



New England Fishery Management Council

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Corrected on 12/18/2017 as marked

MEMORANDUM

DATE: December 15, 2017
TO: Scientific and Statistical Committee
CC: Groundfish Committee
FROM: Groundfish Plan Development Team
SUBJECT: **Candidate Atlantic halibut OFLs and ABCs for fishing years 2018 to 2020**

The Groundfish Plan Development Team (PDT) discussed candidate overfishing limits (OFLs) and acceptable biological catches (ABCs) for Atlantic halibut.

1. Information reviewed:

- Draft Halibut Assessment Report for 2017, December 1, 2017 (P. Rago)
- Draft summary of how the assessment ToRs were addressed, December 2017 (P. Rago)
- Addendum to assessment report, December 15, 2017 (P. Rago)

2. Overview

This memorandum provides information to support fishing year 2018 – 2020 OFL and ABC recommendations by the SSC for Atlantic halibut, based on the peer review results of the 2017 Plan B assessment of Atlantic halibut in December 2017. The terminal year of the assessment is 2016.

The assessment and peer review report are provided as separate documents and the data in the assessment is not repeated within this memorandum.

The PDT did not make specific recommendations for fishing year 2018 to 2020 OFLs/ABCs for Atlantic halibut. Rather, the PDT offers some options for the SSC to consider.

Catch Performance

The PDT provides information on catch performance for Atlantic halibut (Table 1 and Figure 2). Catch is the calendar year catches from 2005-2016. Historical OFLs and ABCs are provided for each fishing year (May 1 start) since 2010. The catch performance information provides calendar year catches from the stock assessments and fishing year ABCs, and therefore do not temporally align.

Appendices

This memorandum includes several appendices:

- A. Biological considerations for halibut
- B. Discard data and discard mortality information
- C. Overview of specifications and recent catches by fishery components
- D. Information on the State of Maine's directed Atlantic halibut fishery
- E. Analysis of data on locations on halibut catches by gear type
- F. Economic information on the Atlantic halibut fishery

3. OFLs and ABCs options for Atlantic halibut

Previous assessment - Based on NMFS determination, Atlantic halibut is overfished, but overfishing is not occurring in 2014. The peer review rejected the halibut assessment at the 2015 operational assessment, and recommended status quo quotas as a basis for setting catch advice from 2016 to 2018.

The GARM 3 benchmark assessment included Canadian landing from NAFO area 5Z and 5Y (Figure 1). The magnitude of the Canadian (5y&5z) landings can be seen in Figure 2 and Table 1. A historical summary of catch components used in the stock assessment is given in Table 2. The SSC adjusted the catch advice following work by the PDT (recommended by the 2015 peer review) to incorporate Canadian catches (see PDT memo to the SSC, dated October 9, 2015).

The PDT estimate for CY2017 catch of Atlantic halibut is 143mt, assuming 100% discard mortality (see PDT memo to the SSC, dated October 13, 2017). This includes a Canadian catch estimate of 33mt, and therefore a US catch of 110mt. The PDT revised its 2017 estimate to account for the discard mortality assumption changes proposed in the assessment by gear type on US discards. This reduced the estimated discards from 40mt to 20mt. Therefore, the revised catch assumption in 2017 is 90mt of US catch and 123mt of total catch (Table 1).

Table 1- Catch performance (CY2010-CY2016), historical OFLs and ABCs (FY2010-FY2018), and the PDT estimated catch assumption (CY2017) for Atlantic halibut. Gear specific mortality rates were applied to estimated discards. Historical OFLs and ABCs were based on 100% discard mortality rates.

Year	US Catch	Canadian Catch (5y & 5z)	US & Canadian Catch	Historical OFLs	Historical ABCs	US Catch Assumption	US&Canadian Catch Assumption
2010	38	23	61	119	71		
2011	52	29	81	130	78		
2012	75	32	107	143	85		
2013	77	38	115	164	99		
2014	71	33	104	180	109		
2015	85	30	115	198	119		
2016	99	34	133	210	158		
2017				210	158	90	123
2018				210	158		

Table 2- Atlantic halibut assessment catch component history.

Terminal year	assessment type	is 5y included	is 5z included	Discards	Discard mortality rate	Total Dealer Landing	recreational
2007	GARM 3	Yes	Yes	trawl & gillnet	100%	yes	No
2010	Operational	No	Yes	trawl & gillnet	100%	yes	No
2014	Operational	No (but adj OFL)	Yes	trawl & gillnet	100%	yes	No
2016	Plan-B	in projection	in projection	trawl & gillnet	by gear type	yes	No

Figure 1-NAFO Area map.

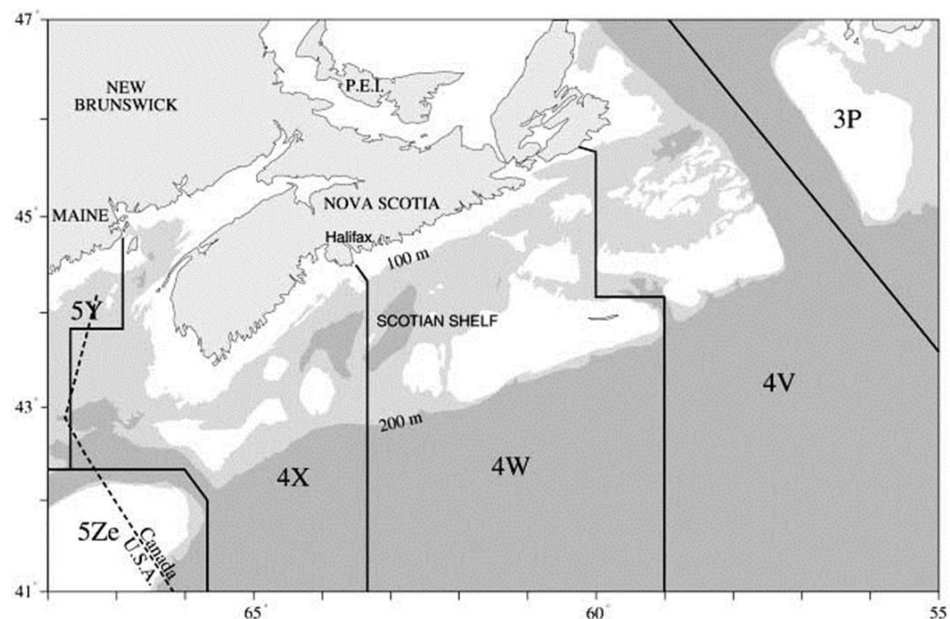
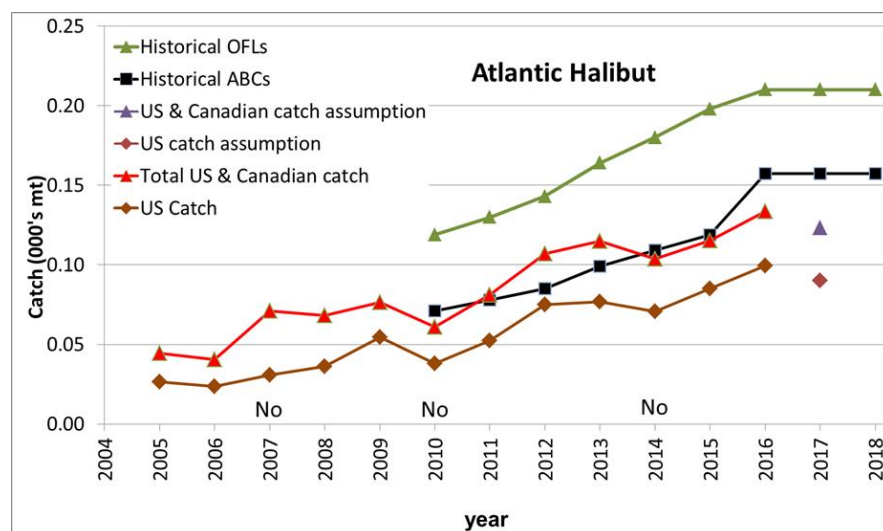


Figure 2- Catch performance for Atlantic halibut including: catches (US & Canadian combined and US only) from CY 2005- CY 2016, historical OFLs and ABCs since FY 2010, CY 2017 “bridge year” catch assumptions. Gear specific mortality rates were applied to estimated discards. Historical OFLs and ABCs were based on 100% discard mortality rates. Overfishing status in the terminal year of the assessment indicated on the x-axis (Yes = overfishing, No= not overfishing, and unk = unknown overfishing status).



Sources of Uncertainty

The PDT discussed sources of uncertainty in the assessment and catch advice:

- The major source of uncertainty is the stock structure and stock identity for Atlantic halibut (see Appendix A).
- The selection of indices in the model is a source of uncertainty because fishery dependent does not cover the full range of the stock boundary (e.g., inshore component, Canadian waters).
- Discards by gillnets of halibut are approximately 50% of all discards in recent years. The assumption on gillnet discard mortality at 30% is a major source of uncertainty as it is based on a study of dogfish discards. By comparison, a study done with sablefish fishery discards of halibut in gillnets, 5 7/8 to 6 1/2 inch mesh, 1983-1984, estimates a 31% survival rate, or 69% mortality (<http://sadcibiz.iotc.iphc.int/publications/techrep/tech0023.pdf>).
 - *“Observers also recorded the condition (excellent, poor, or dead) of the setnet-caught halibut. Klein (unpublished ”) stated that survival ranged from 31 to 64 percent in 1983 and concluded that survival probably tended towards the lower end of the range. These data equate to mortality rates of 36 to 69 percent, with the actual mortality rate approaching 69 percent.”*
- The PDT discussed the disparate halibut discard mortality assumptions between gear types, and considered the potential implications for management and catch limits. The PDT acknowledged that if the dynamics of the halibut fishery change (e.g., the relative proportion of halibut discarded in the trawl fishery decrease) it could have implications for halibut management. For example, such changes in fishery dynamics could lead to foregone yield, or increase the risk that the ABC would be exceeded if the difference in mortality rates are not a good reflection of the true mortality rates. However, the PDT struggled to understand the exact implications that changing fishery dynamics would have on future catches with respect to the ABC. The PDT has some general concern that differences in mortality rate could result in changes in the fishery dynamics which may introduce additional uncertainty in the removals in the future if these differences in the mortality rate results are not a reflection of reality.
- High-grading (i.e., up-grading and retaining only certain size fish for better price) for legal-sized fish does occur in the trawl and gillnet fishery and appears to be increasing in recent years in the trawl fishery (see Appendix B). This could run counter to assumptions on discard mortality by gear type.
- Another source of uncertainty is that the preliminary State of Maine 2017 data suggests lower landings than assumed in the PDT’s 2017 bridge year estimate (see Appendix D). However, the PDT still recommends using the 2017 bridge year estimate in the projections, as the final CY2017 data is not yet available.
- Although not unique to this method when compared with other empirical approaches, because this approach relies on adjusting the catch relative to the bridge year, holding the quota constant in the out-years is a source of uncertainty (i.e., catch advice could be lower or higher).

Catch Advice Options

Based on the recommendation of the 2017 peer review, Atlantic halibut is overfished, but overfishing is unknown. The stock is in a rebuilding plan with an end date of 2056, but projections are not possible with the current model formulation.

OFL

Based on the 2017 peer review, a basis for determining OFL was undefined based on the peer review recommendation that additional simulation work would be needed.

ABC

The PDT referred to the addendum to the assessment when developing options for ABC.

Following the recommendation of the 2017 peer review and as a starting point for SSC consideration of catch advice as an ABC for FY2018, bootstrap analyses of the model forecasts suggest an 80% confidence interval of 121mt to 154mt and median of 137mt. Note that this assumes a $K_p=0.75$ and $K_d=0.5$.

As a sensitivity with 100% discard mortality assumes, bootstrap analyses of the model forecasts suggest an 80% confidence interval of 141mt to 180mt and median of 160mt. Note that this assumes a $K_p=0.75$ and $K_d=0.5$.

Under either approach, the total ABC would be reduced by Canadian catch, in this case 33mt, to determine a US ABC.

A. Biological considerations for halibut

IMPORTANT BIOLOGICAL CONSIDERATIONS FOR HALIBUT

- Halibut have an interesting life history for managers to consider. Halibut are long lived (> 40 years), and relative to other flatfish in the region they exhibit late maturity, with most females not reaching sexual maturity until age 7 or 8 (Armsworthy and Campana, 2010; Sigourney et al., 2006). These traits would suggest that halibut are especially susceptible to overfishing. However, other aspects of their life history, such as rapid juvenile growth (>10cm/year) and high female fecundity may make this species resilient to moderate levels of fishing mortality (Cargnelli et al., 1999; Trzcinski and Don Bowen, 2006).
- Adult halibut inhabit a wide range of depths (25m to >1500m) (Cargnelli et al., 1999; Armsworthy et al., 2014). Because halibut can inhabit deep waters on the continental slope, some portion of the resource in US waters may be unavailable to the fishery and fisheries independent surveys.

The stock structure of halibut is a major source of uncertainty for the management and assessment of this resource.

- Halibut spawning grounds have not been identified in US waters, and halibut larvae are rarely captured in US waters during ichthyoplankton surveys (Cargnelli et al., 1999; Sigourney et al., 2006). This suggests that halibut either spawn in the deep waters along the continental slope where they are undetected by our fisheries and surveys, or that there are source/sink dynamics between the US and Canadian halibut stocks. If the latter hypothesis is correct, the halibut population in US waters is likely sustained by spawning in Canada (Shackell et al., 2016).
- Conventional tagging studies have provided insight into the movement patterns of halibut in the northwest Atlantic. Tagging studies have shown that there is considerable variability in the movements of tagged halibut; some animals have been recaptured in close proximity to their release site after an extended time at liberty, while others have been shown to make extensive migrations (>1000km). There is some evidence to suggest that juvenile halibut undertake longer migrations than adults (e.g., Stobo et al., 1988).
- Tagged halibut released in the Gulf of Maine, Georges Bank, Browns Bank, and on the southern Scotian Shelf were often recaptured near their release site, or they migrated to the north and east, typically towards Cape Breton and Newfoundland (Martin and McCracken, 1950; Wise and Jensen, 1961; Stobo et al., 1988; Kanwit, 2007; Figure 1). Many of the observed movements were transboundary. On the other hand, halibut tagged in Canadian waters have rarely been recaptured in US waters. For example, den Heyer et al (2013) tagged 1,913 halibut throughout Canadian waters, and only three of the 444 recaptures have been reported from US waters.
- Data recovered from pop-up satellite archival tags (PSAT's) deployed on adult halibut in Canadian waters suggest that spawning may occur on the southern edge of the Grand Banks, in deep waters along the continental slope (Armsworthy et al., 2014).

- Numerous authors (e.g., Stobo et al., 1988; Kanwit, 2007; Armsworthy et al, 2016) have expressed support for the hypothesis of “compensatory emigration” to describe the stock structure of halibut in US and Canadian waters. In short, this hypothesis presumes that spawning takes place on the Grand Bank and Scotian Shelf, and that the larvae are transported by the prevailing deep water currents towards the south and west. Once halibut are ready to spawn, they undertake long distance migrations to the north and east, to return to their natal spawning grounds, thus closing their life cycle. Proponents of the compensatory migration hypothesis have suggested that halibut in US and Canadian waters should be managed and assessed as a transboundary resource.
- Halibut in US waters may also represent a mix of resident and migratory fish, which would present important implications for fisheries management (Grasso, 2008; Shackell et al., 2016). If the sub-stock structure was not recognized, there is a risk that local resident populations could be vulnerable to depletion.

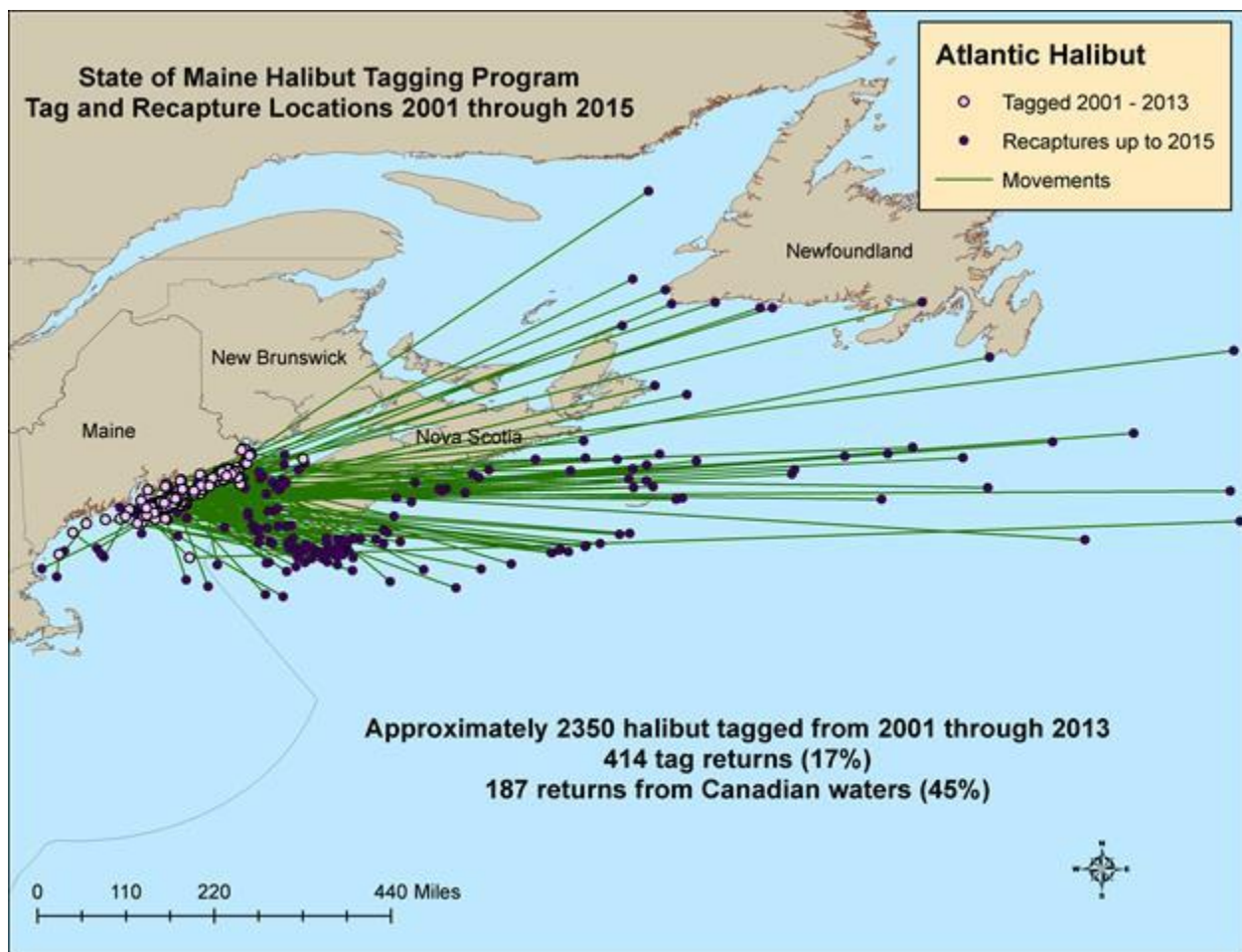


Figure 1. Recapture locations of halibut that were tagged in Maine state waters from 2001 through 2003.

Armsworthy, S.L., and Campana, S.E. 2010. Age determination, bomb-radiocarbon validation and growth of Atlantic halibut (*Hippoglossus hippoglossus*) from the northwest Atlantic. *Environmental Biology of Fishes*, 82: 279-295.

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B. Discard data and discard mortality information

Summary of Observed Discard Data and Discard Mortality Information for Atlantic Halibut

Observed Discard Data for Atlantic Halibut

The Plan Development Team (PDT) explored the reasons that Atlantic halibut were discarded in the federal groundfish fishery. Specifically, the PDT was interested in knowing whether halibut are primarily discarded due to being undersized, or due to the vessel having already reached the one fish per trip limit. The PDT provides a preliminary summary of the Atlantic halibut discard disposition data from observed groundfish trips/hauls by gear type from both the Northeast Fisheries Observer Program (NEFOP) and At-Sea Monitoring (ASM) program from calendar years 2010 to 2016. Of note, this analysis is based on all observed discards (raw, non-expanded NEFOP and ASM percentages). Differences among gear types could be confounded by variation in observer/ASM coverage rates.

Briefly, the trawl and gillnet fisheries account for the majority of observed halibut discards. From 2010 to 2016, these two fisheries accounted for 91.7% to 100% of all observed discards in the federal groundfish fishery. Atlantic halibut discards have also been observed in the bottom longline fishery.

Table 3 and Table 4 summarize the discard disposition types for the trawl and gillnet fisheries respectively.

The PDT focused on the following discard disposition categories:

- 1) “Regulations Prohibit Retention, Quota Filled” - refers to halibut discarded due to the vessel having already reached its one fish per trip limit.
- 2) “Regulations Prohibit Retention, Too Small” - refers to halibut that are under the legal size limit.
- 3) “Retaining Only Certain Size, Better Price, Trip Quota In Effect” - refers to halibut that the vessel chose to discard in the anticipation of catching another larger (and therefore higher value) halibut on the same trip.
- 4) “Upgraded” - refers to halibut that the vessel chose to discard after catching a larger, higher value halibut later on in the trip (also known as high grading).

The PDT was initially interested in the first two categories, but explored the second two when data analysis revealed notable percentages of halibut discarded due to these disposition reasons. Remaining discard disposition categories include several that are mainly related to poor quality and are grouped together under “Other.”

Most of halibut discarded in the trawl fishery across the timeseries (76.6%) were discarded due to being undersized (

Table 3). An increasing percentage of halibut discarded by the trawl fishery in recent years were discarded due to the vessel having already reached the one fish limit, suggesting an increase in the availability of legal sized halibut in US waters. A small percentage (0.8% and 2.0% respectively) of halibut discards were attributed to the “Retaining Only Certain Size” and “Upgraded” categories across the timeseries. These four disposition categories (Quota Filled, Too Small (Prohibited), Retaining Only Certain Size, and Upgraded) together make up 97.8% of all halibut discards in the trawl fishery from 2010-2016. The remaining 2.2% fall under the “Other” category, which contains a variety of other discard disposition reasons, mainly Poor Quality.

Similarly, most of halibut discarded in the gillnet fishery across the timeseries (75.8%) were discarded due to being undersized (Table 4). However, the percentage of halibut discarded in the gillnet fishery across the timeseries due to the vessel having already reached the one fish limit is much lower (8.0%) than that in the trawl fishery (18.4%). A small percentage (0.9% and 0.9% respectively) of halibut discards were attributed to the “Retaining Only Certain Size” and “Upgraded” categories across the timeseries. These four disposition categories (Quota Filled, Too Small (Prohibited), Retaining Only Certain Size, and Upgraded) together make up 85.6% of all halibut discards in the gillnet fishery from 2010-2016. The remaining 14.4% fall under the “Other” category, which contains a variety of other discard disposition reasons, mainly Poor Quality.

Table 3 - Percentage of observed halibut discards* (by weight) by disposition type for the trawl fishery from CY2010-CY2016).

	Year	2010	2011	2012	2013	2014	2015	2016	All Years Combined
Disposition									
	Regulations Prohibit Retention, Quota Filled	3.4%	11.2%	14.7%	19.6%	25.3%	28.5%	36.0%	18.4%
	Regulations Prohibit Retention, Too Small	88.8%	84.8%	81.4%	77.4%	69.9%	62.8%	56.5%	76.6%
	Retaining Only Certain Size, Better Price, Trip Quota In Effect	0.3%	0.1%	0.6%	0.0%	0.5%	1.7%	4.3%	0.8%
	Upgraded	1.0%	1.3%	1.4%	1.2%	2.2%	6.1%	3.2%	2.0%
	Other (mainly Poor Quality)	6.4%	2.6%	1.9%	1.8%	2.1%	0.9%	0.0%	2.2%
	Total	100%	100%	100%	100%	100%	100%	100%	100%
# of Observed Hauls with Halibut		761	1129	1024	889	606	360	295	5064

* The Groundfish PDT focused on the following discard disposition reasons: Quota Filled, Too Small (Prohibited), Retaining Only Certain Size, and Upgraded, which together make up 97.8% of all halibut discards in the trawl fishery from 2010-2016. The “Other” category contains a variety of other discard disposition reasons, mainly Poor Quality.

Table 4 - Percentage of observed halibut discards* (by weight) by disposition type for the gillnet fishery from CY2010-CY2016).

	Year	2010	2011	2012	2013	2014	2015	2016	All Years Combined
Disposition									
	Regulations Prohibit Retention, Quota Filled	6.3%	29.2%	0.0%	3.2%	8.5%	2.3%	7.4%	8.0%
	Regulations Prohibit Retention, Too Small	76.6%	62.1%	85.9%	84.1%	78.7%	81.1%	62.2%	75.8%
	Retaining Only Certain Size, Better Price, Trip Quota In Effect	0.0%	0.0%	0.0%	0.0%	0.6%	0.2%	5.5%	0.9%
	Upgraded	0.0%	0.9%	0.0%	2.8%	0.5%	1.0%	0.8%	0.9%
	Other (mainly Poor Quality)	17.1%	7.8%	14.1%	9.9%	11.8%	15.4%	24.1%	14.4%
	Total	100%	100%	100%	100%	100%	100%	100%	100%
# of Observed Hauls with Halibut		178	331	258	183	260	258	115	1583

*The PDT focused on the following discard disposition reasons: Quota Filled, Too Small (Prohibited), Retaining Only Certain Size, and Upgraded, which together make up 85.6% of all halibut discards in the gillnet fishery from 2010-2016. The “Other” category contains a variety of other discard disposition reasons, mainly Poor Quality.

The PDT also examined differences in halibut discard rates between the federal groundfish fishery and the directed Maine state-water halibut fishery. Across all federally permitted groundfish trips, the majority of halibut are discarded, while discard rates are much lower in the Maine state waters fishery (Table 3). The PDT acknowledges that there could be several reasons for the discrepancies in discard rates between the two fisheries.

Differences in gear selectivity could explain some of this discrepancy. The Maine state-water fishery is executed using longline gear, and vessels are required to use large hooks (size 14/0 to 16/0) that are designed to minimize the capture of juvenile halibut. In contrast, most of the halibut caught in the federal fishery are captured using trawl and gillnet gear. Trawl gear is known to have a relatively high selectivity for juvenile halibut, and a low selectivity for adult halibut.

While federal groundfish fishermen are only permitted to retain one halibut per trip, this provision does not apply to vessels in the Maine state water fishery. Instead, fishermen in the Maine state water fishery are allotted 25 tags per season, and are allowed to land up to 25 legal sized fish on a single trip. Therefore, fewer legal-sized fish are likely to be discarded in the Maine state water fishery because of quota restrictions.

Some of the discrepancies could also be attributed to differences in monitoring in the two fisheries. The federal groundfish fishery is monitored through the observer program and at-sea monitoring, and halibut bycatch rates on observed trips are used to estimate discards for the entire fishery. However, monitors and observers are not typically deployed on vessels in the Maine state water halibut fishery.

Finally, it is possible that there are differences in the size structure of the halibut resource within US waters. For example, legal sized halibut may be most abundant in statistical areas 512 and 513, where the majority of catch from the Maine state water fishery operates, while the halibut resource in other areas may be predominately comprised of sub-legal fish. However, the current resolution of fisheries independent data is not likely sufficient to test this hypothesis in any detail.

Table 3. Summary of halibut landings and discards in the federal groundfish fishery and the Maine state water halibut fishery from 2012 through 2016. The catch data were obtained from GARFO year-end catch reports.

Fishing Year	<u>Total</u>				<u>Federal Groundfish Fishery</u>				<u>State Waters</u>			
	OFL	US ABC	ACL	Total Catch	Catch	Landings	Discards	% Discarded	Catch	Landings	Discards	% Discarded
2012	143	85	83	75.7	60.7	15.5	45.3	74.6%	13.3	11.9	1.3	9.8%
2013	164	99	96	79.0	54.7	14.3	40.4	73.9%	22.8	21.1	1.7	7.5%
2014	180	109	106	78.6	47.8	21.2	26.6	55.6%	28.7	27.4	1.3	4.5%
2015	198	100	97	102.0	59.0	22.0	37.0	62.7%	41.1	39.5	1.5	3.6%
2016	210	124	119	108.1	56.9	20.3	36.6	64.3%	47.9	46.5	1.3	2.7%

Atlantic Halibut Discard Mortality

The PDT had summarized information on Atlantic halibut discard mortality in response to a Council motion on the subject (see letter from NEFMC to NMFS re Atlantic halibut discard mortality, dated Feb. 15, 2017). This information is summarized below:

Recent published peer review literature, tagging studies by the State of Maine, and the most recent Canadian assessment of Atlantic halibut suggest the discard mortality rate for Atlantic halibut is well-below 100% for long-line gear and less than 100% for otter-trawl gear (see References). The Council had requested that NMFS review this information and potentially make changes starting in-season in fishing year 2016 with respect to monitoring discards in the fishery.

The Council made this request in light of the availability of scientific studies on the subject, the use of the results (specifically den Heyer, et al. 2011 and 2013) in the 2014 Canadian assessment of Atlantic halibut, and evidence from the State of Maine's tagging studies. The tagging studies reveal that the majority of tagged returns in the last four years are from Canadian waters with many at liberty for greater than 8 years (see letter from NEFMC to State of Maine re Atlantic halibut, dated Nov. 21, 2016). This information and studies were not considered in 2012 – previous correspondence with the NEFSC on the subject (see letter from NEFMC to NEFSC on groundfish discard mortality on June 25, 2012 and the response on Aug. 23, 2012).

Further, the Council had requested that GARFO apply a similar approach to examine Atlantic halibut discard mortality in the commercial groundfish fishery as was considered for Gulf of Maine cod in the recreational fishery (see letter from GARFO to NEFMC, dated Apr. 23, 2015).

GARFO sent a response letter back to the Council (see GARFO to NEFMC re Halibut Issues, dated June 19, 2017) stating that at the 2017 assessment update for halibut all of the available scientific studies would be considered to inform a potential change to the discard mortality assumption, and that if the available information supports a change, GARFO would incorporate the new discard mortality assumption for quota monitoring.

References:

Cox, S.P., Benson, A., and den Heyer, C.E. 2016. Framework for the Assessment of Atlantic Halibut Stocks on the Scotian Shelf and Southern Grand Banks. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/001. v + 57 p.

Neilson, J.D., K.G. Waiwood, and S.J. Smith. 1989. Survival of Atlantic Halibut (*Hippoglossus hippoglossus*) caught by longline and otter trawl gear. Canadian Journal of Fisheries and Aquatic Sciences 46:887-897.

Trumble, R.J., Kaimmer, S.M. and Williams, G.H. (2002) A review of the methods used to estimate, reduce, and manage bycatch mortality of Pacific halibut in the commercial longline groundfish fisheries of the northeast Pacific. In: Lucy, J.A., Studholme, A.L. (eds.), Catch and Release Symposium in Marine Recreational Fisheries. American Fisheries Society Symposium. 30, Bethesda, MD, pp. 88–96.

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C. Overview of specifications and recent catches by fishery components

Distribution of ABCs and ACLs

Overview

Groundfish ABCs and ACLs are distributed to various components of the fishery.

1. First, *expected catch* by *Canadian* vessels is deducted from the total ABC, and the amount remaining is the portion of the ABC available to U.S. vessels (U.S. ABC). Since fishing year 2010, expected Canadian catch has only been considered for Eastern GB cod and haddock and GB yellowtail, which are jointly managed with Canada. However, based on the results of recent assessments, some Canadian catch of GB winter flounder, white hake and halibut does occur. Although these stocks are not jointly managed, Canadian catch should be accounted for when distributing the ABC/ACLs to ensure that biological objectives are met, and total catch does not exceed the overall ABC.
2. Expected catch from *state waters* and the *other sub-component* is then deducted from the U.S. ABC¹. These sub-components are not subject to specific catch controls by the Groundfish FMP. As a result, the state waters and other sub-components are not allocations, and these components of the fishery are not subject to accountability measures if the catch limits are exceeded. Because the state waters and other sub-component values are based on expected catch, there is no downward adjustment for management uncertainty that applies to fisheries with specific allocations and accountability measures.
3. After the state and other sub-components are deducted, the remaining portion of the U.S. ABC is the amount available to the fishery components that receive an allocation (i.e., subject to accountability measures). Allocation are made first to non-groundfish fisheries (e.g., scallop, midwater trawl, small-mesh fisheries), and the portion of the U.S. ABC remaining is the commercial groundfish allocation.
4. Once the U.S. ABC is distributed to the various fishery components, sub-annual catch limits (sub-ACLs) are set by reducing the amount of the ABC distributed to each component to account for management uncertainty (i.e., the likelihood that management measures will result in a level of catch greater than the catch target). For each stock, management uncertainty is estimated using the following criteria: Enforceability and precision of management measures, adequacy of catch monitoring, latent effort, and catch of groundfish in non-groundfish fisheries. The following default management uncertainty buffers are used for groundfish stocks:
 - 3% for stocks with no state waters catch;
 - 7% for zero possession stocks;
 - 7% for recreational allocations; and
 - 5% for all other stocks/components of the fishery.

Application to Atlantic Halibut Specifications for FY2018-FY2020

1. *Expected Canadian catch*- Consistent with the approach used in FW 53, FW55, and FW56, the PDT recommended using the average catch of the most recent three years available (CY 2014-CY 2016) from the 2017 groundfish operational assessments as the expected Canadian catch. The expected Canadian catch value is 33mt, and is deducted from the total ABC to determine the U.S. ABC.
2. *State Waters* -The three-year (FY2014-FY2016) average catch is 39.2mt. Based on this evaluation, the PDT recommended increasing the 2018-2020 state sub-component to 32%

¹ For GOM cod and haddock, the state waters and other sub-component are deducted from the commercial portion of the U.S. ABC (after allocating to the recreational fishery).

of the U.S. ABC (from 20%) to cover the three-year average catch. However, the Council recommended that Atlantic halibut remains at the FY2017 percentage value for the state sub-component of 20% of U.S. ABC (e.g., at 125mt ABC is 25mt) not to exceed a value of 50 mt for FY2018-FY2020. The Council's recommendation is used in the specifications. This recommendation was made given that state waters catches - especially those from Maine state waters - are expected to decline from the catch average. *Other Sub-Component* – The three-year (FY2014-FY2016) average catch is 2.1mt. Based on this evaluation, the PDT recommended decreasing the 2018-2020 other sub-component to 2% of the U.S. ABC (from 3%) to cover the three-year average catch.

3. *Groundfish Fishery sub-ABC*- Since no other components of the catch have allocations, the remaining portion is the groundfish sub-ABC for Atlantic halibut for FY2018-FY2020
4. *Groundfish Fishery sub-ACL* – The default management uncertainty buffer on the groundfish sub-ABC is 5%. The remaining portion is the groundfish sub-ACL for Atlantic halibut for FY2018-FY2020.

D. Information on the State of Maine's directed Atlantic halibut fishery

The State of Maine has a long history of fishing for and landing Atlantic Halibut (Figure 1). Since 2010, landings, value, and participation in a State waters only fishery has greatly increased (Figure 1 and Table 1).

The State of Maine inshore fishery is subjected to many restrictions. Some important ones include;

- Participants may only fish for Halibut in state waters (< 3 nm) unless landing Halibut under their federal groundfish permit.
- Commercial Halibut fishermen must obtain an Atlantic Halibut endorsement on their state Commercial Fishing License
- It shall be illegal to land, sell, or possess any Atlantic Halibut which measures less than 41 inches in total length.
- It shall be illegal to possess or land marine species other than Atlantic Halibut while fishing for Atlantic Halibut aboard commercial vessels in Maine's territorial waters, with an exemption for federal permit holders fishing under a groundfish permit.
- It shall be illegal to fish for Atlantic Halibut in Maine's territorial waters by any method other than using size 14/0, 15/0 or 16/0 circle hooks, with an exemption for federal permit holders fishing under a groundfish permit.
- No vessel may fish for Atlantic Halibut using more than 450 circle hooks.
- All legal size Atlantic Halibut caught in Maine's coastal waters and intended to be retained by a Commercial Fishing license holder or recreational fisherman shall be immediately tagged with a landing tag approved by (and purchased from) the Department of Marine Resources
- Landings tags must remain on the fish until the fish has reached its final destination as a legal-sized fish that is not offered or intended for sale, trade, or barter by a recreational fisherman or prior to retail sale by a Commercial Fishing license holder or Wholesale Seafood Dealer. It is illegal to possess Atlantic Halibut which are not properly tagged.
- No individual or vessel will be issued more than 25 landing tags per (calendar) year except that commercial fishing license holders who also hold a Federal Multispecies Permit shall be exempted from the individual tag limit provided that no one federally permitted vessel is assigned more than 25 landing tags per year.
- Commercial, party, or charter vessels may land no more than 25 Atlantic Halibut per year. Recreational vessels may land no more than 5 Atlantic Halibut per year.
- Reporting requirements
 - o Persons who obtain an Atlantic halibut endorsement will be required to maintain a log. The log must include the following information:
 - o Harvester name & license number, Boat name and hull ID, Designate negative report period if no harvesting activity occurred, Date fished & landed, Number of crew (including captain), Gear type & quantity, Number of sets 8, Set time (hours gear fished), Depth (in fathoms), Area fished (Latitude/Longitude in dd/mm/ss, or Loran bearings, or NMFS statistical area and distance from shore), Sea time (including steaming time), Species caught including bycatch and sub-legal halibut, quantity & unit of measurement, Total length of halibut retained or released, Research tag number of halibut released or recaptured, License number of dealer sold to or if not sold to a licensed dealer, disposition of catch, Port landed, Signature written or electronic.

The small state waters longline halibut fishery off coastal Maine in May-June provides income in fisheries-dependent communities at a time when landings from other fisheries, particularly lobster, are typically low or non-existent. In general, the State of Maine inshore fishery is composed of lobster fishermen who target halibut using longline gear before the lobster fishery ramps up in the spring/early summer.

This artisanal fishery is made possible by the availability of halibut in inshore waters during those spring months. Some Maine halibut fishermen hypothesize the migration is driven by the large flatfish pursuing river herring runs returning to natal waters. Many of the fishermen who participate in this artisanal fishery have limited access to federal regional fisheries management and so enforcement and compliance has been an issue in the past. However, the State of Maine has improved its outreach and enforcement efforts starting in 2016, resulting in preliminarily lower landings during the 2017 inshore season.

Also during January 2017 Maine DMR hired a scientist to work at least half-time on Halibut. The main responsibilities of this position are to provide data analysis of landings and historical tagging information, aid ongoing projects working with Gulf of Maine Halibut, reinvigorating both the floy and PSAT tagging projects, and performing at-sea observations on targeted halibut trips. Maine DMR has also recently been invited to submit a full proposal, entitled “*Engaging fishermen as citizen-scientists to track Halibut food habits*” to the SK funding opportunity for 2017.

Table 1: Metric tons of Halibut kept, landed, and discarded from the state of Maine harvester and dealer reports. *2016 data are preliminary and subject to change without notice. **2017 data are extremely preliminary and subject to change without notice. Longline data are from Maine inshore fishery only (harvester reported data). Data pulled 12/13/2017

Year	Longline Kept	Longline Discards	Maine Dealer Landings	Total Longline
2002	5.11	1.33	5.07	6.44
2003	3.71	0.60	4.75	4.31
2004	6.24	0.52	6.54	6.76
2005	8.85	0.67	11.30	9.52
2006	11.93	1.68	13.61	13.62
2007	16.38	2.80	19.44	19.18
2008	15.37	3.42	20.99	18.79
2009	30.25	3.53	36.61	33.78
2010	16.18	2.58	15.03	18.76
2011	15.77	3.48	16.60	19.25
2012	22.57	9.80	22.58	32.37
2013	21.64	3.71	22.90	25.35
2014	31.38	4.41	29.85	35.79
2015	35.59	4.29	42.37	39.88
2016*	37.47	2.95	49.32	40.42
2017**			32.96	

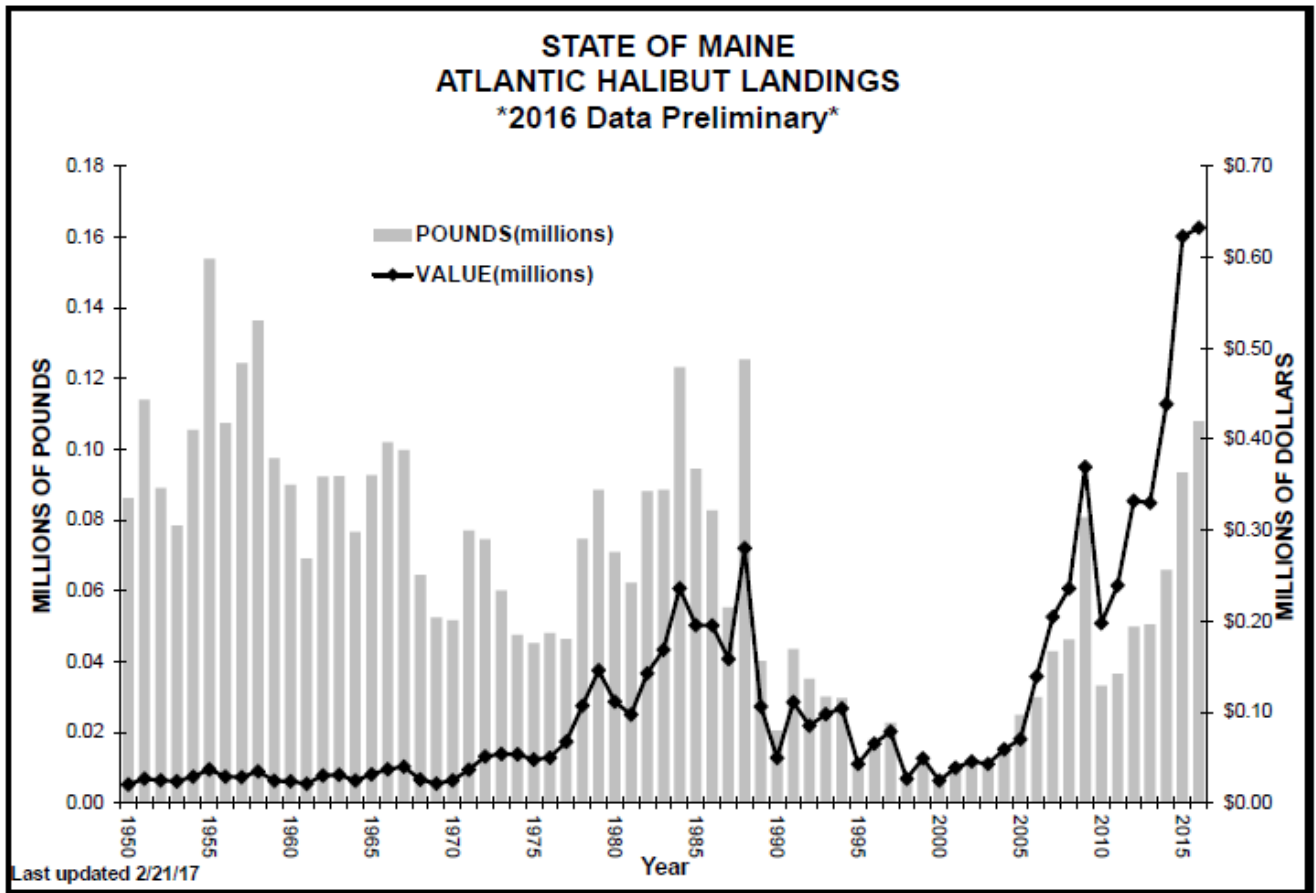


Figure 1: Dealer reporting of Atlantic Halibut landed 1950-2016. Note 2016 data are preliminary. Source: <http://www.maine.gov/dmr/commercial-fishing/landings/documents/halibut.graph.pdf>

E. Analysis of data on locations on halibut catches by gear type

Catch Locations of Atlantic Halibut by Gear Type

Overview

The groundfish PDT analyzed observer data (NEFOP and ASM) that was collected between January, 2010 and August, 2016 to examine the catch locations of halibut by gear type in the northeast Multispecies groundfish fishery. The PDT also examined harvester-reported halibut catch data from the Maine Department of Marine Resources to examine spatial patterns of halibut catches in the Maine state-water halibut fishery.

New England Multispecies Groundfish Fishery

Trawl Fishery – Standard Trawl Gear: From 2011 to 2016 there were 55,089 observed large mesh trawl tows made with standard trawl gear (NEGEAR Code = 050) in the dataset. Halibut were observed in 3,361 tows (7.1%). Halibut were rarely observed in large mesh trawl tows made south of Cape Cod (Figure 1). Halibut were caught on the backside of Cape Cod, in the Great South Channel, and along the northern flank of Georges Bank. Halibut were also encountered in Massachusetts Bay and off Cape Ann, and east of the Western Gulf of Maine (WGOM) closed area. Halibut appeared to be common in trawl tows made in the central Gulf of Maine (i.e., north of 43°), although there was less trawl effort in this region.

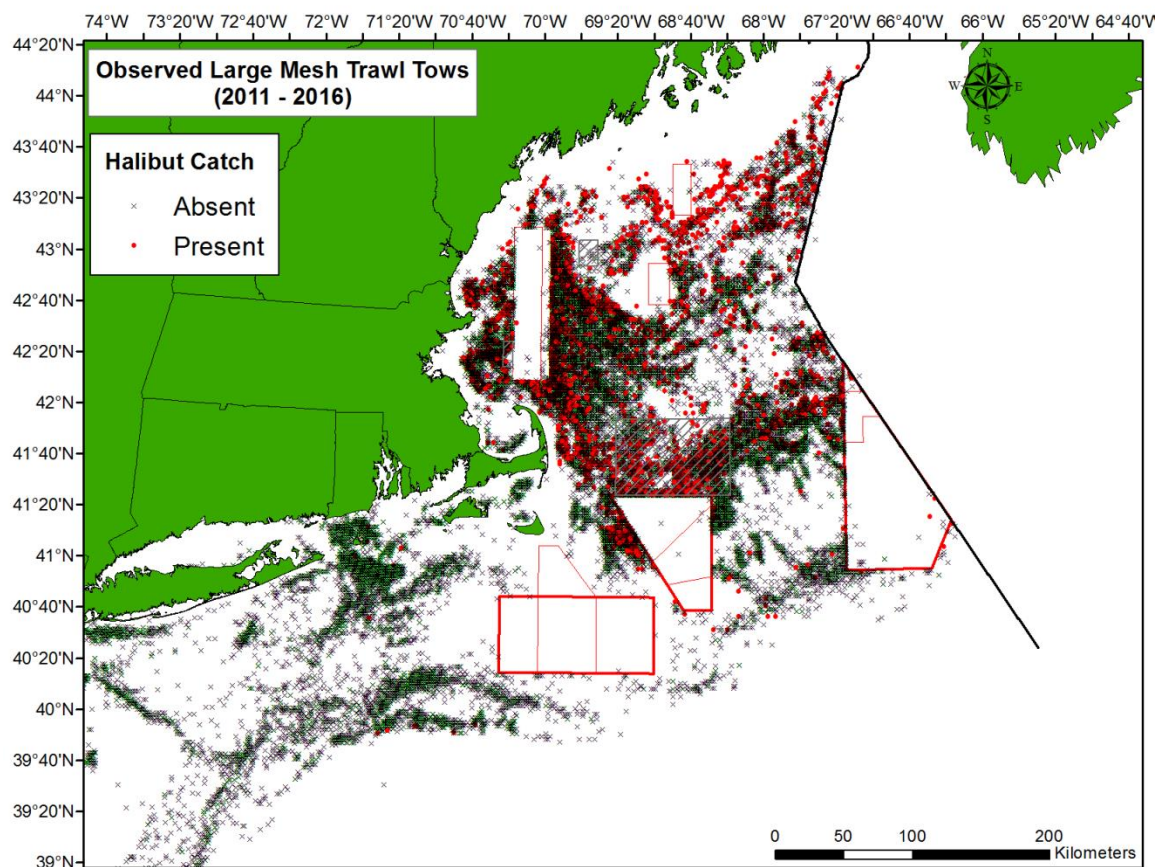


Figure 1 – Locations of observed large mesh trawl tows from 2011 to 2016.

CY 2015 was the most recent complete year of observer data that was available for this analysis. 7,607 large mesh trawl tows were observed in 2015, of which 368 encountered halibut (4.8%, Figures 2 and 3). Halibut were rarely observed south of Cape Cod. Halibut were commonly observed in the Great South Channel, north of Closed Area 1, in the deep water off the northern flank of Georges Bank, and east of the WGOM closed area.

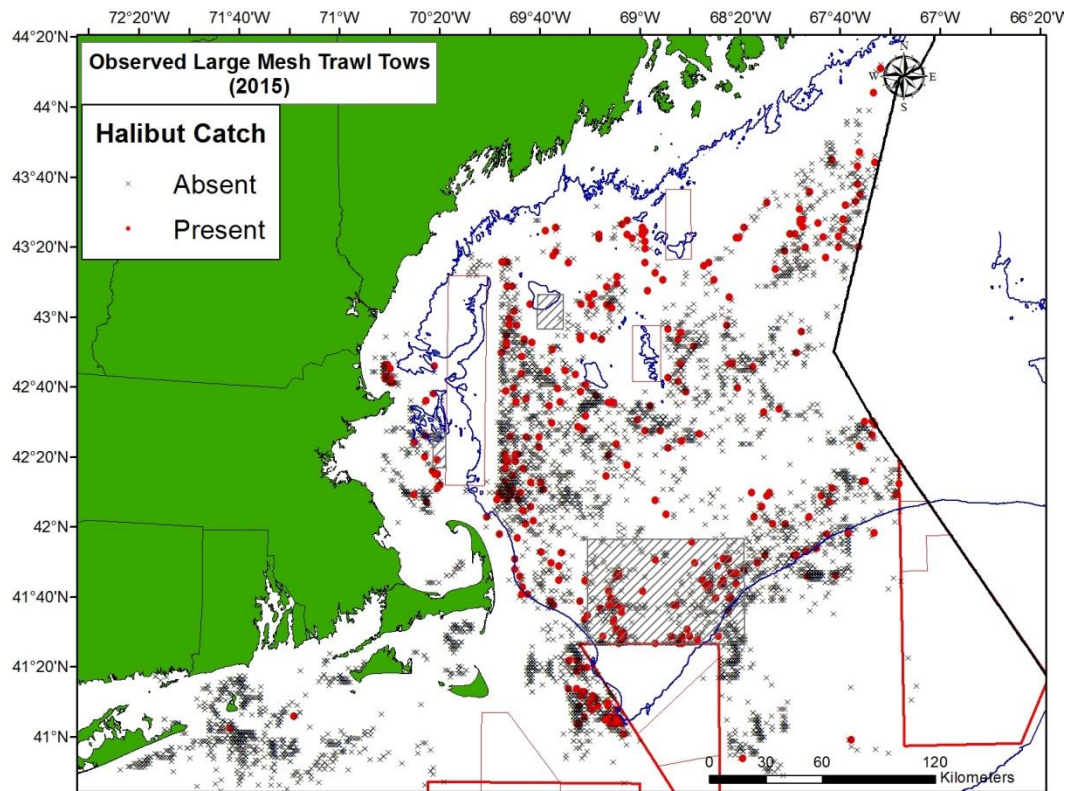


Figure 2 – Locations of observed large mesh trawl tows in 2015.

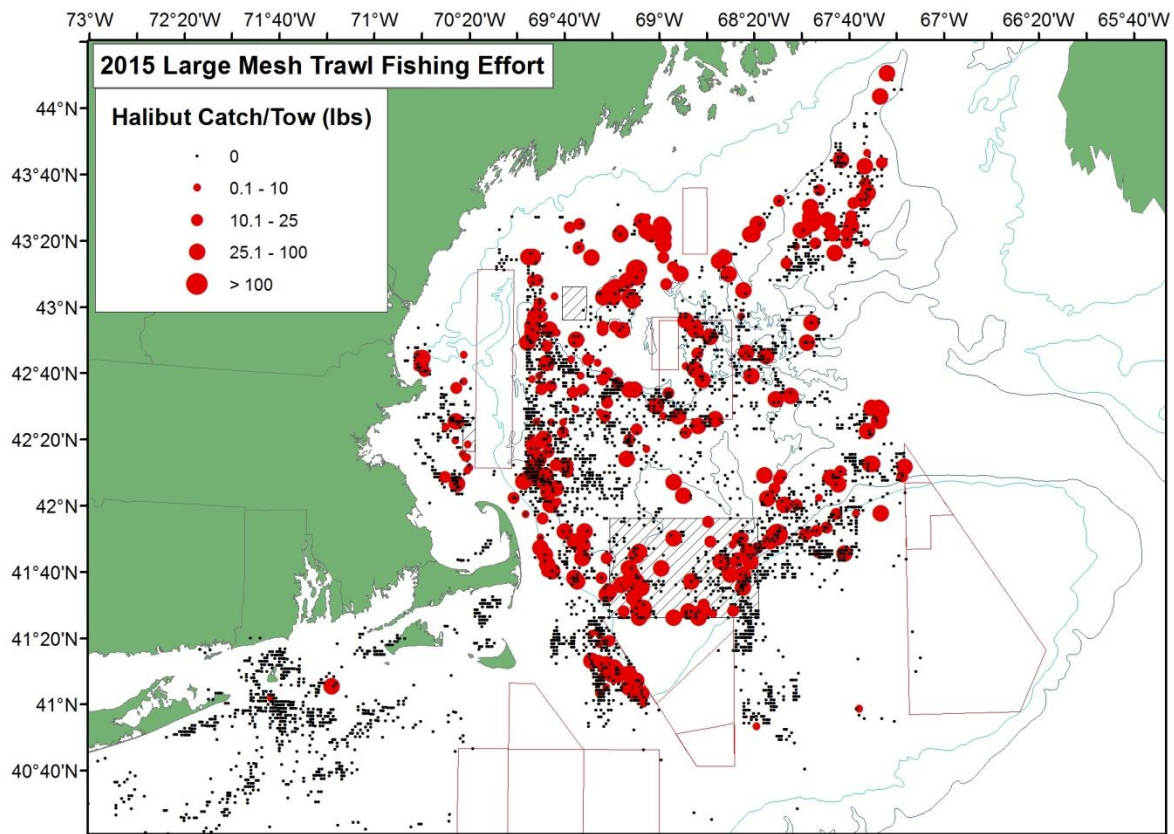


Figure 3 – Halibut catches observed on large mesh trawl tows in 2015.

Trawl Fishery – Selective Trawl Gear: From 2011 to 2016 there were 3,831 observed large mesh trawl tows that used selective gear (NEGEAR Code = 054 or 057) in the dataset. Halibut were encountered on 206 of these tows (5.4%). Much of the observed fishing effort was focused on Georges Bank, particularly along the northern edge and southern portion of the bank, primarily by vessels that were targeting haddock. Halibut were observed in Closed Area 2, off the northern edge of Georges Bank, in the halibut trawl gear AM area, and along the southwest portion of the bank, near the 100 meter contour (Figure 4).

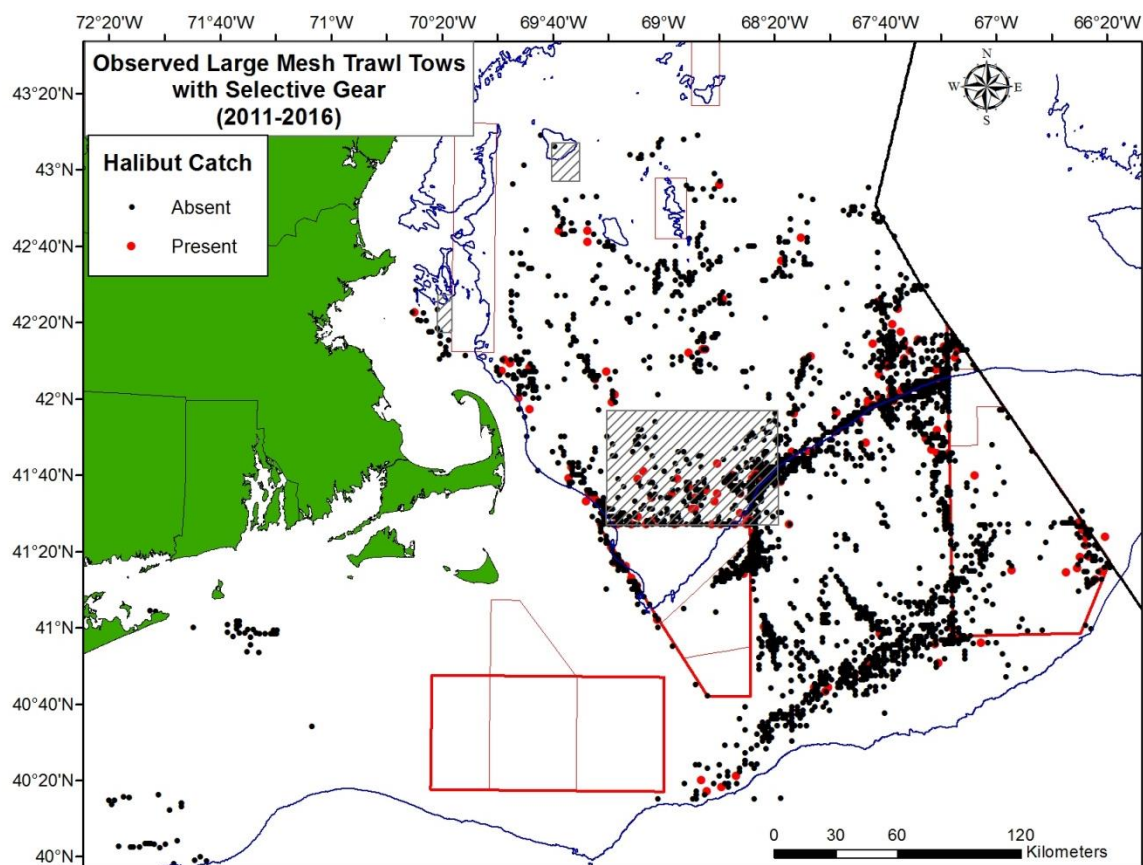


Figure 4 – Locations of observed trawl tows with selective gear from 2011 to 2016.

Small Mesh Trawl Hauls – From 2011 to 2016 there were 19,709 observed small mesh trawl tows in the dataset. Halibut catches in this fishery were very rare, as halibut were only observed on 52 tows (0.26%). Much of the fishing effort was concentrated in southern New England and the Mid-Atlantic, where few halibut were encountered (Figure 5). However, halibut were captured in observed small mesh trawl tows made off Cape Ann, and in the central Gulf of Maine.

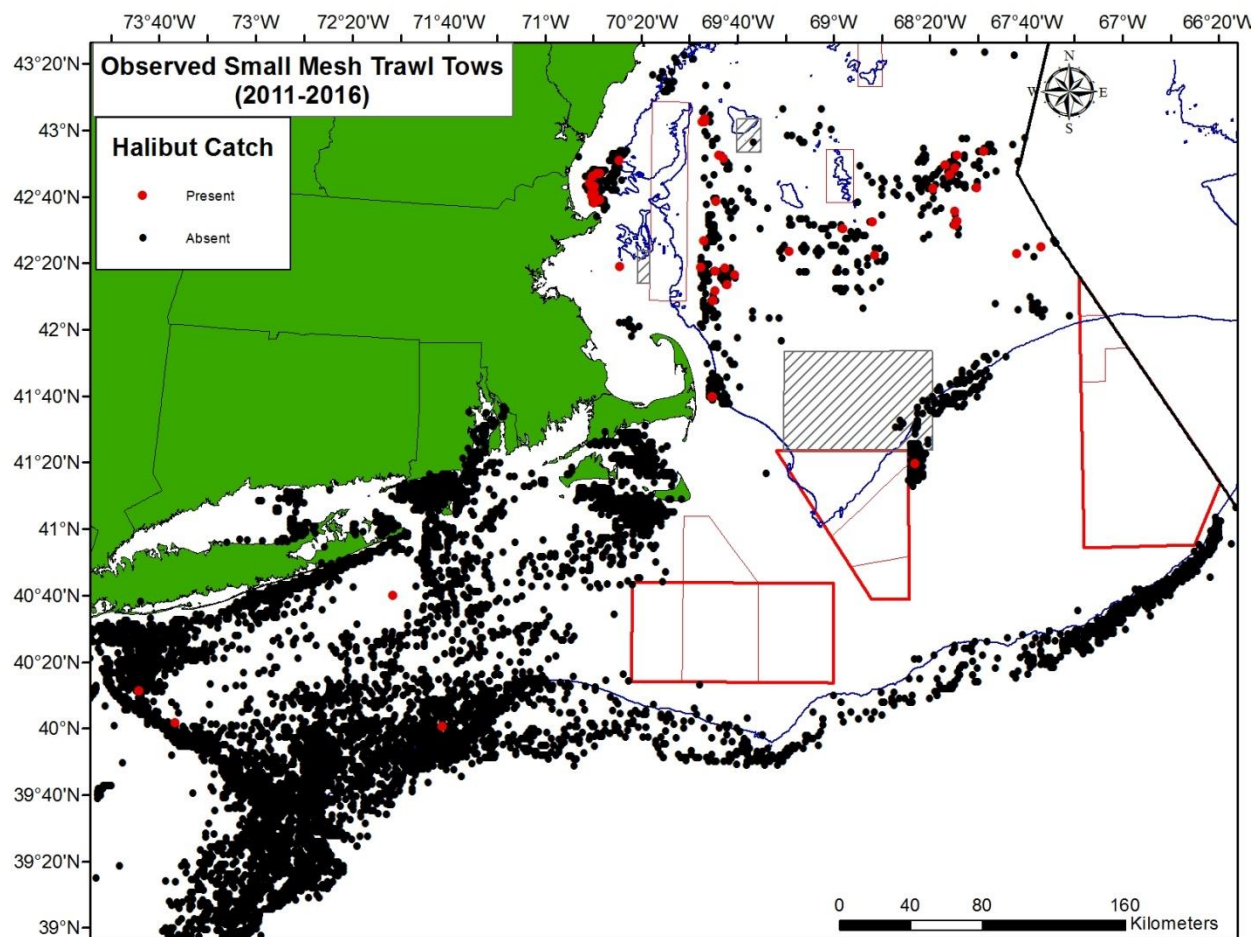


Figure 5 – Locations of observed small mesh trawl tows that were made between 2011 and 2016.

Large and Extra Large Mesh Gillnet – From 2011 to 2016 there were 30,209 observed gillnet hauls (large and extra large mesh). Halibut were present in 1,578 of these observed hauls (5.2%). The distribution of observed fishing effort is shown in Figure 6, and the locations where halibut were observed are shown in Figure 7. Although there was a substantial amount of observed gillnet fishing effort in southern New England, halibut were rarely observed in that region. Halibut were observed in gillnet hauls in the Great South Channel, on the western border of the WGOMN closed area, on Platts Bank, and near Cashes Ledge.

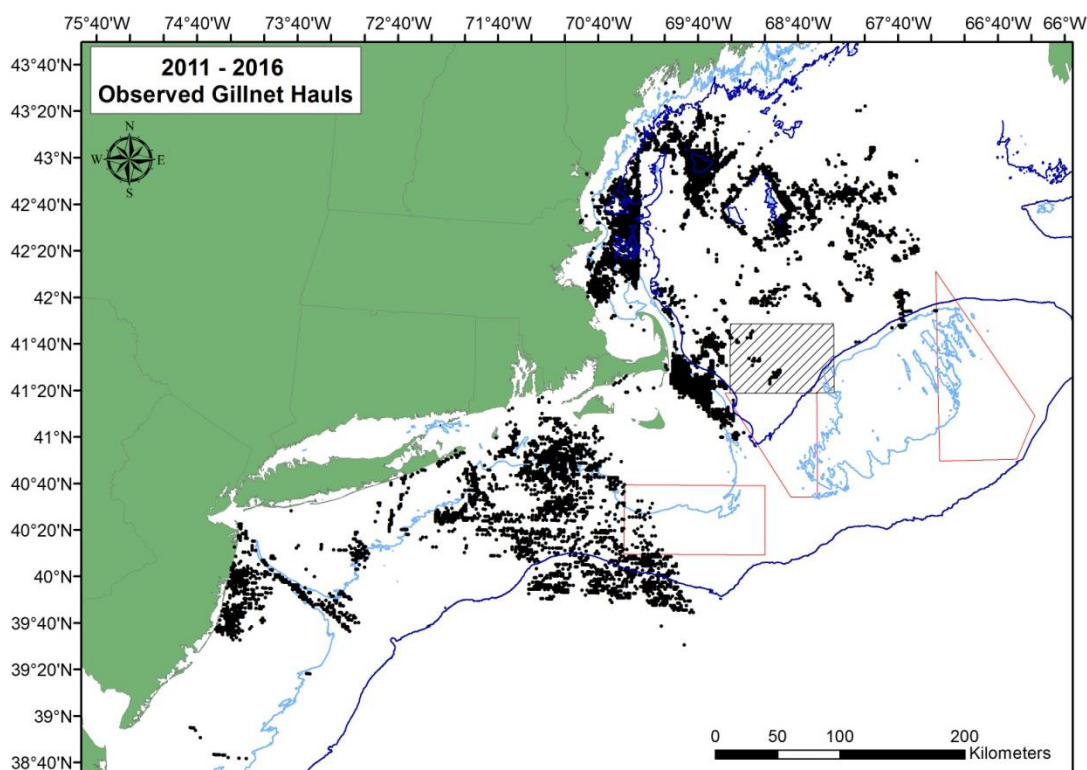


Figure 6 – Observed haul locations for gillnet trips from 2011 to 2016.

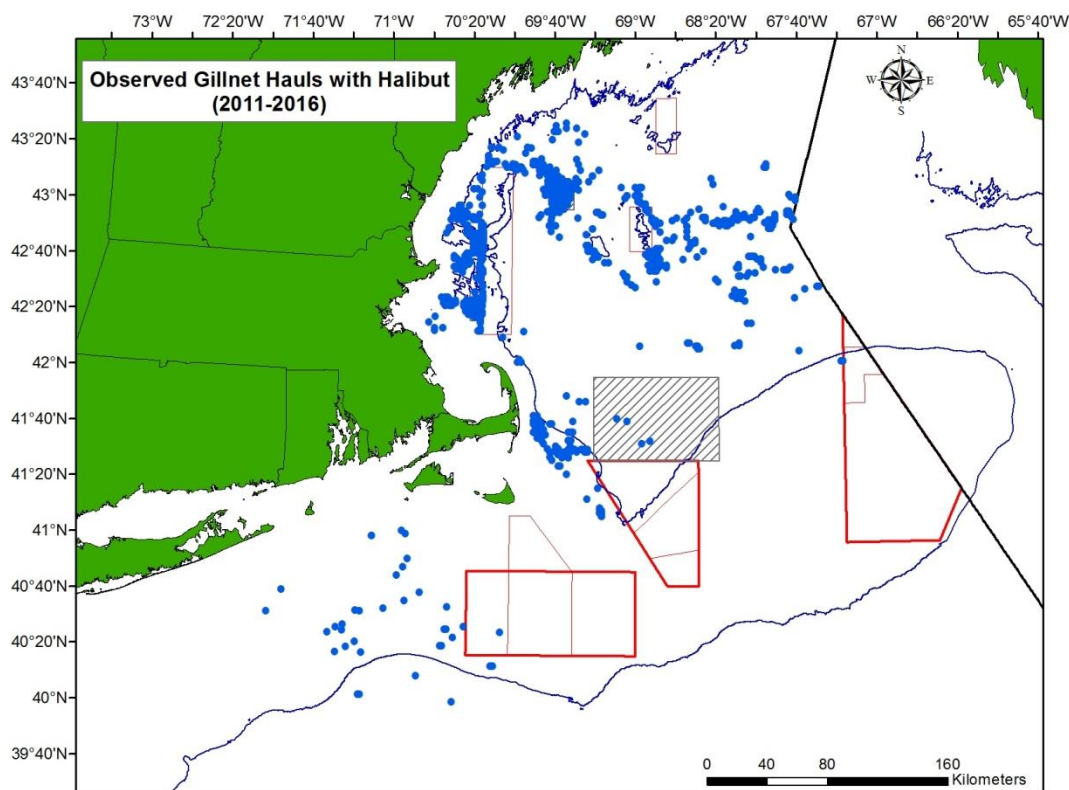


Figure 7 – Observed haul locations for gillnet trips that encountered a halibut from 2011 to 2016.

Longline Hauls – From 2011 to 2016 there were 1,792 observed longline hauls in the dataset, which included fishing effort in the Gulf of Maine, Great South Channel, and Georges Bank. The primary target

species reported on these longline hauls was cod (41%), haddock (24%), tilefish (17.3%), and spiny dogfish (12.2%). Atlantic halibut was only listed as the primary target species on one of the 1,792 observed longline hauls. Halibut were only present in four of the 1,792 observed hauls (0.22%), indicating that the federal longline fishery does not capture significant quantities of halibut.

Handline Gear – From 2011 to 2016 there were 1,149 observed locations where handgear (NEGEAR Code = 020) was deployed. Halibut were not observed at any of these locations.

Maine State Water Halibut Fishery

The groundfish PDT received harvester-reported halibut catch data from the Maine Department of Marine Resources. The dataset was limited to trips where halibut were caught, and included both kept and discarded halibut from 2003-2016. The data were reviewed and any questionable records were omitted from the database prior to the analysis. The dataset included vessels with both state-only and federal permits.

The analysis was limited to halibut that were captured in the longline fishery, which accounted for the vast majority of records in the Maine Harvester database. Of the 16,749 halibut that were present in the database, 16,589 were captured using longline gear, while the remaining halibut were caught using hooks (n=130), “pot & trap crab/other” (n=4), otter trawl (n=8), or “other gear” (n=18).

Only longline catch locations with an associated geographic position (in decimal degrees) were included in the analysis. Catch locations were not available for over 1,000 halibut in the database. In addition, for some of the trips, the position was provided in LORAN bearings, but not in decimal degree coordinates, and these records were also excluded from the analysis.

Before the data were plotted in ArcGIS, some records were filtered out of the database because the reported catch locations seemed implausible. After the data were filtered, the dataset contained of 7,558 trip level records with at least one halibut present in the catch, and 15,407 reported halibut. For the majority of trips, the vessel reported catch between one and five halibut. The majority of harvester reported trips occurred along the eastern coast of Maine, particularly in statistical areas 511 and 512 (Figure 8).

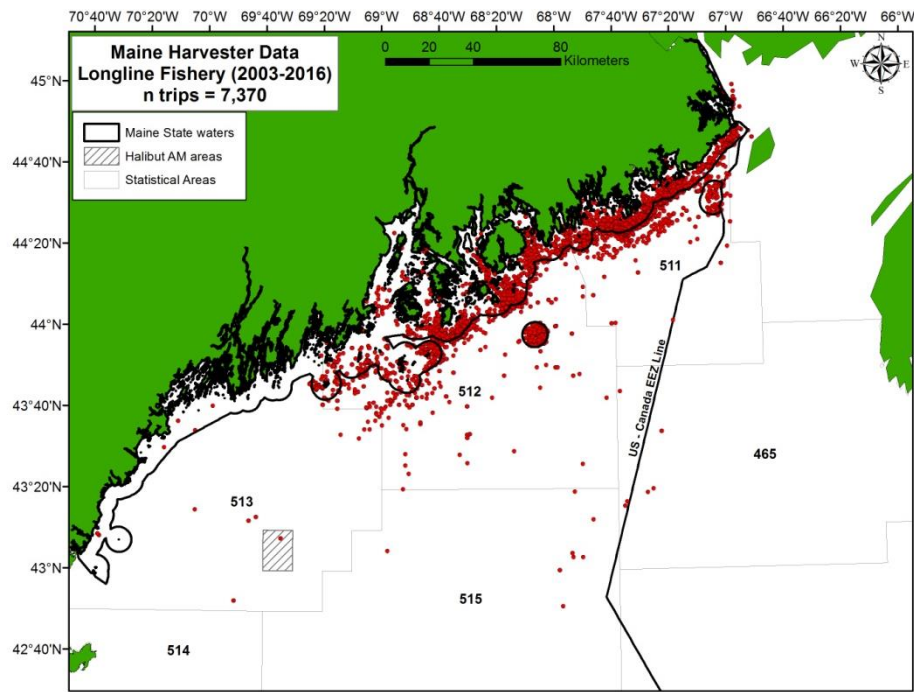


Figure 8. Harvester reported longline fishing locations with at least one halibut present in the catch from 2003-2016. The data were filtered to exclude any trips with a location that was suspected to be an error.

The trip locations reported in the filtered dataset were aggregated by 10 minute squares to examine where the longline fishery effort for halibut is occurring. From 2003 to 2016, the longline fishery primarily caught halibut in waters north of 43°40'N, and between 69°20' and 67°W (Figure 9). The geographic distribution of longline fishing effort from 2011 to 2016 was also examined (Figure 10), to investigate whether spatial patterns of fishing effort have shifted over time.

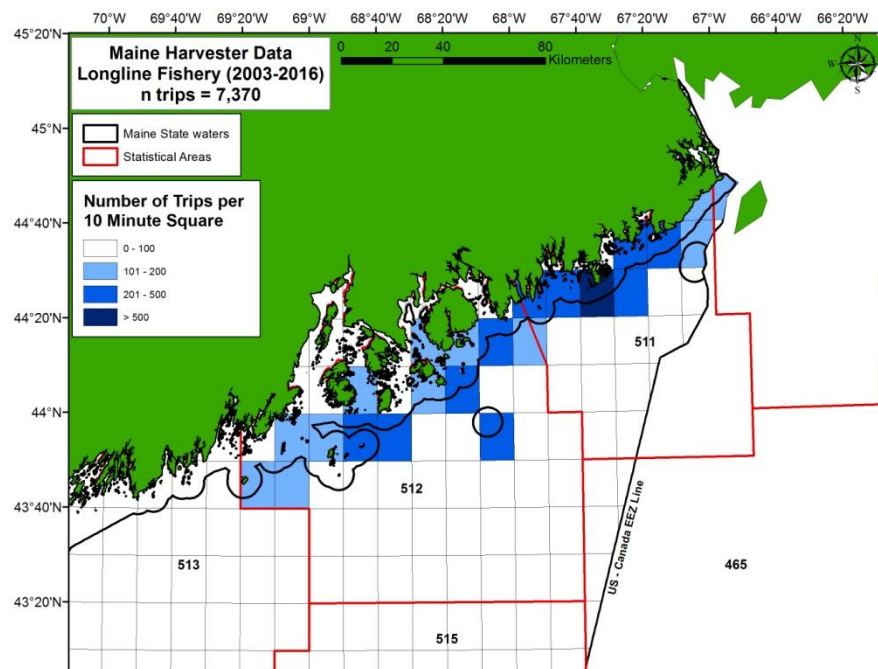


Figure 9. Number of longline trips with a halibut catch reported in each 10 minute square between 2003 and 2016.

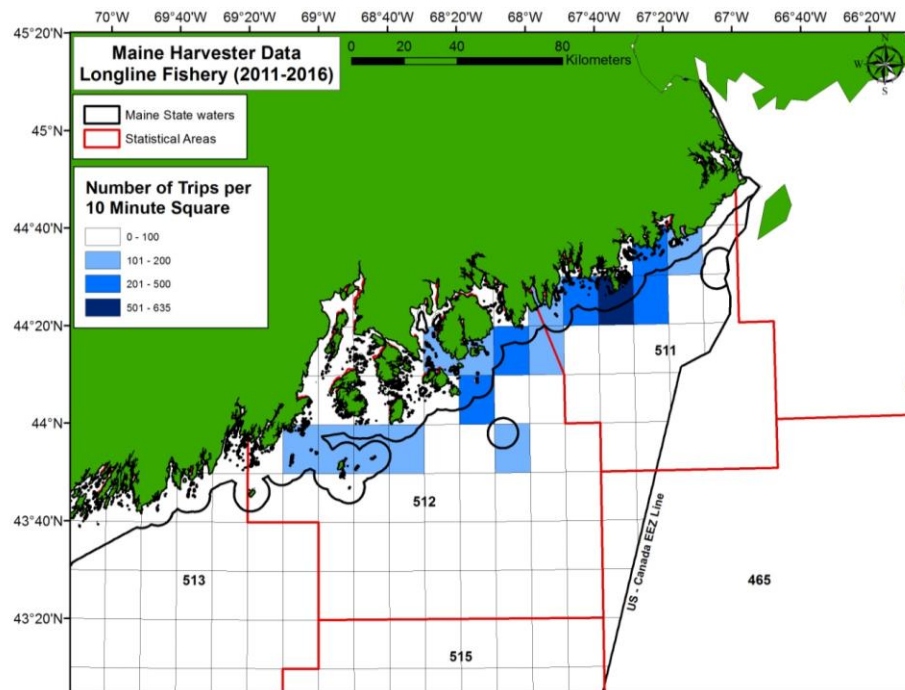


Figure 10. Number of longline trips with a halibut catch reported in each 10 minute square between 2011 and 2016.

The total catch of halibut (kept and discard) were aggregated by 10 minute squares (catch weight in each 10 minute square/total halibut catch) to investigate that spatial distribution of halibut catches in the longline fishery between 2003 and 2016 (Figure 11), and between 2011 and 2016 (Figure 12). It should be noted that the catch weights were not standardized with respect to fishing effort (e.g., number of hooks fished, soak time, etc...) or with respect to the weight type (e.g., ungraded, "meat", whole weight) that was recorded in the database.

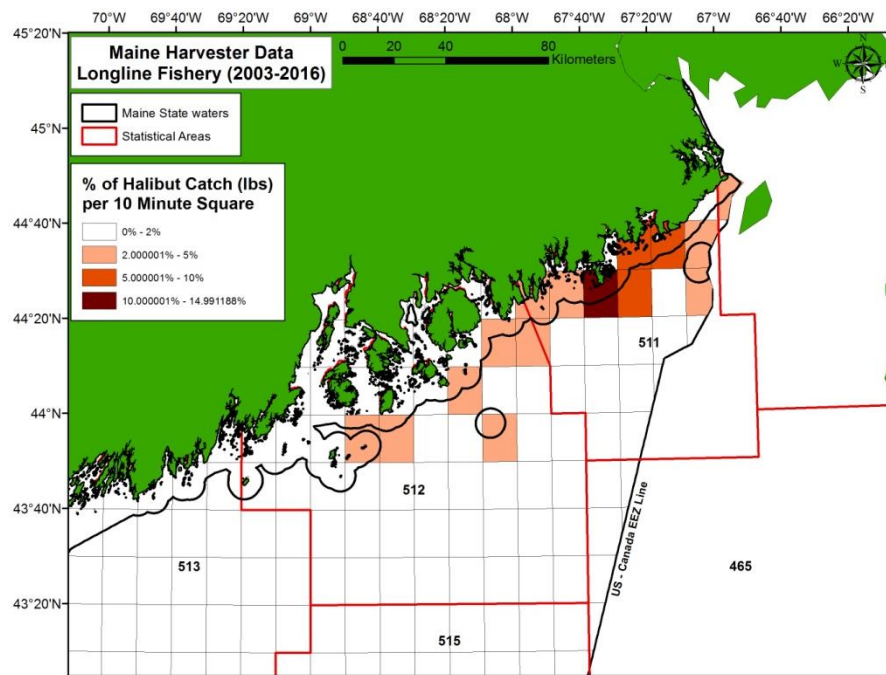


Figure 11. Proportion of longline halibut catch (catch weight in each 10 minute square/total halibut catch weight) reported in each 10 minute square between 2003 and 2016.

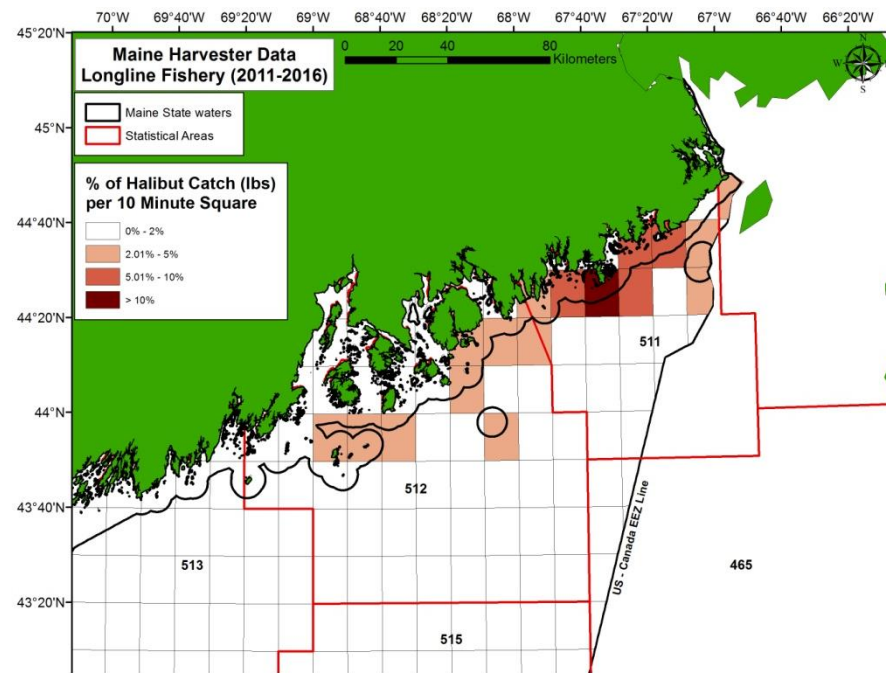
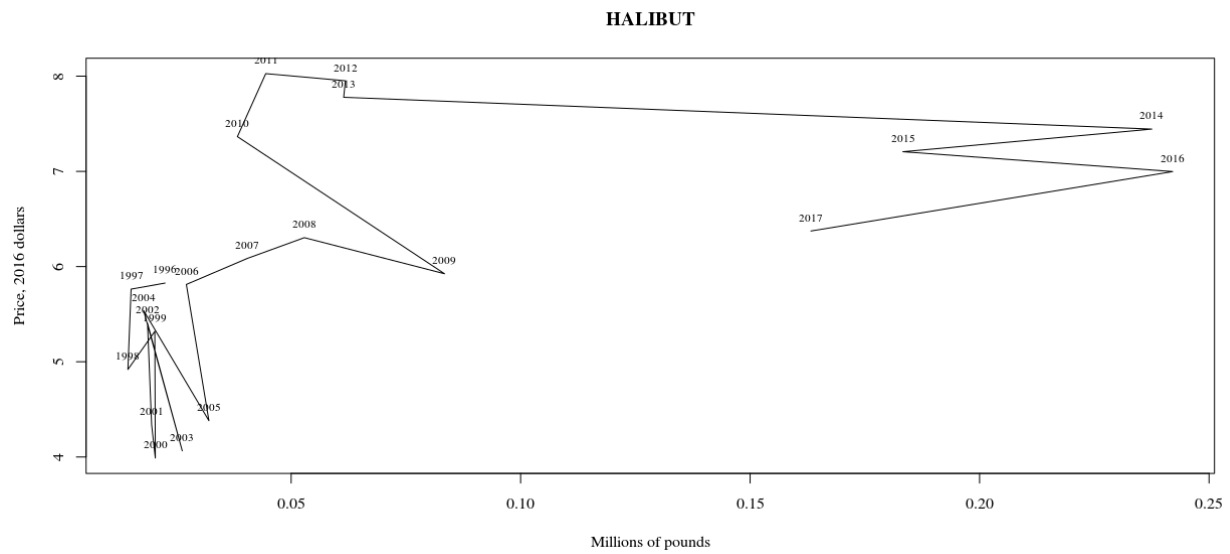
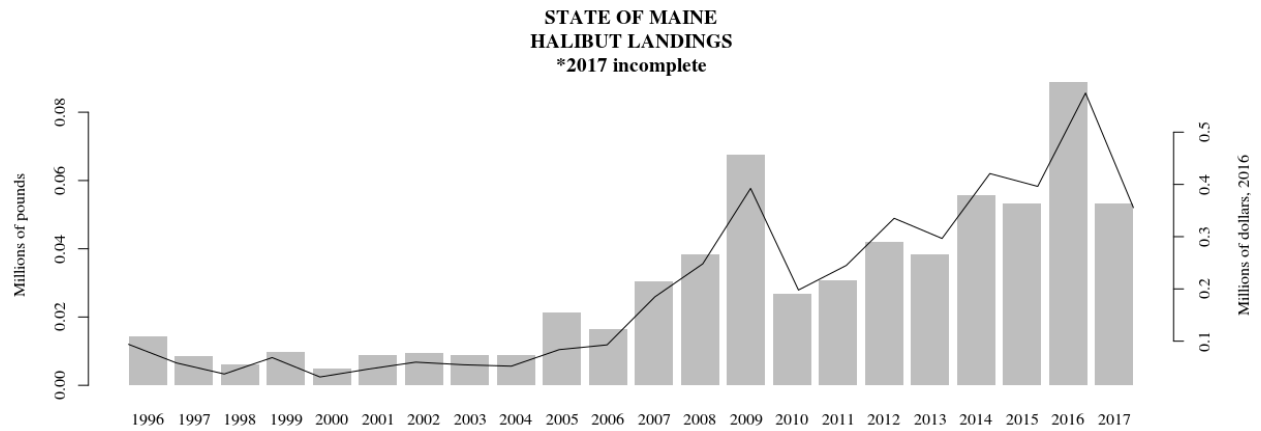


Figure 12. Proportion of longline halibut catch (catch weight in each 10 minute square/total halibut catch weight) reported in each 10 minute square between 2011 and 2016.

F. Economic information on the Atlantic halibut fishery



HALIBUT price by year, 2016 dollars

