend that the "PlanBsmooth" approach be simulation tested to answer questions about the assessment techniques stability and that other control rule options be investigated such as capping the proportional change from year to year when using this approach.

The Council has also supported a phased approach under their comments for National Standard 1 that we view is warranted now under this circumstance.

The commercial and recreational fishery deserve an SSC evaluation that includes all relevant information before being subjected to the economic losses derived from an assessment approach which is rife with uncertainty.

Sincerely,

Jackie Odell, Executive Director
Northeast Seafood Coalition

Maggie Raymond, Executive Director
Associated Fisheries of Maine

MEMO

To: Tom Nies, Executive Director, New England Fishery Management Council
From: New England groundfish sector managers
Date: August 22, 2022
Re: Georges Bank cod catch data, and fishing effort indices

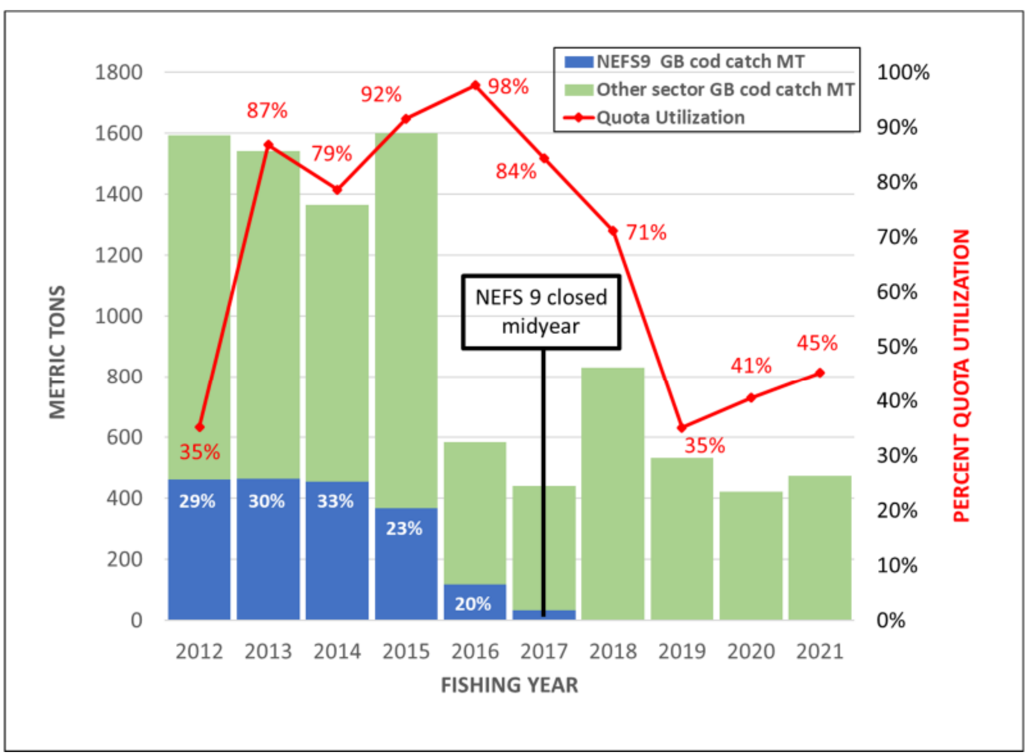
At its August 25 meeting, the SSC is to review additional relevant information concerning Georges Bank cod catch and economic indicators. Managers of New England's groundfish sectors gathered information on several indices, some that may not be yet available from GARFO for the Groundfish PDT but that the sectors have ready access to.

Historical GB Cod (East + West) Catch Information

Generally, in FYs 2012-2017, GB cod (East + West) quota utilization was high, ranging from about 80% to nearly 100%, except in FY 2012. In FYs 2018-2021, utilization fell to 35%-45%.[1]

Much of that decline may be attributable to GARFO's barring the Carlos Rafael fleet from fishing, which occurred in the middle of FY 2017. Rafael's fleet was enrolled in Northeast Fishery Sector IX (NEFS 9). Nearly all of NEFS 9's annual catch was harvested by Rafael vessels, thus NEFS 9's catch records are a reasonable proxy for the Rafael fleet's catch. Figure 1 shows the decline in GB cod quota utilization after NEFS 9 was closed and the Rafael fleet ceased harvesting:

Figure 1: NEFS 9 and Other Sector GB Cod (East + West) Catch, FY2 2012-2021[2]



The Rafael fleet and permits were sold, but their directed fishing effort on Georges Bank cod was never fully replaced. Several of the vessels did not re-engage in groundfishing, and the firm which acquired most of the assets does not target GB cod.[3]

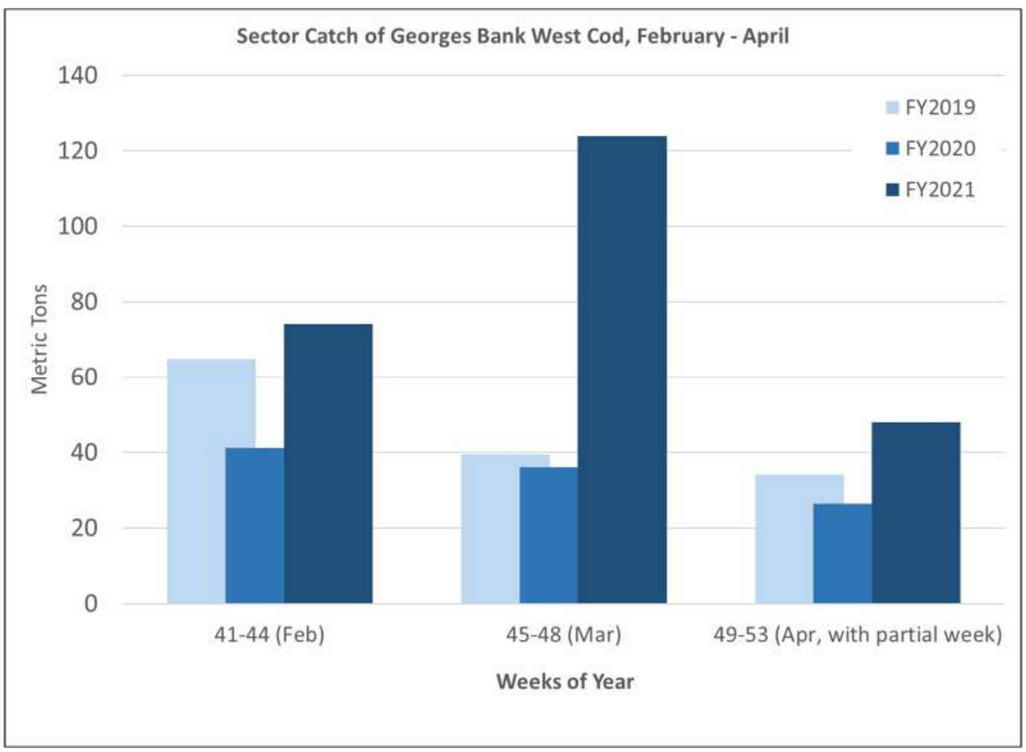
Some measure of decline could also be attributable to the broader reduction in the offshore groundfish fleet since inception of the sector system. Some vessels operating from ports in Southern New England that fished seasonally for groundfish have modified their fishing plans away from groundfish.

In-Season Catch Utilization

FY 2021

We understand the most recent spring bottom trawl survey's GB West cod catch was low. However, the sector fleet had a markedly different experience, with FY 2021 end of year spring catch rates substantially higher than in the previous two years:

Figure 2: Sector Catch of GB West Cod, Spring FYs 2019-2021[4]



FY 2022

Total GB cod (East + West) quota utilization for the first three months of FY 2022 largely reflects the roughly 75% reduction in quota from last year (Table 1, next page):

Table 1: First Quarter (May-July) Sector GB Cod (East + West) Catch, FY2021 vs. FY2022[5]

Fishing Year	Cumulative Catch MT	Pct Quota Caught
2021	130.8	12.5%
2022	31.1	13.1%
Reduction	*(76%)*	

This reduction in catch should not be portrayed as an indicator of abundance, but primarily a combination of GB cod avoidance behaviors, high fuel prices, and high quota prices as discussed below. It is critical that this reduction is understood and characterized appropriately.

GB Cod ACE Lease Prices

Sectors communicate regularly with each other and their members concerning availability of ACE to lease. Lease prices and actual or expected quota utilization generally rise and fall in tandem. Following is a sector's data table showing median annual asking prices for leased GB cod (East + West) ACE compared to year-end quota utilization. We then matched the calendar year average ex-vessel price of codfish in New England (expressed in dollars per live/ACE pound) to the fishing year:

Table 3: GB Cod (East + West) ACE Lease Price vs. Quota Utilization, and ex-vessel cod price, FYs 2016-2022 YTD[6]

Fishing Year	Median Lease Asking Price	Quota Utilization
2022 YTD	$4.38	13%
2021	$0.30	45%
2020	$0.43	41%
2019	$0.55	35%
2018	$1.03	71%
2017	$1.25	84%
2016	$1.50	98%

Calendar Year	New England cod Ex-vessel price
2022	Unknown
2021	$2.23
2020	$2.20
2019	$2.26
2018	$2.22
2017	$2.39
2016	$1.90

The FY 2022 YTD lease asking median price of $4.38 – easily the highest seen for any stock over the duration of the groundfish catch share program – reflects concern that this year's low GB cod quotas could force individual vessels or entire sectors to cease fishing in the GB stock areas midyear. Some sectors have implemented cod catch hotspot reporting systems to help their members avoid concentrations of codfish.

Outlandish lease prices may serve as a 'canary in the coal mine' that fishermen's observations of abundance do not gybe with population assessments. At the start of FY 2022, the GB West cod quota was cut by about 90% - immediately after the over 100% surge in year-over-year catch at the end of FY 2021 as shown in Figure 2.

Other stocks with record-low quotas do not show this signal. For example, the SNE yellowtail quota is just 12.2 MT. Yet quota is available in the marketplace for $0.10-$0.25 – versus a calendar year 2021 New England ex-vessel yellowtail flounder price of about 90 cents.[7]

Fuel Prices

We know of no publicly available source for historical marine diesel fuel prices in New England. Instead, we gathered first quarter (May through July of the fishing year, for the three most recent fishing years) diesel fuel price data from three sources as indices of change:

- The U.S. Energy Information Administration's (EIA) New England monthly average diesel fuel prices.[8] We deducted the Massachusetts excise tax (24.0 cents/gal.) and federal fuel tax (18.3 cents/gal.) from the EIA's prices to try to approximate a non-road use sales price.
- The Pacific States Marine Fisheries Commission's monthly survey of West Coast marine diesel fuel prices.[9] Prices are usually before tax.
- The U.S. EIA's New York Harbor monthly Ultra-Low Sulfur No. 2 Diesel Spot Price,[10] which is a wholesale price.

Table 4: Sample Diesel Fuel Prices, First Quarter FYs 2020-2022

Calendar Month/Year	US EIA NE Retail Price	PSMFC Marine Diesel Survey	US EIA NY Harbor Spot
May 20	2.209	2.287	0.887
Jun 20	2.207	2.228	1.124
July 20	2.217	2.362	1.24
Avg 2020 Q1	**2.21**	**2.29**	**1.08**
May 21	2.710	2.925	2.024
Jun 21	2.786	3.010	2.121
July 21	2.825	3.365	2.127
Avg 2021 Q1	**2.77**	**3.10**	**2.09**
May 22	5.871	5.108	4.646
Jun 22	5.695	5.571	4.362
July 22	5.320	5.833	3.696
Avg 2022 Q1	**5.63**	**5.50**	**4.23**

May-July avg price increase			
2020>2021	25%	35%	93%
2021>2022	103%	78%	103%

Anecdotally we understand the actual prices groundfishermen paid were somewhere between the bounds of the figures in Table 4. The near doubling in price from 2021 to 2022 is probably the most valuable takeaway. Fuel is by far the highest non-wage cost of goods sold of a fishing trip.[11] Its cost is either split in some fractional manner between the vessel owner and the crew, or deducted entirely from the crew share.[12] In either case, absent offsetting increases in per-trip revenue (which sectors are unable to measure), high fuel prices have been a disincentive to catching expensive quota during the summer of 2022.

FY 2022 Cumulative Effects

The combination of high fuel and quota costs, along with concerns about abundance levels seen in the spring but not reflected in the spring survey, led to a significant reduction is sector fishing effort in the first quarter of FY 2022 compared to recent prior years:

Table 5: First Quarter (May-July) Sector Fishing Effort, FYs 2020-2022[13]

	Count			*Year over year change*		
May-July	**Sector trips**	**Sector days fished**	**Unique vessels**	**Sector trips**	**Sector days fished**	**Unique vessels**
2020	3,054	3,781	151	--	--	--
2021	2,468	3,211	117	-19%	-15%	-23%
2022	1,607	2,340	107	-35%	-27%	-9%

Other reasons cited by managers for this year's reduced effort include declining ACE catch in the SNE stock area, better fishing opportunities in other fisheries, lack of crew, and infrastructure.

A Note Concerning FY 2022 Catch of GB East Cod

The sector fleet has already caught over a third of its GB west cod ACE, and will very likely convert substantial quantities of GB East to GB West cod to continue fishing in most of the Georges Bank and all of the Southern New England stock areas. These conversions may translate to lost U.S. fishing opportunities in the eastern area, and we do not want this to negatively impact US fishermen in future analytical assessments or allocation negotiations.

We hope this additional information provides some value and context to the SSC.

Sincerely,

John Haran
Fixed Gear Sector

David Leveille
Northeast Fishery Sectors 2, 6

Linda McCann
Northeast Fishery Sector 8

Amy Morris
Fixed Gear Sector

Dan Salerno
Northeast Fishery Sectors 5, 11

Hank Soule
Sustainable Harvest Sectors

cc: Northeast Seafood Coalition

References

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[1] GARFO cumulative multispecies catch reports at https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/h/nemultispecies.html

[2] GARFO annual multispecies catch reports at https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/h/nemultispecies.html

GARFO's "Sector End of Year Accounting of NE Multispecies Catch" reports.

[3] Personal communication with sector manager.

[4] GARFO cumulative multispecies catch reports at https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/h/nemultispecies.html. These reports are updated weekly, and users can capture each update to construct weekly and monthly tallies of catch. Report data are very preliminary and can be based on estimates of catch which are later corrected with actual weights.

[5] Ibid.

[6] GARFO cumulative multispecies catch reports at https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/h/nemultispecies.html

Lease prices from personal communications with sector managers.

Ex-vessel prices available at https://www.fisheries.noaa.gov/foss/f?p=215:200:17497534508690:Mail:NO:::

[7] Ibid.

[8] https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2DXL0_PTE_R1X_DPG&f=M

[9] https://www.psmfc.org/efin/data/fuel.html. Four-state monthly average (AK, CA, OR, WA).

[10] https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EER_EPD2DXL0_PF4_Y35NY_DPG&f=M

[11] NOAA Technical Memorandum NMFS-NE-227 "Northeast Trip Cost Data - Overview, Estimation, and Predictions," p12, at https://repository.library.noaa.gov/view/noaa/4636

[12] NOAA Technical Memorandum NMFS-NE-227 "An Overview of the Annual Cost Survey Protocol and Results in the Northeast (2007 to 2009), p8, at https://repository.library.noaa.gov/view/noaa/4635

[13] Data contributed by all managers of active fishing sectors. "Sector trips" are all trips declared under a sector fishing code. "Sector days fished" is sum of hours outside the VMS demarcation line, converted to days. "Unique vessels" is count of individual vessels making a sector trip.