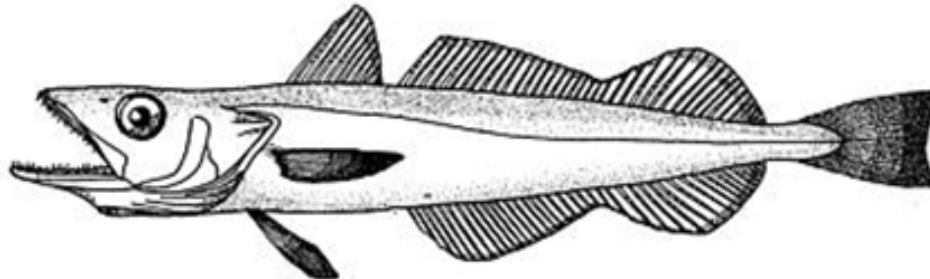
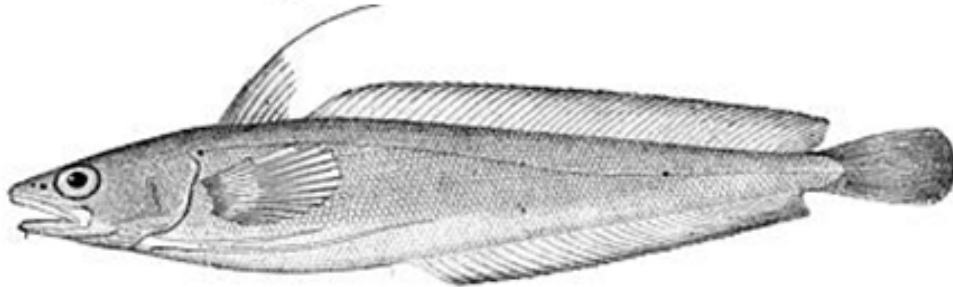
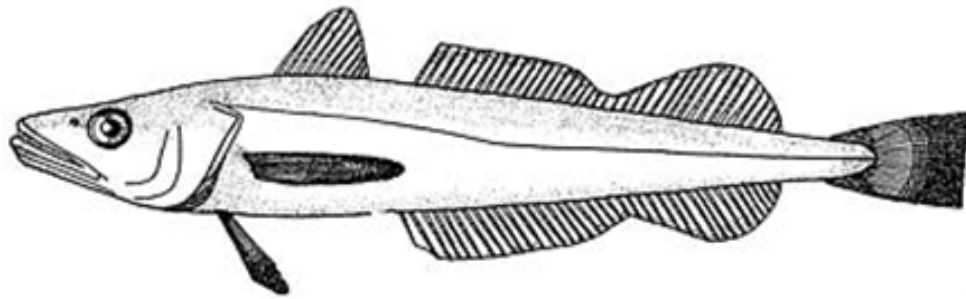


NEW ENGLAND FISHERY MANAGEMENT COUNCIL

**Stock Assessment and Fishery Evaluation
(SAFE Report)
For the Small-Mesh Multispecies Fishery
Fishing Years 2017-2019**



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1.0 Executive Summary

This Stock Assessment and Fishery Evaluation Report (SAFE) was prepared by Greater Atlantic Regional Fisheries Office (GARFO) and the Northeast Fisheries Science Center (NEFSC), and reviewed by the New England Fishery Management Council's Whiting Plan Development Team (PDT) which added conclusions and recommendations (Section 3.0). This report and procedure is mandated by Amendment 19 to the Northeast Multispecies Fishery Management Plan and its implementing regulations, the fourth prepared since 2014. The last SAFE Report was prepared in 2016 to support specification adjustments for 2017-2019.

This year's report consists primarily of a fishery performance report (Section 5.0) that estimates total catch by stock to determine whether they exceed the Annual Catch Limit (ACL) and potentially trigger a post-season accountability measure (AM). Going into more detail than in past reports, this year's SAFE Report includes a description of trends in effort and economics (Section 6.0). Rounding out the report is a summary of the September 2020 management track assessments.

In fishing year 2019, catch of northern silver hake totaled 2.9 million pounds and was 4.6% of the Annual Catch Limit (ACL), plus 188,000 pounds of recreational catch which up until now has not been included in the small-mesh multispecies ACL framework. Discards were 9.1% of total catch. Catch of southern whiting totaled 12.6 million pounds and was 31.1% of the ACL. Discards were 33% of total catch, primarily associated with small-mesh fishing for squid, contributing to 68% of total southern whiting discards.

Catch of northern red hake totaled 583,000 pounds, or 41% of the ACL. Discards accounted for 49.2% of total catch. Catch of southern red hake totaled 3.3 million pounds, or 148% of the ACL, plus an estimated 736,000 pounds of recreational catch (MRIP). Discards accounted for 63.9% of total catch.

According to the plan's post-season accountability measure, the southern red hake catch at 148% of the ACL would trigger accountability measures (AM) and reduce the TAL on a 1:1 basis going forward. The Whiting PDT however DOES NOT recommend automatic implementation of a reduced TAL trigger to account for the overage this year.

The assessments determined that both stocks of silver hake are not overfished and overfishing is not occurring. The recommended specifications use a three-year moving average to determine OFL and ABC, in this case the 2017-2019 fall survey. However the 2017 fall survey was incomplete so the specifications for southern whiting (including silver and offshore hakes) relied on an average of 2018-2019 fall biomass indices. The PDT's conclusions and recommendations for northern silver hake and southern whiting stocks rely on a traditional approach, updated with new data to estimate biomass and scientific uncertainty, including the risk of overfishing at the ABC limit. More details are provided in Section 7.1.

A research track assessment (RTA) for red hake stocks was conducted in March 2020, focusing on stock structure and survey trawl efficiency. During the assessment, the existing AIM model was rejected due to non-significant fit and an alternative SPR assessment using catch-adjusted swept area biomass estimates was not used to determine biological reference points. The RTA however determined that exploitation rates were low and that fishing was not the main driver of changes in biomass. The management track assessment used an empirical approach and reached the same conclusion, but status could not be determined and was classified as "unknown" More details are provided in Section 7.2.

The Whiting PDT's recommendations for OFL and ABC were presented and reviewed by the Council's Scientific and Statistical Committee on November 12, 2020. Because there was no established way to determine OFL with no biological reference points from the assessment, several options were presented by different applications of the Plan B Smooth Approach that has been applied to groundfish stocks with empirically-based assessments.

The SSC approved ????, which results in the following specifications to account for scientific and management uncertainty, expected discards, and state-water landings.

[Table of SSC approved specifications goes here]

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2.0 Table of Contents

1.0	Executive Summary	1
2.0	Table of Contents	4
2.1	List of Tables	4
2.2	List of Figures.....	5
2.3	List of Maps.....	6
3.0	Conclusions and Recommendations	7
3.1	Fishery Performance and Accountability Measures	9
4.0	Management Background (Nicole Lengyel Costa and Andrew Applegate)	11
4.1	2019 Small-Mesh Multispecies Management Update	13
5.0	Fishery Performance Report – Annual Catch Limit Accounting (Dan Caless)	16
5.1	Silver hake	16
5.2	Red hake.....	18
5.3	Bycatch of Red and Silver Hake by Fishery Group	20
5.4	Bycatch in the Small-Mesh Multispecies Fishery (Andrew Applegate).....	21
6.0	Effort and Economic Trends in the Small-Mesh Multispecies Fishery (Dr. Naresh Pradhan)	30
6.1	Summary of economic trends and conditions.....	30
7.0	Stock Assessments and Status	35
7.1	Silver hake	35
7.2	Red hake.....	35
7.2.1	Recent assessments	35
7.2.2	Summary of the MTA and overview of the empirical approach	35
7.2.3	Stock status	36
7.2.4	Description of the alternative approach	36
7.2.5	Productivity and Mean Generation Time Estimate for Southern Red Hake.....	36
8.0	Whiting PDT Members and Contributors to this Document	39
9.0	References	40

2.1 List of Tables

Table 1. Red Hake strategies for setting 2021-2023 catch specifications. These approaches would define an OFL and uncertainty in the Plan B estimates would be applied to derive ABC. 8

Table 2. 2021-2023 specification (mt) estimates and options by stock. See Table 1 for more detail about red hake options 1 to 5f..... 9

Table 3. Northern area exemption program seasons.....	11
Table 4. Mesh size dependent possession limits.....	12
Table 5. Small-mesh multispecies in-season accountability measure adjustment triggers, effective 2017.	14
Table 6. Fishing year 2019 whiting (silver and offshore hake) landings and discards by stock area.	17
Table 7. Fishing year 2019 red hake landings and discards by stock area.....	19
Table 8. Estimated 2019 fishing year bycatch of red and silver hake by management area and fishery group.....	21
Table 9. Estimated small-mesh multispecies fishery discards by area and fishing year, 2017-2019. Only trips landing 2000 or more lbs. whiting or 400 or more lbs. red hake or greatest landed revenue was from whiting or red hake are included.....	23
Table 10. Estimated small-mesh multispecies fishery group, GARFO binning rules applied, 2017-2019. Only trips landing 2000 or more lbs. whiting or 400 or more lbs. red hake or greatest landed revenue was from whiting or red hake are included.	24
Table 11. Quarter reassignments when no or very few observed trips were associated with a VTR trip stratum. Quarters represent three -onth periods for the May to April fishing year.....	25
Table 12. Fishery group reassignments when no or very few observed trips were associated with a VTR trip stratum. All DOF and State trips were associated with Uncategorized observed trips. Quarters represent three-month periods for the May to April fishing year.....	25
Table 13. Vessels, landings, revenue and prices for small-mesh multispecies.....	32
Table 14. Effort, landings, and revenue for whiting and red hake.....	33
Table 15. Effort, landings, revenue and price for all vessels and trips landing ≥ 1 lbs. of small-mesh multispecies.	34
Table 16. Sensitivity to assumption analysis	39

2.2 List of Figures

Figure 1. Small-mesh fishery specification framework adopted and approved in Amendment 19.	10
Figure 2. Southern red hake specifications and catch by fishing year.....	13
Figure 3. Amount kept on whiting trips by area group, fishing year, and fishing year quarter. Whiting trips are those either targeting whiting and red hake (largest percent of revenue on trip) or landing 2000 or more lbs. of whiting or 400 lbs. of red hake on a trip. Data are summarized from Vessel Trip Reports with landings in fishing years 2017-2019.....	26
Figure 4. Amount kept on whiting trips by area group, fishing year, and binned fishery group Whiting trips are those either targeting whiting and red hake (largest percent of revenue on trip) or landing 2000 or more lbs. of whiting or 400 lbs. of red hake on a trip. Data are summarized from Vessel Trip Reports with landings in fishing years 2017-2019.....	28
Figure 5. Efforts, landings, and revenues in small-mesh multispecies fisheries.....	31
Figure 6. Efforts in landing ≥ 1 pounds of whiting and red hake	31
Figure 7. Landings, revenues, and prices for whiting and red hakes on landings ≥ 1 pounds.....	32

Figure 8. Calculation of the age at which a female southern red hake produces 50% of lifetime egg production, a proxy for a mean generation time for a mating pair to replace itself with a mating pair in a subsequent generation..... 38

2.3 List of Maps

Map 1. Small-mesh exemption areas in the Gulf of Maine and Georges Bank..... 15

3.0 Conclusions and Recommendations

The Whiting PDT developed several sets of OFL and ABC options based on different applications of the Plan B Smooth Approach for consideration by the SSC, but does not have a preference or specific recommendation. The justification and potential issues with each approach are summarized in Table 1 and numerical estimates of OFL and ABC are summarized in Table 2. For comparison, a range of OFL and ABC at various exploitation rates is also given in Table 2, but the SSC should be mindful that only a fraction of the stock area is within the seasonal small-mesh exemption areas, particularly in the northern management area (see Map 1).

Table 1. Red Hake strategies for setting 2021-2023 catch specifications. These approaches would define an OFL and uncertainty in the Plan B estimates would be applied to derive ABC.

Plan B proportional change (2017-2019) applied to:	Justification	Issues
1. 2017-2019 actual estimated catch	Follows standard Plan B smooth approach application (yellowtail flounder)	Catch may not be representative of OFL, especially with fishing restrictions. May be driven by circumstances that affect the fishery or by actual catch that exceed the OFL.
2. Existing OFL from 2018-2020 specifications	Applies Plan B smooth approach to previous OFL, rather than actual catch	Uses OFL estimate from rejected AIM model application
3. 1981-2009 OFL forecast from Plan B smooth in that time period (previous estimate using the Plan B smooth approach)	Consistent with overfishing definition, but using Plan B method to evaluated OFL during the MSY proxy time period	Period may not be representative of contemporary stock productivity.
4. 2017-2019 OFL forecast from Plan B smooth in that time period (previous estimate using the Plan B smooth approach)	Follows Plan B smooth approach, using Plan B estimate for 2017-2019 as representative of MSY proxy, rather than actual catch.	May be sensitive to rapid changes in survey swept area biomass.
5. Fixed exploitation rate applied to SWAB 2017-2019 (TYMA).	Fishing mortality estimates are exceptionally low, particularly for the northern stock. Uses an F MSY proxy that is more consistent with life history	Catch limits may exceed availability of the stock due to regulations. Mean exploitation rates for time series were rejected by the MTA as the basis for catch advice.

Table 2. 2021-2023 specification (mt) estimates and options by stock. See Table 1 for more detail about red hake options 1 to 5f.

Stock	Strategy	North		South	
		OFL (% ch)	ABC (% ch)	OFL (% ch)	ABC (% ch) ¹
Silver hake/Whiting	Same method Update scientific uncertainty	39.93 (-28%)	20.41 (-34%)	72.16 (+101%)	40.99 (103%)
Red hake	1 Catch	229 (-73%)	TBD	1,919 (+67%)	1,440 (+43%)
	2 2018 specs	785 (-6%)	TBD	1,460 (+27%)	1,095 (+9%)
	3 Plan B OFL	1,722 (+105%)	TBD	3,181 (+177%)	2,386
	4 2019 Plan B	2,328 (+177%)	TBD	3,093 (+169%)	(+137%)
	5a (2% expl)	4,602 (+448%)	TBD	1,294 (+13%)	2,320
		27,615 (3187%)		7,766 (+575%)	(+130%)
	5f (12% expl)		TBD		971 (-4%) 5,824 (+478%)

3.1 Fishery Performance and Accountability Measures

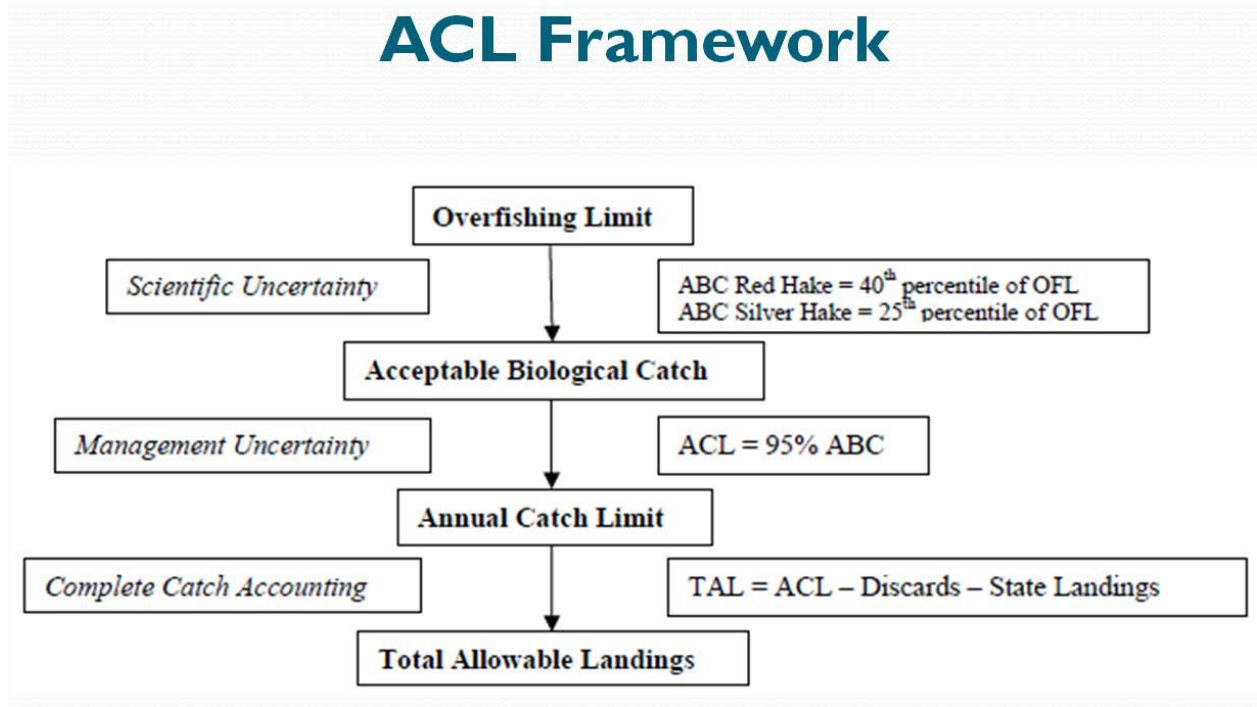
According to the plan’s post-season accountability measure, the southern red hake catch at 148% of the ACL would trigger accountability measures (AM) and reduce the TAL on a 1:1 basis going forward. More details are provided in Section 5.0.

The Whiting PDT however DOES NOT recommend automatic implementation of a reduced TAL trigger to account for the overage this year. According to the plan’s ACL Framework (Figure 1), the TAL trigger determines when during the fishing year the red hake possession limit is reduced from 5,000 lbs. to 400 lbs. to discourage targeting and encourage avoidance, thereby reducing risk of overfishing.

It should be noted that the AM for an overage in 2018 was NOT applied in 2019 and that new assessments conclude that overfishing is not occurring. New OFL and ABC specifications are likely to be a considerable increase from the 2018-2019 specifications and Framework Adjustment 62 would reduce the 5,000 lbs. possession limit to 1,000 lbs. for selective small-mesh trawls and 600 lbs. for all other gears.

¹ Scientific uncertainty buffer to set southern red hake ABC was set at 25% by Framework 62 as a rebuilding measure.

Figure 1. Small-mesh fishery specification framework adopted and approved in Amendment 19.



4.0 Management Background (Nicole Lengyel Costa and Andrew Applegate)

The Small-Mesh Multispecies Fisheries Management Plan (FMP) specifies the management measures for the northern and southern stocks of silver hake (*Merluccius bilinearis*), the northern and southern stocks of red hake (*Urophycis chuss*), and a single stock of offshore hake (*Merluccius albidus*), which primarily co-occurs with the southern stock of silver hake. Catches of silver hake and offshore hake are generally not differentiated in the market and are therefore collectively referred to as “whiting” with the fishery that harvests these species referred to as the “whiting” fishery. Silver hake and red hake are both managed as two distinct stocks, a northern and a southern, based on geographic delineations. Because the vessels in these fisheries are using small mesh, they are regulated by a series of exemptions that have evolved over time through various different amendments and framework adjustments to the Northeast (NE) Multispecies, or Groundfish FMP.

Currently the small mesh multispecies fishery is managed by a collection of exemptions to the NE Multispecies FMP. These exemptions allow a fishery to be exempt from the minimum mesh size provided they catch less than 5% of regulated multispecies. There are currently five exemption areas (Map 1) that are open seasonally (Table 3) with possession limits dependent upon the species and mesh size (Table 4).

Table 3. Northern area exemption program seasons

	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Cultivator			June 15 – October 31									
GOM* Grate			July 1 – November 30									
Small I			July 15 – November 15									
Small II	– June 30								January 1 –			
Cape Cod RFT†					Sept 1 – Nov 20							
					September 1 – December 31							

* GOM = Gulf of Maine

† RFT = Raised Footrope Trawl

The Gulf of Maine Grate Raised Footrope area is open from July 1 through November 30 of each year and requires the use of an excluder grate on a raised footrope trawl with a minimum mesh size of 2.5 inches. Small Mesh Areas I and II are open from July 15 through November 15, and January 1 through June 30, respectively. A raised footrope trawl is required in Small Mesh Areas I and II, and the trip limits are mesh size dependent. Cultivator Shoal Exemption Area is open from June 15 – October 31, and requires a minimum mesh size of 3 inches. The Raised Footrope Trawl Exemption Areas are open from September 1 through November 20, with the eastern portion remaining open until December 31. A raised footrope trawl, with a minimum mesh size of 2.5-inch square or diamond mesh, is required. The Southern New England and Mid-Atlantic Regulated Mesh Areas are open year-round and have mesh size dependent possession limits for the small-mesh multispecies.

The mesh size dependent possession limits for all the areas with that requirement are:

Table 4. Mesh size dependent possession limits

Codend Mesh Size	Silver and offshore hake, combined, possession limit	Northern red hake	Southern Red Hake
Smaller than 2.5"	3,500 lb	3,000 lb/1500 lb	5,000 lb
Larger than 2.5", but smaller than 3.0"	7,500 lb	3,000 lb/1500 lb	5,000 lb
Equal to or greater than 3.0"	30,000 lb (40,000 lb in Southern Area)	3,000 l/1500 lb b	5,000 lb

The exemption areas were implemented as part of several different amendments and framework adjustments to the Northeast Multispecies FMP. In 1991, Amendment 4 incorporated silver and red hake and established an experimental fishery on Cultivator Shoal. Framework Adjustment 6 (1994) was intended to reduce the catch of juvenile whiting by changing the minimum mesh size from 2.5 inches to 3 inches. Small Mesh Areas I and II, off the coast of New Hampshire, were established in Framework Adjustment 9 (1995). The New England Fishery Management Council (Council) established essential fish habitat (EFH) designations and added offshore hake to the plan in Amendment 12 (2000). Also in Amendment 12, the Council proposed to establish limited entry into the small-mesh fishery. However, that measure was disapproved by the Secretary of Commerce because it did not comply with National Standard 4² as a result of measures that benefited participants in the Cultivator Shoal experimental fishery and because of the “sunset” provision that would have ended the limited entry program at some date. The Raised Footrope Trawl Area off of Cape Cod was established in Framework Adjustment 35 (2000). A modification to Framework Adjustment 35 in 2002 adjusted the boundary along the eastern side of Cape Cod and extended the season to December 31 in the new area. Framework Adjustment 37 modified and streamlined some of the varying management measures to increase consistency across the exemption areas. In 2003, Framework Adjustment 38 established the Grate Raised Footrope Exemption Area in the inshore Gulf of Maine area.

The Northeast Multispecies FMP was implemented primarily to manage the commercial cod and haddock fisheries in the Gulf of Maine and Georges Bank³. The FMP is complicated and has been changed numerous times since 1985 (almost 20 Council amendments and over 50 framework adjustments; not including dozens of emergency, interim, and Secretarial amendments implemented outside of the Council process.)

Specifications for 2018-2020 (NEFMC 2017) adjusted the OFL, ABC, ACL, and TALs to account for changes in stock biomass. Spring survey biomass declined since the 2014 survey and the 2018-2020 specification were set at a considerably lower level in accordance with the harvest control rule.

Framework adjustment 62 for Whiting, Red Hake, & Offshore Hake was submitted in August 2020 to establish a rebuilding plan and management measures for the southern red hake stock. To achieve rebuilding, Framework adjustment 62 included a preferred alternative that would reduce the ABC to 75% of the overfishing limit or F_{MSY} proxy for the duration of the rebuilding period (5-10 years) or until the southern red hake biomass reaches the B_{MSY} target (currently estimated to be 1.01 kg/tow), whichever

² National Standard 4 states that measures “shall not discriminate between residents of different States,” and that fishing privileges must be “fair and equitable to all such fishermen.”

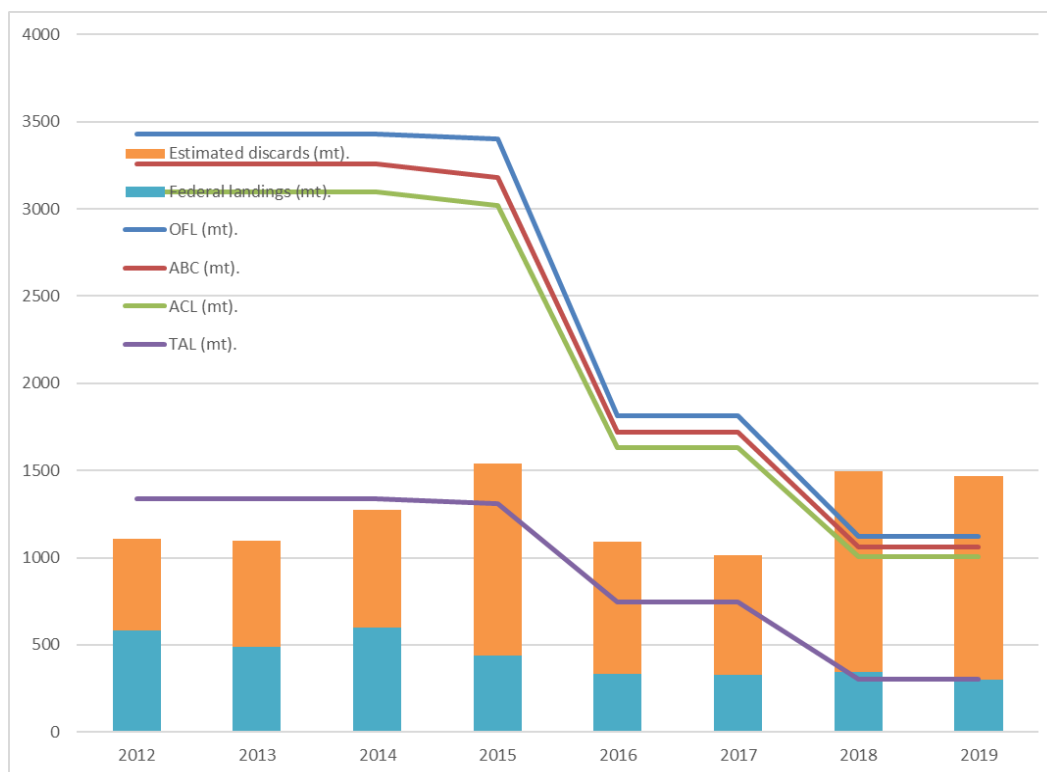
³ The large-mesh species (cod, haddock, pollock, flounders, etc.) were commonly referred to as the “regulated” species because they were the focus of management originally. That term is confusing as almost all of the commercially viable stocks are now “regulated.” This document refers to the management of those species as the “groundfish fishery” or the “large-mesh multispecies fishery.”

happens first. To restrict landings of southern red hake, Framework adjustment 62 included a preferred alternative for reducing the year round possession limit of southern red hake for all gear and fisheries. The possession limit would be 1,000 lbs. for selective small-mesh trawls and large-mesh trawls, and 600 lbs. for standard small-mesh trawls. Final action and an implementation date for Framework adjustment 62 has yet to be determined.

4.1 2019 Small-Mesh Multispecies Management Update

Commercial landings and discards increased for northern silver hake from 2018 to 2019, however total catch remained low at just below 5% of the ACL. For southern whiting, although commercial landings were fairly similar from 2018 to 2019, discards nearly doubled with total catch comprising 31.1% of the ACL in 2019. Commercial landings, discards, and total catch for northern red hake in 2019 were very similar to that of 2018 comprising 42% and 41% of the ACL in 2018 and 2019 respectively. For southern red hake, landings and discards were similar from 2018 to 2019 with the ACL again being exceeded in 2019. The following figure summarizes the specifications and annual catches for southern red hake:

Figure 2. Southern red hake specifications and catch by fishing year.



Two management actions were implemented that affected the 2019 small-mesh multispecies fishery; the in-season accountability measures that triggered possession limit reductions for the northern and southern red hake stocks.

Northern and Southern Red Hake Possession Limit Adjustment Trigger

The Federal regulations governing small-mesh fisheries include an in-season accountability measure intended to reduce the risk of exceeding the ACLs for each stock. The Northeast Multispecies FMP establishes a percentage of the TAL that, once harvested, requires NMFS to take action to reduce the

possession limit for that stock to an incidental level for the remainder of the fishing year. Table 5 displays the possession limit adjustment triggers for each of the four small-mesh stocks.

In fishing year 2019, landings for both the southern and northern red hake stocks had landings that reached their respective triggers. Accordingly, NMFS reduced the possession limits for each stock to the incidental levels through the in-season accountability measure. Effective September 9, 2019, the northern red hake possession limit was reduced from 3,000 lb (1,361 kg) to the 400-lb (181-kg) incidental limit. Effective February 3, 2020, the southern red hake possession limit was reduced from 5,000 lb (2,268 kg) to the 400-lb (181-kg) incidental limit for the remainder of 2019 fishing year.

Table 5. Small-mesh multispecies in-season accountability measure adjustment triggers, effective 2017.

Species	In-season Adjustment Trigger (percent)
Northern Red Hake	37.9
Northern Silver Hake	90
Southern Red Hake	90
Southern Silver Hake	90

Southern Red Hake Landings Exceed the ACL for FY 2018 and FY2019

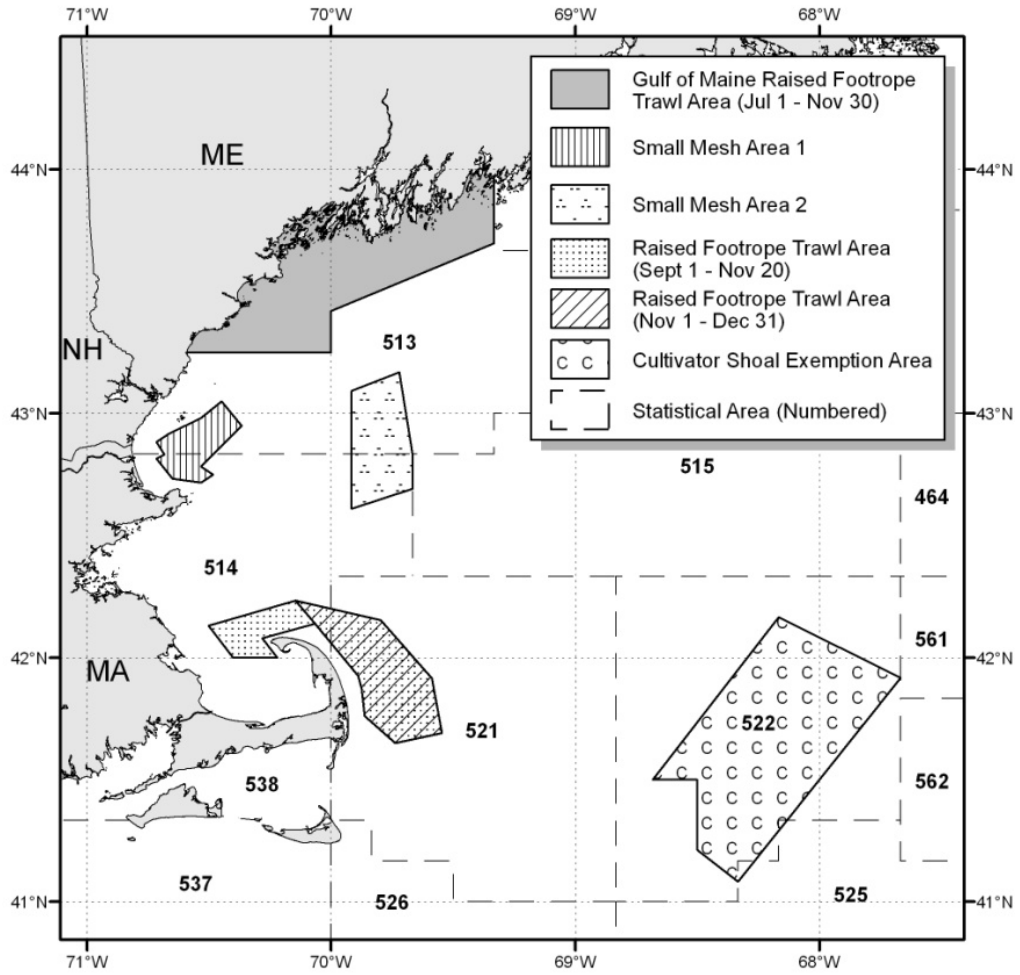
If the catch (landings and discards) of a small-mesh multispecies stock exceeds the stock’s ACL in a given fishing year, NMFS is required to reduce the in-season possession limit adjustment trigger in a subsequent fishing year by 1 percent for each 1 percent by which the ACL was exceeded.

Currently, possession limits for three of the four small-mesh stocks are reduced to the incidental level when 90 percent of the TAL is harvested. The exception, northern red hake, has a possession limit adjustment trigger of 37.9 percent. NOAA Fisheries reduced the northern red hake in-season possession limit adjustment trigger from 62.5 percent of the total allowable landings (TAL) to 37.9 percent of the TAL, effective with the 2017 fishing year because catch exceeded the ACL in a previous year. Consequently, each year, when 37.9 percent of the TAL is landed, the northern red hake possession limit will be reduced from 3,000 lb per trip to the incidental possession limit of 400 lb per trip.

In 2018, southern red hake landings exceeded the ACL by 49.6 percent, triggering the post-season AM to reduce the possession limit adjustment trigger percentage by 49.6 percent. Accordingly, NMFS will need to take action to reduce the possession limit adjustment trigger from 90 percent to 40.4 percent.

In 2019, southern red hake catch totaled 3.3 million pounds, or 148% of the ACL (Section 5.2). This total does not include an additional 736,000 pounds caught by the recreational fishery, once thought to be an insignificant fraction and not included in the ACL framework (Figure 1). Accordingly, the Council should consider whether or not to take action to reduce the possession limit adjustment trigger below 40.4 percent, the AM trigger in 2020. It should be noted that the 2019 overage occurred when the AM trigger was 90% in fishing year 2019.

Map 1. Small-mesh exemption areas in the Gulf of Maine and Georges Bank



5.0 Fishery Performance Report – Annual Catch Limit Accounting (Dan Caless)

Annual catch limits were implemented for the small-mesh fishery, via Secretarial Amendment, on May 1, 2012, and adopted by the Council through Amendment 19 to the Northeast Multispecies FMP later that year. These catch limits were implemented for fishing years 2012 through 2014, revised catch limits were implemented for 2015-2017 and 2018-2020. This report contains complete catch accounting information for fishing year 2018. Catch accounting information for fishing year 2017 can be found in the Stock Assessment and Fishery Evaluation (SAFE) Report (https://s3.amazonaws.com/nefmc.org/5_Annual-Monitoring-Report-for-Fishing-Year-2017_180919_150658.pdf) and for fishing year 2018 in the Annual Monitoring Report. The annual catch limit was derived using the procedure shown in Figure 2. The specifications are listed in **Error! Reference source not found.** for silver hake and whiting and **Error! Reference source not found.** for red hake.

GARFO staff summarized commercial, state water commercial, and recreational landings of whiting and red hake for fishing year 2019. Following existing SBRM procedures to apply discard to kept-all ratios on observed trips to the total (i.e. all species) fleet landings, GARFO staff estimated silver hake and red hake discards.

5.1 *Silver hake*

Some 60% of northern silver hake catches occurred on squid/whiting trips and another approximately 13% were caught on squid trips. Almost all of the catch for both kinds of trips were landings. Groundfish trips were the third highest group, catching 11.8% of whiting catch, mostly discards.

Over 80% of the southern whiting catches were from squid and squid/whiting trips, with squid trip catch about double the squid/whiting catch. About 60% of the squid trip catch was from landings while almost all of the squid/whiting trip catch was from landings.

Table 6. Fishing year 2019 whiting (silver and offshore hake) landings and discards by stock area⁴.

	Pounds	Metric tons	Percent of ACL (29,475 mt)	Percent of total catch
Northern silver hake commercial landings	2,664,917	1,209	4.1%	83.6%
Northern silver hake state-permitted only vessel landings	43,297	20	0%	1%
Northern silver hake research catch outside of Magnuson	169	0	0%	0%
Northern silver hake estimated discard	291,140	132	0.4%	9.1%
Northern silver hake recreational catch (MRIP)	187,977	85	0.3%	5.9%
Northern silver hake catch	2,999,523	1,361	4.6%	100.0%
	Pounds	Metric tons	Percent of ACL (18,425 mt)	Percent of total catch
Southern whiting commercial landings	8,295,610	3,763	20.4%	65.6%
Southern whiting state-permitted only vessel landings	164,194	74	0.4%	1.3%
Southern whiting research catch outside of Magnuson	6,719	3	0.0%	0.1%
Southern whiting estimated discard	4,171,051	1,892	10.3%	33.0%
Southern whiting hake recreational catch (MRIP)	4,908	2	0.0%	0.0%
Southern whiting catch	12,637,573	5,732	31.1%	100.0%

⁴ MRIP recreational data include only preliminary landings from 2019 as of July 23, 2020. Total catch includes all sources except for recreational landings because the annual catch limit does not include them.

5.2 Red hake

We estimated 55,884 lb of northern red hake discards from the lobster fishery, approximately 10% of the northern red hake catch. A note of caution about the uncertainty of this estimate. This was based on 15 observed trips discarding minute amounts of red hake. An informal bootstrap analysis resulted in a 95% confidence interval of zero to approximately 147,000 lb of discards. The FY18 estimate for this was zero. This suggests regarding this particular estimate with caution due to its imprecision.

Over 80% of southern red hake was caught on squid, scallop, and squid/whiting trips. More than 90% of the squid fishery catch was discards, all of the scallop fishery catch was discards and most of the squid/whiting catch was landings.

Table 7. Fishing year 2019 red hake landings and discards by stock area⁵.

	Pounds	Metric tons	Percent of ACL (685 mt)	Percent of total catch
Northern red hake commercial landings	278,105	126	18.4%	44.9%
Northern red hake state-permitted only vessel landings	-	-	0%	0%
Northern red hake research catch outside of Magnuson	47	0	0%	0%
Northern red hake estimated discard	304,638	138	20.2%	49.2%
Northern red hake recreational catch (MRIP)	36,566	16.6	2.4%	5.9%
Northern red hake catch	582,790	264	38.6%	100.0%
	Pounds	Metric tons	Percent of ACL (1,007 mt)	Percent of total catch
Southern red hake commercial landings	665,123	302	30.0%	16.5%
Southern red hake state-permitted only vessel landings	51,600	23	2.3%	1.3%
Southern red hake research catch outside of Magnuson	141	0	0.0%	0.0%
Southern red hake estimated discard	2,568,183	1,165	115.7%	63.9%
Southern red hake recreational catch (MRIP)	735,591	334	33.1%	18.3%
Southern red hake catch	3,285,047	1,490	148.0%	100.0%

⁵ MRIP recreational data include only preliminary landings from 2019 as of July 23, 2020. Total catch includes all sources except for recreational landings because the annual catch limit does not include them.

5.3 Bycatch of Red and Silver Hake by Fishery Group

Fleets were defined by the captain's trip declaration on vessel trip reports, but when that information was missing or ambiguous the species group that comprised the majority of the total was applied. Some trips had neither a trip declaration or a majority of revenue attributable to a species group and were assigned to an unknown or other category⁶. These data were also stratified by half-year to estimate discards by fishery group and half year. Estimated discards in each stratum were summed to estimate total discards of silver and red hake below.

In general "whiting" trips did not catch as much small mesh mullets as did "squid" or "squid whiting" trips due to the business rules for categorizing trips. Many "squid" trips were categorized by declaration – declared longfin or illex trips - but many of them targeted small mesh multispecies based on revenue. In general, for trips declared DOF or without a declaration, if the vessel had a limited-access longfin or illex permit but no small mesh groundfish permit (no limited-access groundfish permit and no groundfish category "K" permit) and squid was the highest revenue by species then the trip was also categorized as "squid".

If after applying the above rules a non-declared trip was still uncategorized, if the vessel had a limited-access longfin or illex permit and did have a small mesh groundfish permit, and the combined revenue of squid and whiting was the highest revenue by species, then the trip was categorized as "squid/whiting". Only if the vessel had a small mesh groundfish permit and no limited-access longfin or illex permit, then if whiting was the highest revenue by species the trip was categorized as a "whiting" trip.

Generally the above rules also required the trip to use small mesh bottom otter trawl gear.

Estimated discards of the four small mesh multispecies stocks were attributed to the above categories as displayed in Table 8. Slightly under half of northern red hake catches were on groundfish trips and squid/whiting trips. The groundfish fishery catches were almost all discards while the squid/whiting catches were nearly all landings.

⁶ GARFO's Data Matching and Imputation System (DMIS) attempts to categorize trips by fishery based on a number of business rules. Generally trips are categorized by trip declaration (either Vessel Monitoring System or Interactive Voice Response system) if available, else by species revenue combined with gear and permit type, else left as uncategorized. In fishing year 2018, trips categorized based on declaration include "northeast multispecies", "scallop", "monkfish", "herring", "surf clam/ocean quahog", "mackerel", and "squid". Categories generally based on maximum species revenue, when there was no trip declaration or the declaration was "declared out of fishery" (DOF), include "squid" again, "whiting", "squid/whiting", "shrimp", "lobster/crab", "whelk/conch", "hagfish", "menhaden", "summer flounder", etc. Other categories are identified by federal permits held or trip data including "Northwest Atlantic Fisheries Organization", "outside" the Exclusive Economic Zone, "state", "party/charter", "recreational", "carrier", and "research". Trips that cannot be categorized into any of the above are considered "uncategorized" or "unknown". In addition, for this small mesh multispecies analysis a "butterfish" category was added if butterfish had the highest revenue by species landed on the trip and the trip was not already categorized by a trip declaration and was not a "state" trip.

Table 8. Estimated 2019 fishing year bycatch of red and silver hake by management area and fishery group.

FISHERY_GROUP_2	NORTHERN_RED_DISCARD (lb, % of total)		SOUTHERN_RED_DISCARD (lb, % of total)		NORTHERN_SILVER_DISCARD (lb, % of total)		SOUTHERN_WHITING_DISCARD (lb, % of total)	
BUTTERFISH	-	-	26,978	1.1	-	-	97,928	2.3
FLUKE	-	-	11,555	0.4	-	-	30,222	0.7
GROUND	133,030	43.7	10,286	0.4	243,714	83.7	32,384	0.8
HAGFISH	5	0.0	-	-	-	-	-	-
HERRING	4,637	1.5	8,160	0.3	3,884	1.3	44,700	1.1
LOBSTER/CRAB	55,884	18.3	53,247	2.1	3	0.0	-	-
MACKEREL	29	0.0	12,957	0.5	2	0.0	63,634	1.5
MENHADEN	-	-	-	-	-	-	-	-
MONKFISH	0	0.0	98	0.0	11	0.0	212	0.0
REDCRAB	-	-	1,414	0.1	-	-	-	-
RESEARCH	47	0.0	139	0.0	47	0.0	220	0.0
SCALLOP	83,003	27.2	569,706	22.2	14,525	5.0	32,484	0.8
SCUP	-	-	49,436	1.9	-	-	187,622	4.5
SHRIMP	-	-	6,165	0.2	-	-	26,303	0.6
SQUID	2,068	0.7	1,544,110	60.1	1,643	0.6	2,854,028	68.4
SQUID/WHITING	10,026	3.3	84,718	3.3	8,111	2.8	162,058	3.9
SURFLAM	2,753	0.9	30,979	1.2	5,378	1.8	47,843	1.1
UNKNOWN	10,691	3.5	153,937	6.0	11,767	4.0	589,783	14.1
WHELK/CONCH	0	0.0	3,634	0.1	-	-	-	-
WHITING	2,512	0.8	805	0.0	2,102	0.7	1,850	0.0
Total	304,685	100.0	2,568,322	100.0	291,187	100.0	4,171,270	100.0
Total Excluding Research	304,638		2,568,183		291,140		4,171,051	

5.4 Bycatch in the Small-Mesh Multispecies Fishery (Andrew Applegate)

Finfish bycatch by vessels that target whiting and red hake were updated for the 2017, 2018, and 2019 fishing years by applying the mean D/Kall ratio for observed trips to the landings reported on Vessel Trip Reports (VTRs). To focus the bycatch analysis on the small-mesh multispecies fishery, observed trips and VTRs were both filtered to retain trips that kept (or landed) 2000 or more pounds of whiting OR 400 pounds of red hake OR the majority of the revenue on the trip was derived from whiting OR red hake. The latter threshold added a few trips that landed small volumes of whiting, red hake, and other fish, mostly for trips that fished in state waters.

Unlike previous bycatch estimation in the 2016 SAFE Report (which has been reanalyzed in two separate reports to the Council since that time), trips were assigned to the same binning that GARFO uses to estimate groundfish bycatch. This binning includes factors such as the vessels permit status, the trip declaration, as well as gear and mesh size observed or reported on VTRs. More information on this binning procedure may be found in ???. The proportion of revenue for species in a trip is part of the binning procedure, so prices from dealer reports were associated with VTR-reported landings by matching VTR serial numbers, or when that failed by year, month, state, and gear type.

Of the estimated 11,779 mt of total bycatch, 5,031 mt were attributable to the whiting fishery (1,995 of 3,994 reported trips; 248 of 1,115 observed trips) and 3,095 mt were attributable to the squid fishery (455 reported and 198 observed trips) (Table 9). For this analysis however, observed and VTR trips were also stratified into quarter (Q1 – May to Jul; Q2 – Aug to Oct; Q3 – Nov to Jan; Q4 – Feb to Apr) (Figure 3) and region fished (the whiting northern management area; NAFO division 5 and NAFO division 6 in the southern management area) (Figure 4).

Bycatch estimates for each fishing year were made for the top 21 species that were identified in previous bycatch analyses (Table 9). Unlike previous years when haddock were the largest component of bycatch in the small-mesh multispecies fishery, the top three species this time were silver hake (1,692 mt), red hake (1,967 mt), and spiny dogfish (890 mt). Most of the silver hake (1,384 of 1,692 mt) and red hake (1,384 of 1,967 mt) came from the Georges Bank and Southern New England area. Bycatch of these species were higher in 2018 (696 reported trips) and 2019 (899 reported trips) than they were in 2017 (506 reported trips). Most of the silver (729 of 1,692 mt) and red hake (1,072 of 1,967 mt) discards were associated with trips binned as the whiting fishery (Table 10). Bycatch associated with selective small mesh gear, such as the raised footrope trawl, were not estimated separately for this analysis but were differences in the D/Kall ratios were estimated in NEFMC 2019.

Whiting trips, whiting and red hake landings, and hence discards declined in the northern management area. Haddock and Atlantic herring discards declined from 2017 to 2019 (Table 9). Haddock discards declined from 209 mt in 2017 to 18 mt in 2019 and Atlantic herring discards declined from 172 mt in 2017 to 72 mt in 2019, both consistent with general trends in the populations of those stocks in the Gulf of Maine. Yellowtail flounder discards however increased.

These results will differ from the silver and red hake discard estimates in Section 5.3, which include any trip that had silver and red hake bycatch regardless of targeting or amount of landings. Estimated coefficient of variation (CV) for these bycatch estimates were derived from the variation in the D/Kall ratios by trip. Between trip variance was greater than the within trip variance, hence the CV estimates was higher than previous bycatch analyses that considered hauls to be independent samples. In addition, some quarters had a relatively low number of observed trips (Figure 3) and in some cases observed trips had to be associated with an adjacent quarter (Table 11) or similar fishery (Table 12) in the same area.

Table 9. Estimated small-mesh multispecies fishery discards by area and fishing year, 2017-2019. Only trips landing 2000 or more lbs. whiting or 400 or more lbs. red hake or greatest landed revenue was from whiting or red hake are included.

Values	Area									Grand Total
	Northern management area			Georges_SNE			Mid_Atlantic			
	2017	2018	2019	2017	2018	2019	2017	2018	2019	
Total trips, VTR	504	391	271	506	696	899	138	242	347	3994
Observed trips, NEFOP & ASM	201	307	50	102	122	145	22	63	103	1115
Total kept, mt	3,484	2,222	1,654	2,441	2,969	2,791	453	599	990	17,602
Kept whiting, mt	2,993	1,847	1,379	1,510	2,089	1,918	153	219	503	12,611
Kept red hake, mt	168	212	221	61	70	73	8	41	93	947
Discards, mt	1,416	880	469	1,379	2,555	2,990	475	508	1,107	11,779
CV	100%	118%	56%	64%	64%	82%	43%	59%	57%	75%
Silver hake	28	127	29	109	648	627	7	23	93	1,692
Silver hake CV.	292%	149%	159%	149%	112%	107%	133%	120%	141%	121%
Red hake, mt	107	84	54	207	549	628	13	152	173	1,967
Red hake CV	186%	195%	101%	98%	111%	76%	82%	114%	118%	107%
Spiny dogfish, mt	189	46	10	46	201	202	80	38	79	890
Spiny dogfish CV.	213%	211%	145%	117%	97%	153%	121%	100%	98%	144%
Butterfish, mt	5	1	1	136	260	197	52	28	94	774
Butterfish CV.	272%	233%	236%	123%	135%	141%	77%	113%	83%	125%
Little skate, mt	21	13	11	104	103	196	2	20	96	568
Little skate CV.	294%	197%	55%	103%	91%	101%	101%	127%	109%	110%
Atlantic herring, mt	172	74	72	16	7	27	10	3	2	383
Atlantic herring CV.	128%	225%	187%	217%	262%	140%	13%	248%	201%	163%
Winter skate, mt	21	129	7	44	38	41	5	4	21	311
Winter skate CV.	309%	407%	101%	142%	179%	162%	188%	194%	154%	272%
Haddock, mt	209	44	18	6	2	2	0	1	0	282
Haddock CV.	151%	187%	136%	179%	227%	275%	140%			158%
Winter flounder, mt	17	14	2	38	57	51	0	6	24	209
Winter flounder CV.	141%	194%	158%	158%	138%	113%	133%	108%	101%	134%
Summer flounder, mt	6	0	1	33	54	31	40	17	5	187
Summer flounder CV.	346%	141%	245%	156%	138%	178%	181%	126%	148%	163%
Barndoor skate, mt	4	3	4	46	35	25	20	11	0	148
Barndoor skate CV.	274%	323%	138%	142%	113%	182%	83%	153%	137%	141%
Monkfish, mt	13	17	7	8	20	28	6	12	18	129
Monkfish CV.	143%	171%	34%	179%	180%	172%	74%	148%	96%	145%
Ocean pout, mt	2	5	2	5	17	19	0	39	25	113
Ocean pout CV.	177%	241%	97%	203%	155%	209%	104%	172%		155%
Yellowtail flounder, mt	21	34	33	1	1	2	0	0	0	92
Yellowtail flounder CV.	187%	221%	87%	161%	161%	283%	227%			164%
Witch flounder, mt	10	19	5	1	11	1	10	4	5	66
Witch flounder CV.	181%	151%	62%	136%	128%	344%	84%	173%	223%	144%
Windowpane flounder, mt	2	0	4	12	13	12	1	3	5	51
Windowpane flounder CV.	224%		0%	187%	148%	151%	78%	99%	89%	142%
American plaice, mt	10	25	10	0	0	0	0	0	0	46
American plaice CV.	128%	158%	49%		0%	0%	141%			127%
Thorny skate, mt	3	2	12	0	0	0	1	0	1	18
Thorny skate CV.	194%	302%	0%		0%		24%	173%		64%
Cod, mt	5	0	4	0	2	1	0	0	0	13
Cod CV.	186%		27%		186%	110%	0%	173%		128%
White hake, mt	1	4	2	0	2	1	0	0	0	10
White hake CV.	149%	371%	200%	172%	283%	313%	141%	173%		276%
Smooth skate, mt	0	0	0	0	0	0	0	0	0	0
Smooth skate CV.		0%	0%		0%	0%				0%

Table 10. Estimated small-mesh multispecies fishery group, GARFO binning rules applied, 2017-2019. Only trips landing 2000 or more lbs. whiting or 400 or more lbs. red hake or greatest landed revenue was from whiting or red hake are included.

Fishery binning											
Values	DOF trip	Fluke	Groundfish	Herring	Scup	Squid	State	Uncategorized	Whiting	Grand Total	
Total trips, VTR	969	8	26	157	147	455	101	136	1995	3994	
Observed trips, NEFOP & ASM	211	2	5	87	34	198	163	167	248	1115	
Total kept, mt	5,172	13	30	292	271	3,989	179	281	7,376	17,602	
Kept whiting, mt	4,010	1	0	245	107	2,179	126	172	5,771	12,611	
Kept red hake, mt	314	0	0	31	5	121	5	11	459	947	
Discards, mt	2,894	3	3	99	270	3,095	163	222	5,031	11,779	
CV	82%	0%	0%	99%	65%	76%	92%	73%	70%	75%	
Silver hake	488	0	0	6	35	345	35	54	729	1,692	
Silver hake CV.	120%	0%	0%	208%	61%	132%	109%	100%	121%	121%	
Red hake, mt	464	0	0	10	41	298	36	44	1,072	1,967	
Red hake CV	120%	0%	0%	161%	92%	111%	102%	117%	99%	107%	
Spiny dogfish, mt	189	0	0	8	36	364	12	11	269	890	
Spiny dogfish CV.	192%	0%	0%	217%	55%	132%	152%	164%	137%	144%	
Butterfish, mt	189	1	0	0	10	295	10	17	250	774	
Butterfish CV.	123%	0%		287%	52%	120%	111%	133%	134%	125%	
Little skate, mt	138	0	0	2	15	92	16	15	289	568	
Little skate CV.	122%	0%	0%	237%	126%	101%	108%	109%	107%	110%	
Atlantic herring, mt	197	0	0	8	0	39	2	3	133	383	
Atlantic herring CV.	135%			219%	73%	191%	138%	115%	195%	163%	
Winter skate, mt	77	0	1	4	10	80	2	5	132	311	
Winter skate CV.	271%	0%	0%	419%	147%	234%	176%	216%	306%	272%	
Haddock, mt	107	0	0	13	1	62	0	1	99	282	
Haddock CV.	171%	0%	0%	146%	151%	148%	231%	208%	151%	158%	
Winter flounder, mt	69	0	0	1	3	19	3	5	109	209	
Winter flounder CV.	149%	0%		140%	117%	139%	103%	119%	126%	134%	
Summer flounder, mt	26	0	0	0	6	84	2	5	63	187	
Summer flounder CV.	208%	0%		319%	166%	163%	143%	243%	139%	163%	
Barndoor skate, mt	23	0	1	1	2	77	1	2	42	148	
Barndoor skate CV.	135%	0%	0%	226%	79%	134%	154%	183%	160%	141%	
Monkfish, mt	26	0	0	1	3	62	1	2	33	129	
Monkfish CV.	161%	0%	0%	155%	99%	129%	191%	215%	163%	145%	
Ocean pout, mt	22	0	0	0	1	3	1	2	85	113	
Ocean pout CV.	191%			188%	139%	211%	207%	185%	143%	155%	
Yellowtail flounder, mt	37	0	0	4	0	11	0	1	40	92	
Yellowtail flounder CV.	193%			141%	117%	157%	273%	159%	141%	164%	
Witch flounder, mt	18	0	0	1	0	24	0	0	22	66	
Witch flounder CV.	158%		0%	132%	150%	138%	293%	180%	138%	144%	
Windowpane flounder, mt	10	0	0	0	1	14	1	2	24	51	
Windowpane flounder CV.	136%			268%	141%	144%	137%	128%	143%	142%	
American plaice, mt	20	0	0	2	0	5	0	0	19	46	
American plaice CV.	127%		0%	119%		133%	127%	104%	126%	127%	
Thorny skate, mt	5	0	0	0	0	4	0	0	8	18	
Thorny skate CV.	80%		0%	228%		84%	284%	14%	47%	64%	
Cod, mt	3	0	0	0	0	3	0	0	6	13	
Cod CV.	139%			173%		133%	137%	69%	120%	128%	
White hake, mt	5	0	0	0	1	1	0	0	3	10	
White hake CV.	337%			199%	135%	207%	402%	337%	231%	276%	
Smooth skate, mt	0	0	0	0	0	0	0	0	0	0	
Smooth skate CV.			0%							0%	

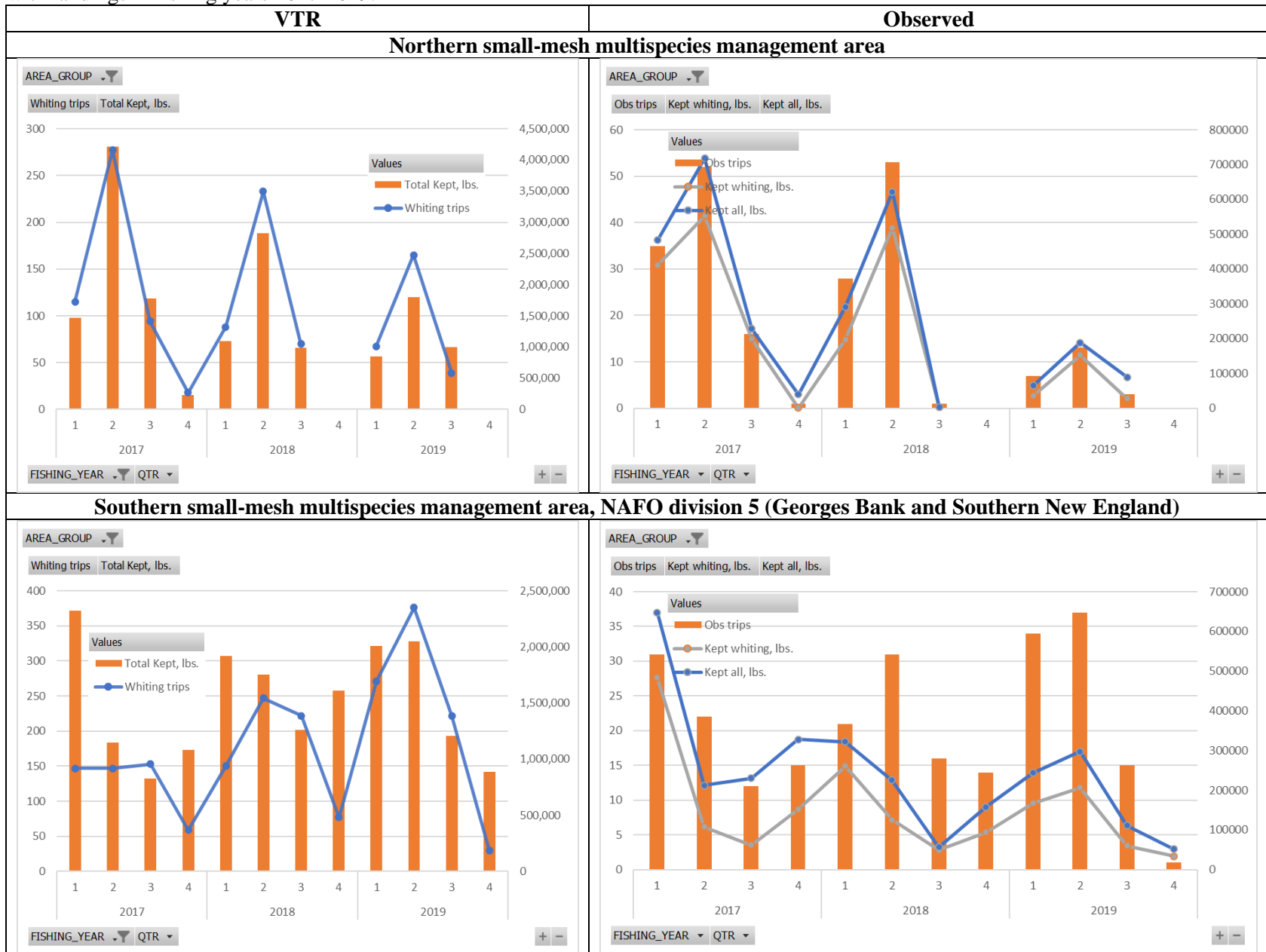
Table 11. Quarter reassignments when no or very few observed trips were associated with a VTR trip stratum. Quarters represent three -onth periods for the May to April fishing year.

FISHERY_GROUP_VT	FISHERY_GROUP_A	FISHING_YEAR_VTR	AREA_GROUP_VTR	QTR_VTR	Values		
					Total trips	Total kept, mt	Total discard, mt
Scup	Scup	2018	Northern	3	1	7	3
		2019	Mid_Atl	4	2	6	
Scup Total					3	13	3
Squid	Squid	2018	Georges_SNE	2	19	39	47
		2019	Georges_SNE	4	13	257	223
			Mid_Atl	4	11	85	119
Squid Total					43	380	389
Uncategorized	Uncategorized				2	14	6
Uncategorized Total					2	14	6
Whiting	Whiting	2018	Northern	3	22	82	41
		2019	Georges_SNE	4	16	105	44
			Mid_Atl	4	10	40	16
Whiting Total					48	226	101
Grand Total					96	633	498

Table 12. Fishery group reassignments when no or very few observed trips were associated with a VTR trip stratum. All DOF and State trips were associated with Uncategorized observed trips. Quarters represent three-month periods for the May to April fishing year.

FISHERY_GROUP_VT	FISHERY_GROUP_A	FISHING_YEAR_VTR	AREA_GROUP_VTR	QTR_VTR	Values		
					Total trips	Total kept, mt	Total discard, mt
DOF trip	Uncategorized				912	4,743	2,703
DOF trip Total					912	4,743	2,703
Herring	Whiting	2017	Northern		1	18	15
					2	36	33
					3	5	4
		2018	Northern		1	15	8
					2	25	12
		2019	Northern		1	10	3
					2	48	25
Herring Total					157	292	99
Squid	Whiting	2017	Northern		1	161	50
					2	527	213
					3	165	80
		2018	Northern		2	65	32
					1	41	5
		2019	Northern		2	51	19
					3	71	19
Squid Total					77	1,081	417
State	Uncategorized				99	173	159
State Total					99	173	159
Whiting	Squid	2017	Mid_Atl		1	79	77
					4	37	40
Whiting Total					34	116	117
Grand Total					1279	6,405	3,495

Figure 3. Amount kept on whiting trips by area group, fishing year, and fishing year quarter. Whiting trips are those either targeting whiting and red hake (largest percent of revenue on trip) or landing 2000 or more lbs. of whiting or 400 lbs. of red hake on a trip. Data are summarized from Vessel Trip Reports with landings in fishing years 2017-2019.



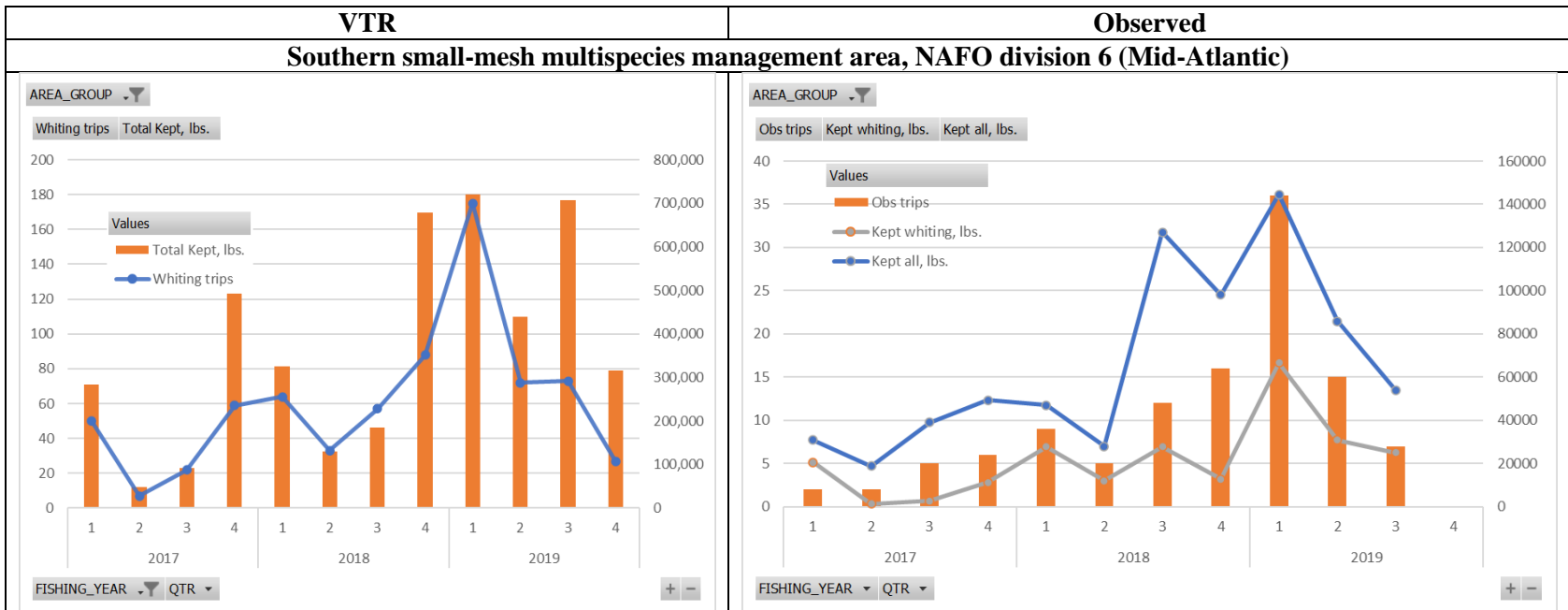
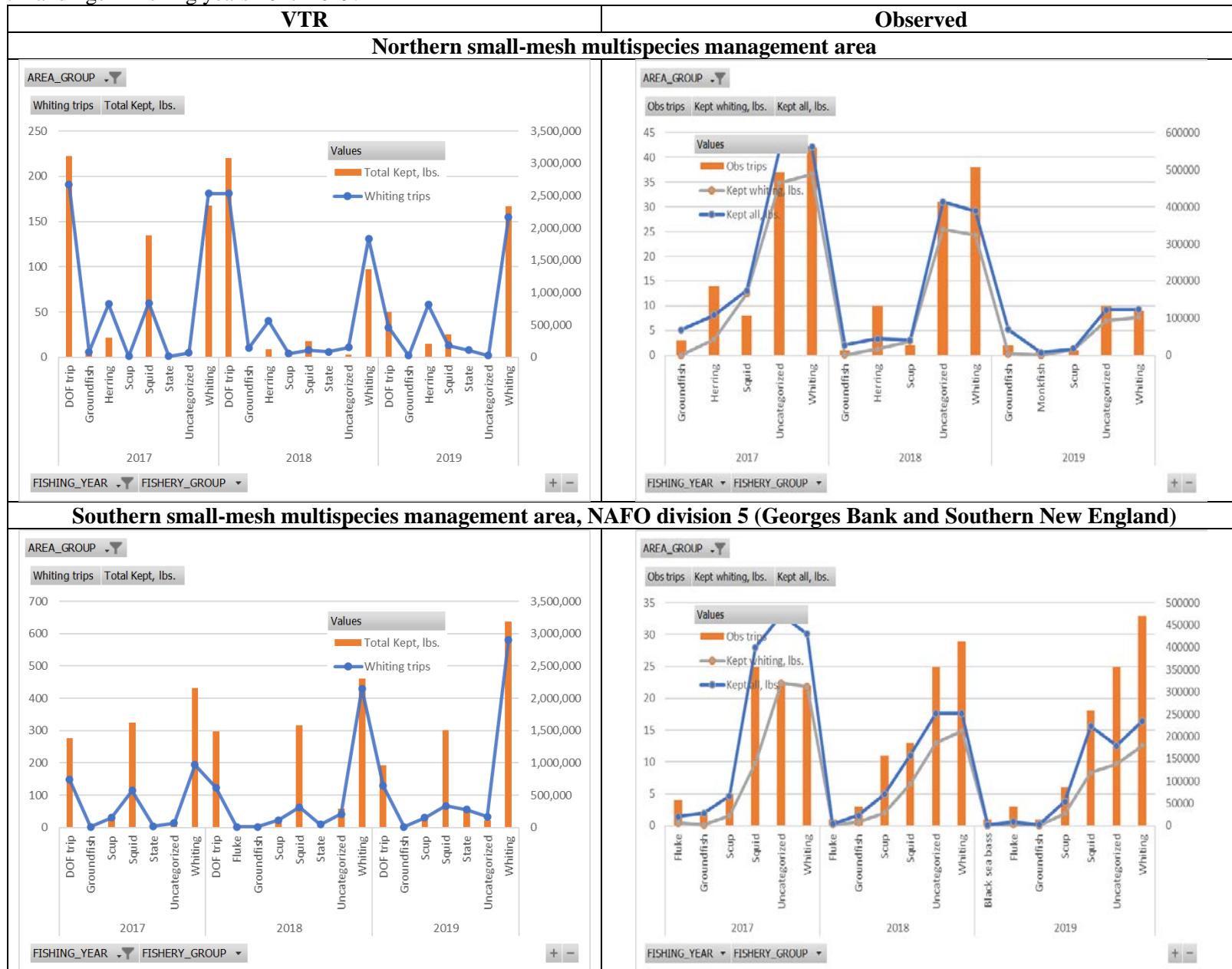
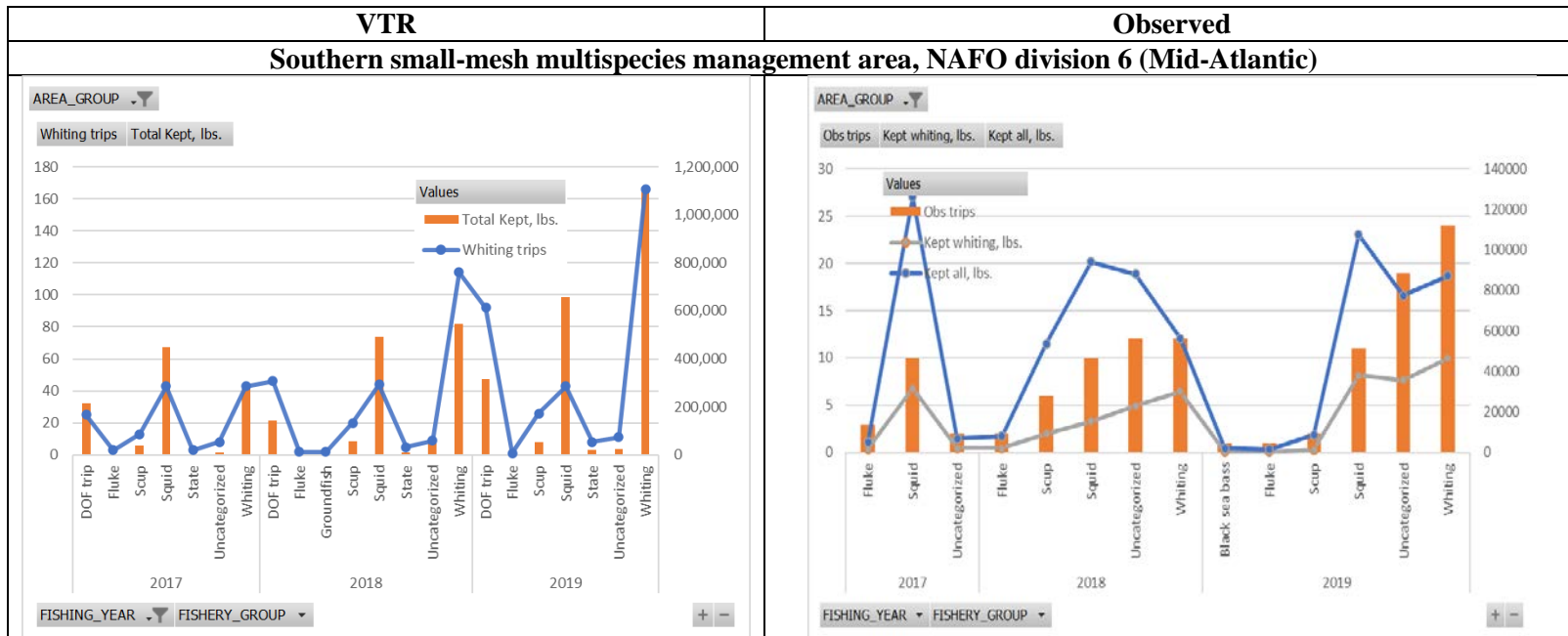


Figure 4. Amount kept on whiting trips by area group, fishing year, and binned fishery group. Whiting trips are those either targeting whiting and red hake (largest percent of revenue on trip) or landing 2000 or more lbs. of whiting or 400 lbs. of red hake on a trip. Data are summarized from Vessel Trip Reports with landings in fishing years 2017-2019.





6.0 Effort and Economic Trends in the Small-Mesh Multispecies Fishery (Dr. Naresh Pradhan)

6.1 Summary of economic trends and conditions

The following analysis includes trends in small-mesh multispecies (SMS) effort (no. of trips and no. of vessels), landings, revenues, and prices during 2012-2019 calendar years. Trends in these variables together with LPUEs are also summarized by management area and targeting in Economic Appendix 1 and 2. Landing per unit of effort (LPUE) analysis has been carried out on the small-mesh multispecies targeted trips. Also analyzed is income dependency from small-mesh multispecies landings for the permits (vessels) or trips (Economic Appendix 1). More details about economic trends in the fishery are summarize in Appendix I.

In 2019, overall there were 304 vessels that landed about 12.4 mil pounds of small-mesh multispecies with \$9 mil in revenue (in 2019 dollar) (Table 13 and Figure 5). The vessels engaged in landing small-mesh multispecies represents about 7.1 percent of all vessels and around 3.29 percent of fishing trips in the region. And, the share of revenue from the small-mesh multispecies was 0.68 percent of the regional ex-vessel fish value (Table 13).

Landings, Revenues, and Prices

Landings. Small-mesh multispecies landings consist of whiting (silver and offshore hakes) and red hake, the majority being silver hake.

Whiting landings. Whiting landings have been declining since 2014. It averaged 12.12 mil pounds in recent past three years (2016-2018). The landings were about 11.47 mil and 10.99 mil pounds in 2017 and 2018, respectively. The 2019 landings slightly decreased by about 0.29 percent to 10.97 mil pounds from 2018 landings and it declined by about 9.51% from 2016-2018 averages (Table 14 and

Figure 7).

Red hake landings. Red hake landing averaged to 0.99 mil pounds during 2016-2018. The landings were about 1.02 mil and 0.9 mil pounds in 2018 and 2019, respectively. The landing in 2019 decreased by about 11.63percent compared to 2018 (Table 14; and Figure 7).

Revenues. Real revenues (in 2019 dollar) from small-mesh multispecies landings were \$10.1 mil and \$9.0 mil in 2018 and 2019, respectively. They were lower than 2016-2018 averages at \$10.53 mil (Table 13). It decreased by 10.9 percent in 2019 compared to 2018 (Table 14). The 2016-2018 average revenue for whiting and red hake were \$9.94 mil and \$0.47 mil, respectively. Revenues declined to \$8.49 mil for whiting and \$0.39 mil for red hake in 2019 from their recent past averages. In 2018, whiting and red hake revenues were at \$9.54 mil and \$0.402 mil, respectively (Table 14).

Prices. In 2018, real prices for whiting and red hake were \$0.85 and \$0.38 per pound (in 2019 dollar), respectively. In 2019, the price decreased to \$0.76 for whiting but increased to \$0.43 for red hake (Table 14).

Fishery Effort

While nearly all small-mesh multispecies landings are made with trawl gear, but other gears such as gillnet and mid-water trawl also make very small volume of landing. Majority of the landings are made

with mesh size between 2” and 3-inch.⁷ Those vessels that land small-mesh multispecies generally hold one of the limited access Northeast Multispecies permit (Categories A-F) or an open access Category K permit. The efforts for small-mesh multispecies landings are analyzed in terms of the number of active vessels and trips.

During 2012-2019, the number of vessels that landed one or more pounds of small-mesh multispecies (i.e., anyone (or combination) of silver hake, offshore hake or red hake) ranged between 304 and 357. The number of boats engaged in small-mesh multispecies landing are on decline with its lowest level in 2019 (Table 15). Averaged during 2012-19, there were about 280 vessels that landed whiting and 188 vessels that landed red hakes⁸. In 2018, there were 2740 vessels (with 6,647 trips) that landed whiting and about 179 vessels (with 3,898 trips) that landed red hake⁹. In 2019, there were 257 vessels (with 7,4823 trips) that landed whiting and about 180 vessels (with 3,847 trips) that landed red hake (Table 14).

Figure 5. Efforts, landings, and revenues in small-mesh multispecies fisheries

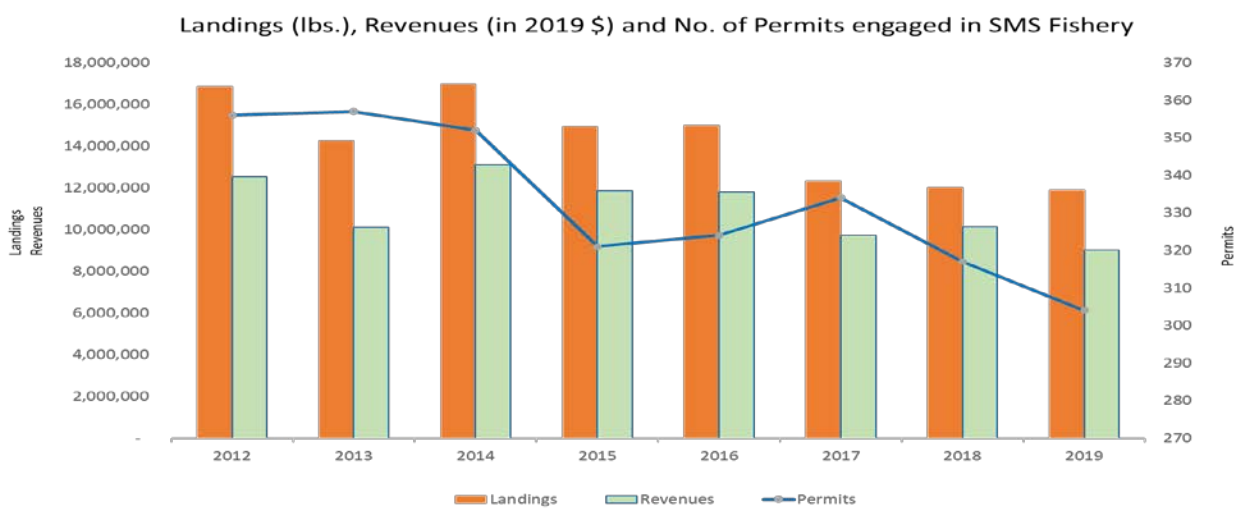
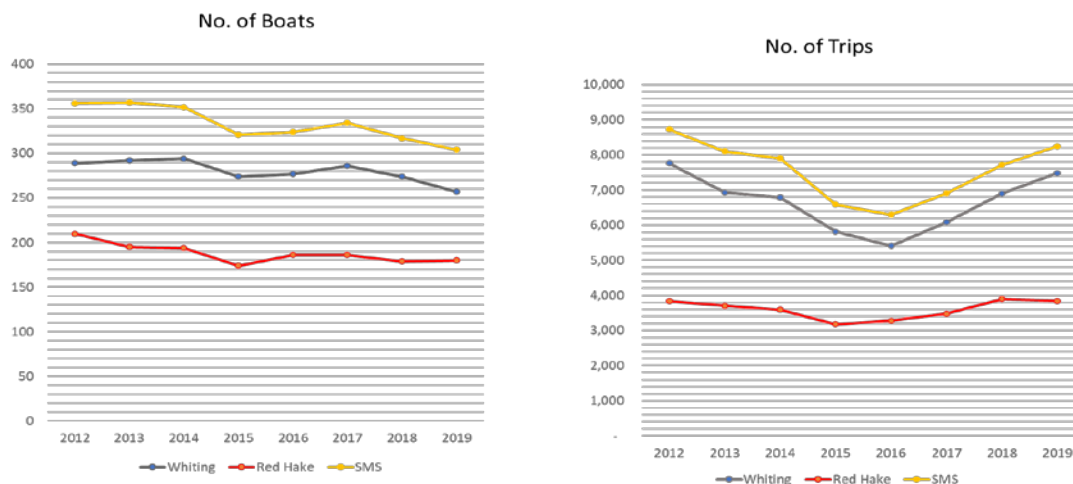


Figure 6. Efforts in landing ≥1 pounds of whiting and red hake



⁷ Prior to 2001, mesh sizes of less than 2” and greater than 5.5” used to land a good volume of silver hake.

⁸ Landed ≥1 pounds of whiting or red hake.

⁹ These vessels are not mutually exclusive and there may be an overlap on the effort (vessels or trips). A vessel or permit may have landed one or both these species. The same is true on trips whether directed or non-directed trips.

Table 13. Vessels, landings, revenue and prices for small-mesh multispecies.

Variables									Percent Change from Lag Year in						
	2012	2013	2014	2015	2016	2017	2018	2019	2013	2014	2015	2016	2017	2018	2019
No. of Permits (active Boats)	4326	4260	4176	4154	4322	4403	4298	4299	-1.53%	-1.97%	-0.53%	4.04%	1.87%	-2.38%	0.02%
No. of Permits (active boats w/ SMS landing)	356	357	352	321	324	334	317	304	.28%	-1.40%	-8.81%	0.93%	3.09%	-5.09%	-4.10%
No. of Trips (for all boats)	276,388	267,201	253,176	252,451	271,759	262,038	250,587	249,981	-3.32%	-5.25%	-0.29%	7.65%	-3.58%	-4.37%	-0.24%
No. of Trips (w/ SMS landing)	8,726	8,098	7,903	6,589	6,299	6,912	7,722	8,246	-7.20%	-2.41%	-16.63%	-4.40%	9.73%	11.72%	6.79%
Permit landing mil lbs. (All fishes)	967.1	799.0	760.5	748.9	753.1	835.6	894.1	852.2	-17.38%	-4.81%	-1.53%	0.56%	10.95%	7.01%	-4.69%
Permit Revenue mil N\$ (All fishes)	1173.6	1082.2	1101.4	1140.2	1249.8	1210.2	1277.2	1331.3	-7.78%	1.77%	3.52%	9.62%	-3.17%	5.54%	4.24%
SMS Revenue mil N\$	11.3	9.2	12.0	11.0	11.2	9.4	10.0	9.0	-18.15%	29.84%	-8.41%	1.78%	-15.63%	6.04%	-9.85%
SMS landing mil lbs (dealer)	17.6	14.7	17.5	15.1	15.1	12.6	12.4	12.4	-16.22%	18.45%	-13.24%	-0.17%	-16.63%	-1.69%	0.02%
SMS landing mil lbs (VTR)	16.9	14.3	17.0	14.9	15.0	12.3	12.0	11.9	-15.40%	18.99%	-12.02%	0.47%	-17.99%	-2.29%	-1.25%
Price_SMS N\$/lb	\$0.64	\$0.63	\$0.69	\$0.73	\$0.74	\$0.75	\$0.81	\$0.73	-2.31%	9.60%	5.57%	1.94%	1.22%	7.87%	-9.87%
Ratio of SMS\$ to Permit\$	0.0096	0.0085	0.0109	0.0096	0.0089	0.0078	0.0078	0.0068	-11.46%	28.24%	-11.93%	-7.29%	-12.36%	0.00%	12.82%
Ratio of Permits(w/ SMS) to Permits(All)	0.082	0.084	0.084	0.077	0.075	0.076	0.074	0.071							
Revenues and Prices (in 2019 dollar):															
Permit Revenue mil R\$ (All fish)	\$1,303.9	\$1,183.3	\$1,202.8	\$1,229.6	\$1,319.6	\$1,247.4	\$1,293.0	\$1,331.3	-9.25%	1.65%	2.23%	7.32%	-5.48%	3.66%	2.96%
SMS Revenue mil R\$	\$12.5	\$10.1	\$13.1	\$11.8	\$11.8	\$9.7	\$10.1	\$9.0	-19.45%	29.68%	-9.55%	-0.35%	-17.64%	4.16%	10.95%
Price_SMS 2019 R\$/lb	\$0.71	\$0.69	\$0.75	\$0.78	\$0.78	\$0.77	\$0.82	\$0.73	-3.86%	9.47%	4.26%	-0.19%	-1.19%	5.95%	10.97%

Figure 7. Landings, revenues, and prices for whiting and red hakes on landings ≥ 1 pounds

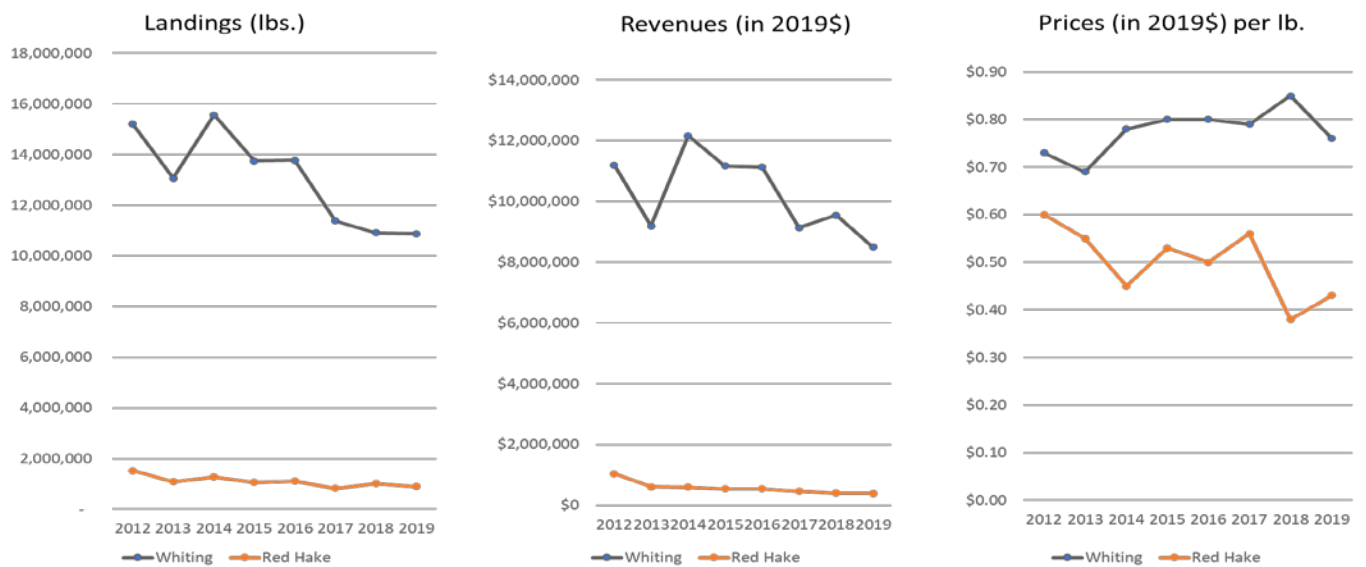


Table 14. Effort, landings, and revenue for whiting and red hake¹⁰.

Species	Year	Trips	Boats	VTR_LBS	VTR_LBS_LIVE	DLR_LBS	Revenue	Revenue19	Price/lb	Price19/lb
Whiting	2012	7,761	289	15,206,650	15,328,489	15,404,215	\$10,081,394	\$11,201,549	\$0.65	\$0.73
	2013	6,935	292	13,069,612	13,174,358	13,265,466	\$8,412,050	\$9,193,497	\$0.63	\$0.69
	2014	6,784	294	15,563,427	15,688,065	15,614,038	\$11,139,910	\$12,161,474	\$0.71	\$0.78
	2015	5,818	274	13,756,727	13,866,803	13,936,224	\$10,349,458	\$11,164,464	\$0.74	\$0.80
	2016	5,411	277	13,774,079	13,884,281	13,863,680	\$10,535,134	\$11,124,746	\$0.76	\$0.80
	2017	6,082	286	11,383,378	11,474,456	11,573,243	\$8,864,494	\$9,138,654	\$0.77	\$0.79
	2018	6,903	274	10,909,848	10,997,222	11,194,715	\$9,526,874	\$9,642,585	\$0.85	\$0.86
	2019	7,482	257	10,878,500	10,965,742	11,253,583	\$8,498,101	\$8,498,101	\$0.76	\$0.76
Red hake	2012	3,835	210	1,528,712	1,528,712	1,743,809	\$934,740	\$1,038,600	\$0.54	\$0.60
	2013	3,703	195	1,087,415	1,087,415	1,101,662	\$555,545	\$607,153	\$0.50	\$0.55
	2014	3,589	194	1,281,782	1,281,782	1,338,863	\$546,372	\$596,476	\$0.41	\$0.45
	2015	3,176	174	1,063,129	1,063,129	1,026,094	\$504,822	\$544,576	\$0.49	\$0.53
	2016	3,275	186	1,115,213	1,115,213	1,068,069	\$509,855	\$538,390	\$0.48	\$0.50
	2017	3,477	186	827,026	827,026	830,421	\$448,334	\$462,200	\$0.54	\$0.56
	2018	3,898	179	1,022,477	1,022,477	1,045,862	\$401,628	\$406,506	\$0.38	\$0.385
	2019	3,847	180	903,516	903,516	921,995	\$393,211	\$393,211	\$0.43	\$0.43
Percent change from lag year:										
Species	Year	Trips	Boats	VTR_LBS	VTR_LBS_LIVE	DLR_LBS	Revenue	Revenue18	Price/lb	Price18/lb
Whiting	2012									
	2013	-10.64%	1.04%	-14.05%	-14.05%	-13.88%	-16.56%	-17.93%	-3.08%	-5.48%
	2014	-2.18%	0.68%	19.08%	19.08%	17.70%	32.43%	32.28%	12.70%	13.04%
	2015	-14.24%	-6.80%	-11.61%	-11.61%	-10.75%	-7.10%	-8.20%	4.23%	2.56%
	2016	-7.00%	1.09%	0.13%	0.13%	-0.52%	1.79%	-0.36%	2.70%	0.00%
	2017	12.40%	3.25%	-17.36%	-17.36%	-16.52%	-15.86%	-17.85%	1.32%	-1.25%
	2018	13.50%	-4.20%	-4.16%	-4.16%	-3.27%	7.47%	5.51%	10.39%	8.90%
	2019	8.39%	-6.20%	-0.29%	-0.29%	0.53%	-10.80%	-11.87%	-10.59%	-11.66%
Red hake	2012									
	2013	-3.44%	-7.14%	-28.87%	-28.87%	-36.82%	-40.57%	-41.54%	-7.41%	-8.33%
	2014	-3.08%	-0.51%	17.87%	17.87%	21.53%	-1.65%	-1.76%	-18.00%	-18.18%
	2015	-11.51%	-10.31%	-17.06%	-17.06%	-23.36%	-7.60%	-8.70%	19.51%	17.78%
	2016	3.12%	6.90%	4.90%	4.90%	4.09%	1.00%	-1.14%	-2.04%	-5.66%
	2017	6.17%	0.00%	-25.84%	-25.84%	-22.25%	-12.07%	-14.15%	12.50%	12.00%
	2018	12.11%	-3.76%	23.63%	23.63%	25.94%	-10.42%	-12.05%	-29.63%	-31.32%
	2019	-1.31%	0.56%	-11.63%	-11.63%	-11.84%	-2.10%	-3.27%	13.16%	11.80%

¹⁰ Where vtr_live>1 and fishname IN ('whiting', 'red hake')

Table 15. Effort, landings, revenue and price for all vessels and trips landing ≥1 lbs. of small-mesh multispecies.

Codes	Descriptions	2012	2013	2014	2015	2016	2017	2018	2019
TRIPS	No. of Trips (w/ SMS landing ≥1 lb.)	8,726	8,098	7,903	6,589	6,299	6,912	7,722	8,246
BOATS	No. of Boats (w/ SMS landing ≥1 lb.)	356	357	352	321	324	334	321	304
TRIP_LBS	Trip landings (all species)	53,197,683	52,704,903	64,250,094	59,376,857	63,794,716	64,478,372	68,081,576	68,389,159
TRIP\$	Trip value (all species)	\$50,159,338	\$48,847,141	\$60,313,966	\$57,939,754	\$62,902,056	\$64,405,937	\$71,111,794	\$73,945,841
SMS_DLRBLS	SMS landings (dealer record)	17,312,319	14,448,392	16,992,029	14,984,857	14,959,981	12,420,420	12,266,921	12,218,091
SMS_VTRLBS	SMS landings (VTR record)	16,857,206	14,261,790	16,969,855	14,929,943	14,999,499	12,301,488	12,019,706	11,869,263
SMS\$	SMS value	\$11,126,769	\$9,025,568	\$11,706,848	\$10,867,839	\$11,063,053	\$9,321,557	\$9,939,999	\$8,915,581
SMS_PRICE	SMS Price per pound	\$0.64	\$0.62	\$0.69	\$0.73	\$0.74	\$0.75	\$0.81	\$0.73
NONE_SMS_PRICE	Non-SMS Price per pound	\$1.09	\$1.04	\$1.03	\$1.06	\$1.06	\$1.06	\$1.10	\$1.16
SMS\$_TO_TRIP\$	Ratio or SMS value to Trip value	0.2218	0.1848	0.1941	0.1876	0.1759	0.1447	0.1398	0.1206
WHITINGS\$	Whiting value	\$10,175,537	\$8,454,105	\$11,148,596	\$10,354,447	\$10,541,251	\$8,866,526	\$9,533,258	\$8,515,950
WHITING_DLRBLS	Whiting landing (dealer record)	15,537,498	13,318,156	15,625,222	13,941,431	13,870,237	11,576,052	11,208,113	11,281,908
WHITING_VTRLBS	Whiting landing (VTR record)	15,328,494	13,174,374	15,688,073	13,866,813	13,884,286	11,474,462	10,997,228	10,965,747
WHITING_PRICE	Whiting Price per pound	\$0.65	\$0.63	\$0.71	\$0.74	\$0.76	\$0.77	\$0.85	\$0.75
WHITINGS\$_TO_TRIP\$	Ratio or Whiting value to Trip value	0.2029	0.1731	0.1848	0.1787	0.1676	0.1377	0.1341	0.1152
REDHAKE\$	Red hake value	\$951,231	\$571,463	\$558,252	\$513,392	\$521,802	\$455,031	\$406,741	\$399,632
REDHAKE_DLRBLS	Red hake landing (dealer record)	1,774,821	1,130,236	1,366,807	1,043,426	1,089,744	844,368	1,058,808	936,182
REDHAKE_VTRLBS	Red hake landing (VTR record)	1,528,712	1,087,416	1,281,782	1,063,130	1,115,213	827,026	1,022,477	903,516
REDHAKE_PRICE	Red hake Price per pound	\$0.54	\$0.51	\$0.41	\$0.49	\$0.48	\$0.54	\$0.38	\$0.43
REDHAKE\$_TO_TRIP\$	Ratio or Red hake value to Trip value	0.019	0.0117	0.0093	0.0089	0.0083	0.0071	0.0057	0.0054
Percent Change from Lag Year:									
TRIPS	No. of Trips (w/ SMS landing ≥1 lb.)		-7.20%	-2.41%	-16.63%	-4.40%	9.73%	11.72%	6.79%
BOATS	No. of Boats (w/ SMS landing ≥1 lb.)		0.28%	-1.40%	-8.81%	0.93%	3.09%	-3.89%	-5.30%
TRIP_LBS	Trip landings lbs. (all species)		-0.93%	21.91%	-7.58%	7.44%	1.07%	5.59%	0.45%
TRIP\$	Trip value (all species) N\$		-2.62%	23.47%	-3.94%	8.56%	2.39%	10.41%	3.99%
SMS_DLRBLS	SMS landings lbs (dealer)		-16.54%	17.60%	-11.81%	-0.17%	-16.98%	-1.24%	-0.40%
SMS_VTRLBS	SMS landings lbs (VTR)		-15.40%	18.99%	-12.02%	0.47%	-17.99%	-2.29%	-1.25%
SMS\$	SMS value (N\$)		-18.88%	29.71%	-7.17%	1.80%	-15.74%	6.63%	-10.31%
SMS_PRICE	SMS Price/lb (N\$/lb)		-2.80%	10.29%	5.27%	1.96%	1.49%	7.97%	-9.95%
NONE_SMS_PRICE	Non-SMS Price/lb (N\$)		-4.30%	-1.19%	3.10%	0.10%	-0.32%	3.58%	5.63%
SMS\$_TO_TRIP\$	Ratio of SMS value to Trip value		-16.68%	5.03%	-3.35%	-6.24%	-17.74%	-3.39%	-13.73%
WHITINGS\$	Whiting value N\$		-16.92%	31.87%	-7.12%	1.80%	-15.89%	7.52%	-10.67%
WHITING_DLRBLS	Whiting landing lbs (dealer)		-14.28%	17.32%	-10.78%	-0.51%	-16.54%	-3.18%	0.66%
WHITING_VTRLBS	Whiting landing lbs (VTR)		-14.05%	19.08%	-11.61%	0.13%	-17.36%	-4.16%	-0.29%
WHITING_PRICE	Whiting Price/lb (N\$)		-3.07%	12.40%	4.09%	2.33%	0.78%	11.06%	-11.26%
WHITINGS\$_TO_TRIP\$	Ratio of Whiting value to Trip value		-14.69%	6.76%	-3.30%	-6.21%	-17.84%	-2.61%	-14.09%
REDHAKE\$	Red hake value N\$		-39.92%	-2.31%	-8.04%	1.64%	-12.80%	-10.61%	-1.75%
REDHAKE_DLRBLS	Red hake landing lbs (dealer)		-36.32%	20.93%	-23.66%	4.44%	-22.52%	25.40%	-11.58%
REDHAKE_VTRLBS	Red hake landing lbs (VTR)		-28.87%	17.87%	-17.06%	4.90%	-25.84%	23.63%	-11.63%
REDHAKE_PRICE	Red hake Price/lb		-5.67%	-19.22%	20.47%	-2.68%	12.55%	-28.71%	11.11%
REDHAKE\$_TO_TRIP\$	Ratio of Red hake value to Trip value		-38.42%	-20.51%	-4.30%	-6.74%	-14.46%	-19.72%	-5.26%

7.0 Stock Assessments and Status

7.1 *Silver hake*

7.2 *Red hake*

7.2.1 Recent assessments

Both stocks of red hake have been reviewed twice this year – the Red Hake Stock Structure Research Track assessment in March, and the Management Track assessment in September. The Research Track assessment focused primarily on whether the two stock areas historically used for northern and southern red hake were appropriate and whether there was any evidence another stock configuration would better reflect the biology of the species. The working group presented analyses of larval connectivity, size structure, growth rates, seasonal movement of adult red hake, and similarity in trends among regions, for example, to explore this question.

The AIM model, traditionally used for status determination and catch advice for red hake, was also run using a variety of different stock configurations to see if there were any that showed a better relationship between catch and biomass than others. The working group also explored a spawning potential ratio model based on swept-area biomass. The biomass estimates were made using efficiencies for the Bigelow net specifically for red hake based on comparisons with a chain-sweep net with an assumed q of one.

The Red Hake Research Track peer review panel agreed there was no compelling reason to change the stock definition for red hake. They also agreed the AIM model was not providing useful information on stock status or BRPs due to poor fit, and the swept-area biomass based SPR model was promising but needed further development, although the results of the chain-sweep study were useful for estimating a more accurate total stock biomass. See the complete Research Track panel report here: <https://apps-nefsc.fisheries.noaa.gov/rcb/publications/crd2007.pdf>

For the Management Track assessment in September the AIM model was not used, since the Research Track review panel had rejected it. Instead, an empirical method using the swept-area biomass estimates was put forward since the Research Track review panel agreed the results of the chain-sweep study were sound. As an alternative method to develop catch advice, a Loess smooth method which looks at the recent trajectory of the stock based on survey indices to adjust catch was put forward. Both of these methods were reviewed by the Assessment Oversight Panel in May.

7.2.2 Summary of the MTA and overview of the empirical approach

During the Management Track assessment meeting, the review panel looked at the swept-area biomass assessment method. For each stock, the efficiency estimates for the Bigelow net were used to estimate total biomass from 1981 through 2019 (the 2009-2019 mean efficiency estimate was used for the years before the Bigelow, on indices converted to Bigelow units). Exploitation rates were then estimated using catch/biomass for each year. Similar to the approach used for the existing biological reference points, the idea was to choose a series of years for which the exploitation rate represented an F_{msy} proxy, and compare the mean 2017-2019 exploitation rate to this proxy to determine overfishing status. For the years the AIM model was used, the F_{msy} proxy was the mean relative exploitation rate (expressed as kt catch over kg/per tow survey index) during 1980-2010, a period currently used as a proxy for MSY). Several other options of time periods to compare to current exploitation indices were the entire time

series, and the Bigelow years (2009-2019, a time series of its own that would not require conversion factors between vessels).

The review panel determined that “the updated swept-area biomass estimates provide qualitative information about stock trends, but the relative exploitation rates should not be used as BRP proxies and do not provide a basis for scientific advice” although “the updated swept-area biomass estimates provide qualitative information about stock trends”. The review panel did not review the Loess method, similar to the Plan B Smoot Approach that has been used for some groundfish stocks with empirically-based assessments. See the complete [Management Track review panel report](#).

7.2.3 Stock status

The overfished and overfishing status of both red hake stocks is considered unknown after the assessment yielded no accepted method to develop biological reference points. However, both the Research track and the Management Track review panels agreed that based on the swept-area biomass analyses there is little evidence of overfishing for either stock.

7.2.4 Description of the alternative approach

For catch advice, the PDT has put forth several options, most of which use the results of the original alternative strategy based on applications of a Plan B Smooth Approach. This method has been used before for catch advice, and was originally created and programmed by Chris Legault at the NEFSC. The method works by taking a time series of survey indices in Albatross units and applying Loess smoothing to these points. We followed the original method used for Georges Bank cod, using a time series of 38 years and a span of 0.3. To evaluate performance of the approach with respect to the red hake stocks, the Loess smoothed data are then fit with a log-linear model to estimate the coefficient to be applied to a moving three-year average. The slope of these points, whether positive indicating an upward trend in survey indices or negative indicating a downward trend, is used as a multiplier to scale catch advice relative to a baseline period up or down to match the apparent trajectory of the stock. The results from these options using this method are presented in the cover memo to the SSC.

7.2.5 Productivity and Mean Generation Time Estimate for Southern Red Hake

The following analysis of potential stock productivity and rebuilding was prepared for Framework Adjustment 62, which initiated a rebuilding program for southern red hake, a stock then considered to be overfished. The subsequent research and management track assessments changed this status to “unknown”.

Beside describing a procedure for associating a mean generation time to half of the lifetime egg production of an unfished female¹¹, the life history parameters that were used in this analysis could be useful for consideration of appropriate levels of fishing mortality.

Although the analysis was for southern red hake, the life history parameters are generally not that different for northern red hake. Important considerations are natural mortality (assumed to be 0.4 in the research track assessment), age at maturity (fully mature at ages 3-4), and maximum observed age (~12 years in age samples from 2011 to 2019 NMFS survey data). Compared to other stocks with similar

¹¹ This of course assumes that the life history parameters are constant when the population is unfished. Many fish delay growth and maturation when stock size is high.

biological characteristics, it is apparent that an extremely low fishing mortality rate is not needed to prevent overfishing. Rebuilding biomass in the face of climate change forcing is another matter.

Stock forecasting models are not available for red hake and it is therefore not possible to estimate changes in biomass (and its uncertainty) at various levels of future fishing mortality and catch. Thus, it is important to estimate the fecundity of southern red hake and the time it would take for a female spawner to replace itself with another female spawner and a male partner. This estimate could be used as a proxy to evaluate a reasonable period for rebuilding to a target biomass level based on a fraction or multiple of a mean generation.

The mean generation for southern red hake is estimated using published estimates of growth and maturity at age, coupled with accepted assumptions of natural mortality and reasonable assumptions about egg viability at age and fecundity at age (as a proportion of female average weight at age). As explained below, a mean generation time for southern red hake is 4.4 years to replace the mating pair with another mating pair when fishing mortality is zero, i.e. survival is calculated from the assumed natural mortality rate (Figure 8). A few sensitivity analyses were used to evaluate the effect of the assumptions on the estimate.

Maturity (the proportion of female fish that are ripe, ripening, or spent) was estimated by O'Brien et. al. (1993). Biomass, or weight per female fish, was estimated as the mean weight of red hake that were aged and collected in the NMFS spring bottom trawl survey in 2011-2019. Adult survival is the proportion of fish at age 1 that survive to subsequent ages, using a natural mortality rate of 0.4 which was used in the recent research track assessment (NEFSC 2020). As a sensitivity analysis, we change the natural mortality rate to 0.2 (a rate that is also assumed for other stocks), which effectively extends the assumed life in the absence of fishing and the age when 50% of lifetime egg production occurs increases to 5.5 years (Table 16). Fecundity (the number of eggs produced by a spawning female) is assumed to increase as a function of female weight at age, but here we assume that over age 3, fecundity increases at a greater rate than biomass. We assume that this relationship increased by five percent each year of life. Although this is a reasonable assumption, a sensitivity analysis shows that the result is not very sensitive to this assumption, the age at which 50% of lifetime egg production occurs declines from 4.4 to 4.2 years. For many fish species, eggs produced by young fish are not as viable as they are for older fish (Heinimaa and Heinimaa 2004). Egg energy content in younger fish are less than they are in older fish (Heinimaa and Heinimaa 2004), implying that this reduced source of nutrition makes larvae less viable before they begin feeding. Thus, for this estimation, we assume that viability of eggs produced by an age 2 female are 20% of the viability of age 5+ fish, 50% for age 3 and 80% for age 4. There is no information about the values that are appropriate for red hake or even that viability of red hake eggs declines for younger spawning red hake. As a sensitivity analysis, we assume that eggs produced by any age female are equally viable. This would increase the production of viable offspring at younger ages, increasing total lifetime egg production, but also reducing the age at which a female has produced 50% of her lifetime egg production. If all eggs are equally viable regardless of the age of the spawner, it would reduce when 50% of lifetime egg production to 3.4 years.

Figure 8. Calculation of the age at which a female southern red hake produces 50% of lifetime egg production, a proxy for a mean generation time for a mating pair to replace itself with a mating pair in a subsequent generation.

Age	Maturity	Biomass	Adult survival	Fecundity (biomass multiplier)	Egg viability factor	Surviving recruits	Cumulative	Percent of total lifetime fecundity	Age @ 50%
(A)	(B)	(C)	(D)	(E)	(F)	(G)=B*C*D*E	(H)=ΣG		
1	0.04	19.35	1.00	1.00	-	-	-	0	
2	0.75	26.78	0.67	1.00	0.20	2.69	2.69	0.06	
3	0.99	31.38	0.45	1.00	0.50	6.98	9.67	0.22	
4	1.00	34.13	0.30	1.05	0.80	8.63	18.31	0.42	
5	1.00	35.94	0.20	1.10	1.00	7.98	26.29	0.61	4.41
6	1.00	37.24	0.14	1.15	1.00	5.80	32.08	0.74	
7	1.00	40.06	0.09	1.20	1.00	4.36	36.44	0.85	
8	1.00	41.70	0.06	1.25	1.00	3.17	39.61	0.92	
9	1.00	39.00	0.04	1.30	1.00	2.07	41.68	0.97	
10	1.00	39.00	0.03	1.351	1.00	1.44	43.12	1.00	

Table 16. Sensitivity to assumption analysis

Factor	Assumption	Age @ 50% lifetime fecundity
M=0.4	0.4	4.41
Fecundity	All ages = 1	4.22
Egg viability	All ages = 1	3.38
M=0.2	0.2	5.47

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