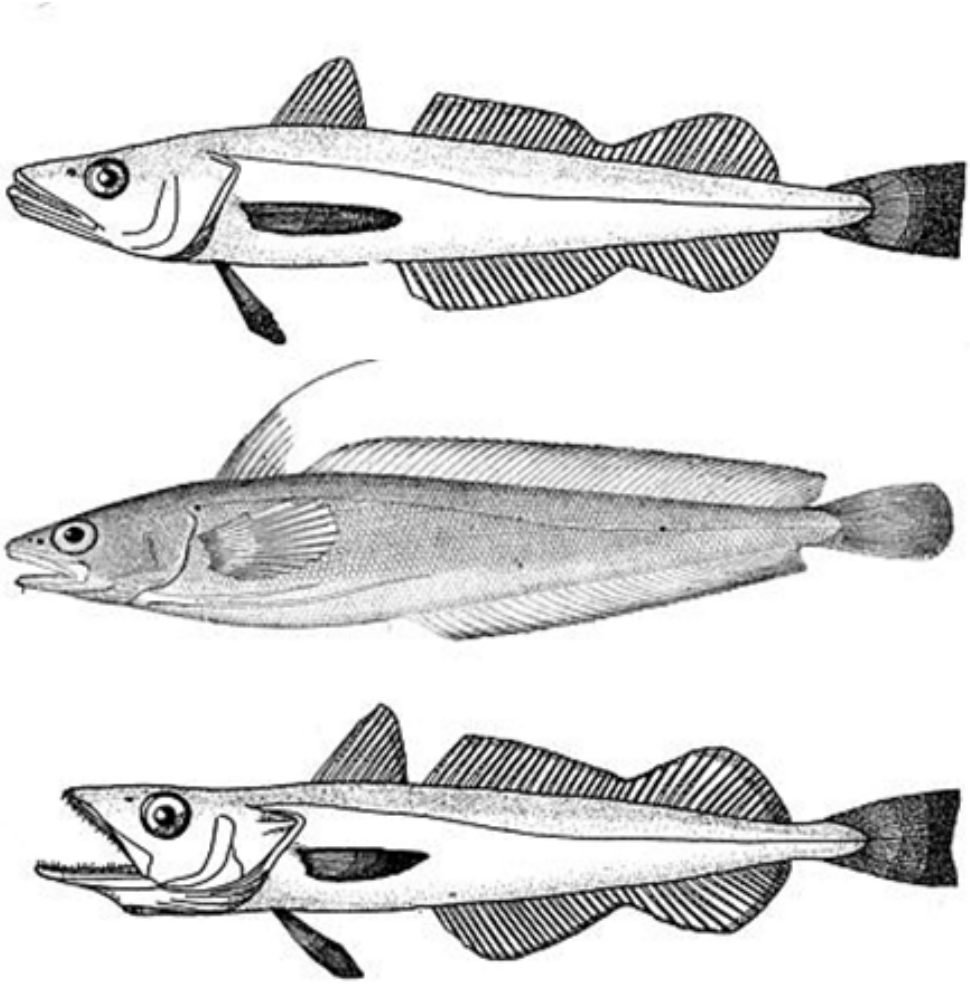
NEW ENGLAND FISHERY MANAGEMENT COUNCIL

Annual Monitoring Report for Fishing Year 2014 With a Red Hake Operational Assessment for Calendar Year 2014



1.0 Executive Summary

This Annual Monitoring Report (AMR) 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). In response to a 2014 request from the Council, the NEFSC conducted a 2015 assessment update for both northern and southern red hake. The 2014 northern red hake assessment update indicated that a large recruitment event had occurred, but little information other than the 2014 spring survey was available about the actual year class size. This update was requested to incorporate new survey data to address the potential impact of the 2014 northern red hake year class as it grows into the fishery. Additionally, this update serves to address the truncated survey coverage in the southern stock in 2014 that was result of mechanical issues on the FSV Henry B. Bigelow.

Stock status determinations for both stocks of red hake have been updated according to the current overfishing definitions using the most recent trawl survey information and catch data. The update assessment (Section 7.1) changes the red hake overfishing level (OFL) from 331 mt to 571 mt in the north and from 3,534 mt to 1,816 in the south. The Council's existing control rule is applied to the 2014 red hake assessment in this report. Using the same procedure that applied to the Acceptable Biological Catch (existing specifications, the PDT recommends setting the ABC) for both red hake stocks using the 40th percentile of the overfishing limit (OFL) distribution. The PDT assessed the performance of the fishery and characterized the current fishery trends. This update shows that the northern red hake survey index increased substantially from 2014 to 2015, owing to the 2014 recruitment year class. The total biomass increased to above the target, but the stock was not previously considered overfished.

Compared to the previous three-year period (2011-2013) the survey biomass index declined significantly in both 2014 and 2015. In contrast, southern red hake catches increased slightly, but remain below the five year average catch. Southern red hake biomass has declined but still remains above the minimum biomass threshold that defines when the stock is overfished. **The stock assessment update shows that both stocks of red hake are not overfished, and overfishing is not occurring.** The northern red hake stock had previously been experiencing overfishing.

A re-estimation of red hake specifications was performed by the Northeast Fisheries Science Center (NEFSC) and presented to the Whiting PDT on August 3, 2015. These re-estimates (Section 7.2) followed the same procedures that were applied in the benchmark assessment, simply adding new survey and catch data. Also, scientific uncertainty in these estimates were estimated and the full range of potential ABC values as well as probability of overfishing (ABC>OFL) were re-evaluated in Section 7.3. These estimates included the ABC at the 40th percentile for red hake, separately for the northern and southern management areas. The previous and newly estimated OFL and associated specifications are summarized in the following table:

Table 1. Proposed 2016-2017 red hake specifications.

Stock	Assessment Year	Spec. Year	OFL (mt)	ABC (mt)	ACL (mt)	ACL Change from Previous Spec.	ACL Change from 2014 Assessment Update
Northern red hake	**2015**	**2015-2017**	**556**	**496**	**471**	**77.1%**	**72.6%**
Northern red hake	2014	2015-2017	331	287	273	2.6%	N/A
Northern red hake	2010	2012 - 2014	314	280	266	N/A	N/A
Southern red hake	**2015**	**2015-2017**	**1,816**	**1,717**	**1,631**	**-47.3%**	**-46.0%**
Southern red hake	2014	2015-2017	3,400	3,179	3,021	-2.4%	N/A
Southern red hake	2010	2012 - 2014	3,448	3,259	3,096	N/A	N/A

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3.0 Conclusions and Recommendations

New small-mesh multispecies specifications for fishing years 2015-2017 became effective on May 1, 2015. Annual Biological Catch (ABC) specifications increased for northern silver hake by 11 percent and by 3 percent for northern red hake. ABC specifications were reduced by 8 percent for southern whiting and by 3 percent for southern red hake (NEFMC 2014). The 2015-2017 specifications package also modified the possession limits and in-season accountability measure (AM). In the same specifications package, the Council reduced the initial northern red hake possession limit from 5,000 to 3,000 lbs. and corrected the AM trigger (when the red hake possession limit is reduced to 400 lbs.) to 62.5% of Total Allowable Landings (TAL). The specifications also set a secondary trigger to reduce the possession limit to 1,500 lbs. when landings reach 45% of the TAL.

This annual monitoring report (AMR) summarizes the fishery performance for the 2014 fishing year, primarily to determine whether post-season AMs would be triggered due to catches exceeding the ABCs. The fishery performance analysis (Section 6.0) was compiled by GARFO and presented to the Whiting PDT in August 2015. Additionally, this report also includes an update assessment of red hake in response to a Council request. The NEFSC conducted the update assessment (Section 7.0), which was also presented to the Whiting PDT in August 2015. The data in this assessment include survey data through the 2015 spring survey and catches through calendar year 2015.

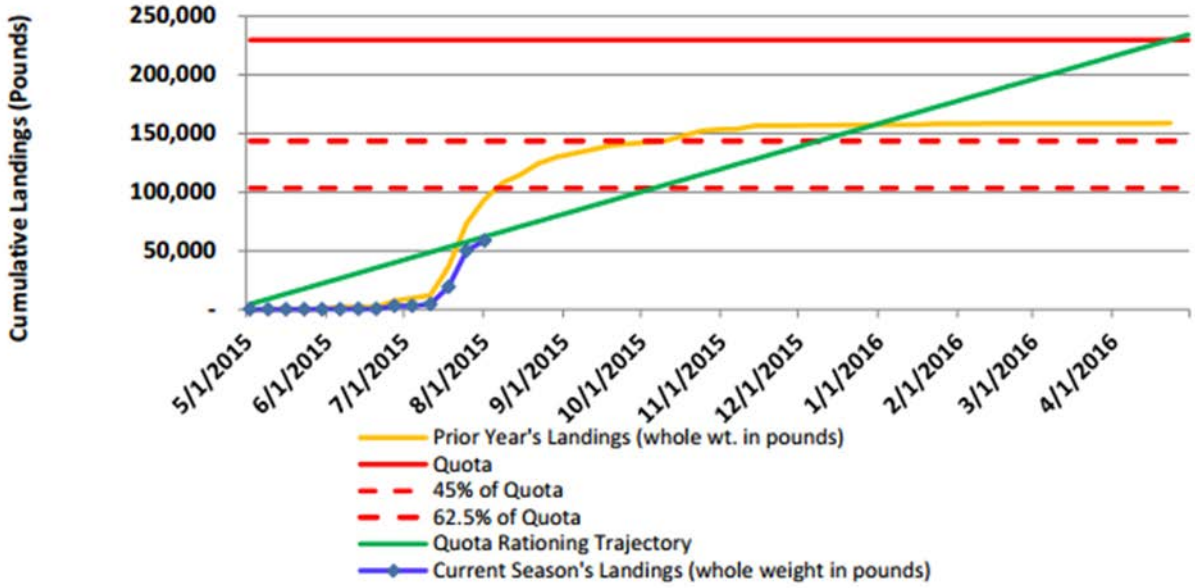
3.1 Fishery Performance and Accountability Measures

Catches and landings of northern silver hake, southern whiting, and southern red hake remained well below their specifications. Catches for northern silver hake were 24% of the annual catch limit (ACL), 17 percent of the ACL for southern whiting, and 41 percent of the ACL for southern red hake. No in-season AMs were triggered and no post-season AMs are required.

The in-season AM was triggered on August 5, 2014 for northern red hake (http://www.greateratlantic.fisheries.noaa.gov/regs/2014/July/14mulnrhpossessionlimitreductiontr.pdf), which had been subject to overfishing in 2013. This in-season trigger reduced the northern red hake possession limit from 5,000 to 400 lbs. This AM capped targeting and landings, which in turn kept catches from exceeding the ABC to an unacceptable level. It is also notable that there was a 27 percent reduction in northern red hake discards in 2014, which advisors believe resulted from less fishing for northern red hake due to the in-season AM and possibly market factors. Final catches for 2014 were estimated to be 612,211 lbs, or 104.4 percent of the ABC. This is less than the 5% tolerance allowed by the FMP and thus **no new post-season AM adjustments are necessary**.

Although not formally a part of the AMR for the 2014 fishing year, the fishing year 2015 landings for northern red hake appear to be tracking close to those for 2014 and the in-season accountability measure is likely to be triggered a few weeks later than last year (see figure below). Catches for the 2015 fishing year will be estimated in next year's AMR.

Figure 1. 2014 and 2015 weekly landings compared to the Total Allowable Landings (TAL, or quota).



3.2 Red Hake Assessment and Specifications

In the last assessment conducted in 2014, two issues were noted that this update assessment addresses. An historic large year class of small red hake in the northern stock was observed in the spring 2014 survey. This occurrence, if the data were accurate and the specifications are not adjusted accordingly, would have the potential for causing an early AM trigger and high discards as the small fish became selected by the small-mesh trawls, particularly when vessels fished in areas where red hake are abundant. The terminal year (2014) for southern silver hake had a sampling problem caused by mechanical problems on the RV Bigelow. Strata 61-68 were not sampled and the specifications for 2015-2017 relied on the three-year moving average weight per tow for 2011-2013. The update assessment in this report addresses that issue and updates the survey data to 2013-2015 for setting specifications.

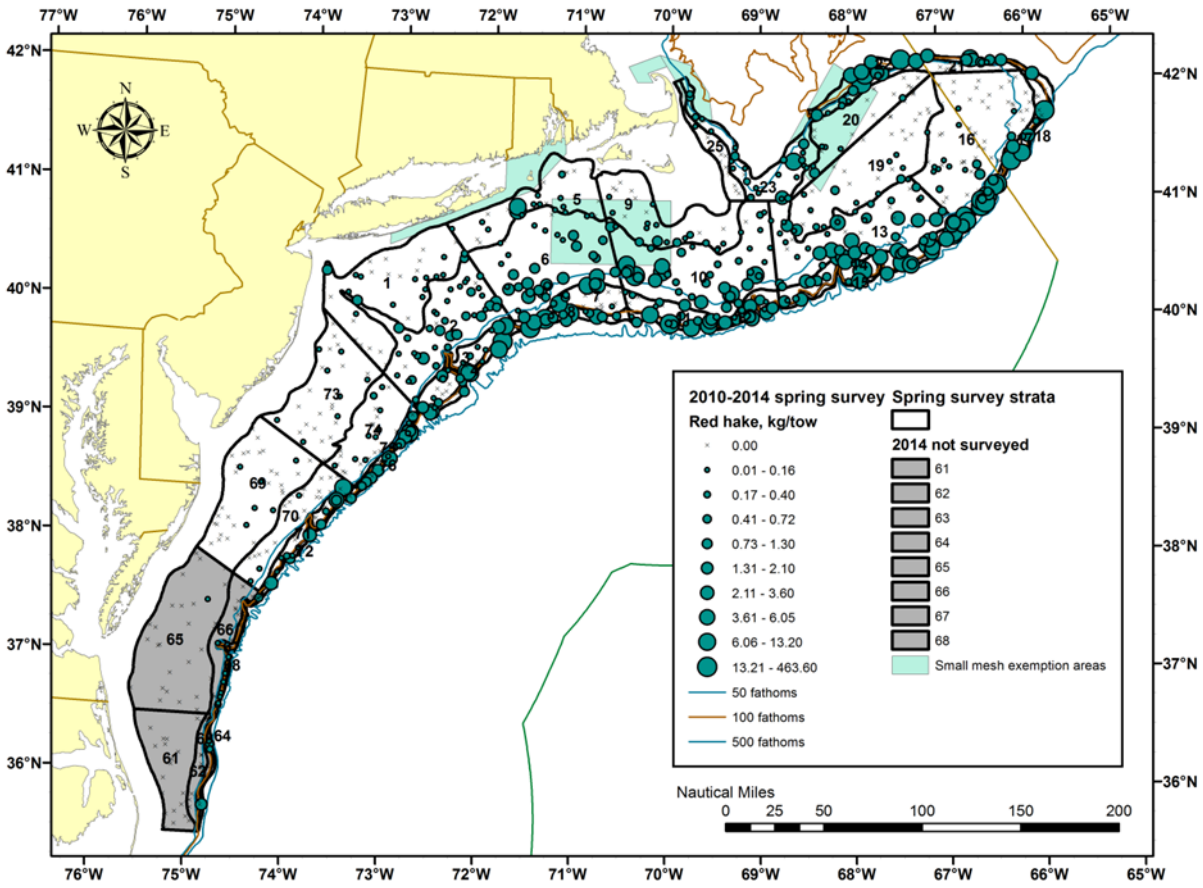
The 2015 spring survey and the update assessment in this AMR confirm the large size of the northern red hake year class first observed in the 2014 spring survey. The amount of biomass associated with this large year class now contributes to two years out of a three-year moving average that is used to set specifications. Following the same statistical procedures as were previously applied, the new assessment indicates that northern red hake overfishing level (OFL) could increase by 80% to 578 mt. Accounting for scientific uncertainty, the ABC would increase by 73% to 496 mt and have a low (14%) probability of causing overfishing. Compared to no action, increasing the specifications would delay an in-season AM trigger, allow for more landings and revenue for the fishery, and potentially reduce discards. If no action is taken, the in-season AM would be triggered early in the season, discards would probably increase, and the fishery would be prevented from achieving optimum yield.

For the reasons given above, **the Whiting PDT recommends that the Council consider revising the specifications for northern red hake through an interim specification process**. If no other management adjustments are associated with it, this action could be undertaken with minimum effort by submitting a Supplemental Information Report.

The 2014 spring survey data were not previously used to set the 2015-2017 specifications, due to the aforementioned mechanical difficulties which reduce the number of strata sampled in the Mid-Atlantic

region. This update assessment, using survey data through spring 2015 offered an opportunity to adjust for the missing survey samples in 2014, using a relatively standard procedure that has been applied in other assessments were surveys have been incomplete. For this assessment, the 2014 spring survey stratified mean weight per tow was adjusted (by 14%) to account for the relative size of and statistical correlation with the consistently sampled southern stock area strata (Map 1). Updating the survey data to 2015 (compared to 2013 in the previous specifications) means that the OFL should be 1,816 mt, 47%[1] lower compared to the existing 2015-2017 specifications. Accounting for management uncertainty, the ABC would be reduced by 46% to 1,717 mt and have a low (25%) probability of causing overfishing. Catch in 2014 was estimated to be 1,113 mt commercial plus 89 mt recreational.

Map 1. 2010-2014 spring survey red hake catch per tow, showing unsampled strata (strata 61-68, shaded grey) in the 2014 spring survey



If at the September 2015 meeting, the Council chooses to submit an interim change in specifications for Secretarial approval, the following updated recommendations would be reviewed by the Scientific and Statistical Committee (SSC) for setting the acceptable biological catch (ABC) specifications for the 2015-2017 fishing years. **If the SSC agrees with the recommendations and there are no other changes in specifications or management measures, the Council could authorize the staff to develop and**

[1] A reduction in the OFL by 44% is warranted if the adjustment for the unsurveyed 2014 spring survey strata is not made.

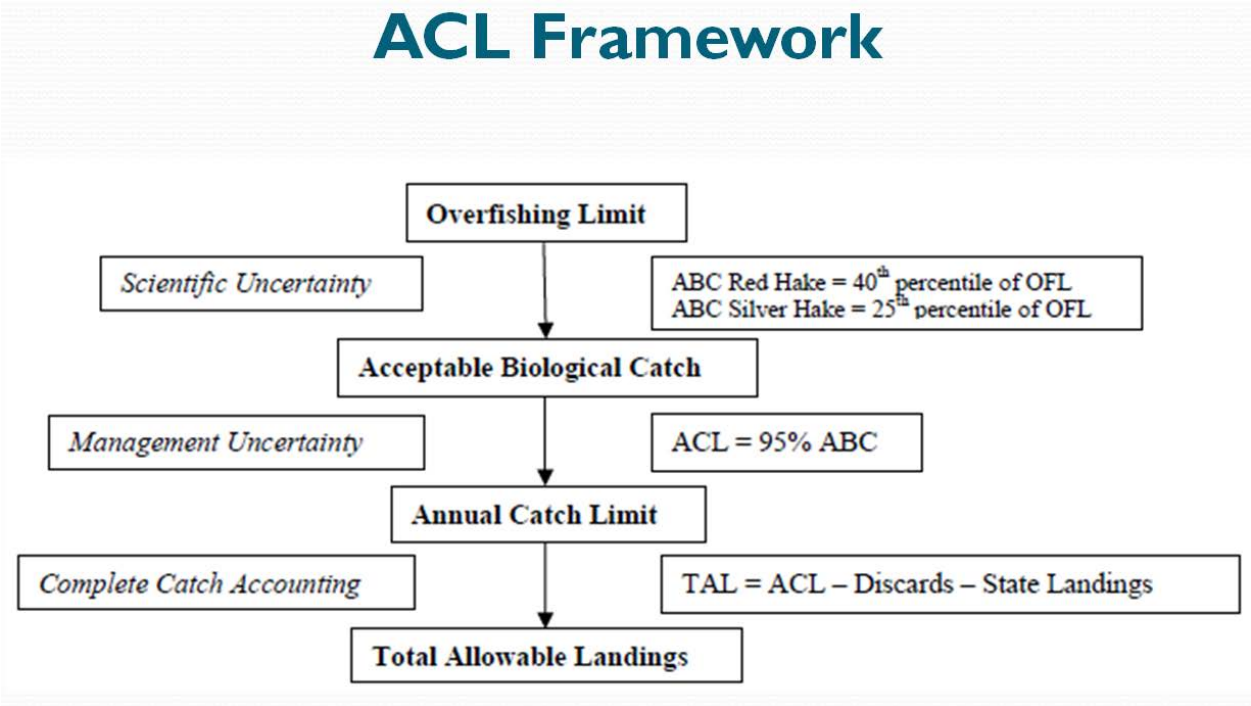
submit a Supplemental Information Report justifying the action to be taken by the Regional Administrator. If the SSC makes a different recommendation or a more extensive document are required, a draft would be developed and approved at the December 2015 Council meeting.

The Whiting PDT makes no recommendations for changing the formulation or basis for setting red hake ABCs, or estimation of the overfishing limits (OFL). The Northeast Fisheries Science Center (NEFSC) prepared an assessment update using the same procedures that were applied to the 2010 Benchmark assessment (http://www.nefsc.noaa.gov/publications/crd/crd1102/index.html), including catch (landings, discards, and transfers-at-sea for bait) data through calendar year 2014. Survey biomass indices were updated through spring 2015 for both northern and southern red hake.

Following the existing Council ABC control rule, the PDT calculated potential ABCs associated with a range of scientific uncertainty to provide specification advice. Not only were the catch and survey data updated with new information, but the NEFSC updated the estimate of scientific uncertainty to give advice about ABC levels (i.e. re-estimated scientific uncertainty in the estimates to determine the buffer in pounds between the OFL and ABC). The red hake control rule sets the hake ABC at the 40th percentile on the cumulative frequency distribution of the scientific uncertainty estimates, which was less conservative than the approach used for silver hake (which uses the 25th percentile), but was still associated with a very low probability of overfishing.

In Amendment 19 and in the 2015-2017 Specifications Package, the Council made the above policy choice about the scientific uncertainty buffer because of the relatively low OFL for northern red hake and the relatively low economic value of red hake, combined with its less important role in the ecosystem, which could result in northern red hake becoming a "choke species" that would overly constrain the access to other fishery resources. The SSC's advice to the Council for setting the 2015-2017 ABCs can be found at: http://s3.amazonaws.com/nefmc.org/SSC_response_whitinghake_Sept2014_FINAL.pdf . It should be noted that the OFL values derived from either the point estimate or the median of the OFL probability distribution are slightly different due the skewness in the distribution of the OFL. For the purpose of this red hake assessment update, the scientific uncertain is re-estimated following the same procedures and risk policy adopted by the Council and approved by NMFS.

Figure 2. Small-mesh fishery specification framework adopted and approved in Amendment 19.



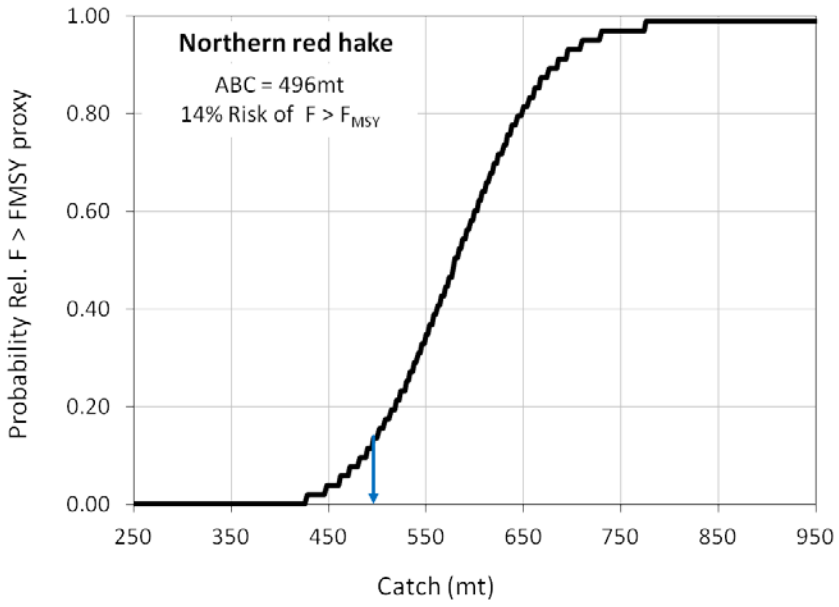
Northern red hake: The 2014 assessment update estimated OFL at 331 mt. Using the 40th percentile of scientific uncertainty estimates, the ABC was established at 287 mt and was estimated to have a near zero probability of overfishing.

The PDT recommends that the Council consider raising the 2016-2017 specifications to be consistent with the new resource conditions characterized by the update assessment in Section 7.0 . This change would also make the specifications consistent with the re-estimated OFL. The PDT recommends increasing the ABC from 287 mt to 496 mt, a 73% increase. Likewise, the ACL would increase from 273 mt to 471 mt. The Federal TAL would be calculated based on the commercial discard rate for the most recent three years, calendar years 2012-2014.

Table 2. Proposed change in interim northern red hake specifications and overfishing probabilities associated with various catch levels, including status quo.

Catch Basis	Catch (mt)	Scientific Uncertainty Percentile of OFL	Percent of 2015 OFL (556mt) derived from the distribution	Percent of 2014 Catch (266 mt)	Probability of overfishing (F > FMSY)
2015 ABC	496	40	89%	54%	14%
2015 ACL	471	36	85%	56%	7%
2014 ABC	287	10	52%	93%	0%
2014 ACL	273	9	49%	97%	0%
Recent Catch (2014)	266	8	48%	100%	0%
Recent 5yr Avg. Catch	284	9	51%	94%	0%

Figure 3. Risk of exceeding F_{MSY} for northern red hake.



Southern red hake ABC options.

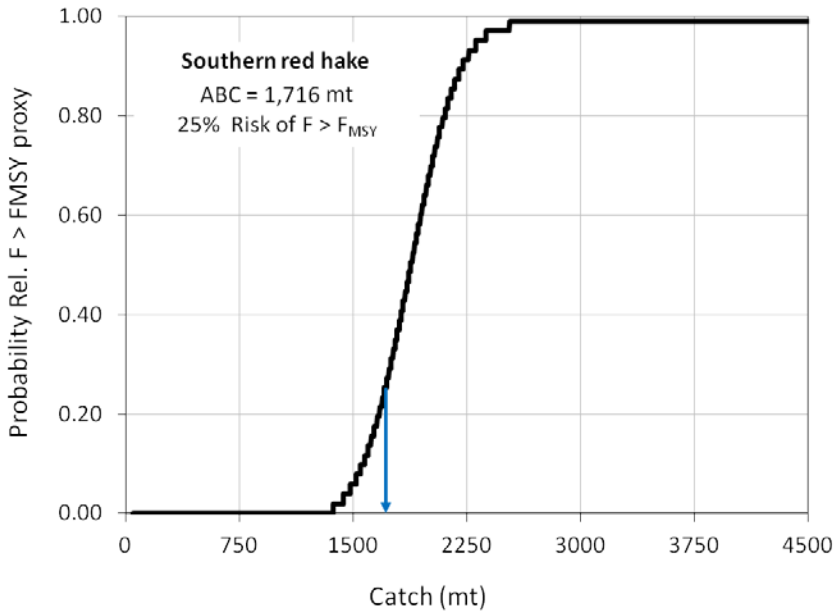
The first and second column in the table below provides basis for the catch option with the associated catch level. Colum 3 is the percentile of the OFL from the cumulative probability distribution. Column 4 is the ratio of catch at the 'N' percentile of OFL relative to median OFL from the distribution and column 5 compares catch at various percentile of the OFL to 2014 catch (i.e. ratio of catch at the x percentile of OFL from the cumulative distribution to 2014 total catch). The last column shows the probability that the indicated catch (or at the ABC) would cause overfishing, accounting for the estimated scientific uncertainty.

The PDT recommends that the Council consider reducing the 2016-2017 specifications to be consistent with the new resource conditions characterized by the update assessment in Section 7.0. This change would also make the specifications consistent with the re-estimated OFL. The PDT recommends reducing the ABC from 3,179 mt to 1,717 mt, a 73% decrease. Likewise, the ACL would decrease from 3,021 mt to 1,631 mt. The Federal TAL would be calculated based on the commercial discard rate for the most recent three years, calendar years 2012-2014. The 2014 southern red hake catch (as well as the five-year average catch before it) was well under the new, lower specifications, so the economic impacts are expected to be negligible.

Table 3. Proposed change in interim southern red hake specifications and overfishing probabilities associated with various catch levels, including status quo.

Catch Basis	Catch (mt)	Scientific Uncertainty Percentile of OFL	Percent of 2015 OFL (1,816mt) derived from the distribution	Percent of 2014 Catch (1,202 mt)	Probability of overfishing (F > FMSY)
2015 ABC	1,717	40	95%	70%	25%
2015 ACL	1,631	32	90%	74%	16%
2014 ABC	3,179	99	175%	38%	99%
2014 ACL	3,021	99	166%	40%	99%
Recent 5yr Avg. Catch	1384	13	76%	87%	2%
Recent Catch (2014)	1201	5	66%	100%	0%

Figure 4. Risk of exceeding F_{MSY} for southern red hake. (**Update figure**)



4.0 Advisory Panel Discussion

[To be modified and updated following the Sept 10th AP meeting]

The Whiting Advisory Panel reviewed the Fishery Performance Report (Section 6.0) and the update assessment results (Section 7.0), adding the following observations and comments:

- Compared to fishing year 2012, catch declined in fishing year 2013 from a variety of factors including:
    - One of the major participants in the fishery was conducting a major vessel overhaul which made few trips targeting whiting during the year.
    - Much of the catch decline in southern whiting was attributable to a reduction in discards. More vessels that catch squid and whiting on Georges Bank began using a 'rope' trawl when targeting squid. Unlike squid, whiting tend to charge the approaching very large mesh in the 'rope' section of the trawl and escape capture.

- Whiting bycatch attributed to trips using shrimp trawls in the southern area are probably due to some CT and RI vessels targeting royal red shrimp in deep water.

- Historically, red hake catches in the Gulf of Maine were much higher when there were no groundfish closed areas and before the small-mesh exemption areas restricted fishing. This change may have implications for setting the OFL based on 1982 to 2012 conditions.

- Advisors and fishermen believe that red and silver hake are moving northward in response to warming water temperatures and that existing stock boundaries may no longer be appropriate for setting catch limits.

- The various net types on 2008 to 2012 observed trips could be classified into four general categories to estimate red hake and groundfish catch rates as follows:
    - Raised footrope trawls, 2-seam and 4-seam (required in five exemption areas and sometimes used in the Cultivator Shoals Area)
    - Standard groundfish trawls (including 'Box' trawls), 2-seam and 4-seam
    - Shrimp trawls
    - Flynets and balloon trawls

- It is important to address overages with management measures that preserve the existing small-mesh exemption areas and seasons

- Developing limited access qualifications for targeting whiting with small-mesh trawls in both the northern and southern fishery management areas is important because:
    - New entrants into the small-mesh fishery would make it more difficult for the fishery to not exceed sub-ACLs
    - Large amounts of landings that are concentrated over short periods of time can depress prices and would have negative economic effects.
    - New entrants in the small-mesh multispecies fishery are likely to lack experience to avoid bycatch and fish cleanly.

5.0 Management Background

The small-mesh multispecies fishery consists of three species: Silver hake (*Merluccius bilinearis*), red hake (*Urophycis chuss*), and offshore hake (*Merluccius albidus*). There are two stocks of silver hake (northern and southern), two stocks of red hake (northern and southern), and one stock of offshore hake, which primarily co-occurs with the southern stock of silver hake. There is little to no separation of silver and offshore species in the market, and both are generally sold under the name "whiting." Throughout the document, "whiting" is used to refer to silver hake and offshore and silver hake combined catches.

Collectively, the small-mesh multispecies fishery is managed under a series of exemptions from the Northeast Multispecies Fishery Management Plan. The Northeast Multispecies FMP requires that a fishery can routinely catch less than 5% of regulated multispecies to be exempted from the minimum mesh size. In the Gulf of Maine and Georges Bank Regulated Mesh Areas (Map 2), there are six exemption areas, which are open seasonally (Table 4).

Table 4. 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 30								
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 (Table 5) for all the areas with that requirement are:

Table 5. Mesh size dependent possession limits

Codend Mesh Size	Silver and offshore hake, combined, possession limit	Red Hake
Smaller than 2.5"	3,500 lb	5,000 lb
Larger than 2.5", but smaller than 3.0"	7,500 lb	5,000 lb
Equal to or greater than 3.0"	30,000 lb (40,000 lb in Southern Area)	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 4[2] 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 Bank[3]. 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.) A few of those amendments and several framework adjustments have addressed the small-mesh fishery specifically and are described below.

Amendment 1 (1987) reduced the spatial footprint of the winter inshore whiting fishery in order to protect struggling large mesh species like redfish, gray sole, and dabs; focused the small-mesh target species to large-mesh species ratio on a selected set of species; and reduced the size of the Georges Bank whiting fishery area to protect yellowtail flounder.

Amendment 2 (1989) made some additional, minor changes to the exempted fishery program for whiting and other small-mesh stocks.

Amendment 4 (1991) established the Cultivator Shoals Exemption Area and formally incorporated silver hake and red hake into the FMP. This amendment also established a minimum mesh size for the directed small-mesh fishery as well. This was intended to control mortality of whiting and red hake in this fishery.

Amendment 5 (1994) established an overfishing definition for red hake, and implemented some other minor modifications to small-mesh management, including a standardized bycatch amount of 500 lb of large-mesh groundfish.

[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."

Framework Adjustment 3 (1994) modified the 500-lb bycatch limit to reduce the incentive for vessels to target groundfish with small mesh. This action changed the limit to "10-percent of the total weight of fish on board, or 500 lb, whichever is less." This preserved the Council's original intent of minimizing mortality on juvenile groundfish, while allowing the legitimate small-mesh fishery to continue.

Framework Adjustment 6 (1994) was intended, in part, to reduce juvenile whiting mortality in the Cultivator Shoals whiting fishery and modified the requirements of that program.

Framework Adjustment 9 (1995) established Small Mesh Areas I and II in the Gulf of Maine and implemented the requirements for fishing in those areas.

An **Adjustment to Amendment 7** (1996) made some minor modifications to non-groundfish bycatch limits in the Cultivator Shoals fishery.

Amendment 12 (1999/2000) addressed a number of small-mesh issues. This amendment officially incorporated offshore hake into the FMP; established essential fish habitat designations for all three small-mesh species; standardized the mesh-size based possession limits (see below); required a Letter of Authorization for several small-mesh exemption areas; and established a provision to allow the transfer of up to 500 lb of small-mesh multispecies at sea. Amendment 12 also proposed a limited access permit program for this fishery. However, that program was not implemented because NMFS determined that it did not comply with the requirement to treat residents of different states equally (National Standard 4.)

Framework Adjustment 35 (2000) established the Raised Footrope Trawl Exemption Area off Cape Cod. A **Modification to Framework 35** (2002) modified the boundaries and seasons of the Cape Cod exemption areas.

Framework Adjustment 37 (2003) eliminated some of the now unnecessary provisions from Amendment 12, clarified the transfer-at-sea provisions, and reinstated the full season (back to an October 31 end date) for the Cultivator Shoal Exempted Fishery. This framework also standardized the types and amounts of incidental species that could be retained in the small-mesh exemption areas between Small Mesh Areas I and II and the Cape Cod Exemption Area.

A new **Control Date** (2003) was formally established with the intentions of developing a limited access permit program.

Framework Adjustment 38 (2003) established the Inshore Gulf of Maine Grate Raised Footrope Trawl Exemption Area along the coast of Maine.

A **Secretarial Amendment** (2012) brought this portion of the FMP into compliance with the Magnuson-Stevens Act requirements to have (1) annual catch limits and (2) measures to ensure accountability for each Council managed fishery. A Secretarial Amendment was necessary because the development of Amendment 19, the mechanism through which the Council was intending to adopt the new requirements, was delayed.

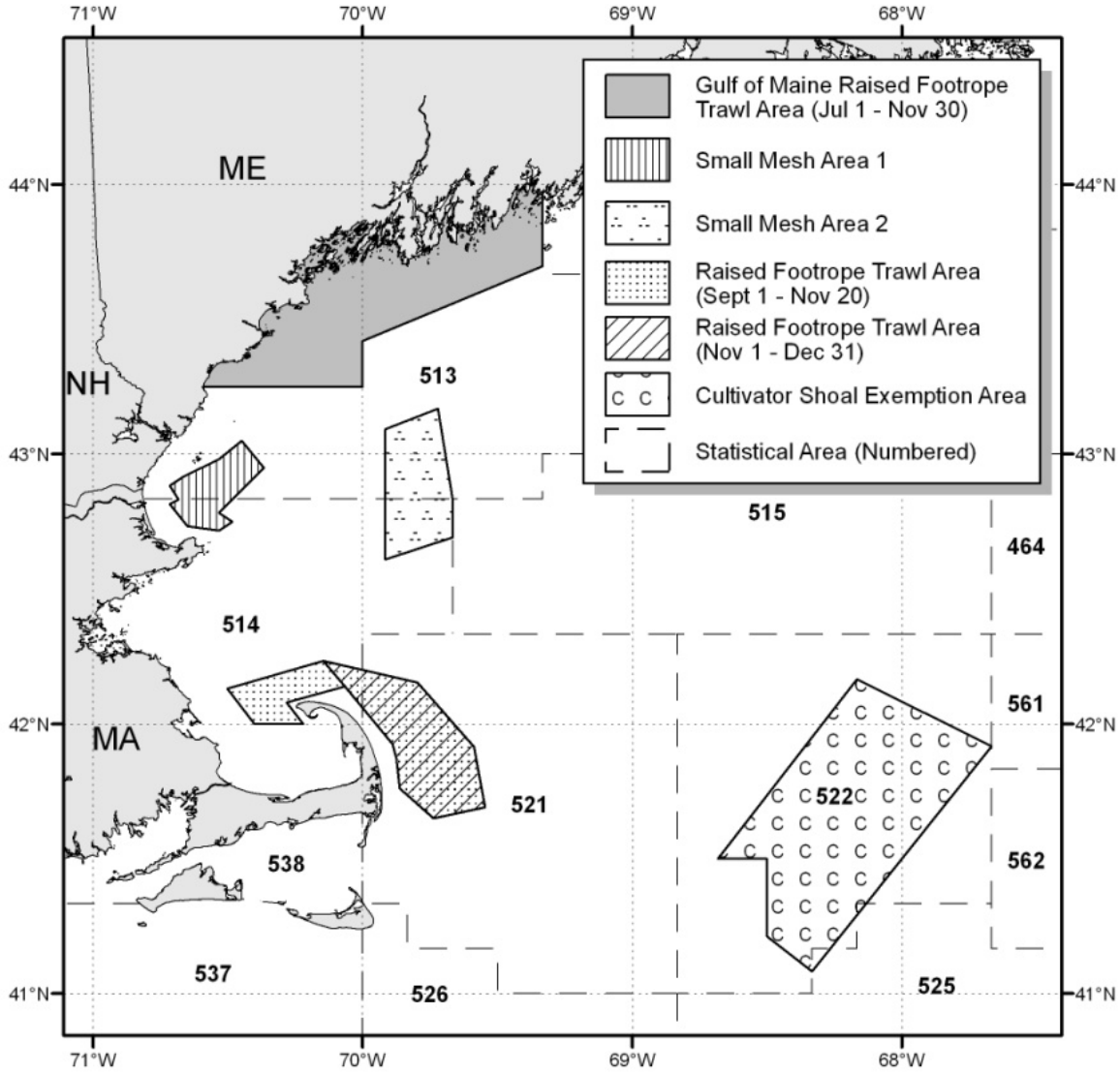
Amendment 19 (2013) allowed the Council to incorporate updated stock assessment information and adopt the annual catch limit structure implemented in the 2012 Secretarial Amendment. Amendment 19 modified the accountability measures, adopted new biological reference points, and established a trip limit for red hake.

Framework Adjustment 50 (2013) established a separate, sub-annual catch limit of Georges Bank yellowtail flounder for the small-mesh fishery (whiting and squid fisheries.)

Framework Adjustment 51 (2014) implemented accountability measures for that sub-annual catch limit.

2015-2017 Specifications (2014) changed the ABC specifications for northern silver and red hakes as well as southern whiting and red hake stocks. The action also included a modification of the northern red hake possession limit to reduce future risk of overfishing as well as a correction to the post-season AM that was triggered when 2013 catches exceeded the ACL by more than five percent.

Map 2. Small-mesh exemption areas in the Gulf of Maine and Georges Bank



6.0 Fishery Performance Report

6.1 Annual Catch Limit Accounting

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 2015-2015. This report contains complete catch accounting information for fishing - 2014year. Catch accounting information for fishing years 2012 and 2013 can be found in the 2013 SAFE Report (http://s3.amazonaws.com/nefmc.org/SAFE-Report-for-Fishing-Year-2013.pdf). The annual catch limit was derived using the procedure shown in Figure 2. The specifications are listed in Table 6.

Table 6. Fishing years 2015-2017 specifications.

	Northern Red Hake	Northern Silver Hake	Southern Red Hake	Southern Whiting
Overfishing Limit (OFL)	331 mt	43,608 mt	3,400 mt	60,148 mt
Acceptable Biological Catch (ABC)	287 mt	24,383 mt	3,179 mt	31,180 mt*
Annual Catch Limit (ACL)	273 mt	23,161 mt	3,021 mt	29,621 mt
Discard Estimate (2008-2010)	60.6% (165 mt)	11.2% (2,594 mt)	55.3% (1,671 mt)	17.1% (5,065 mt)
State-Waters Landings (3%)	3.1 mt	598 mt	39 mt	715 mt
Federal TAL (mt)	104 mt	19.949 mt	1,309 mt	23,833 mt
Federal TAL (lb)	229,719.3 lb	43,978,904 lb	2,886,703 lb	52,543,113 lb

* Includes an increase of 4 percent to account for offshore hake catch.

Northern red hake landings decreased by 36 percent from 2013 to 2014 (Table 7). Likewise, northern red hake discards also decreased, but less substantially (17 percent.) In total, northern red hake catches decreased by 23 percent from 2013 to 2014. The northern red hake possession limit was dropped to 400 lb on August 5, 2014, which was a few weeks earlier than the possession limit reduction in 2013 (August 26). Southern red hake catches increased between 2013 and 2014 by 16 percent.

Northern silver hake catches have increase substantially from 2013 to 2014, with a 72 percent increase in total catch, but still remain well below the catch limits (only 24 percent of the ACL was harvested in 2014.) Meanwhile, southern whiting catches stayed relatively stable, with only a slight (2 percent) decrease in total catch.

Compared to the 2008-2010 discard estimate used in the specifications setting, the 2012-2013 average northern red hake discards have increased, from 65 to 73 percent of total catch in 2014. The discard estimates have decreased compared to the previous average for southern red hake (56 down to 53 percent, which is a slight increase from 2013, which was 49 percent) and northern silver hake (26 down to 16 percent in 2014), and southern whiting, which decreased to 11 percent of total catch Landings by vessels only permitted to fish in state waters was less than a percent of the total landings for all four stocks combined in 2014.

While combined, small-mesh multispecies landings made up 80 percent of the total catch in 2014, the trends are very different for red hake versus silver hake/whiting. Red hake discards are a very significant source of catch (56 percent for the two stocks combined. And even more drastic for northern red hake, where 73 percent of the total commercial catch is discarded. On the other hand, silver hake/whiting discards are a much smaller portion of the catch, just 13 percent of the two stocks combined.

Table 7. Fishing year 2014 red hake landings and discards by stock area.

	Pounds	Metric tons	Percent of ACL (266 mt)	Percent of Total Catch	Percent Change from 2013
Northern red hake commercial landings	162,393	74	27.69%	26.53%	-36 %
Northern red hake state-permitted only vessel landings	-	-	0.00%	0.00%	n/a
Northern red hake estimated discards	449,818	204	76.70%	73.47%	-17%
Northern red hake recreational landings (MRIP)	8,657	4	n/a	n/a	58%
Northern red **hake catch***	612,211	278	104.40%	100.00%	-23%
	Pounds	Metric tons	Percent of ACL (3,096 (12,518 mt)	Percent of Total Catch	Percent change from 2013
Southern red hake landings	1,320,377	599	19.3%	46.9%	22%
Southern red hake state-permitted only vessel landings	9,449	4	0.1%	0.3%	103%
Southern red hake estimated discard	1,486,374	674	21.8%	52.8%	11%
Southern red hake recreational landings (MRIP)	211,984	96	n/a	n/a	29%
Southern red hake **catch***	2,816,200	1,277	41.3%	100.0%	16%

Table 8. Fishing year 2014 whiting landings and discards by stock area.

	Pounds	Metric tons	Percent of ACL (12,518 mt)	Percent of Total Catch	Percent change from 2013
Northern silver hake commercial landings	5,526,581	2,507	20.0%	83.8%	75%
Northern silver hake state-permitted only vessel landings	29,166	13	0.1%	0.4%	-54%
Northern silver hake estimated discard	1,037,489	471	3.8%	15.7%	73%
Northern silver hake recreational landings (MRIP)	36,755	17	n/a	0.6%	-63%
Northern silver hake catch*	6,593,236	2,991	23.9%	100.0%	72%
	Pounds	Metric tons	Percent of ACL (12,518 mt)	Percent of Total Catch	Percent change from 2013
Southern whiting landings	11,057,660	5,016	15.5%	88.7%	-2%
Southern whiting state-permitted only vessel landings	13,558	6	0.0%	0.1%	-56%
Southern whiting estimated discard	1,392,568	632	2.0%	11.2%	2%
Southern whiting recreational landings (MRIP)	0	0	n/a	0.0%	-100%
Southern whiting catch*	12,463,786	5,653	17.5%	100.0%	-2%

7.0 Red Hake Stock Assessment

7.1 Assessment (Index-Based) and Stock Status Update

Information used in this assessment update includes data from the NEFSC surveys, as well as commercial fishery data from vessel trip reports, dealer landings records and on-board fishery observers updated through 2014. The NEFSC bottom trawl survey switched from the FRV *Albatross IV* to the FSV *Bigelow* in spring 2009. Hence, survey data given here are in "*Albatross IV"* units. Following the accepted index approach from the 2010 benchmark assessment, this assessment update for both stocks of red hake are based on the three year moving average of spring survey index for years 2013-2015 and exploitation indices for years 2012-2014.

Red hake

The red hake assessment update indicates that both northern and southern stocks are not overfished and overfishing is not occurring. The recent three year arithmetic mean biomass index based on the NEFSC spring bottom trawl survey for northern red hake (2013-2015 = 3.55 kg/tow) and southern red hake (2013-2015 = 0.62 kg/tow) were both above the management threshold (1.27 kg/tow in the north vs 0.51 kg/tow in the south). The terminal year (2014) exploitation index based on the ratio of catch to the spring survey index for the northern stock (0.09 kt/kg) and for the southern stock (1.91 kt/kg) were updated and both values were below the management threshold (0.163 kt/kg in the north and 1.320 kt/kg in the south (Table 9-Table 10 and Figure 5-Figure 6).

Table 9. ***Northern red hake*** - Total catch (kt), NEFSC spring survey biomass in albatross units (kg/tow) and index of relative exploitation ratios of total catch to the spring survey biomass (kt/kg) for northern red hake.

Year	Northern Spring Survey arithmetic kg/tow	Northern Spring Survey 3-year Average kg/tow	Total Northern Landings (000's mt)	Northern Discards (000's mt)	Northern Recreational Catch (000's mt)	Northern total Catch (000's mt)	Northern Exploitation Index (kg/000's mt)
1955							
1956							
1957							
1958							
1959							
1960			3.79			3.79	
1961			3.28			3.28	
1962			1.91	1.60	0.01	3.52	
1963			3.28	1.60	0.00	4.89	
1964			1.41	1.70	0.00	3.11	
1965			2.77	1.62	0.00	4.40	
1966			5.58	1.60	0.00	7.18	
1967			1.86	1.40	0.00	3.27	
1968	1.14		2.63	1.30	0.00	3.93	3.45
1969	0.64		2.02	1.12	0.00	3.14	4.91
1970	0.54	0.77	1.03	1.10	0.00	2.13	3.94
1971	0.65	0.61	4.81	1.16	0.00	5.97	9.21
1972	1.56	0.92	15.03	0.96	0.00	15.99	10.25
1973	4.31	2.17	15.29	0.91	0.00	16.20	3.76
1974	2.43	2.77	7.22	0.82	0.00	8.04	3.31
1975	4.25	3.67	8.70	1.20	0.00	9.90	2.33
1976	3.37	3.35	6.34	0.93	0.00	7.26	2.15
1977	2.66	3.43	0.89	1.08	0.00	1.98	0.74
1978	2.57	2.87	1.22	1.12	0.00	2.34	0.91
1979	2.04	2.42	1.52	1.22	0.01	2.75	1.35
1980	3.88	2.83	1.03	1.37	0.00	2.40	0.62
1981	6.35	4.09	1.25	1.32	0.03	2.60	0.41
1982	2.13	4.12	1.21	1.46	0.00	2.67	1.26
1983	3.70	4.06	0.90	1.35	0.00	2.25	0.61
1984	2.98	2.94	1.06	1.33	0.00	2.39	0.80
1985	3.91	3.53	0.99	1.27	0.00	2.26	0.58
1986	3.26	3.39	1.46	1.19	0.00	2.65	0.81
1987	2.94	3.37	1.01	1.05	0.00	2.07	0.70
1988	2.00	2.73	0.86	0.90	0.00	1.76	0.88
1989	1.65	2.20	0.78	1.45	0.00	2.22	1.35
1990	1.33	1.66	0.83	0.60	0.00	1.43	1.07
1991	1.62	1.53	0.74	0.82	0.00	1.56	0.96
1992	2.50	1.82	0.92	0.73	0.00	1.65	0.66
1993	2.82	2.32	0.77	0.08	0.00	0.85	0.30
1994	1.59	2.31	0.73	0.08	0.00	0.81	0.51
1995	1.97	2.13	0.19	0.06	0.00	0.25	0.13
1996	1.79	1.79	0.41	0.66	0.01	1.07	0.60
1997	1.81	1.86	0.34	0.13	0.00	0.46	0.26
1998	2.52	2.04	0.19	0.13	0.00	0.32	0.13
1999	2.32	2.22	0.22	0.47	0.00	0.69	0.30
2000	3.19	2.68	0.20	0.06	0.00	0.25	0.08

Table 9 Continued. Northern red hake.

Year	Northern Spring Survey arithmetic kg/tow	Northern Spring Survey 3-year Average kg/tow	Total Northern Landings (000's mt)	Northern Discards (000's mt)	Northern Recreational Catch (000's mt)	Northern total Catch (000's mt)	Northern Exploitation Index (kg/000's mt)
2001	3.58	3.03	0.22	0.14	0.00	0.36	0.10
2002	4.46	3.74	0.28	0.10	0.00	0.38	0.08
2003	1.00	3.01	0.21	0.09	0.00	0.30	0.30
2004	1.77	2.41	0.10	0.06	0.00	0.16	0.09
2005	1.10	1.29	0.10	0.06	0.00	0.15	0.14
2006	0.91	1.26	0.10	0.18	0.00	0.28	0.30
2007	2.06	1.36	0.07	0.13	0.00	0.20	0.10
2008	3.49	2.15	0.05	0.06	0.00	0.11	0.03
2009	1.75	2.43	0.09	0.10	0.00	0.18	0.10
2010	2.02	2.42	0.07	0.24	0.00	0.31	0.15
2011	2.18	1.98	0.14	0.10	0.00	0.24	0.11
2012	1.73	1.98	0.10	0.19	0.00	0.29	0.17
2013	1.35	1.75	0.10	0.22	0.00	0.31	0.23
2014	3.02	2.03	0.07	0.19	0.01	0.27	0.09
2015	6.27	3.55					

Table 10. ***Southern red hake*** - Total catch (kt), NEFSC spring survey biomass in albatross units (kg/tow) and index of relative exploitation ratios of total catch to the spring survey biomass (kt/kg) for northern red hake.

Year	Southern Spring Survey arithmetic kg/tow	Southern Spring Survey 3-year Average kg/tow	Total Southern Landings (000's mt)	Southern Discards (000's mt)	Southern Recreational Catch (000's mt)	Southern total Catch (000's mt)	Southern Exploitation Index (kg/000's mt)
1955							
1956							
1957							
1958							
1959							
1960							
1961							
1962			11.87	4.00	0.89	16.76	
1963			31.90	4.00	0.77	36.67	
1964			43.37	3.76	0.85	47.98	
1965			92.99	4.29	0.63	97.92	
1966			107.92	3.77	0.09	111.79	
1967			58.78	3.66	0.17	62.61	
1968	1.29		18.14	3.72	0.58	22.43	17.45
1969	1.08		52.93	3.62	0.49	57.04	52.72
1970	1.72	1.36	11.45	3.14	0.41	15.01	8.71
1971	3.49	2.10	35.13	2.31	0.29	37.73	10.82
1972	3.59	2.93	61.19	2.10	0.18	63.47	17.68
1973	3.99	3.69	51.36	2.24	0.32	53.92	13.51
1974	2.84	3.47	26.64	2.16	0.19	28.99	10.22
1975	3.18	3.34	19.98	1.76	0.05	21.79	6.85
1976	5.31	3.78	22.47	1.83	0.65	24.94	4.69
1977	2.30	3.60	7.06	1.82	0.75	9.63	4.19
1978	7.65	5.09	5.46	2.44	0.97	8.87	1.16
1979	1.51	3.82	7.59	2.67	0.25	10.50	6.94
1980	2.38	3.85	4.08	2.70	0.14	6.93	2.91
1981	4.61	2.84	2.32	2.72	0.18	5.21	1.13
1982	3.34	3.45	3.17	3.78	0.03	6.98	2.09
1983	2.21	3.39	1.44	3.89	0.14	5.47	2.48
1984	1.33	2.29	1.27	3.91	0.55	5.73	4.30
1985	1.39	1.64	0.90	2.97	0.03	3.90	2.80
1986	1.73	1.49	0.69	3.39	0.21	4.29	2.47
1987	0.88	1.33	0.94	3.31	0.47	4.73	5.38
1988	1.01	1.21	0.87	3.46	0.25	4.58	4.56
1989	0.49	0.79	0.93	5.01	0.44	6.37	13.09
1990	0.71	0.73	0.80	4.75	0.51	6.06	8.57
1991	0.61	0.60	0.93	2.61	0.29	3.82	6.26
1992	0.47	0.59	1.25	6.34	0.19	7.78	16.74
1993	0.42	0.50	0.92	5.31	0.09	6.32	14.91
1994	0.68	0.52	0.98	1.72	0.07	2.77	4.11
1995	0.52	0.54	1.43	1.33	0.05	2.80	5.43
1996	0.45	0.55	0.70	0.38	0.02	1.10	2.43
1997	1.16	0.71	1.00	2.42	0.17	3.59	3.10
1998	0.21	0.61	1.15	0.74	0.05	1.95	9.10
1999	0.46	0.61	1.35	1.06	0.05	2.46	5.42
2000	0.42	0.36	1.42	0.25	0.04	1.71	4.04

Table 10 continued. Southern red hake.

Year	Southern Spring Survey arithmetic kg/tow	Southern Spring Survey 3-year Average kg/tow	Total Southern Landings (000's mt)	Southern Discards (000's mt)	Southern Recreational Catch (000's mt)	Southern total Catch (000's mt)	Southern Exploitation Index (kg/000's mt)
2001	0.64	0.51	1.47	0.14	0.02	1.63	2.54
2002	0.54	0.54	0.66	0.33	0.01	1.00	1.85
2003	0.21	0.46	0.62	0.35	0.02	0.99	4.79
2004	0.15	0.30	0.59	0.62	0.01	1.21	7.88
2005	0.38	0.25	0.36	1.01	0.06	1.42	3.77
2006	0.38	0.30	0.38	0.67	0.05	1.10	2.90
2007	0.86	0.54	0.47	1.55	0.02	2.04	2.37
2008	0.47	0.57	0.58	0.81	0.07	1.47	3.10
2009	1.34	0.89	0.58	0.87	0.10	1.54	1.15
2010	0.92	0.91	0.58	0.74	0.09	1.41	1.52
2011	1.79	1.35	0.50	1.01	0.12	1.62	0.91
2012	1.06	1.26	0.75	0.65	0.04	1.44	1.36
2013	0.64	1.16	0.44	0.58	0.08	1.10	1.71
2014*	0.63	0.78	0.56	0.55	0.09	1.20	1.91
2015	0.58	0.62					

Figure 5. ***Northern Red hake*** spring survey biomass in kg/tow (LEFT) and relative exploitation ratios (RIGHT) of the total catch to the spring survey indices in kt/kg and associated 3-yr moving averages (red lines). The horizontal dash lines represent the biomass and overfishing thresholds and the solid line is the biomass target. The BOTTOM panels reflect the most recent two decades of the entire time series.

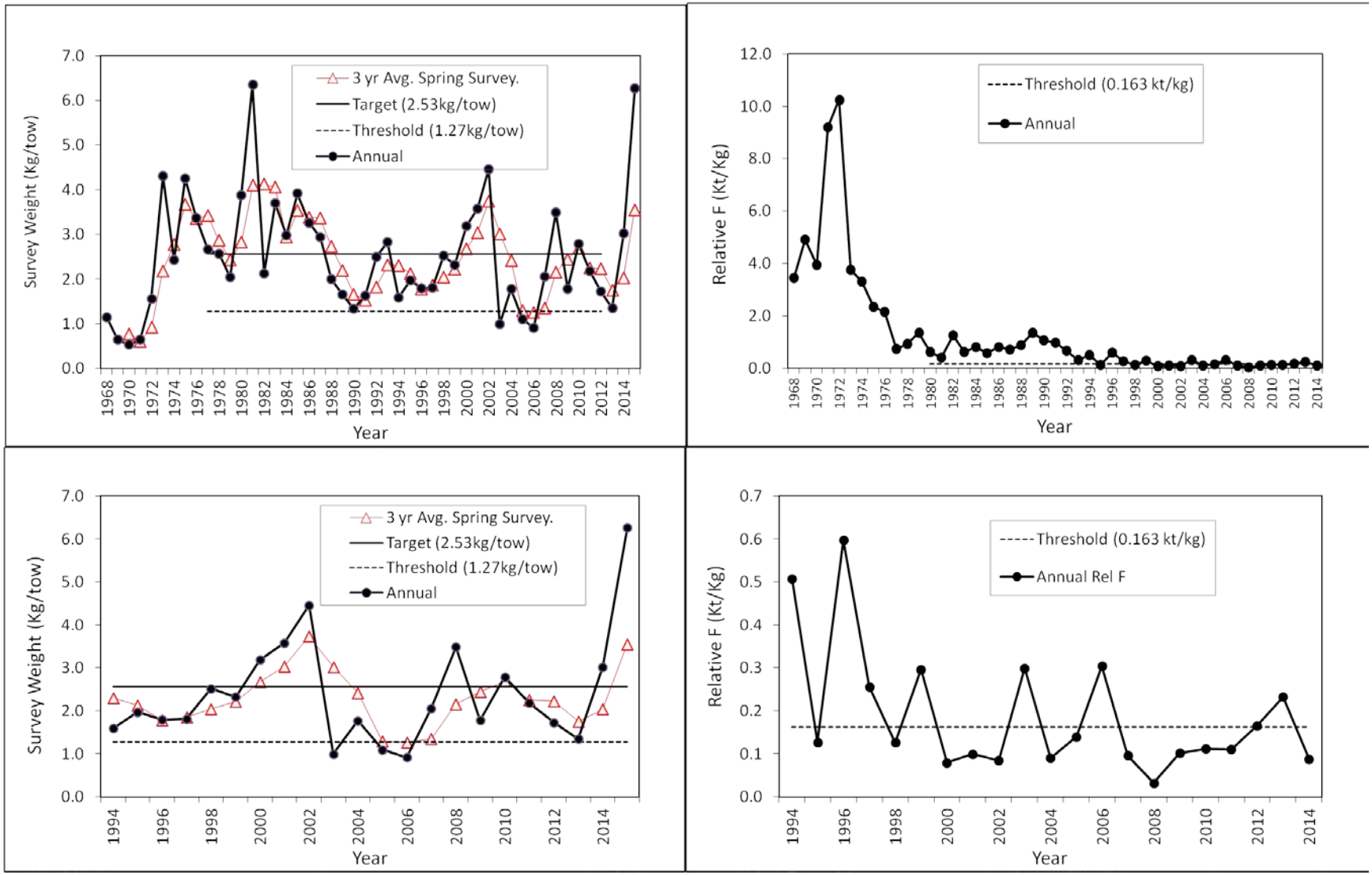


Figure 6. ***Southern red hake*** spring survey biomass in kg/tow (LEFT) and relative exploitation ratios (RIGHT) of the total catch to the spring survey indices in kt/kg and associated 3-yr moving averages (red lines). The horizontal dash lines represent the biomass and overfishing thresholds and the solid line is the biomass target. The BOTTOM panels reflect the most recent two decades of the entire time series

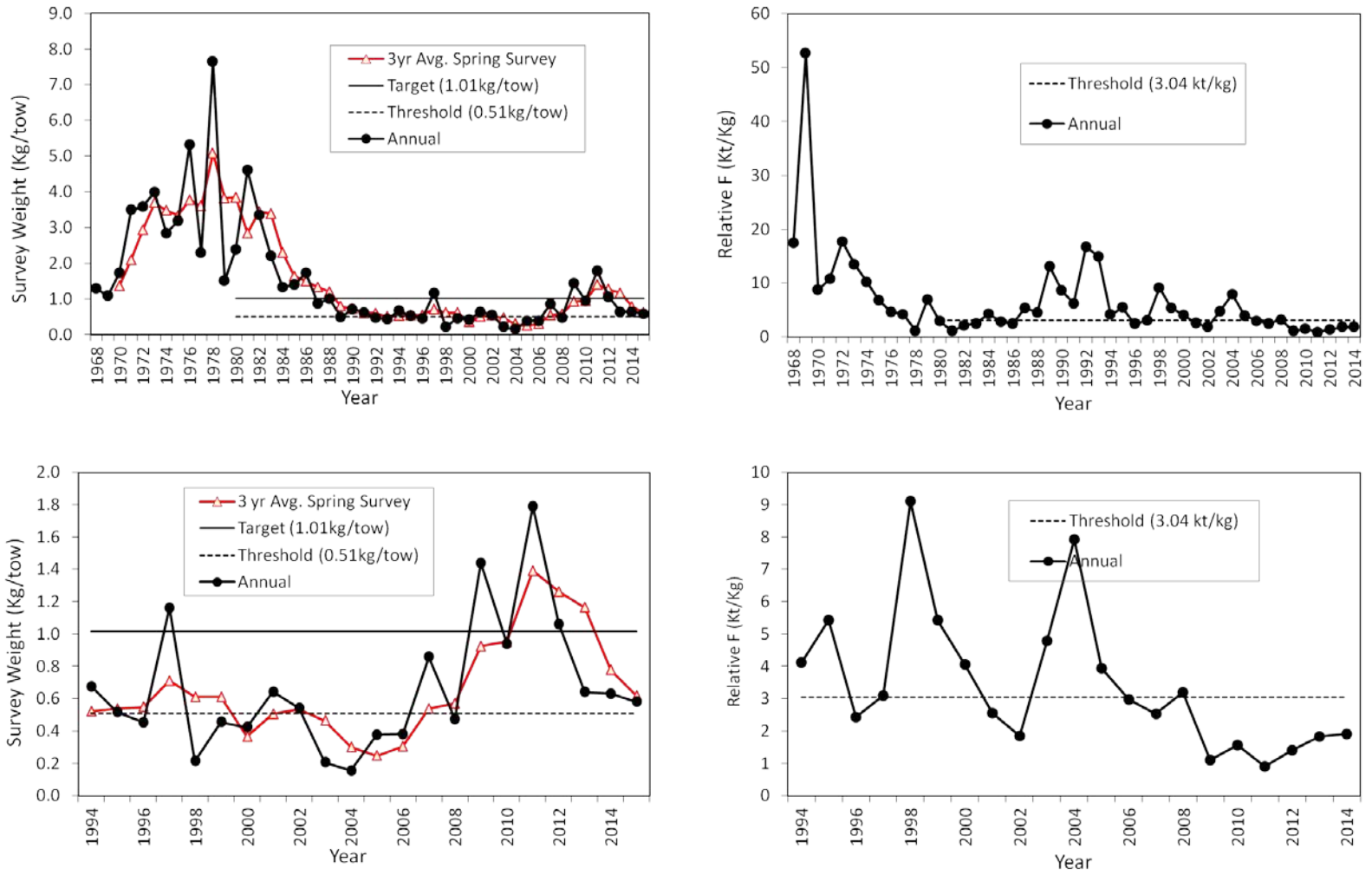


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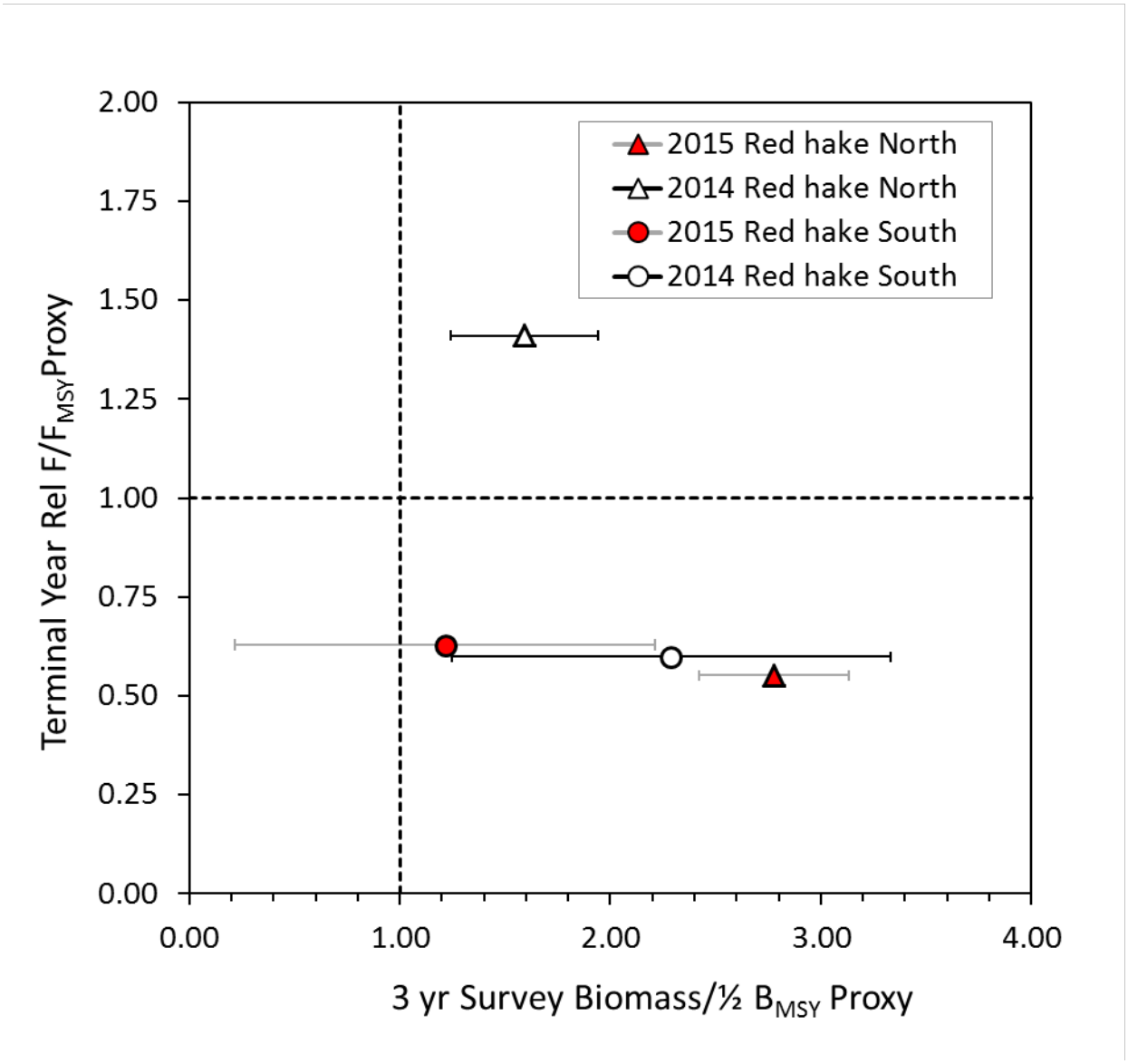
Figure 7. Red hake biomass and fishing stock status plots for specification years 2015-2017 (labeled as 2014 from the previous assessment and 2015 for the updated assessment) and associated 95% confidence intervals. The triangle and circle symbols are points estimates derived from the ratio of the most recent 3yr average index to the overfishing threshold (½ B_{MSY} proxy) while the 95% CI were calculated from the 5th and 95th percentile of the cumulative distribution of the recent 3year index of biomass and Relative F.



7.2 Overfishing Limit (OFL) and Allowable Biological Catch (ACL)

The overfishing limit (OFL) as adopted in Amendment 19 is an annual limit derived as the product of current population biomass and fishing rate that will produce the long-term sustainable maximum yield, after taking into account the variance for each factor.

Uncertainty in the silver hake OFL was estimated as a joint product of the probability distribution between the F_{MSY} proxy and the most recent 3-year average of the spring survey biomass (2013-2015) applied to F_{MSY} proxy. It should be noted that the variance for the survey indices explicitly incorporates the Bigelow conversion coefficients and associated standard errors from the calibration experiment (Miller et al. 2010) for years 2013-2015 to approximate the Albatross variance equivalent based on the following relationship:

$$V(I_{survey}) = \left[\frac{V\left[\frac{I_{HBB}^{yr1}}{\rho}\right] + V\left[\frac{I_{HBB}^{yr2}}{\rho}\right] + V\left[\frac{I_{HBB}^{yr3}}{\rho}\right]}{3} \right]$$

The variance for the observed indices for each year and vessel was estimated from the expected values $E(I_{vessel}^{yr})$ of the stratified mean weight (kg/tow) and the observed coefficient of variance (CV) as:

$$V(I_{vessel}^{yr}) = (CV * E(I))^2$$

The variances for the Henry B. Bigelow survey indices, calibrated to Albatross IV units (Miller et al 2010) by applying the conversion coefficient (ρ), were estimated using Taylor series expansion in the following relationship:

$$V(I_{HBB \rightarrow ALB}^{yr1-yr3}) = \left(\frac{I_{HB}^{yr}}{\rho}\right)^2 \times \left[\frac{V(I_{HB}^{yr})}{(I_{HB}^{yr})^2} + \frac{V(\rho)}{\rho^2}\right]$$

Although survey mean weights were estimated from a length-based based model, the standard errors were derived from the constant model as a proxy for the length-based estimates due to unavailable variance estimates for the length-based calibration approach. A comparison of the aggregated survey mean weights between the length-based and constant model approach showed minimal differences, therefore, the application of the variance from the constant model was assumed to be a reasonable approximation for the length-based model.

Red hake does not have an accepted analytical model from the previous benchmark assessment, the SARC agreed to use the relative F (RelF) from the AIM analysis strictly as a proxy F_{MSY} for red hake (**NEFSC, 2011**). The probability distribution for F_{MSY} proxy was obtained from the AIM bootstrap distribution. For each bootstrap calculation, the saved predicted values of the Ln (replacement ratio) and random residuals from the initial regression of the replacement ratio and the RelF estimates are passed to a regression routine, and the α and β values saved to obtain 1,000 realizations of the replacement F ($-\alpha/\beta$). ABC is the level of catch that accounts for scientific uncertainty in the estimate of the OFL and any other scientific uncertainty. The National Standard 1 guidelines prescribe that "the determination of ABC should be based, when possible, on the probability that an actual catch equal to the stock's ABC would result in overfishing." ABC's for specification years 2016-2017 were updated for each stock of red hake.

Using proxy values for F_{MSY} approved by the 51st SAW (NEFSC 2011a) and estimates of scientific uncertainty for the reference point and for the three year moving average for NMFS trawl survey biomass, ABCs were updated for red hake were updated by stock area per the current specification in Amendment 19. The small-mesh multispecies ABCs are expressed as a percentile of the overfishing level (OFL) distribution that estimates quantifiable scientific uncertainty, with the 50th percentile being risk neutral. Described below are the current ABC specifications for red hake:

- Northern and southern red hake ABCs based on the 40th percentile of the stochastic estimate of OFL.

Estimated OFL for both red hake stocks are summarized in Table 11 and **i**n Figure 8 based on the median value of the OFL distribution. The resulting OFL estimates for northern red stock was 556 mt (95% confidence interval of 133-968mt) and 1,817 mt (95% confidence interval of 1,191-2,514- mt) for the southern red hake.

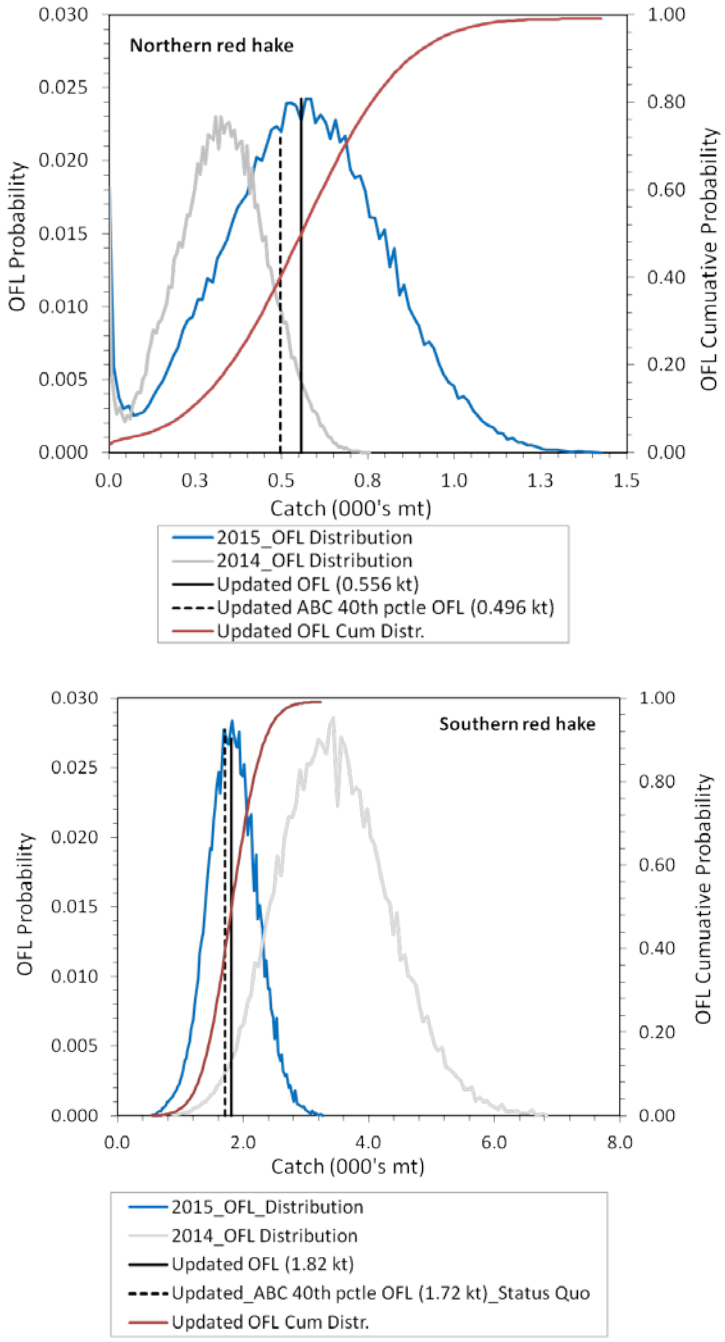
The recommended 2016-2017 ABC for red hake stocks are also provided in Table 11 and Figure 8. The proposed red hake 2015 – 2017 ABCs at 40^{th} percentile to account for scientific uncertainty would be:

- 496 mt (89% of OFL; 209% of 2014 catch) north
- 1,717 mt (95% of OFL; 143% of 2014 catch) south

Table 11. Summary stock status and Overfishing limit (OFL) for specification year 2016-2017 for both northern and southern red hake stocks. Allowable Biological Catch (ABC) estimate, defined as the 40th percentile of OFL distribution and associated risk of exceeding F_{MSY} proxy are provided.

	North	**South**
3-year Average Spr. Index 2013-2015 (kg/tow)	3.55	0.62
BMSY Proxy Threshold (kg/tow)	1.27	0.51
Biomass Stock Status - Ratio of recent 3-year average Spr. index to BMSY Proxy	**2.81**	**1.22**
Terminal Year (2014) Relative Exploitation Index (kt/kg)	0.09	1.91
FMSY Proxy 1982-2010 (kt/kg)	0.16	3.04
Overfishing Stock Status - Ratio of Terminal year(2014) Exploitation index to FMSY Proxy	**0.55**	**0.63**
OFL (000's mt) estimated from a normal distribution	**0.56**	**1.82**
ABC (000's mt)	**0.50**	**1.72**
ABC/OFL	0.89	0.95
Pr (F > FMSY) @ ABC	14%	25%

Figure 8. Updated (blue) and current (light gray) OFL frequency distribution for the northern (TOP) and southern (BOTTOM) stock of red hake derived as a cross product of the fall survey and relative exploitation probability distributions. The spring survey probability distributions were derived from the most recent three-year mean and variance and assuming a normal error structure while distribution of relative exploitation was calculated as the average of the ratios of catch to the spring survey biomass from 1982-2010 with a normal error structure.



7.3 Risk Analyses (Probability of Overfishing)

The probability of fishing mortality exceeding F_{MSY} proxy was estimated for a range of 2014 catches at the median of F_{MSY} for red hake (Table 12 and Table 13; Figure 9). Relative exploitation was calculated at each realization of the survey biomass distribution (from the normal distribution as described above). The probability that a catch exceeded a percentile of F_{MSY} was estimated as the sum of the products of the probability of each relative F exceeding that catch (1 or 0) and the probability of each survey realization. Fishing at the proposed ABC's for both stocks of red hake results in a low-moderate risk (14%) and a moderate risk (25%) risk of exceeding the overfishing limit for the northern and southern stocks respectively at the proposed updated ABC levels.

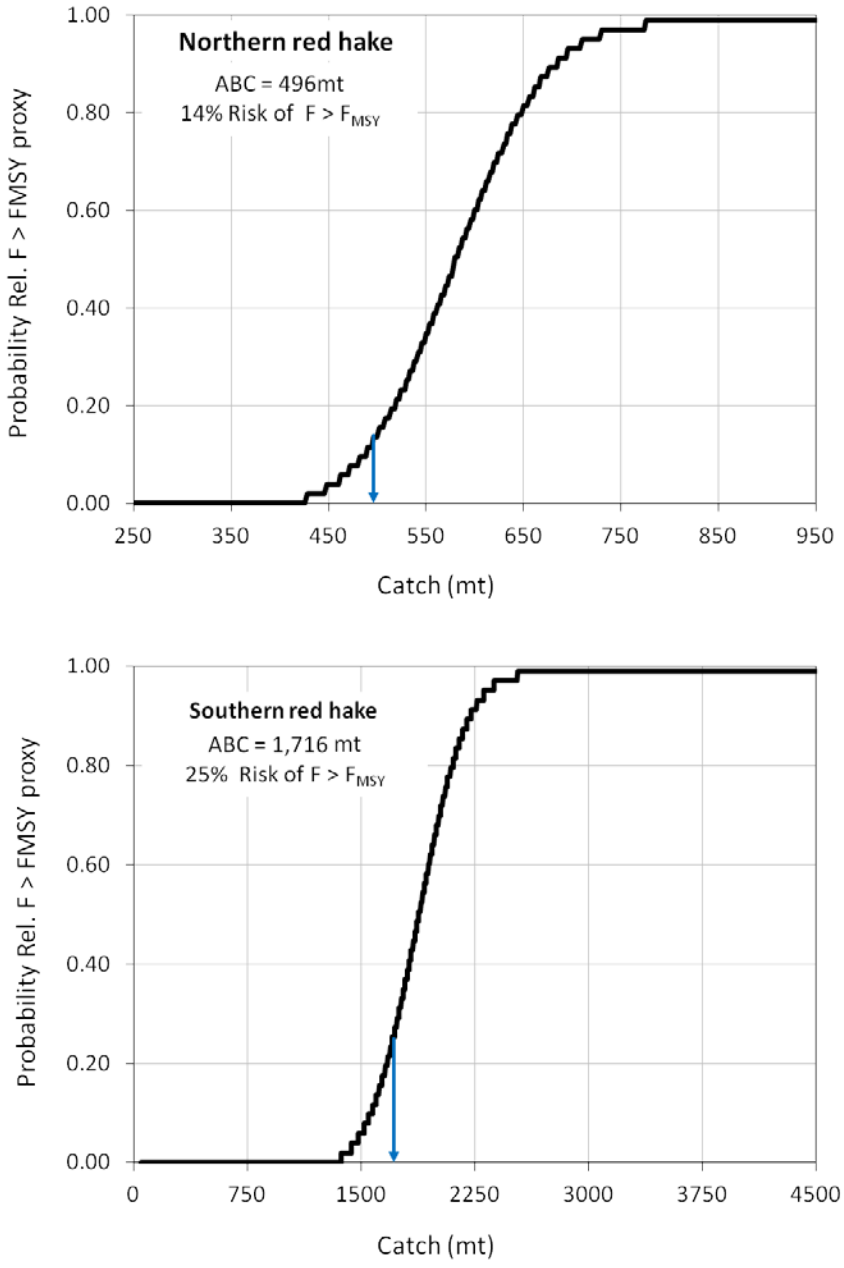
Table 12. Risk of exceeding F_{MSY} proxy over a range of catches (ABC and OFL estimate from the probability distribution in Bold) for ***northern red hake*** stocks. Relative F probabilities were calculated from realizations of the three average fall survey distribution and the OFL estimate. ***Note that the median OFL from the distribution as reported in table below is slightly different from the point estimate due to skewness in the distribution***

Catch Basis	Catch (mt)	Scientific Uncertainty Percentile of OFL	Percent of 2015 OFL (556mt) derived from the distribution	Percent of 2014 Catch (266 mt)	Probability of overfishing (F > FMSY)
2015 ABC	496	40	89%	54%	14%
2015 ACL	471	36	85%	56%	7%
2014 ABC	287	10	52%	93%	0%
2014 ACL	273	9	49%	97%	0%
Recent Catch (2014)	266	8	48%	100%	0%
Recent 5yr Avg. Catch	284	9	51%	94%	0%

Table 13. Risk of exceeding F_{MSY} proxy over a range of catches (ABC and OFL estimate from the distribution in Bold) for and ***southern red hake*** stocks. Relative F probabilities were calculated from realizations of the three average fall survey distribution and the OFL estimate. ***Note that the OFL from the distribution as reported in the table below is slightly different from the point estimate due to skewness in the distribution***

Catch Basis	Catch (mt)	Scientific Uncertainty Percentile of OFL	Percent of 2015 OFL (1,816mt) derived from the distribution	Percent of 2014 Catch (1,202 mt)	Probability of overfishing (F > FMSY)
2015 ABC	1809	40	100%	66%	25%
2015 ACL	1719	32	95%	70%	16%
2014 ABC	3179	99	175%	38%	99%
2014 ACL	3021	99	166%	40%	99%
Recent Catch (2014)	1201	5	66%	100%	99%
Recent 5yr Avg. Catch	1384	13	76%	87%	99%

Figure 9. Probability of exceeding F_{MSY} proxy for the northern (TOP) and southern (BOTTOM) ***red hake*** stocks based on the updated 2015 OFL. The risk of overfishing is a product of the probability of Rel.F > F_{MSY} proxy for each survey realizations and the survey probability distributions.



7.4 Assessment Summary

The red hake stock assessments were updated with catch through 2014 and spring survey biomass indices through 2015. Red hake catch data consisted of commercial landings and, commercial discards and recreational catches. Catch data were combined with the spring Northeast Fisheries Science Center trawl survey via an index-based approach that compares a three-year moving average for spring biomass to the relative exploitation ratio of catch to survey. Uncertainty in the overfishing limits was re-estimated to determine the proposed ABC levels, using the Council's existing control rule and process defined and approved by the SSC for the 2015-2017 specifications.

The new assessment results show that both stocks of red hake were not overfished and overfishing is not occurring in 2014. The three-year average spring biomass index (3.55kg/tow in the north vs 0.62kg/tow in the south) are both above the overfished management threshold (1.27 kg/tow in the north vs 0.51kg/tow in the south), hence neither red hake stock is overfished. Although it was not previously overfished, the large biomass increase in the north is attributable to the recent strong 2014 year class However, in the south it should be noted that the three-year biomass index (updated from 2011-2013 to 2013-2015 spring surveys) has notably declined and is approaching the minimum biomass threshold associated with an overfished condition.

The 2014 exploitation index measured as the ratio of catch to survey has remained consistently low since the previous benchmark assessment (0.09 kt/kg in the north vs 1.91 kt/kg in the south) and well below the management overfishing definition thresholds (2.78 kt/kg in the north vs 34.17 kt/kg in the south). The northern three-year average exploitation index (0.162kt/kg) is 55% of the 0.162kt/kg overfishing threshold in the north; and is 63% of the 3.04 kt/kg overfishing threshold in the south.

The proposed ABC recommendations for red hake for fishing year 2016 – 2017 was estimated at 496 mt in the north (73% increase from the previous assessment) and 1,717 mt in the south (45% decrease from the previous assessment). The proposed ABCs are approximately 89% of the OFL in the north and 95% of the OFL in the south with a low-moderate risk (14%) of exceeding the overfishing limit in the north and a moderate risk (25%) in the south.

Stock biomass for northern red hake has improved and suggests the stock can withstand higher catches than the current 2015-2017 specifications would allow (taking the increased uncertainty in the OFL estimate into account). The 2014 year class will grow and contribute to increasing fishery catches. If no specification changes are made, the large 2014 year class is likely to result in higher catch levels from increasing fishery discards, but given the marginal change in stock status and the low-moderate risk of exceeding the overfishing limit, it would probably not contribute to overfishing except with respect to the status quo ABC.

Southern red hake stock biomass has declined in the recent three years, while catches remaining relatively stable. Discards are however constitute a majority of the catch for both northern and southern stocks. Since catches have remained relatively stable while stock biomass has declined, the relative exploitation index has increased without causing overfishing. Continuing declines in stock biomass with constant catch increases the probability of overfishing and the risk that the southern red hake stock could become overfished.

8.0 Whiting PDT Membership

The Whiting Plan Development Team includes:

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10.0 Appendix I – Assessment Background and Fishery Information

10.1 Introduction

This document summarizes the update of red hake stock assessment results based on the last adopted benchmark approach in 2010 (NEFSC, 2011). Overfishing limits (OFL) and Allowable Biological Catch (ABC) were re-estimated based on the existing framework and specifications developed by the Northeast Fisheries Science Center (NEFSC) and the Council's Whiting Plan Development Team (PDT) are also provided in this document.

In the previous benchmark assessment, the goal was to produce an analytical model based assessment with appropriate reference point to set OFLs for red, silver and offshore hake. However, due to difficulties of the models resolving conflicting signals coming from low catches, particularly early in the time series and increasing stock biomass coupled with an increasing truncation in age structure, an index-based assessment for both red and silver hake were adopted as basis for reference points update and stock status determination. In the case of offshore, the SAW determined that there was no sufficient information about catch or trends in abundance and biomass to guide management of the stock. Instead, offshore hake are accounted for in the ABC estimates for the southern silver hake stock to account for customary reported catches of both species in the trawl fishery.

Due to the lack of an analytical model from the benchmark, the council directed the Whiting PDT in a collaborative effort with the NEFSC to develop ABC setting methods and recommend ABCs for the small mesh multispecies stocks that incorporates measures of scientific uncertainty. The methods were reviewed in April 2011 and did not become effective until May, 1 2012 via a Secretarial Amendment with an ACL specifications developed by the Council for Amendment 19.

In this updated assessment, catch and survey indices through 2015 updated to update ABC recommendations for fishing year 2015-2017. Catch information consisted of commercial and recreational landings and discards for red hake. Catch data was combined with fisheries independent survey data from the fall and spring NEFSC trawl survey in a simple Index-based approach that utilizes a three year moving average of the spring biomass index and relative exploitation ratio of catch to the survey. Uncertainty in the Overfishing Limits was re-estimated and ABC recommendations are provided based on the current Amendment 19 ABC definitions for both red and silver hake.

10.2 Red hake life history

Red hake, *Urophycis chuss*, is a demersal gadoid species distributed from the Gulf of St. Lawrence to North Carolina, and are most abundant from the western Gulf of Maine through Southern New England waters. Red hake are separated into northern and southern stocks for management purposes. The northern stock is defined as the Gulf of Maine to Northern Georges Bank region, while the southern stock is defined as the Southern Georges Bank to Mid-Atlantic Bight region (Map 3).

Red hake migrate seasonally, preferring temperatures between 5 and 12° C (41-54° F) (Grosslein and Azarovitz 1982). During the spring and summer months, red hake move into shallower waters to spawn, then move offshore to deep waters in the Gulf of Maine and the edge of the continental shelf along Southern New England and Georges Bank in the winter. Spawning occurs from May through November, with primary spawning grounds on the southwest part of Georges Bank and in the Southern New England area off Montauk Point, Long Island (Colton and Temple 1961).

Red hake do not grow as large as white hake, and normally reach a maximum size of 50 cm (20 in) and 2 kg (4.4 lb.) (Musick 1967). Females are generally larger than males of the same age, and reach a maximum length of 63 cm (25 in) and a weight of 3.6 kg (7.9 lb.) (Collette and Klein-MacPhee eds. 2002). Although they generally do not live longer than 8 years, red hake have been recorded up to 14 years old. In the northern stock, the age at 50 percent maturity is 1.4 years for males and 1.8 years for females, and the size at 50 percent maturity is 22 cm (8.7 in) for males and 27 cm (10.6 in) for females (O'Brien et al. 1993). In the southern red hake stock, the age at 50 percent maturity is 1.8 years for males and 1.7 years for females, and the size at 50 percent maturity is 24 cm (9.5 in) for males and 25 cm (9.8 in) for females (O'Brien et al. 1993).

Red hake prefer soft sand or muddy bottom, and feed primarily on crustaceans such as euphausiids, decapods, and rock crabs as well as fish such as haddock, silver hake, sea robins, sand lance, mackerel and small red hake (Bowman et al. 2000). Primary predators of red hake include spiny dogfish, cod, goosefish, and silver hake (Roundtree 1999). As juveniles, red hake seek shelter from predators in scallop beds, and are commonly found in the mantle cavities of (or underneath) sea scallops. In the fall, red hake likely leave the safety of the scallop beds due to their increasing size and to seek warmer temperatures in offshore waters (Steiner et al. 1982).

10.3 Fishery

The northern red hake stock generally has significantly lower commercial catches than the southern stock due to higher fishery activity in the south relative to the north. In 1966, total commercial catches peaked over 118,000 mt but have since declined progressively. After 1976, catches declined considerably due to the withdrawal of the distant water fleet. Commercial catches attained a historical low of 1300 mt in 2004 and has averaged approximately 1,600 mt in the recent decade.

10.3.1 Commercial Landings

Commercial landings for both stocks (north and south) of red hake were updated for years through, derived from the trip-based allocation procedure described in the GARM III Data meeting (GARM 2007; Legault et al. 2008b; Palmer 2008; Wigley et al. 2007a). With the implementation of mandatory vessel trip reports (VTRs) since 1994, the port interview process was discontinued and the area and effort information was obtained directly from the VTRs. Unfortunately, the matching of dealer reports and VTRs has been problematic and secondary allocation procedures are needed to assign the area and effort information to dealer landings. Currently, a standardized procedure is used to assign area and effort from VTRs to dealer-reported landings from 1994 onward (Wigley et al.2007a). The product from this process is stored the NEFSC allocation (AA) database tables. Landings are matched to VTRs in a hierarchal manner, with landings matched at the top tier (level A, direct matching) having a higher confidence in the area and fishing effort attribution than those matched at the lower tiers. The matching rates have improved over time with over 80% of red hake landings being matched at the highest level in recent years.

Landings of red hake decreased in the north by 29% from 95mt in 2013 to 68mt in 2014 and increased in the south by 28% from 439mt in 2013 to 560 mt in 2014 (Table 9 and Table 10). The commercial fishery for both red hake continues to be dominated by vessels fishing with trawl gear with less than 10% contributed from other fleets (Table 16 and Table 17).

10.3.2 Commercial discards

In recent years, red hake are discarded in the commercial fishery primarily due to limited market demand. Other reasons include poor quality, minimum retention size (too small) and filled quota, particularly for northern red hake stock.

Direct sampling of the commercial fishery for discards has been conducted by fisheries observers since 1989. Beginning in May 2010, Amendment 16 created a new class of fisheries observers to support sector management of the northeast US groundfish fishery. These new observers were termed 'at-sea monitors', or ASMs. ASMs are deployed in the same manner as observers certified through the Northeast Fisheries Observer Program (NEFOP; Palmer et al. 2013), but they collect only basic information on fishery catches and length frequency distributions. Between 2010 and 2012, ASM coverage averaged approximately 20% of total groundfish trips whereas regular observer coverage (NEFOP) averaged about 6% (Palmer et al. 2013). An evaluation of length frequency distributions showed very minor differences between NEFOP and ASM when the sampling was sufficient to make comparisons. For the purpose of this assessment update, no distinctions were made between data collected by ASM and NEFOP observers with respect to discard estimation.

Total red hake discards for years 2011-2013 was estimated using the same approach from the previous benchmark assessment. The discard estimation approach is based on the Standardized Bycatch Reporting Methodology (SBRM) recommended in the GARM III Data meeting (GARM 2007, Wigley et al. 2007b). This method estimates observed ratio of species x to kept all species for large mesh (≥ 5") otter trawl, small mesh (< 5") otter trawl, shrimp trawl, scallop dredge, Sink gillnet and longline and applied to total landings by these gears and by half year. Uncertainty in the discard estimates was estimated based on the SBRM approach detailed in the GARM III Data meeting (GARM 2007, Wigley et al. 2007b). Average annual discards of the total catch for northern and southern red hake in the recent three years (2012-2014) were approximately 70% and 51% respectively. Total discards of red hake decreased in both stocks by XX% from 216 mt in 2013 to approximately 186 mt in 2014 in the north and by XX% from 582 mt in 2013 to 553mt in 2014 (Table 19 and Table 20).

Evaluation of discard estimates by selected major gear groups (i.e. large mesh and small mesh trawl) all show decrease discarding of red hake in the north with the exception of the large mesh trawl. In 2014, northern red hake discards was dominated by the small mesh and large mesh trawl contributing to over 90% of red hake discards. For northern red hake, the small mesh trawl remains the primary source of red hake discarding. In the south, the small mesh trawl remains the primary source of red hake discarding, contributing to over 83% of red hake discards.

10.3.3 Recreational Catch

In the previous benchmark assessment, recreational catch estimates were based on data collected under the Marine Recreational Fisheries Statistical Survey (MRFSS) which began in 1981. In this assessment update, MRFSS data have been re-estimated using the revised methodologies consistent with the new Marine Recreational Information Program (MRIP) which has replaced MRFSS program (**NMFS 2012**). Recreational catches of red hake are presented in Table 18 and Figure 11**.** Recreational catches of red hake have been variable without trend. Since 2013, recreational catches of red hake in the north has quadrupled from 2.6 mt to 12.2 mt in 2014. However, in the south, red hake recreational catches declined by 38% from 143 mt in 2013 to 88 mt in 2014.

10.4 Survey catches

Research bottom trawl surveys are conducted annually by the Northeast Fisheries Science Center (NEFSC) in April (denoted as spring) and October (denoted as fall) extending from the Gulf of Maine to Cape Hatteras in offshore waters at depths 27-365 meters dating back to 1963. The NEFSC survey is conducted using a randomized stratified design which allocates samples relative to the size of the strata, defined by depth.

The NEFSC spring and fall strata catches (strata 20-30 and 36-40 in the north and 1-19 and 61-76 in the south) were used to estimate relative stock biomass and relative abundance for red hake (Figure XX). Conversion coefficients, which adjust for survey door, vessel, and net changes in NMFS groundfish surveys (red hake uses 1.31 for BMV oval doors and silver hake uses 2.360 for the Yankee 41 net; Rago et al. 1994; Byrne and Forrester 1991) were applied to the catch of each tow for years 1973-2008.

Beginning in 2009, the NMFS bottom trawl surveys were conducted with a new vessel, the NOAA ship *Henry B. Bigelow*, which uses a different net and protocols from the previous survey vessel. Conversion coefficients by length have been estimated for both red and silver hake (**NEFSC, 2011**) and were applied in this assessment.
The red hake spring biomass index in the north has been decreasing since 2010 (2.80 kg/tow), declining by approximately 52% in 2013 (1.35 kg/tow). In 2015, the spring biomass index doubled to (6.27 kg/tow), from 3.02kg/tow in 2014, owing to the 2014 year class. However in the south, red hake spring biomass index has continued declining since 2011. The 2015 survey terminal year estimate declined by 8% from 0.63 kg/tow in 2013 to 0.58 kg/tow in 2014 (Table 9-Table 10 and Figure 5-Figure 6).

The NEFSC spring 2014 survey did not cover the full range of the southern stock due to mechanical difficulties experienced by NOAA research vessel Henry B. Bigelow. As a result, the PDT recommends an adjustment factor based on complete survey coverage in 2004-2013 be applied to the 2014 survey index to account for the missing strata. Following a reviewed and accepted procedure that has been applied to other stock assessments, the adjustment factor was calculated as a ratio of years with complete strata to the same set of years with missing strata. This resulted in average adjustment factor of 0.86 applied to the spring 2014 survey. Consequently this resulted in a reduction in the stratified mean weight per tow from 0.733kg/tow to 0.633kg/tow (approx. a 16% decrease in the mean stratified weight per tow).

11.0 Assessment Tables

Table 14. Summary of major regulatory measures for the Small Mesh Multispecies Fishery since 1987.

Year	Ammendment/ Framework Adj.	Brief Summary
1987	Amendment 1	Established area and seasonal restriction pertaining to small mesh fishing for silver and red hake went into effect
1991	Amendment 4	Mandatory reporting and sea sampling compliance. Defined and established the Cultivator Shoals Area mesh program. Set minimum Mesh restrictions for small mesh multispecies 2.5 inches. Goal to improve size selectivity and bycatch reduction fo regulated multispecies
1994	Framework Adj. 6	Increased minimum mesh size from 2.5 in to 3.0 Intend to reduce catch on Juve market
1995	Framework Adj. 9	Implementation of small mesh Areas I and II off the coast of New Hampshire
1999/2000	Amendment 12	Adjustment to fishing seasons to the cultivator Shoals Area Small mesh program. Established possession limits for vessels fishing outside cultivator Shoals Area. Gear regulation adjustment was implemented. allowances for transferring silver hake at sea (bait)
2000	Framework Adj. 35	Implementation of Raised Footrope Trawl off Cape Cod
2002	Modification to Framework Adj. 35	Adjusted the boundary along the eastern side of cape Cod and extended the season to Dec 31
2003	Framework Adj. 37	Streamed lined varying management measures to increase consistency between exemption areas
2003	Control Date	Implemented with intentions of developing a limited access program
2003	Framework Adj. 38	Established the Grate raised Footrope Exemption in the GOM area.
2012	Secretarial Amendment	Brought portions of the FMP into compliance with the Magnuson-Stevens Act requirements to (10 have ACL (2) measures to ensure accountability for each council managed fishery. The secretarial amendment was necessary because the mechanism through which the Council was intending to adopt Amendment 19 was delayed
2013	Amendment 19	Allowed Council to incorporate updated stock assessment information and adopt the ACL structure implemented in the secretarial amendment. Modification to accountability measures and adoption of new biological reference points and trip limit for red hake was established.
2013	Framework Adjustment 50	Established a separate sub-ACL of GB yellowtail flounder for the small mesh fishery (whiting and squid fishery)
2014	Framework Adjustment 51	Implemented accountability measures for sub-ACL

Table 15. Summary of Current possession limits for silver, red and offshore hake.

Exemption Area	Codend Mesh Size	Silver and offshore hake combined, possession limit (lbs)	Red hake possession limit (lbs)
Gulf of Maine Raised foot Rope)	Mesh < 2.5"	7,500	5,000
Cultivator Shoals	Mesh >= 3.0"	30,000	5,000
Area I & II	Mesh < 2.5" 2.5" < Mesh < 3.0" mesh >= 3.0"	3,500 7,500 30,000	5,000
Cape Cod Raised Foot Rope	2.5" < Mesh < 3.0" mesh >= 3.0"	7,500 30,000	5,000
SNE and MA	Mesh < 2.5" 2.5" < Mesh < 3.0" mesh >= 3.0"	3,500 7,500 40,000	5,000

Table 16. Northern red hake estimated commercial landings in metric tons (TOP) and percent (BOTTOM) by major gear groupings from 1994-2014.

Year	Northern Stock			
	Trawl	Scallop Dredge	Other	Total
1994	681		37	718
1995	160		15	175
1996	390		4	394
1997	308		14	322
1998	170		3	173
1999	200		6	206
2000	165		6	172
2001	191	2	12	205
2002	242		3	245
2003	180		5	185
2004	73		10	83
2005	70	0	3	73
2006	77	0	0	77
2007	40	0	0	40
2008	7		0	7
2009	34		0	34
2010	51	0	0	51
2011	99		0	99
2012	77		0	77
2013	78		1	79
2014	57		1	58

Year	Northern Stock			
	Trawl	Scallop Dredge	Other	Total
1994	95%	0%	5%	100%
1995	91%	0%	9%	100%
1996	99%	0%	1%	100%
1997	96%	0%	4%	100%
1998	98%	0%	2%	100%
1999	97%	0%	3%	100%
2000	96%	0%	4%	100%
2001	93%	1%	6%	100%
2002	99%	0%	1%	100%
2003	97%	0%	3%	100%
2004	87%	0%	13%	100%
2005	96%	0%	4%	100%
2006	100%	0%	0%	100%
2007	100%	0%	0%	100%
2008	98%	0%	2%	100%
2009	100%	0%	0%	100%
2010	100%	0%	0%	100%
2011	100%	0%	0%	100%
2012	100%	0%	0%	100%
2013	99%	0%	1%	100%
2014	99%	0%	1%	100%

Table 17. Southern red hake estimated commercial landings in metric tons (TOP) and percent (BOTTOM) by major gear groupings from 1994-2014.

Year	Southern Stock			
	Trawl	Scallop Dredge	Other	Total
1994	851		132	983
1995	987	0	436	1,423
1996	694		5	700
1997	982		17	999
1998	1,142		12	1,154
1999	1,337		14	1,351
2000	1,398		17	1,415
2001	1,437	0	26	1,463
2002	653		10	663
2003	619		3	623
2004	568	0	19	587
2005	340	1	15	356
2006	363	2	11	375
2007	453	6	12	472
2008	477	0	102	580
2009	531	1	48	579
2010	528	0	24	553
2011	476	0	19	495
2012	722	0	28	751
2013	421	0	17	439
2014	540	0	19	559

Year	Southern Stock			
	Trawl	Scallop Dredge	Other	Total
1994	87%	0%	13%	100%
1995	69%	0%	31%	100%
1996	99%	0%	1%	100%
1997	98%	0%	2%	100%
1998	99%	0%	1%	100%
1999	99%	0%	1%	100%
2000	99%	0%	1%	100%
2001	98%	0%	2%	100%
2002	99%	0%	1%	100%
2003	99%	0%	1%	100%
2004	97%	0%	3%	100%
2005	96%	0%	4%	100%
2006	97%	0%	3%	100%
2007	96%	1%	3%	100%
2008	82%	0%	18%	100%
2009	92%	0%	8%	100%
2010	96%	0%	4%	100%
2011	96%	0%	4%	100%
2012	96%	0%	4%	100%
2013	96%	0%	4%	100%
2014	97%	0%	3%	100%

Table 18. Northern and southern red hake total recreational catch (mt) from 2004–2014, derived from the Marine Recreation Information Program (MRIP).

Year	North			South		
	Landings	Discards	Catch	Landings	Discards	Catch
2004	0.000	0.000	0.000	10.360	5.070	15.430
2005	0.000	0.000	0.000	87.550	30.880	118.430
2006	0.160	0.540	0.700	49.870	27.260	77.130
2007	0.140	0.270	0.410	144.480	6.710	151.190
2008	0.320	0.170	0.490	85.620	31.470	117.090
2009	1.190	0.330	1.520	106.000	27.280	133.280
2010	0.520	0.470	0.990	125.350	27.340	152.690
2011	0.680	0.810	1.490	67.870	26.470	94.340
2012	0.460	0.470	0.930	69.440	15.970	85.410
2013	2.390	0.190	2.580	75.720	67.390	143.110
2014	5.340	6.870	12.210	69.010	19.530	88.540

Table 19. Northern red hake estimated commercial discards in metric tons (TOP) and percent (BOTTOM) by major gear groupings.

Year	Trawl large mesh	Trawl small mesh	Shrimp trawl	Scallop Dredge	Sink Gillnet	Longline	Total
1989	394.95	692.05	329.90	0.00	4.86	0.00	1421.75
1990	144.86	304.94	314.48	0.00	4.63	0.00	768.91
1991	222.03	309.40	212.53	0.00	3.91	17.93	765.80
1992	147.84	486.92	87.56	2.39	0.88	0.36	725.94
1993	493.83	42.10	4.60	24.50	0.80	0.00	565.83
1994	8.84	0.00	7.50	2.19	3.84	0.00	22.38
1995	15.28	22.91	10.66	0.79	1.61	0.00	51.26
1996	11.78	508.40	105.80	2.98	3.71	0.00	632.67
1997	14.41	0.49	84.81	5.71	1.06	0.00	106.47
1998	1.14	0.00	0.00	0.14	1.45	0.00	2.73
1999	308.70	128.45	0.00	2.28	2.82	0.00	442.24
2000	27.89	0.40	0.00	4.06	3.65	0.00	36.01
2001	47.45	65.29	0.66	2.71	11.74	0.00	127.84
2002	30.86	53.47	0.00	2.12	3.21	0.51	90.17
2003	30.14	27.78	0.36	16.12	2.24	0.00	76.63
2004	26.42	25.27	0.79	0.84	1.81	1.67	56.80
2005	35.73	10.79	0.17	14.71	0.53	2.93	64.86
2006	41.41	125.14	3.33	1.39	8.83	1.54	181.64
2007	21.80	69.48	5.99	14.80	0.10	0.92	113.11
2008	36.11	15.14	1.59	0.35	2.59	2.13	57.91
2009	43.26	63.56	1.42	2.95	1.04	0.66	112.89
2010	33.69	153.99	3.96	10.04	1.25	5.72	208.65
2011	34.40	43.92	1.82	18.11	1.78	0.84	100.87
2012	56.37	113.55	6.16	9.43	1.69	0.91	188.12
2013	59.82	140.88	0.29	13.47	1.22	0.08	215.75
2014	82.20	96.24	0.00	6.50	0.92	0.36	186.22

Year	Trawl large mesh	Trawl small mesh	Shrimp trawl	Scallop Dredge	Sink Gillnet	Longline	Total
1989	28%	49%	23%	0%	0%	0%	100%
1990	19%	40%	41%	0%	1%	0%	100%
1991	29%	40%	28%	0%	1%	2%	100%
1992	20%	67%	12%	0%	0%	0%	100%
1993	87%	7%	1%	4%	0%	0%	100%
1994	40%	0%	34%	10%	17%	0%	100%
1995	30%	45%	21%	2%	3%	0%	100%
1996	2%	80%	17%	0%	1%	0%	100%
1997	14%	0%	80%	5%	1%	0%	100%
1998	42%	0%	0%	5%	53%	0%	100%
1999	70%	29%	0%	1%	1%	0%	100%
2000	77%	1%	0%	11%	10%	0%	100%
2001	37%	51%	1%	2%	9%	0%	100%
2002	34%	59%	0%	2%	4%	1%	100%
2003	39%	36%	0%	21%	3%	0%	100%
2004	47%	44%	1%	1%	3%	3%	100%
2005	55%	17%	0%	23%	1%	5%	100%
2006	23%	69%	2%	1%	5%	1%	100%
2007	19%	61%	5%	13%	0%	1%	100%
2008	62%	26%	3%	1%	4%	4%	100%
2009	38%	56%	1%	3%	1%	1%	100%
2010	16%	74%	2%	5%	1%	3%	100%
2011	34%	44%	2%	18%	2%	1%	100%
2012	30%	60%	3%	5%	1%	0%	100%
2013	28%	65%	0%	6%	1%	0%	100%
2014	44%	52%	0%	3%	0%	0%	100%

Table 20. Southern red hake estimated commercial discards in metric tons (TOP) and percent (BOTTOM) by major gear groupings.

Year	Trawl large mesh	Trawl small mesh	Shrimp trawl	Scallop Dredge	Sink Gillnet	Longline	Total
1989	643.63	4917.34	0.00	0.00	0.00		5560.97
1990	1328.70	3352.21	0.00	0.00	0.00		4680.90
1991	445.29	2143.80	1.63	0.09	21.35		2612.16
1992	768.06	5519.00	20.58	3.30	0.00		6310.94
1993	8163.62	6404.06	17.18	4.76	0.00		14589.61
1994	641.52	2407.37	50.20	0.69	0.00		3099.77
1995	110.37	1248.92	27.47	0.45	0.00		1387.21
1996	237.02	341.23	19.29	0.19	0.00		597.72
1997	1012.93	2046.14	44.27	2.06	0.00		3105.40
1998	4754.53	712.63	2.37	0.45	0.00		5469.97
1999	3606.00	325.80	31.19	0.89	0.00		3963.87
2000	5695.34	118.85	63.70	7.62	0.00		5885.50
2001	1751.96	252.38	36.94	0.00	0.00		2041.28
2002	17.54	303.02	15.41	0.44	0.00		336.40
2003	18.23	285.56	5.42	1.28	0.00		310.48
2004	180.41	433.37	19.07	0.37	0.00		633.22
2005	136.20	907.02	38.52	0.24	0.03		1082.01
2006	99.08	464.33	64.29	0.01	0.09		627.80
2007	158.15	1356.99	15.99	0.00	0.02		1531.14
2008	148.78	456.85	46.21	0.03	13.09		664.96
2009	128.31	717.86	51.48	0.16	0.00		897.81
2010	83.22	591.31	31.24	0.30	0.00		706.06
2011	22.86	928.76	57.61	0.67	0.00		1009.90
2012	18.13	551.79	78.78	0.28	0.00		648.98
2013	7.33	545.64	29.05	0.20	0.00		582.21
2014	52.29	462.41	39.16	0.00	0.04		553.89

Year	Trawl large mesh	Trawl small mesh	Shrimp trawl	Scallop Dredge	Sink Gillnet	Longline	Total
1989	12%	88%	0%	0%	0%	0%	100%
1990	28%	72%	0%	0%	0%	0%	100%
1991	17%	82%	0%	0%	1%	0%	100%
1992	12%	87%	0%	0%	0%	0%	100%
1993	56%	44%	0%	0%	0%	0%	100%
1994	21%	78%	2%	0%	0%	0%	100%
1995	8%	90%	2%	0%	0%	0%	100%
1996	40%	57%	3%	0%	0%	0%	100%
1997	33%	66%	1%	0%	0%	0%	100%
1998	87%	13%	0%	0%	0%	0%	100%
1999	91%	8%	1%	0%	0%	0%	100%
2000	97%	2%	1%	0%	0%	0%	100%
2001	86%	12%	2%	0%	0%	0%	100%
2002	5%	90%	5%	0%	0%	0%	100%
2003	6%	92%	2%	0%	0%	0%	100%
2004	28%	68%	3%	0%	0%	0%	100%
2005	13%	84%	4%	0%	0%	0%	100%
2006	16%	74%	10%	0%	0%	0%	100%
2007	10%	89%	1%	0%	0%	0%	100%
2008	22%	69%	7%	0%	2%	0%	100%
2009	14%	80%	6%	0%	0%	0%	100%
2010	12%	84%	4%	0%	0%	0%	100%
2011	2%	92%	6%	0%	0%	0%	100%
2012	3%	85%	12%	0%	0%	0%	100%
2013	1%	94%	5%	0%	0%	0%	100%
2014	9%	83%	7%	0%	0%	0%	100%

Table 21. Northern red hake - Summary of total catch (kt), NEFSC spring survey biomass in albatross units (kg/tow) and index of relative exploitation ratios of total catch to the spring survey biomass (kt/kg) for northern red hake. Note: This assessment update was based on the most recent three year average of both the fall survey biomass the relative exploitation ratio from 2013-2015.

Year	Northern Spring Survey arithmetic kg/tow	Northern Spring Survey 3-year Average kg/tow	Total Northern Landings (000's mt)	Northern Discards (000's mt)	Northern Recreational Catch (000's mt)	Northern total Catch (000's mt)	Northern Exploitation Index (kg/000's mt)
1955							
1956							
1957							
1958							
1959							
1960			3.79			3.79	
1961			3.28			3.28	
1962			1.91	1.60	0.01	3.52	
1963			3.28	1.60	0.00	4.89	
1964			1.41	1.70	0.00	3.11	
1965			2.77	1.62	0.00	4.40	
1966			5.58	1.60	0.00	7.18	
1967			1.86	1.40	0.00	3.27	
1968	1.14		2.63	1.30	0.00	3.93	3.45
1969	0.64		2.02	1.12	0.00	3.14	4.91
1970	0.54	0.77	1.03	1.10	0.00	2.13	3.94
1971	0.65	0.61	4.81	1.16	0.00	5.97	9.21
1972	1.56	0.92	15.03	0.96	0.00	15.99	10.25
1973	4.31	2.17	15.29	0.91	0.00	16.20	3.76
1974	2.43	2.77	7.22	0.82	0.00	8.04	3.31
1975	4.25	3.67	8.70	1.20	0.00	9.90	2.33
1976	3.37	3.35	6.34	0.93	0.00	7.26	2.15
1977	2.66	3.43	0.89	1.08	0.00	1.98	0.74
1978	2.57	2.87	1.22	1.12	0.00	2.34	0.91
1979	2.04	2.42	1.52	1.22	0.01	2.75	1.35
1980	3.88	2.83	1.03	1.37	0.00	2.40	0.62
1981	6.35	4.09	1.25	1.32	0.03	2.60	0.41
1982	2.13	4.12	1.21	1.46	0.00	2.67	1.26
1983	3.70	4.06	0.90	1.35	0.00	2.25	0.61
1984	2.98	2.94	1.06	1.33	0.00	2.39	0.80
1985	3.91	3.53	0.99	1.27	0.00	2.26	0.58
1986	3.26	3.39	1.46	1.19	0.00	2.65	0.81
1987	2.94	3.37	1.01	1.05	0.00	2.07	0.70
1988	2.00	2.73	0.86	0.90	0.00	1.76	0.88
1989	1.65	2.20	0.78	1.45	0.00	2.22	1.35
1990	1.33	1.66	0.83	0.60	0.00	1.43	1.07
1991	1.62	1.53	0.74	0.82	0.00	1.56	0.96
1992	2.50	1.82	0.92	0.73	0.00	1.65	0.66
1993	2.82	2.32	0.77	0.08	0.00	0.85	0.30
1994	1.59	2.31	0.73	0.08	0.00	0.81	0.51
1995	1.97	2.13	0.19	0.06	0.00	0.25	0.13
1996	1.79	1.79	0.41	0.66	0.01	1.07	0.60
1997	1.81	1.86	0.34	0.13	0.00	0.46	0.26
1998	2.52	2.04	0.19	0.13	0.00	0.32	0.13
1999	2.32	2.22	0.22	0.47	0.00	0.69	0.30
2000	3.19	2.68	0.20	0.06	0.00	0.25	0.08
2001	3.58	3.03	0.22	0.14	0.00	0.36	0.10
2002	4.46	3.74	0.28	0.10	0.00	0.38	0.08
2003	1.00	3.01	0.21	0.09	0.00	0.30	0.30
2004	1.77	2.41	0.10	0.06	0.00	0.16	0.09
2005	1.10	1.29	0.10	0.06	0.00	0.15	0.14
2006	0.91	1.26	0.10	0.18	0.00	0.28	0.30
2007	2.06	1.36	0.07	0.13	0.00	0.20	0.10
2008	3.49	2.15	0.05	0.06	0.00	0.11	0.03
2009	1.75	2.43	0.09	0.10	0.00	0.18	0.10
2010	2.02	2.42	0.07	0.24	0.00	0.31	0.15
2011	2.18	1.98	0.14	0.10	0.00	0.24	0.11
2012	1.73	1.98	0.10	0.19	0.00	0.29	0.17
2013	1.35	1.75	0.10	0.22	0.00	0.31	0.23
2014	3.02	2.03	0.07	0.19	0.01	0.27	0.09
2015	6.27	3.55					

Table 22. Southern red hake - Summary of total catch (kt), NEFSC spring survey biomass in albatross units (kg/tow) and index of relative exploitation ratios of total catch to the spring survey biomass (kt/kg) for southern red hake. Note: This assessment update was based on the most recent three year average of both the spring survey biomass (2013-2015) and the relative exploitation ratios from 2013-2015.

Year	Southern Spring Survey arithmetic kg/tow	Southern Spring Survey 3-year Average kg/tow	Total Southern Landings (000's mt)	Southern Discards (000's mt)	Southern Recreational Catch (000's mt)	Southern total Catch (000's mt)	Southern Exploitation Index (kg/000's mt)
1955							
1956							
1957							
1958							
1959							
1960							
1961							
1962			11.87	4.00	0.89	16.76	
1963			31.90	4.00	0.77	36.67	
1964			43.37	3.76	0.85	47.98	
1965			92.99	4.29	0.63	97.92	
1966			107.92	3.77	0.09	111.79	
1967			58.78	3.66	0.17	62.61	
1968	1.29		18.14	3.72	0.58	22.43	17.45
1969	1.08		52.93	3.62	0.49	57.04	52.72
1970	1.72	1.36	11.45	3.14	0.41	15.01	8.71
1971	3.49	2.10	35.13	2.31	0.29	37.73	10.82
1972	3.59	2.93	61.19	2.10	0.18	63.47	17.68
1973	3.99	3.69	51.36	2.24	0.32	53.92	13.51
1974	2.84	3.47	26.64	2.16	0.19	28.99	10.22
1975	3.18	3.34	19.98	1.76	0.05	21.79	6.85
1976	5.31	3.78	22.47	1.83	0.65	24.94	4.69
1977	2.30	3.60	7.06	1.82	0.75	9.63	4.19
1978	7.65	5.09	5.46	2.44	0.97	8.87	1.16
1979	1.51	3.82	7.59	2.67	0.25	10.50	6.94
1980	2.38	3.85	4.08	2.70	0.14	6.93	2.91
1981	4.61	2.84	2.32	2.72	0.18	5.21	1.13
1982	3.34	3.45	3.17	3.78	0.03	6.98	2.09
1983	2.21	3.39	1.44	3.89	0.14	5.47	2.48
1984	1.33	2.29	1.27	3.91	0.55	5.73	4.30
1985	1.39	1.64	0.90	2.97	0.03	3.90	2.80
1986	1.73	1.49	0.69	3.39	0.21	4.29	2.47
1987	0.88	1.33	0.94	3.31	0.47	4.73	5.38
1988	1.01	1.21	0.87	3.46	0.25	4.58	4.56
1989	0.49	0.79	0.93	5.01	0.44	6.37	13.09
1990	0.71	0.73	0.80	4.75	0.51	6.06	8.57
1991	0.61	0.60	0.93	2.61	0.29	3.82	6.26
1992	0.47	0.59	1.25	6.34	0.19	7.78	16.74
1993	0.42	0.50	0.92	5.31	0.09	6.32	14.91
1994	0.68	0.52	0.98	1.72	0.07	2.77	4.11
1995	0.52	0.54	1.43	1.33	0.05	2.80	5.43
1996	0.45	0.55	0.70	0.38	0.02	1.10	2.43
1997	1.16	0.71	1.00	2.42	0.17	3.59	3.10
1998	0.21	0.61	1.15	0.74	0.05	1.95	9.10
1999	0.46	0.61	1.35	1.06	0.05	2.46	5.42
2000	0.42	0.36	1.42	0.25	0.04	1.71	4.04
2001	0.64	0.51	1.47	0.14	0.02	1.63	2.54
2002	0.54	0.54	0.66	0.33	0.01	1.00	1.85
2003	0.21	0.46	0.62	0.35	0.02	0.99	4.79
2004	0.15	0.30	0.59	0.62	0.01	1.21	7.88
2005	0.38	0.25	0.36	1.01	0.06	1.42	3.77
2006	0.38	0.30	0.38	0.67	0.05	1.10	2.90
2007	0.86	0.54	0.47	1.55	0.02	2.04	2.37
2008	0.47	0.57	0.58	0.81	0.07	1.47	3.10
2009	1.34	0.89	0.58	0.87	0.10	1.54	1.15
2010	0.92	0.91	0.58	0.74	0.09	1.41	1.52
2011	1.79	1.35	0.50	1.01	0.12	1.62	0.91
2012	1.06	1.26	0.75	0.65	0.04	1.44	1.36
2013	0.64	1.16	0.44	0.58	0.08	1.10	1.71
2014*	0.63	0.78	0.56	0.55	0.09	1.20	1.91
2015	0.58	0.62					

12.0 Assessment Figures

Map 3. Northern and southern management and assessment areas for small-mesh multispecies stocks (Northern stock: 512-515, 521-522 and 561. Southern stock: 525-526, 562, 533-534, 537-539, 541-543, 611-616, 621-623, 625-628, 631-638). The dots represent the management and assessment area used for offshore hake.

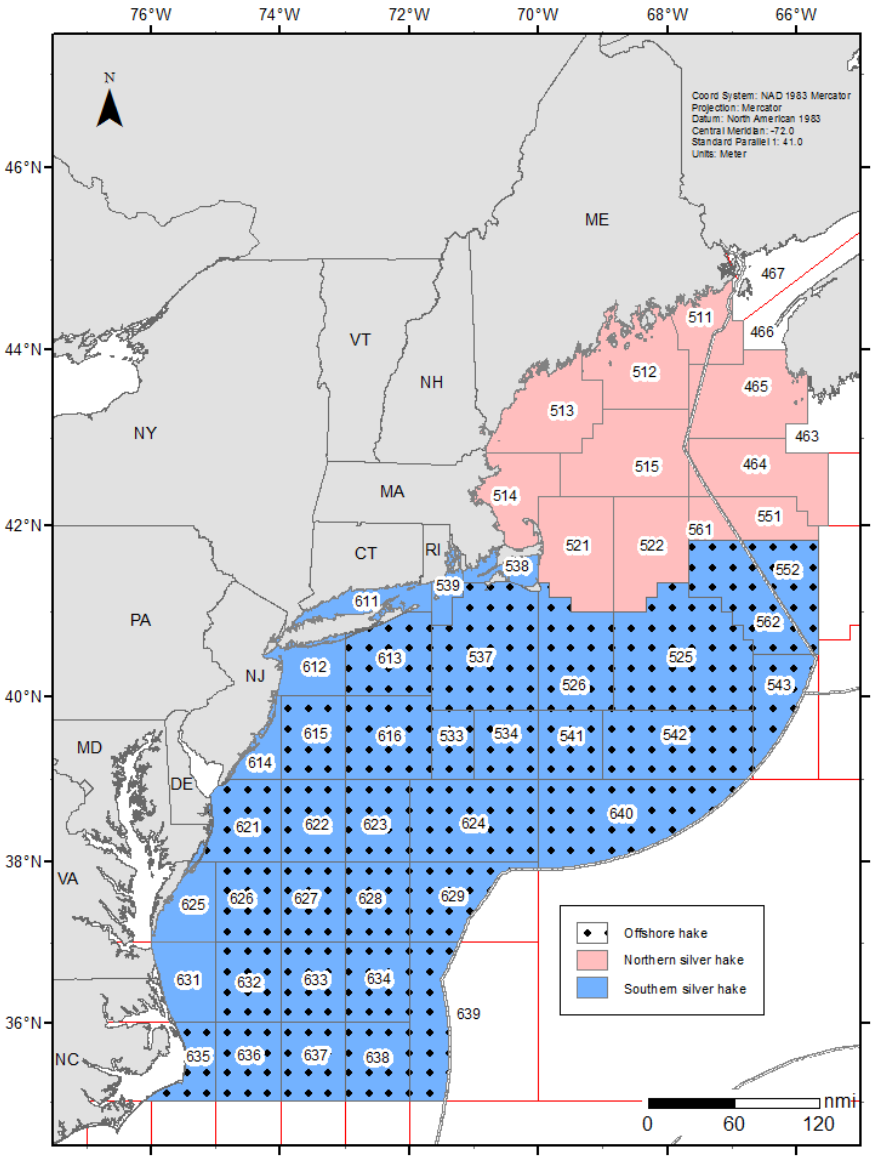


Figure 4.1. Statistical areas used to define the northern and southern silver hake, *Merluccius bilinearis*, and offshore hake, *Merluccius albidus* stocks.

Figure 10. Total catches (mt) of both northern (TOP) and southern (BOTTOM) ***red hake*** stocks by catch dispositions (landed and discarded) for years 1955-2014.

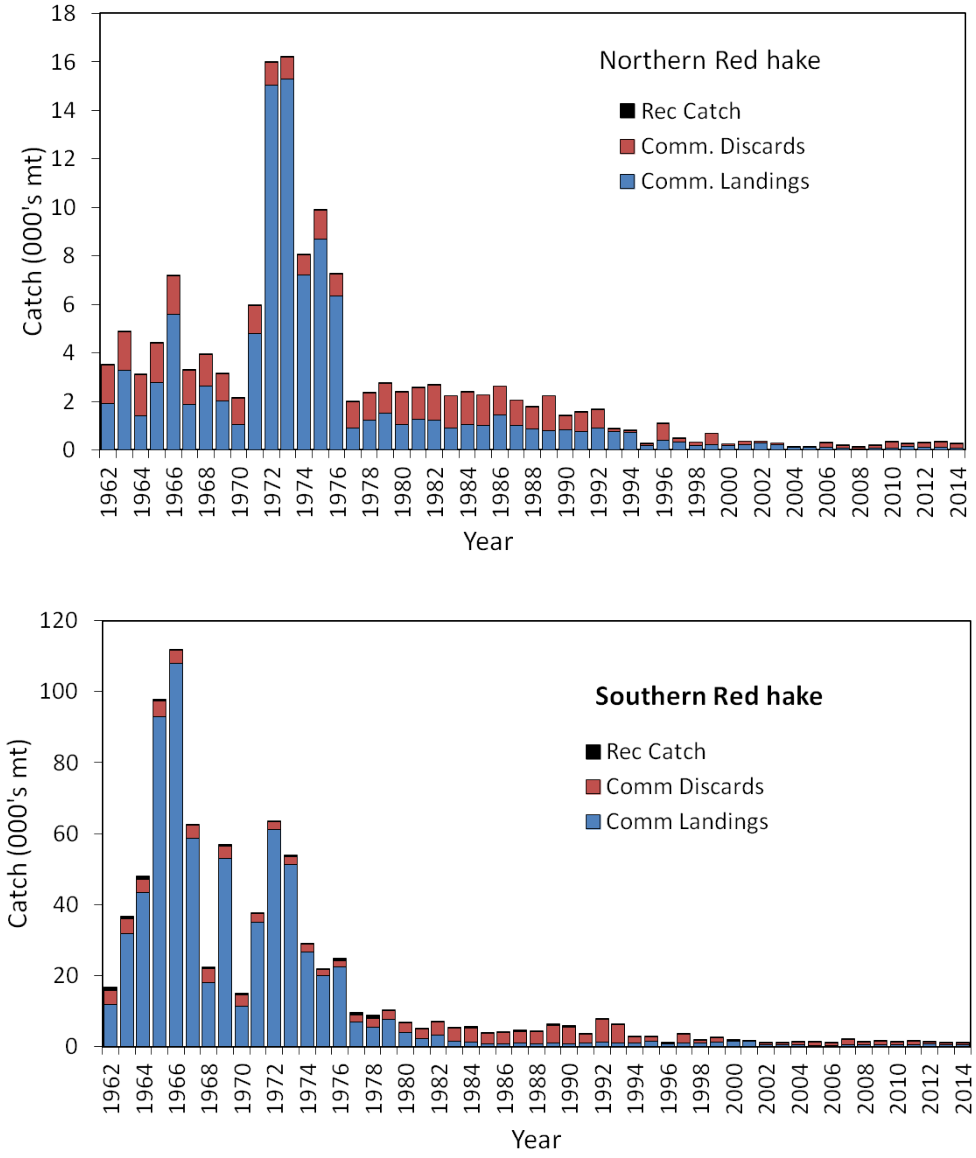
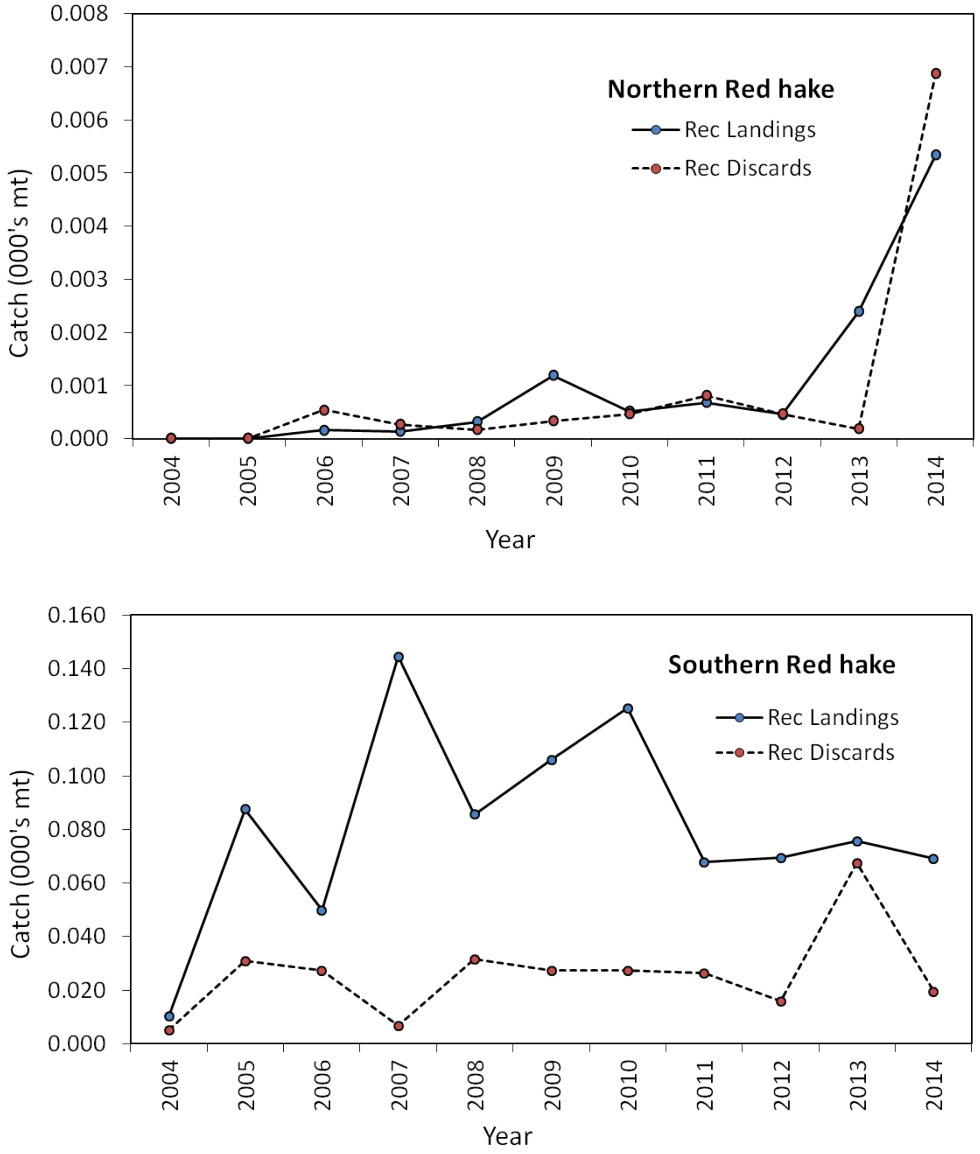


Figure 11. Recreational catches of northern (TOP) and southern (BOTTOM) **red hake** stocks derived from the Marine Recreation Information Program (MRIP) from 2004-2014.



Map 4. Northeast Fisheries Science Center (NEFSC) bottom trawl offshore survey strata included in the northern (20-30 and 36-40) and southern (01-19 and 61-76) silver and red hake stock assessments.

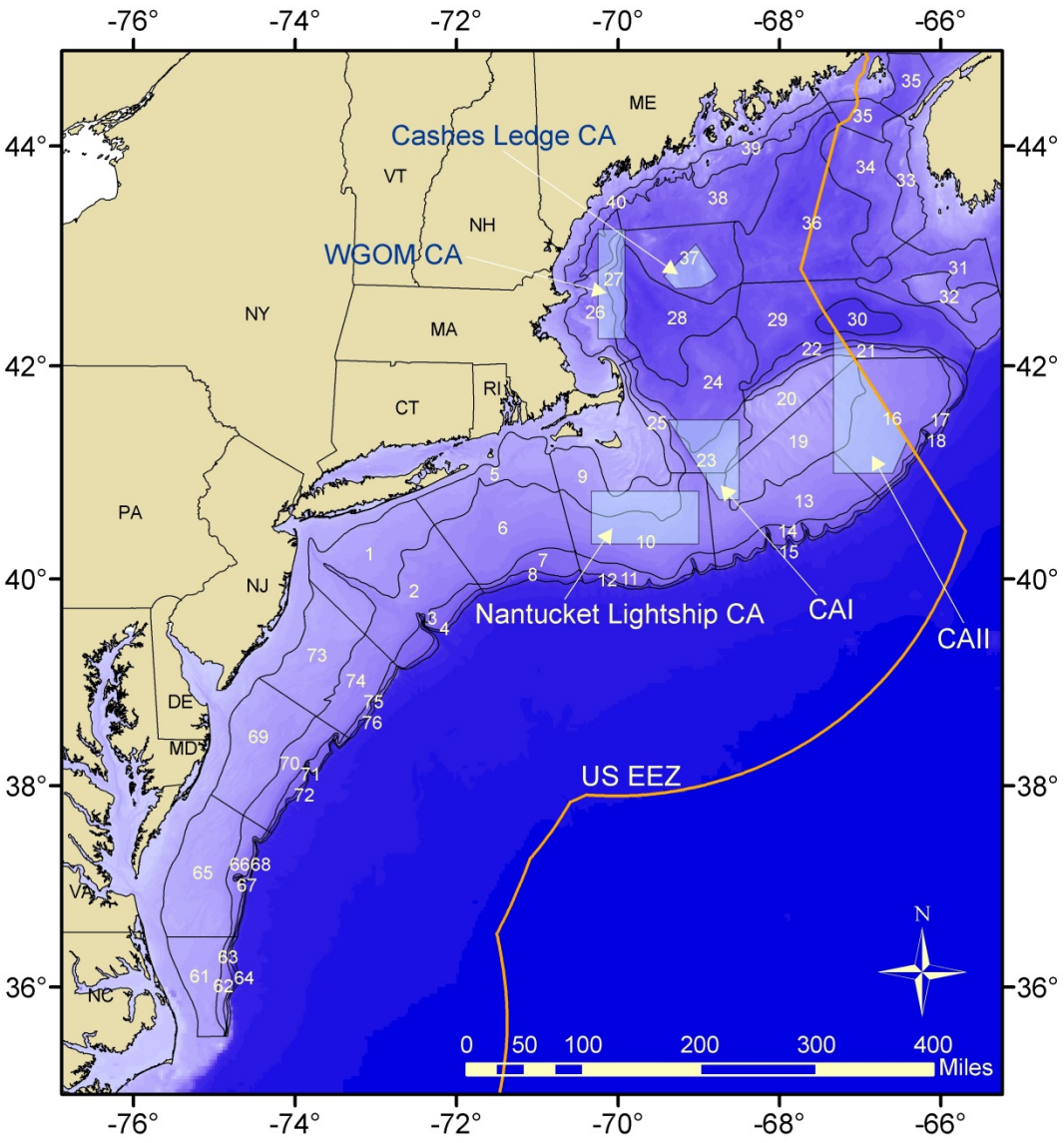
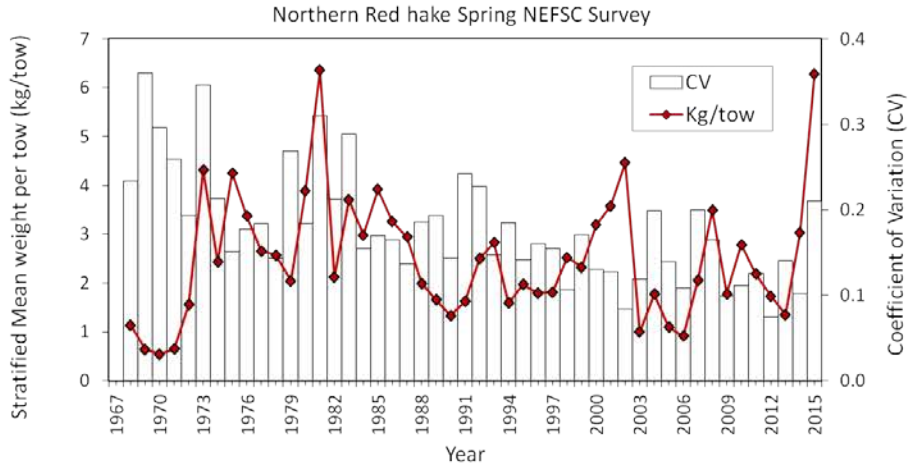
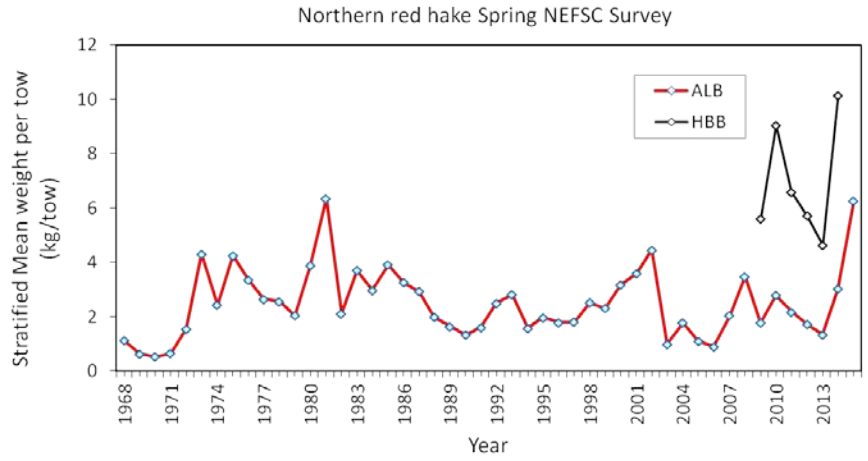
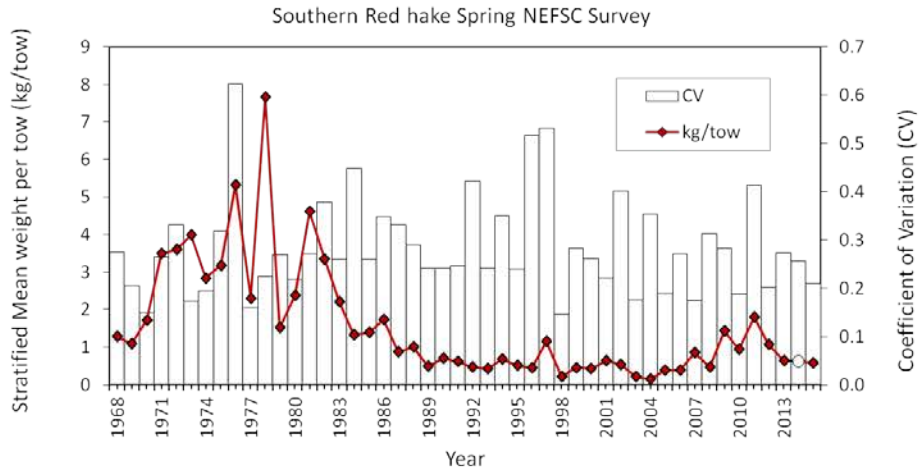


Figure 12. Northeast Fisheries Science Center spring survey index of biomass (kg/tow) and estimated coefficient of variation (CV) for both northern (TOP) and southern (BOTTOM) ***red hake*** in Albatross units from 1968-2015. Bottom panels show both unconverted estimates from FSV H. Bigelow vessel (2009-2014). Note: The spring survey is the basis for the assessment update for this stock. In the south, 2014 estimate (black circle and CV in red) were adjusted in this update due lack of full coverage of the 2014 spring survey of the southern red hake stock.







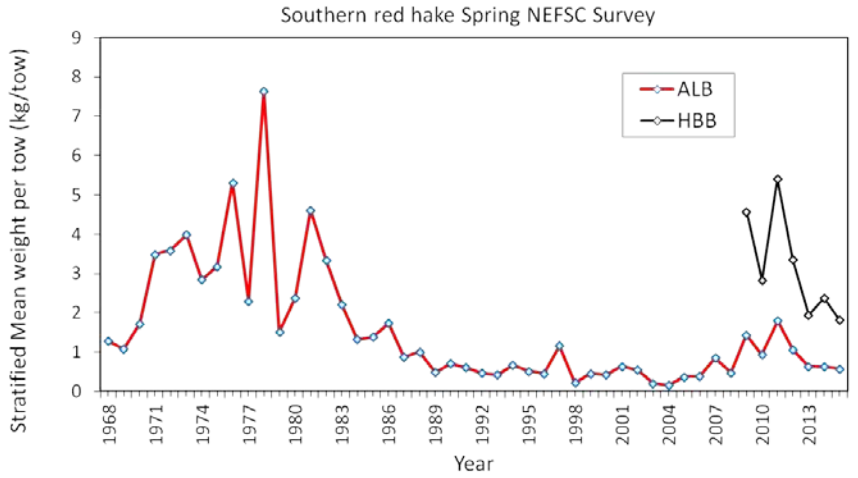
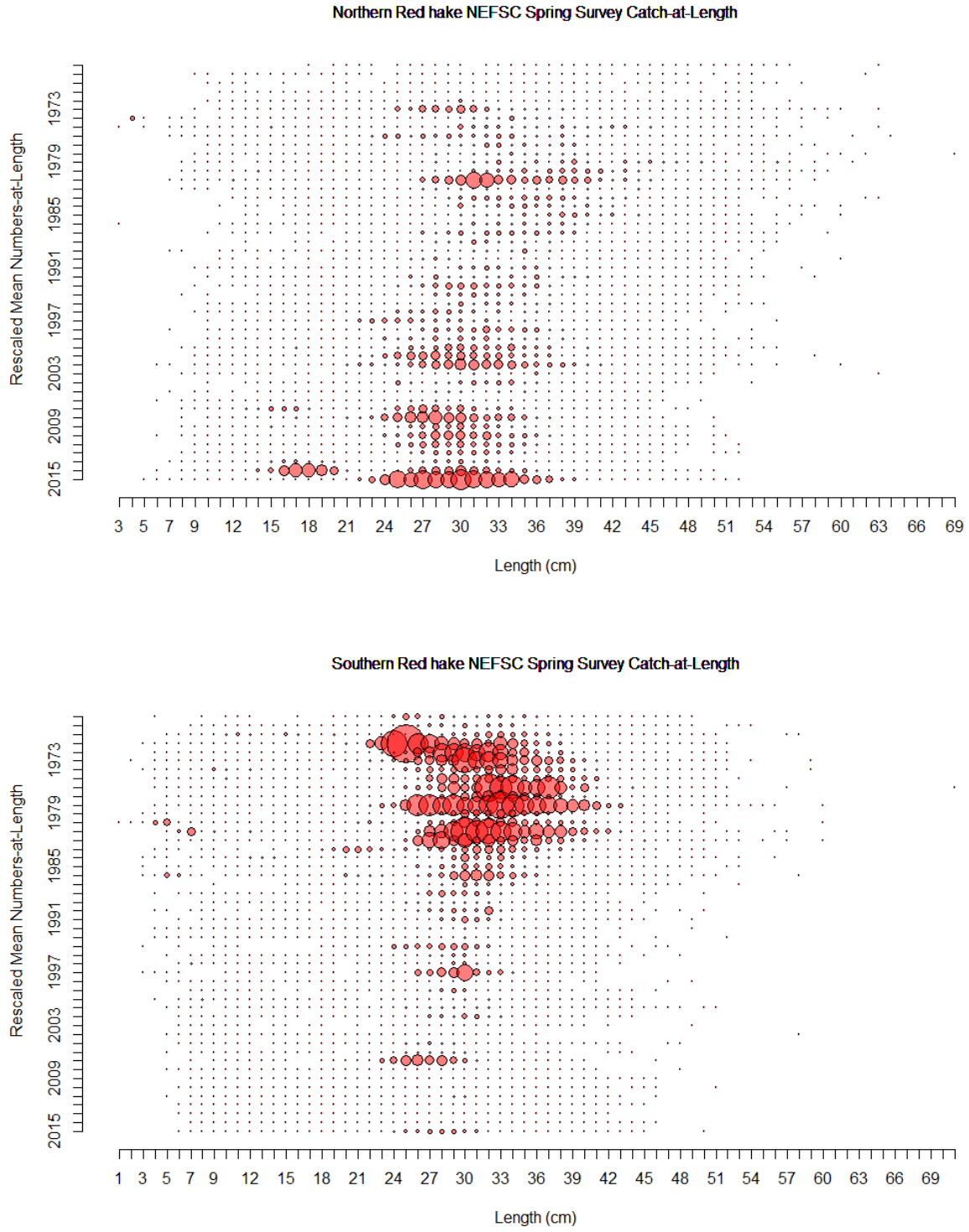


Figure 13. Catch-at-length from the NEFSC spring trawl survey from 1968 to 2015 for both northern (TOP) and southern (BOTTOM) ***red hake*** stocks



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