Northeast Fisheries Science Center Reference Document 18-02

2017 Northern and Southern Silver Hake and Red Hake Stock Assessment Update Report

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January 2018

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

January 2018

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EXECUTIVE SUMMARY

This assessment of the small-mesh multispecies stocks (silver, red, and offshore hakes) is an update of the existing 2010 benchmark assessment (NEFSC 2011). Based on the last assessment update in 2014, stocks of silver and red hake were not overfished and overfishing was not occurring.

This assessment updates catch data and research survey indices through 2016 for silver hake, and through 2017 for red hake to inform recommendations for the 2018-2020 overfishing limit (OFL) and allowable biological catch (ABC) specification cycle.

Catch information consisted of commercial landings, commercial discards, and for red hake, recreational catch. Catch data were combined with fisheries-independent survey data from the fall and spring Northeast Fisheries Science Center (NEFSC) bottom-trawl survey (BTS) in a simple empirical approach (Index-Based Method) that utilizes a three-year moving average of the biomass index and relative exploitation ratio (catch divided by NEFSC survey biomass index, kt/kg).

Following the empirical approach adopted at the 2010 benchmark assessment, the northern silver hake three-year average biomass based on the NEFSC fall BTS for 2014 to 2016 was estimated at 19.92 kg/tow, 521% above the proxy biomass threshold (3.21 kg/tow). For southern silver hake, the three-year average biomass was estimated at 1.05 kg/tow, which is 27% above the proxy biomass threshold (0.83 kg/tow).

For northern red hake, the three-year average survey biomass, based on the NEFSC spring BTS for 2015 to 2017, was estimated at 5.13 kg/tow, which is 304% above the proxy biomass threshold of 1.27 kg/tow. The southern red hake three-year average survey biomass based on the NEFSC spring BTS for 2015 to 2017 was estimated at 0.38 kg/tow, 25% below the proxy biomass threshold (0.508 kg/tow).

The exploitation ratio for northern silver hake based on the three-year average estimates of catch to survey was estimated to be 0.149 kt/kg, which is 5% of the overfishing proxy threshold (2.78 kt/kg). In the south, the exploitation ratio was estimated to be 5.85 kt/kg, 17% of the overfishing proxy threshold (34.18 kt/kg).

For northern red hake, the annual exploitation ratio was estimated to be 0.09 kt/kg, 55% of the overfishing threshold (0.163 kt/kg). In the south, the annual exploitation ratio was 4.13 kt/kg, which is 32% above the overfishing proxy threshold (3.04 kt/kg).

Based on this updated assessment, it is recommended that both northern and southern stocks of silver hake are not overfished and overfishing is not occurring. In the case of red hake, it is recommended the northern stock is not overfished and overfishing is not occurring. However, for the southern stock of red hake, it is recommended that the stock is overfished and overfishing is occurring. This is a recommended change in stock status for southern red hake since the last assessment update, and can be attributed mostly to the continued poor condition of the stock.

It should be noted that there is no official assessment update for offshore hake. The peer review panel at the 2010 benchmark assessment determined that information about offshore hake catches or trends in abundance and biomass was insufficient to guide management of the stock. Instead, offshore hake are accounted for in the ABC estimates for the southern silver hake stock complex in order to consider customary reported catches of both species in the trawl fishery.

LIFE HISTORY

Silver Hake

Silver hake (*Merluccius bilinearis*), also known as whiting, range primarily from Newfoundland to South Carolina (Figure 1). Silver hake are fast swimmers with sharp teeth, and are important predators on fish, crustaceans, and squid (Lock and Packer 2004). In US waters, two stocks have been identified based on differences in head and fin lengths (Almeida 1987), otolith morphometrics (Bolles and Begg 2000), otolith growth differences, and seasonal distribution patterns (Lock and Packer 2004). The northern silver hake stock inhabits Gulf of Maine - Northern Georges Bank waters, and the southern silver hake stock inhabits Southern Georges Bank - Middle Atlantic Bight waters (Figure 2).

Bolles and Begg (2000) reported some mixing of silver hake due to their wide migratory patterns, but the degree of mixing among the management areas is unknown. A re-evaluation of stock structure in the last silver hake benchmark assessment also suggested that reproductive isolation between the two stocks is unlikely, based on trends in adult biomass, icthyoplankton survey, and growth and maturity analyses (NEFSC 2011). Because the evidence on silver hake stock structure (morphometrics, tagging, discontinuous larvae distribution, homogeneous growth and maturity) is mixed, it was concluded that there was no strong biological evidence to support a separate- or a single-stock structure for silver hake. Thus, the northern and southern stock definition was maintained as the basis for science and management (NEFSC 2011).

Silver hake migrate in response to seasonal changes in water temperatures, moving toward shallow, warmer waters in the spring. They spawn in these shallow waters during late spring and early summer and then return to deeper waters in the autumn (Brodziak et al. 2001). The older, larger silver hake especially prefer deeper waters. During the summer, portions of both stocks can be found on Georges Bank. During the winter, fish in the northern stock move to deep basins in the Gulf of Maine, while fish in the southern stock move to outer continental shelf and slope waters. Silver hake are widely distributed, and have been observed at temperature ranges of 2 to 17 °C (36 to 63 °F) and depth ranges of 11 to 500 m (36 to 1,640 ft). However, they are most commonly found at temperatures between 7 and 10 ºC (45 to 50 ºF) (Lock and Packer 2004).

Female silver hake are serial spawners, producing and releasing up to three batches of eggs in a single spawning season (Collette and Klein-MacPhee 2002). Major spawning areas include the coastal region of the Gulf of Maine from Cape Cod to Grand Manan Island, southern and southeastern Georges Bank, and the southern New England south of Martha's Vineyard. Peak spawning occurs earlier in the south (May to June) than in the north (July to August). More than 50% of age 2 fish (20 to 30 cm, 8 to 12 in) and virtually all age 3 fish (25 to 35 cm, 10 to 14 in) are sexually mature (O'Brien et al. 1993). Silver hake grow to a maximum length of more than 70 cm (28 in). Ages up to 14 years have been observed in US waters, although few fish older than age 6 have been observed in recent years (Brodziak et al. 2001, NEFSC 2011).

Silver hake populations constitute an important link in the food web. They are prey for major predators in the northwest Atlantic ecosystem, and consumptive estimates for silver hake indicate that they are also a major source of predatory consumption (NEFSC 2011).

Red Hake

Red hake (*Urophycis chuss*) is a demersal gadoid species distributed from the Gulf of St. Lawrence to North Carolina, most abundant in waters from the western Gulf of Maine through Southern New England (Fig.1). 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, while the southern stock is defined as the southern Georges Bank to Mid-Atlantic Bight (Fig.2).

Red hake migrate seasonally, preferring temperatures between 5 and 12 °C (41 and 54 °F) (Grosslein and Azarovitz 1982). During the spring and summer months, red hake move into shallower waters to spawn, then in winter move offshore to deep waters in the Gulf of Maine and on the edge of the continental shelf along Southern New England and Georges Bank. Spawning occurs from May through November, with primary spawning grounds on the southwest part of Georges Bank and in Southern New England 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). However, females are generally larger than males of the same age, and can reach a maximum length of 63 cm (25 in) and a weight of 3.6 kg (7.9 lb) (Collette and Klein-MacPhee 2002). Although they generally do not live longer than 8 years, red hake up to 14 years old have been recorded. In the northern stock, the age at 50% maturity is 1.4 years for males and 1.8 years for females, and the size at 50% 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% maturity is 1.8 years for males and 1.7 years for females, and the size at 50% 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 (Rountree 1999). Juvenile red hake seek shelter from predators in sea 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 sea scallop beds due to their increasing size and to seek warmer temperatures in offshore waters (Steiner et al. 1982)

MANAGEMENT

The small-mesh multispecies fishery is managed under a series of exemptions from the Northeast Multispecies Fishery Management Plan (FMP). The Northeast Multispecies FMP requires that a fishery 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 (RMAs), there are six exemption areas that open seasonally. The exemption areas were implemented as part of several different amendments and framework adjustments to the Northeast Multispecies FMP (Tables 1 and 2). 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 silver hake by changing the minimum mesh size from 2.5 to 3 in. 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

(NEFMC) established essential fish habitat (EFH) designations and added offshore hake to the plan in Amendment 12 (2000). Also in Amendment 12, the NEFMC 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 owing to measures that differentially benefited participants 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. In 2003, two more frameworks were put in place. Framework Adjustment 37 modified and streamlined some of the varying management measures to increase consistency across the exemption areas. Framework Adjustment 38 established the Grate Raised Footrope Exemption Area in the inshore Gulf of Maine.

Vessels participating in any of the exemption areas must have a Northeast Multispecies limited access or open access category K permit, and a letter of authorization from the NOAA Fisheries Greater Atlantic Regional Administrator to fish in Cultivator Shoal and the Cape Cod Raised Footrope Areas. None of the exemption areas have a possession limit for red hake. Most of the areas (Small-mesh Areas I and II, the Cape Cod Raised Footrope Area, Southern New England Exemption Area, and the Mid-Atlantic Exemption Area) have mesh-size dependent, combined possession limits for silver and offshore hake. The Gulf of Maine Grate Raised Footrope Area has a possession limit of 7,500 lb and a 2.5 in minimum mesh size, and Cultivator Shoal has a possession limit of 30,000 lb and a 3 in minimum mesh size.

HISTORY OF THE FISHERY

Silver Hake

The commercial silver hake fishery in the United States may have begun as early as the mid-1800s (Anderson et al. 1980). Prior to the early 1920s, landings of silver hake, commonly known as whiting, totaled less than 7 million lb (3,175 mt) annually, and most fishermen considered silver hake a nuisance fish because its soft flesh tended to spoil quickly without refrigeration. Technological advances in handling, freezing, processing, and transportation aided in expanding the market and creating new opportunities to capitalize on silver hake. Until this time, the fishery operated primarily inshore using pound nets. As the demand for silver hake increased, operations began to extend offshore, and vessels started using otter trawls to catch more of this species. Floating traps, gillnets, purse seines, and longline trawls were also employed. By 1950, US commercial silver hake landings had increased to more than 45,000 mt. Today, almost all of the US commercial silver hake catch is taken with otter trawls.

Prior to 1960, the commercial exploitation of silver hake in the Northwest Atlantic was exclusively by US fleets. Beginning in the late 1950s, before countries declared 200-mile economic exclusionary zones, vessels from other countries started to operate in these waters. By the late 1950s the so-called "distant-water fleets" led by the USSR, had reached the banks of the Scotian Shelf. By 1961, Soviet scouting/research vessels were fishing on Georges Bank. By 1962, international factory freezer fleets (ranging in capacity from 500 to 1,000 grt) were intensively exploiting the silver and red hake stocks on the Scotian Shelf and on Georges Bank. In 1962, the distant-water fleet landed 41,900 mt of silver hake (43% of total silver hake landings), and that number increased to 299,200 mt (85% of total silver hake landings) in 1965.

Total commercial silver hake landings also peaked in 1965, at 351,000 mt. Unable to sustain such high rates of fishing, the abundance of silver hake off the US Atlantic coast began to decline. As a result, total commercial catches decreased significantly after 1965 and reached a 20-year low of 55,000 mt in 1970. The US recreational landings also dropped after 1965 to about half the levels of previous years (Table 3 and Fig.3).

After 1970, silver hake catches by the distant-water fleet in US waters increased again, especially in southern New England and the Mid-Atlantic. Between 1971 and 1977, distant-water fleet landings from the southern stock averaged 75,000 mt annually and accounted for 90% of the total harvest from the southern stock. The size and efficiency of distant-water fleet factory ships also increased, many ranging between 1,000 and 3,000 grt. In 1973, the International Commission for the Northwest Atlantic Fisheries established time and area restrictions that constrained the distant-water fleet to small "windows of opportunity" to fish for US silver hake. These windows restricted the distant-water fleet to the continental slope of Georges Bank and the Mid-Atlantic. As effort control regulations tightened, international fleets gradually left most areas of Georges Bank.

Although international fishing ceased on Georges Bank by about 1980 and in the Mid-Atlantic by about 1986, the US groundfish fleet's technologies and fishing practices began to advance. Between 1976 and 1986, domestic fishing effort (number of days) increased by nearly 100% in the Gulf of Maine, 57% on Georges Bank, and 82% in southern New England (Anthony 1990). These increases in effort, although directed primarily toward principal groundfish species (cod, haddock, yellowtail flounder), were accompanied by a 72% decline in silver hake biomass. In turn, US East Coast landings of silver hake began to decline, dropping to 16,100 tons in 1981. Since that time, landings have remained relatively stable, but at much lower levels in comparison to earlier years. The US East Coast silver hake catches are taken almost exclusively by otter trawls, either as bycatch from other fisheries or through directed fisheries targeting silver hake at a variety of sizes.

Red Hake

Following the arrival of the distant-water fleet in the early 1960s, commercial catches of red hake peaked at almost 113,000 mt in 1966 from almost 8,000 mt in 1960. Landings then declined sharply to 12,500 mt in 1970. Although landings increased briefly in 1972, the increased restrictions on distant-water fishing fleet effort resulted in a steady decline of red hake catches. Prior to implementation of the Magnuson Fishery Conservation and Management Act in 1977, the distant-water fleet accounted for approximately 80 to 90% of red hake landings from both stocks. Between 1977 and 1986, landings generally declined due to restrictions placed on distant-water fleets, and international landings ceased in 1987. Although international fishing has ceased in US waters, catches of red hake have generally declined, to less than 100 mt in 2005, and have remained low (Table 4 and Fig.5).

CATCH

Commercial Landings

In 1994, mandatory vessel trip reports (VTRs) were implemented to collect data on effort and area fished, replacing the port interview process used in prior years. Area and effort

information is now obtained directly from the VTRs. Unfortunately, matching dealer reports on what is landed with VTRs has been problematic. 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. 2008). Landings are matched to VTRs hierarchaly, 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. Since 2011, more than 78% of silver hake and 80% of red hake landings are being matched at the highest level. Landings that could not be matched following the tier system approach are allocated based on landings with known matches.

Southern mixed landings of silver and offshore hake were estimated using a length-based species-split algorithm to disaggregate total commercial landings of silver hake from offshore hake. Offshore hake and silver hake survey proportions-at-length were updated (2014 to 2016) and applied to the nominal commercial landings-at-length of silver hake. Although the estimated proportion of landed offshore hake has increased in recent years, landed offshore hake on average still constitutes a small fraction of the total hake landed in the southern stock. Time-series average proportion of landed offshore hake since 1955 is approximately 4%, consistent with the current basis for adjusting southern silver hake ABC to account for offshore hake catches in the southern silver hake complex (Fig. 4).

Trends in commercial landings for silver hake in the north have more than doubled since the last update, from 1,370 mt in 2013 to 3,070 mt in 2016. In the south, silver hake commercial landings decreased by 69%, from 6,750 mt in 2013 to 3,290 mt in 2016.

Similar to silver hake, commercial landings for red hake in recent years have been increasing in the north and declining in the south. Estimated commercial landings of northern red hake were 140 mt in 2016, a 52% increase from 95 mt in 2013. However, southern red hake commercial landings decreased by 10.7% , from 439 mt in 2013 to 392 mt in 2016.

Commercial landings for both red and silver hake continue to be dominated by vessels fishing with trawl gear, with less than 10% contributed from other fleets (Tables 5 to 8, Figs. 6 to 7)

Commercial Discards

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

Fisheries observers have been directly sampling the commercial fishery for discards since 1989. Beginning in May 2010, Amendment 16 created a new class of fisheries observer to support sector management of the US northeast groundfish fishery. These observers were termed “at-sea monitors” (ASMs). The ASMs are deployed as an integral component of catch monitoring and quota tracking, but also provide information on catch composition (*i.e*. size distributions) and data used estimate total discards. For the purpose of this update, ASM trips were aggregated with NEFOP trips to generate discard estimates for both red and silver hake. An evaluation of length frequency distributions showed very minor differences between NEFOP and ASM when the sampling was sufficient to make comparisons. For this assessment update, no distinctions were made between data collected by ASM and NEFOP with respect to discard estimation.

Total silver hake and red hake discard for 2014 to 2016 was estimated using the same approach as in the last benchmark assessment. The discard estimation approach is based on the Standardized Bycatch Reporting Methodology (SBRM) recommended in the GARM III Data meeting (GARM 2008, Wigley et al. 2007). This method estimates observed discarded ratio of species X discard-to-kept all species for large mesh (≥ 5 in) otter trawl, small mesh (< 5 in) 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 2008, Wigley et al. 2007). Mean proportion of discard weight relative to the total catch for both northern silver and red hake for 2014 to 2016 were approximately 12% and 69% respectively (Tables 3 and 4). However in the south, the recent three-year average proportion of annual discards was approximately 11% for silver hake and 57% for red hake (Tables 3 and 4). Total discards of silver hake in the north increased by 24%, from 250 mt in 2013 to 310 mt in 2016. In the south, total discards decreased by 16%, from 640 mt in 2013 to 540 mt in 2016 (Table 3). Total discards of red hake in both the north and south have increased since 2013. The 2016 estimated discards in the north were approximately 260 mt, an 18% increase from 220 mt in 2013. In the south, discards increased by 31%, from 580 mt in 2013 to 760 mt in 2016 (Table 4).

Evaluation of discard estimates by selected major gear groups shows that trawl gear remains the primary source of discarding for both silver and red hake. In the south, the contribution from small-mesh trawls is much more pronounced for both red and silver hake, constituting more than 90% of the discards; in the north, the proportions between the small-mesh and large-mesh trawls varies between each species of hake. In 2015, 90% of silver hake estimated discard was by the large-mesh trawls and by 2016, both the large- and small-mesh trawls accounted for approximately 55% and 41% of the total discards respectively. For northern red hake, large- and small-mesh trawls accounted for similar proportions of discards (45 to 50%) in 2015; in 2016, the small-mesh trawls dominated, contributing approximately 72% of the total red hake discards (Tables 10 to 13; Figs. 8 and 9).

Recreational Catch

In the previous benchmark assessment, recreational catch estimates were based on data collected under the Marine Recreational Fisheries Statistical Survey (MRFSS) that began in 1981. In this assessment update, MRFSS data have been re-estimated using the revised methodologies consistent with the Marine Recreational Information Program (MRIP) that has replaced MRFSS program (NMFS 2012). Following the consensus from the previous benchmark assessment, recreational catch for silver hake was not included in this update due to the low amounts. Hence, it is expected that recreational catches of silver hake will have negligible impact on total catch. Recreational catches of red hake are presented in Table 9 and Fig. 10. Recreational catches of red hake have varied without trend since 2013. In 2016, recreational catches of red hake in the north declined by 16%, from 3.5 mt in 2013 to 2.9 mt in 2016. However in the south, recreational catches of red hake almost doubled, from 68 mt in 2013 to 130 mt in 2016.

SURVEY INDICES

Research bottom-trawl surveys have been conducted annually since 1963 by the Northeast Fisheries Science Center in spring (March through May) and fall (September through November) extending from the Gulf of Maine to Cape Hatteras, NC in offshore waters at depths between 27 and 365 m. The NEFSC bottom-trawl survey is a randomized stratified design that allocates samples relative to the size of the strata, defined by depth.

The NEFSC spring and fall bottom-trawl survey stratified 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 both red and silver hake (Fig. 11). Conversion coefficients were applied to account for periodic changes in vessels and (or) gears prior to 2008 (Byrne and Fogarty 1985, Byrne and Forrester 1991).

Beginning in 2009, the NEFSC bottom-trawl surveys were conducted with a new vessel, the NOAA Ship *Henry B. Bigelow*, which uses a different net and protocols than were used in the past. Conversion coefficients by length have been estimated for both red and silver hake (NEFSC 2011) and were applied in this assessment.

The northern silver hake fall bottom-trawl survey biomass index continues to increase, supported by several strong years between 2008 and 2015. In 2016, the survey index peaked at the second highest value observed over the entire time series (21.51 kg/tow). In the south, the silver hake fall bottom-trawl survey biomass index has been slightly more variable, but has been declining since 2010 with the exception of the 2016 estimate. In 2015, the southern silver hake index declined to the lowest in the time series. The observed increased in 2016 is due to the growth of the 2012 year class. Recruitment of silver hake in the south continues to be weak and with no indication of any strong year classes in the recent years (Tables 14 and 15; Figs. 12, 14a and b).

The age composition for silver hake in the fall bottom-trawl survey continues to be dominated by ages 1 and 2 with little-to-no indication of expansion in the age structure in the northern or southern stocks. Since 2009, both stocks have shown strong age 1 recruitment signals but these barely show up in subsequent age groups (Fig.14), likely due to cannibalism and predation on the smaller fish.

The northern red hake spring bottom trawl survey biomass index has also been increasing in recent years. In 2015, the northern red hake index increased substantially to the highest observed in the time series, estimated at 6.27 kg/tow. This increase was supported by the strong year class in 2014. In 2016 and 2017, the index declined to a stable average of 4.56 kg/tow but this is still well above the time series average. In contrast, the southern red hake spring biomass index has been declining since 2011 to the fourth lowest value of the time series in 2017 (0.25 kg/tow). Survey abundance at length indicates a declining trend over time with poor recruitment in recent years (Tables 16-17; Figs. 13, 15a and b).

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 fisheries

observers updated through 2016. Because the NEFSC bottom-trawl survey switched from the NOAA Ship *Albatross IV* to the NOAA Ship *Henry B. Bigelow* in spring 2009, survey data given here are in "Albatross IV" units. Following the accepted index approach from the previous benchmark assessment, the assessment update for both stocks of silver hake are based on the three-year moving average of the NEFSC fall bottom-trawl survey and exploitation indices for years 2014 to 2016. In the case of red hake, the three-year moving average of the NEFSC spring bottom-trawl survey index for years 2015 to 2017 and exploitation index for years 2014 to 2016 were used in this assessment update.

In the absence of an analytical assessment for silver hake, the biological reference points for both the northern and southern silver hake stocks are as follows (from NEFSC 2010):

> The silver hake biomass threshold is reached when the three-year moving average of the fall survey weight per tow is less than one half B_{MSY} proxy, where the B_{MSY} proxy is defined as the average weight per tow observed from 1973-1982. The most recent estimates of the biomass threshold are 3.21 kg/tow for the northern stock, and 0.83 kg/tow for the southern stock.Silver hake overfishing occurs when the ratio between the catch and the arithmetic fall survey biomass index from the most recent three years exceeds the overfishing threshold, where the overfishing threshold estimates are based on annual exploitation ratios (catch divided by arithmetic fall survey biomass) averaged from 1973-1982. The most recent estimates of the overfishing threshold are 2.78kt/kg for the northern stock and 34.19kt/kg for the southern stock of silver hake.
>
> The red hake is overfished biomass threshold is reached when the three year moving average of the spring survey weight per tow (kg/tow) is less than one half of the B_{MSY}, where the B_{MSY} proxy is defined as the average observed from 1980-2010. The current estimates of $B_{THRESHOLD}$ for the northern and southern stocks are 1.27 kg/tow and 0.51 kg/tow, respectively.
>
> Red hake overfishing occurs when the ratio between catch and spring survey biomass (kg/tow) for the northern and the southern stocks exceeds 0.163 kg/tow and 3.038 kg/tow, respectively, derived from AIM analyses from 1980-2009.

Silver Hake

In the northern management area, the three-year average biomass based on the NEFSC fall bottom-trawl survey for 2014 to 2016 data was estimated at 19.92 kg/tow, and is above both the management threshold (3.21 kg/tow) and the target (6.42 kg/tow). In the southern management area, the three-year average biomass, also based on the NEFSC fall bottom-trawl survey for 2014 to 2016 data, was estimated at 1.05 kg/tow and is above the management threshold (0.83 kg/tow) but below the management target (1.65 kg/tow). It should be noted that the three-year average fall index in the southern management area has been declining since 2012 and is approaching the management threshold. In 2012, the southern three-year average index was estimated at 2.19 kg/tow (166% above the threshold), and in 2016 the three-year average index is only 27% above the management threshold (Tables 14 and 15; Figs. 16 and 17).

The silver hake exploitation index, measured as the ratio of catch to survey index, has remained consistently low since the early 2000s. In the north, the 2016 three-year average relative exploitation index was 0.149 kt/kg, well below the management overfishing threshold (2.78 kt/kg). Similarly in the south, the 2016 three-year average exploitation index was estimated

at 5.8 5 kt/kg and is also below the management threshold of 34.17 kt/kg (Tables 14 and 15; Figs. 16 and 17).

Red Hake

The current northern red hake three-year average of the NEFSC spring survey biomass index for years 2015 to 2017 was estimated at 5.13 kg/tow and is more than four times the northern red hake management threshold (1.27 kg/tow). However in the south, the three-year average spring biomass index has been declining since 2012, and is estimated at 0.38 kg/tow in 2017 which is below the southern management threshold of 0.51 kg/tow (Tables 16 and 17; Figs.18 and 19).

The annual exploitation index for red hake in the north was above the management threshold in 2014 but has been declining in recent years and is currently estimated to be below the management threshold. The 2016 northern red hake exploitation index was estimated at 0.09 kt/kg, which is approximately 44% below the management threshold (0.163 kt/kg). In the south, the red hake exploitation index was estimated at 4.13 kt/kg and is 36% above the management threshold (3.04 kt/kg). The continued decline in the NEFSC spring bottom-trawl survey biomass index, coupled with relatively stable catches of southern red hake, contributed to the recent increase in the southern red hake exploitation index (Tables 16 and 17; Figs. 18 to 19).

STATUS OF THE STOCKS

Based on both the 2016 silver hake NEFSC fall bottom-trawl survey biomass and relative exploitation indices, it is recommended that the northern and southern stocks of silver hake are not overfished and overfishing is not occurring.

In the case of red hake, it is recommended that the northern stock is not overfished and overfishing is not occurring. However in the south, it is recommended that red hake stock is overfished and overfishing is occurring. This represents a change in stock status for southern red hake since the last assessment update (Tables 14-17 and Figs. 16 to 20).

OVERFISHING LIMIT (AND ALLOWABLE BIOLOGICAL CATCH)

The overfishing limit (OFL) adopted in Amendment 19 is an annual limit, derived as the product of current population biomass and fishing rate that will produce 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 three-year average of the NEFSC fall bottom-trawl survey biomass index (2014 to 2016). For red hake, the three-year average NEFSC spring bottom-trawl survey biomass index (2015 to 2017) is applied to the F_{MSY} proxy. It should be noted that the variance for the survey indices explicitly incorporates the *Henry B. Bigelow* conversion coefficients and standard errors from the calibration experiment (Miller et al. 2010) to approximate the *Albatross IV* variance equivalent based on the following relationship:

$$V_{3yravg} = \left[\frac{V\left[\frac{I_{HB}^{yr1}}{\rho}\right] + V\left[\frac{I_{HB}^{yr2}}{\rho}\right] + V\left[\frac{I_{HB}^{yr3}}{\rho}\right]}{3} \right]$$

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) were derived by applying the conversion coefficient (ρ), using Taylor series expansion in the following relationship:

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

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 because variance estimates for the length-based calibration approach were not available. A comparison of the aggregated survey mean weights between the length-based and constant-model approach showed minimal differences; therefore, the applying the variance from the constant model was assumed to be a reasonable approximation for the length-based model.

Silver hake probability distributions for F_{MSY} proxy were derived from a lognormal distribution of the mean and variance for 1973 to1982. A preliminary evaluation of the F_{MSY} distribution assumed a normal error structure of the mean and variance but was deemed undesirable due to resulting unrealistic catches in the OFL estimates. This is because the time period used to define the F_{MSY} distribution reflects a period of high variability in silver hake catches, , dominated by the distant-water fleets from 1973 to 1982. Although 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 ($-\alpha/\beta$).

The acceptable biological catch (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 not result in overfishing."

The ABCs for specification years 2018 to 2020 were updated for each stock of red and silver hake. However, the southern silver hake ABC was adjusted by 4% to account for the average amount of offshore hake catch in southern silver hake trips.

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

- Northern and southern red hake: ABCs are based on the 40th percentile of the stochastic estimate of OFL.
- Northern and southern silver hake: ABCs are based on the 25th percentile of the stochastic estimate of OFL. In the southern stock area, the ABC is increased by 4% to account for the customary estimated catches of offshore hake.

Estimated OFL for both red and silver hake are summarized in Tables 18 to 23 and Figs. 21 to 22 based on the median value of the OFL distribution. The resulting OFL estimate for northern silver hake stock was 58,350 mt (90% confidence interval of 30,540 to 586,162 mt) and 37,108 mt (90% confidence interval of 20,285 to 471,800 mt) for the southern silver hake. The northern red hake OFL estimate was 807 mt (90% confidence interval of 99 to 1,881 mt) and 1,121 mt (90% confidence interval of 433 to 1,866 mt) for the southern red hake stock.

The recommended 2018-2020 ABC for red and silver hake are also provided in Tables 18 to 23 and Figs. 21 to 22.

Described next are the 2018-2020 ABC specifications for red and silver hake:

- Silver hake 2018-2020 ABC set at 25th percentile to account for scientific uncertainty:
  - 31,030 mt (53% of OFL; 908% of 2016-2017 FY catch) north
  - 20,170 mt (54% of OFL; 525% of 2016-2017 FYcatch) south
- Red hake 2018-2020 ABC set at 40th percentile to account for scientific uncertainty:
  - 720 mt (89% of OFL; 178% of 2016-2017 FY catch) north
  - 1,060 mt (94% of OFL; 97% of 2016-2017 FY catch) south

RISK ANALYSES (PROBABILITY OF OVERFISHING)

The probability of mortality exceeding F_{MSY} was estimated for a range of 2016 catches at the median of F_{MSY} for red and silver hake (Tables 22 to 23 and Fig. 23 to 24). Relative exploitation was calculated at each realization of the survey biomass distribution (from the normal distribution as described earlier). 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 ABCs for both stocks of silver hake results in a less than 1% risk of exceeding the overfishing limit. However for red hake, there is a low risk (11%) and a moderate

risk (23%) risk of exceeding the overfishing limit for the northern and southern stocks respectively at the proposed updated ABC levels.

SUMMARY

The updated stock assessment for small-mesh multispecies groundfish was completed by adding catch and indices through 2016 to the previous 1955 to 2013 assessment update to inform recommendations for the 2018 to 2020 OFL and ABC. Catch information consisted of commercial landings and discard and, for red hake, recreational catch. Catch data were combined with fishery-independent survey data from the NEFSC fall and spring bottom-trawl survey in a simple index-based approach that utilizes a three-year moving average of the fall and spring survey biomass index (kg/tow) and relative exploitation ratio of catch divided by NEFSC survey biomass index, kt/kg. Uncertainty in the OFLs was re-estimated to determine current ABC levels based on the current definition in Amendment 19.

Results of the assessment update show that stocks of silver hake are not overfished and overfishing is not occurring. The three-year average NEFSC fall bottom-trawl biomass indicies (19.92 kg/tow in the north, 1.05 kg/tow in the south) are well above the overfished management threshold (3.21 kg/tow in the north, 0.83 kg/tow in the south). The northern silver hake stock continues to show strong increases in the survey biomass due to several strong recent year classes. In the south, recruitment remains poor. The index is declining and approaching the management threshold. The exploitation index, measured as the ratio of catch to survey, has remained consistently low since the previous benchmark assessment and well below (0.14 kt/kg in the north, 3.86 kt/kg in the south) the management overfishing definition thresholds (2.78 kt/kg in the north, 34.17 kt/kg in the south).

The red hake assessment update indicates that the northern stock is not overfished and overfishing is not occurring. However, the southern red hake stock is overfished and overfishing is occurring. This represents a change in stock status for southern red hake since the last assessment update. The recent three-year arithmetic mean biomass indices, based on the NEFSC spring bottom-trawl survey for the northern stock (2015 to 2017 = 5.13 kg/tow) was above the biomass threshold (1.27 kg/tow). For the southern stock, the recent three-year arithmetic mean biomass index (2015 to 2017 = 0.38 kg/tow), was below the biomass threshold respectively (0.51 kg/tow). The northern red hake annual exploitation index (0.09 kt/kg) is below the management threshold (0.163 kt/kg). In the south, the exploitation index (4.13 kt/kg) is above the management threshold (3.038 kt/kg).

The proposed ABC recommendations for silver hake, 2018 to 2020, set at the 25th percentile to account for scientific uncertainty, was estimated at 31,030 mt in the north and 20,170 mt in the south. Both ABCs were above 50% of the OFL with zero risk of exceeding the overfishing limit. Red hake proposed ABC recommendations, 2018 to 2020, set at the 40th percentile of the OFL, resulted in 720 mt in the north (89% of OFL) and 1,060 mt in the south (94% of OFL), with low (11%) and moderate (23%) risks of exceeding the overfishing limit in the north and the south, respectively.

Stock status of northern silver hake continues to improve, supported by strength of multiple strong year classes in recent years. While the stock status for southern silver hake remains in good standing, it should be noted that the biomass index continues to decline due to poor recruitment in recent years despite the reduction in catch in recent years. The proposed OFL

estimates suggest that both stocks can withstand higher levels of catch with very little to no risk of exceeding the overfishing limit. Nevertheless, catch also remains a major source of uncertainty in the overfishing reference points as implied by the OFL uncertainty estimates. The range of years (1973 to 1982) adopted in the 2010 benchmark assessments for deriving the overfishing definition reference points remains a source of uncertainty, because that range does not incorporate contemporary measures of stock productivity. The transition from the 1970s to the 1980s highlights periods of high and low productivity with respect to the stock dynamics. Recognizing the potential for non-stationary productivity in the stock dynamics and the implications on estimates of the OFL, a precautionary basis for ABC should be maintained to account for the level of uncertainty in the OFL. Other sources of uncertainty in the assessment include: truncation in the age structure, estimates of predatory consumption, and catch estimates relative to mixed landings in the fishery (NEFSC 2011).

Similar to northern silver hake, stock status of red hake in the north remains strong, also supported by good year classes, particularly in 2014. Relative exploitation of red hake increased modestly in recent years but remains below the time-series average and the reference period (1980 to 2009). Given these conditions, red hake in the north is not overfished and overfishing is not occurring. In the south, the red hake NEFSC bottom trawl survey biomass index has been declining since 2012, but catch has been relatively stable. This resulted in a change in stock status from not overfished and overfishing not occurring to overfished and overfishing occurring.

ACKNOWLEDGMENTS

Special thanks to Gary Shepherd for his assistance with aspects of data summary and input on this report. This assessment could not be possible without the staff support of the NOAA Fisheries Ecosystems Survey Branch, the Fisheries Sampling Branch, the Population Biology Branch's age and growth group, and the and Data Management Systems Division. This assessment update benefitted from valuable feedback by Dr. Andrew Applegate and the New England Fishery Management Council's Plan Development Team.

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Table 1 Summary of major federal regulatory measures for small-mesh multispecies fishery, 1987 to 2014

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 2 Summary of 2017 federal possession limits for silver, offshore red, and red hake

Exemption Area	Codend Mesh Size	Season	Silver and offshore hake combined, possession limit (lbs)
Gulf of Maine Raised Foot Rope	Mesh < 2.5"	Jul. 1 - Nov. 30	7,500
Cultivator Shoal	Mesh >= 3.0"	Jun. 15 - Oct. 31	30,000
Area I & II	Mesh < 2.5"	(Area I) Jul. 15 - Nov. 15 (Area II) Jan. 1 - June 30	3,500
	2.5" < Mesh < 3.0"		7,500
	mesh >= 3.0"		30,000
Cape Cod Raised Foot Rope	2.5" < Mesh < 3.0"	(West) Sept. 1 - Nov. 20 (East) Sept. 1 - Dec. 31	7,500
	mesh >= 3.0"		30,000
SNE and MA	Mesh < 2.5"	Open Continually (year round)	3,500
	2.5" < Mesh < 3.0"		7,500
	mesh >= 3.0"		40,000

Exemption Area	Codend Mesh Size	Season	Red hake possession limit (lbs)
Gulf of Maine Raised foot Rope	Mesh < 2.5"	Jul. 1 - Nov. 30	3,000
Cultivator Shoals	Mesh >= 3.0"	Jun. 15 - Oct. 31	3,000
Area I & II	Mesh < 2.5" 2.5" < Mesh < 3.0" mesh >= 3.0"	(Area I) Jul. 15 - Nov. 15 (Area II) Jan. 1 - June 30	3,000
Cape Cod Raised Foot Rope	2.5" < Mesh < 3.0" mesh >= 3.0"	(West) Sept. 1 - Nov. 20 (East) Sept. 1 - Dec. 31	3,000
SNE and MA	Mesh < 2.5" 2.5" < Mesh < 3.0" mesh >= 3.0"	Open Continually (year round)	5,000

Table 3 Estimate of commercial landings and discards of northern and southern silver hake by year, 1965 to 2016. Southern estimates are derived using survey length-based proportions of silver and offshore hake. Data reported here for 2014 through 2016 were used in this assessment update.

Year	Northern Stock					Southern Stock				
	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards
1955	53.360			53.360		13.260			13.260	
1956	42.150			42.150		14.240			14.240	
1957	62.750			62.750		16.430			16.430	
1958	49.900			49.900		12.900			12.900	
1959	50.610			50.610		16.390			16.390	
1960	45.540			45.540		8.820			8.820	
1961	39.690			39.690		12.650			12.650	
1962	42.430	36.575		79.005		12.615	5.325		17.940	
1963	36.400	37.525		73.925		15.407	74.023		89.430	
1964	37.220	57.240		94.460		20.014	127.036		147.050	
1965	29.510	15.793		45.303		10.754	283.366		294.120	
1966	33.570	14.239		47.809		2.262	200.058		202.320	
1967	26.490	6.882		33.372		5.631	81.749		87.380	
1968	30.870	10.506		41.376		8.738	49.422		58.160	
1969	16.010	8.047		24.057		7.494	67.396		74.890	
1970	15.220	12.305		27.525		6.197	20.633		26.830	
1971	11.160	25.243		36.403		4.166	66.344		70.510	
1972	6.440	18.784		25.224		5.582	88.381		93.963	
1973	14.010	18.086		32.096		4.091	97.989		102.080	
1974	6.910	13.775		20.685		0.288	102.112		102.400	
1975	12.570	27.308		39.878		6.348	65.812		72.160	
1976	13.480	0.151		13.631		6.303	58.307		64.610	
1977	12.460	0.002		12.462		9.310	47.850		57.160	
1978	12.610			12.610		11.477	14.353		25.830	
1979	3.420			3.420		11.523	4.877		16.400	
1980	4.730			4.730		9.982	1.698		11.680	
1981	4.420		2.640	7.060	37%	10.387	3.043	3.500	16.930	21%
1982	4.660		2.910	7.570	38%	11.753	2.397	4.650	18.800	25%
1983	5.310		2.640	7.950	33%	11.240	0.620	4.810	16.670	29%
1984	8.290		2.590	10.880	24%	12.548	0.412	4.880	17.840	27%
1985	8.300		2.560	10.860	24%	11.499	1.321	3.870	16.690	23%
1986	8.500		2.350	10.850	22%	9.150	0.550	4.330	14.030	31%
1987	5.660		2.110	7.770	27%	9.548	0.002	4.250	13.800	31%
1988	6.790		1.790	8.580	21%	8.950		4.500	13.450	33%
1989	4.650		2.320	6.970	33%	13.000		6.570	19.570	34%
1990	6.380		1.960	8.340	24%	13.020		5.970	18.990	31%
1991	6.060		1.260	7.320	17%	9.740		3.080	12.820	24%
1992	5.310		1.420	6.730	21%	10.530		3.450	13.980	25%
1993	4.360		0.690	5.050	14%	12.490		5.170	17.660	29%
1994	3.900		0.240	4.140	6%	12.180		5.940	18.120	33%
1995	2.590		0.630	3.220	20%	11.990		1.400	13.390	10%
1996	3.620		0.820	4.440	18%	12.130		0.480	12.610	4%
1997	2.800		0.240	3.040	8%	12.550		0.620	13.170	5%
1998	2.050		0.690	2.740	25%	12.560		0.530	13.090	4%

Table 3, continued. Estimate of commercial landings and discards of northern and southern silver hake by year, 1965 to 2016. Southern estimates are derived using survey length-based proportions of silver and offshore hake. Data reported here for 2014 through 2016 were used in this assessment update.

Year	Northern Stock					Southern Stock				
	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards
2000	2.590		0.360	2.950	12%	9.470		0.330	9.800	3%
2001	3.390		0.480	3.870	12%	8.880		0.190	9.070	2%
2002	2.590		0.510	3.100	16%	4.890		0.410	5.300	8%
2003	1.810		0.200	2.010	10%	6.280		0.600	6.880	9%
2004	1.050		0.120	1.170	10%	6.970		1.200	8.170	15%
2005	0.830		0.060	0.890	7%	6.400		1.580	7.980	20%
2006	0.900		0.040	0.940	4%	4.580		0.160	4.740	3%
2007	1.010		0.750	1.760	43%	5.070		0.150	5.220	3%
2008	0.620		0.170	0.790	22%	5.580		1.030	6.610	16%
2009	1.040		0.190	1.230	15%	6.750		0.840	7.590	11%
2010	1.690		0.790	2.480	32%	6.390		0.780	7.170	11%
2011	1.930		0.120	2.050	6%	5.750		1.810	7.560	24%
2012	1.950		0.290	2.240	13%	5.430		1.020	6.450	16%
2013	1.370		0.250	1.620	15%	4.790		0.640	5.430	12%
2014	**2.55**		**0.470**	**3.020**	**16%**	**4.71**		**0.660**	**5.370**	**12%**
2015	**2.19**		**0.310**	**2.500**	**12%**	**4.26**		**0.290**	**4.550**	**6%**
2016	**3.07**		**0.310**	**3.380**	**9%**	**3.29**		**0.540**	**3.830**	**14%**

Table 4 Estimate of commercial and recreational landings and discards for northern and southern red hake by year, 1960 to 2016. Data reported here for 2014 through 2016 were used in this assessment update.

	Northern Stock						Southern Stock					
Year	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Recreational Catch (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Recreational Catch (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards
1960	3.792				3.792		4.286				4.286	
1961	3.276				3.276		8.105				8.105	
1962	1.911		0.010	1.600	3.521		11.865		0.890	4.000	16.755	
1963	1.225	2.056	0.000	1.600	4.881		29.712	2.189	0.770	4.000	36.671	
1964	0.288	1.121	0.000	1.700	3.109		32.622	10.751	0.850	3.760	47.983	
1965	0.200	2.573	0.000	1.620	4.393		25.246	67.744	0.630	4.290	97.910	
1966	0.885	4.690	0.000	1.600	7.175		3.985	103.937	0.090	3.770	111.782	
1967	0.577	1.286	0.000	1.400	3.263		6.764	52.019	0.170	3.660	62.613	
1968	0.552	2.075	0.000	1.300	3.927		7.001	11.137	0.580	3.720	22.438	
1969	0.146	1.875	0.000	1.120	3.141		5.539	47.389	0.490	3.620	57.038	
1970	0.261	0.771	0.000	1.100	2.132		4.679	6.775	0.410	3.140	15.004	
1971	0.377	4.428	0.000	1.160	5.965		3.227	31.907	0.290	2.310	37.734	
1972	0.538	14.488	0.000	0.960	15.986		1.995	59.199	0.180	2.100	63.474	
1973	0.362	14.926	0.000	0.910	16.198		3.603	47.759	0.320	2.240	53.922	
1974	0.891	6.332	0.000	0.820	8.043		2.183	24.460	0.190	2.160	28.993	
1975	0.450	8.251	0.000	1.200	9.901		2.065	17.911	0.050	1.760	21.786	
1976	0.653	5.684	0.000	0.930	7.267		3.905	18.560	0.650	1.830	24.945	
1977	0.889	0.002	0.000	1.080	1.971		2.522	4.540	0.750	1.820	9.632	
1978	1.223		0.000	1.120	2.343		3.327	2.136	0.970	2.440	8.873	
1979	1.523		0.010	1.220	2.753		6.624	0.968	0.250	2.670	10.512	
1980	1.029		0.000	1.370	2.399		3.927	0.155	0.140	2.700	6.922	
1981	1.246		0.030	1.320	2.596	51%	2.124	0.196	0.180	2.720	5.220	52%
1982	1.210		0.000	1.460	2.670	55%	2.993	0.177	0.030	3.780	6.980	54%
1983	0.895		0.000	1.350	2.245	60%	1.334	0.107	0.140	3.890	5.471	71%
1984	1.059		0.000	1.330	2.389	56%	1.214	0.057	0.550	3.910	5.731	68%
1985	0.992		0.000	1.270	2.262	56%	0.827	0.076	0.030	2.970	3.903	76%
1986	1.457		0.000	1.190	2.647	45%	0.644	0.050	0.210	3.390	4.294	79%
1987	1.013		0.000	1.050	2.063	51%	0.943		0.470	3.310	4.723	70%
1988	0.862		0.000	0.900	1.762	51%	0.871		0.250	3.460	4.581	76%
1989	0.776		0.000	1.450	2.226	65%	0.931		0.440	5.010	6.381	79%
1990	0.826		0.000	0.600	1.426	42%	0.798		0.510	4.750	6.058	78%
1991	0.743		0.000	0.820	1.563	52%	0.925		0.290	2.610	3.825	68%
1992	0.918		0.000	0.730	1.648	44%	1.245		0.190	6.340	7.775	82%
1993	0.768		0.000	0.080	0.848	9%	0.924		0.090	5.310	6.324	84%
1994	0.727		0.000	0.080	0.807	10%	0.983		0.070	1.720	2.773	62%
1995	0.186		0.000	0.060	0.246	24%	1.428		0.050	1.330	2.808	47%
1996	0.409		0.010	0.660	1.079	61%	0.700		0.020	0.380	1.100	35%
1997	0.338		0.000	0.130	0.468	28%	0.999		0.170	2.420	3.589	67%
1998	0.187		0.000	0.130	0.317	41%	1.154		0.050	0.740	1.944	38%
1999	0.220		0.000	0.470	0.690	68%	1.351		0.050	1.060	2.461	43%

Table 4, continued. Estimate of commercial and recreational landings and discards for northern and southern red hake by year, 1960 to 2016. Data reported here for 2014 through 2016 were used in this assessment update.

	Northern Stock						Southern Stock					
Year	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Recreational Catch (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards	Commercial Landings (000's mt)	Foreign Landings (000's mt)	Recreational Catch (000's mt)	Commercial Discards (000's mt)	Total Catch (000's mt)	% Discards
2001	0.222		0.000	0.140	0.362	39%	1.469		0.020	0.140	1.629	9%
2002	0.275		0.000	0.100	0.375	27%	0.663		0.010	0.330	1.003	33%
2003	0.210		0.000	0.090	0.300	30%	0.623		0.020	0.350	0.993	35%
2004	0.103		0.000	0.060	0.163	37%	0.588		0.020	0.620	1.228	50%
2005	0.096		0.000	0.060	0.156	38%	0.356		0.120	1.010	1.486	68%
2006	0.096		0.001	0.180	0.277	65%	0.375		0.080	0.670	1.125	60%
2007	0.069		0.000	0.130	0.199	65%	0.470		0.150	1.550	2.170	71%
2008	0.052		0.000	0.060	0.112	54%	0.580		0.120	0.810	1.510	54%
2009	0.085		0.002	0.100	0.187	53%	0.575		0.130	0.870	1.575	55%
2010	0.067		0.001	0.240	0.308	78%	0.578		0.150	0.740	1.468	50%
2011	0.139		0.001	0.100	0.240	42%	0.495		0.090	1.010	1.595	63%
2012	0.097		0.001	0.190	0.288	66%	0.751		0.090	0.650	1.491	44%
2013	0.095		0.003	0.220	0.318	69%	0.439		0.140	0.580	1.159	50%
2014	**0.070**		**0.012**	**0.190**	**0.272**	**70%**	**0.560**		**0.090**	**0.52**	**1.17**	**44%**
2015	**0.100**		**0.002**	**0.270**	**0.372**	**73%**	**0.388**		**0.030**	**0.85**	**1.268**	**67%**
2016	**0.140**		**0.003**	**0.260**	**0.403**	**65%**	**0.392**		**0.130**	**0.76**	**1.282**	**59%**

Table 5 Northern silver hake estimated commercial landings by major fishing gear groups, in metric tons (left) and percentage of total annual landings, (right) 1994 to 2016

Year	Trawl	Scallop Dredge	Other	Total
1994	3744	0	154	3898
1995	2293		320	2613
1996	3562		58	3620
1997	2730		72	2802
1998	2007	0	38	2045
1999	3407		40	3446
2000	2477		114	2591
2001	3300	9	89	3398
2002	2565	0	31	2596
2003	1753	3	52	1808
2004	970		80	1049
2005	725	2	92	819
2006	883	2	19	904
2007	978	0	9	987
2008	543		37	580
2009	949		61	1010
2010	1643	1	49	1694
2011	1846		72	1918
2012	1871	1	67	1939
2013	1305		66	1372
2014	2394	0	155	2549
2015	2086		101	2188
2016	2952		91	3043

Year	Trawl	Scallop Dredge	Other	Total
1994	96.0%	0.0%	3.9%	100%
1995	87.8%	0.0%	12.2%	100%
1996	98.4%	0.0%	1.6%	100%
1997	97.4%	0.0%	2.6%	100%
1998	98.1%	0.0%	1.9%	100%
1999	98.8%	0.0%	1.2%	100%
2000	95.6%	0.0%	4.4%	100%
2001	97.1%	0.3%	2.6%	100%
2002	98.8%	0.0%	1.2%	100%
2003	97.0%	0.2%	2.9%	100%
2004	92.4%	0.0%	7.6%	100%
2005	88.5%	0.2%	11.3%	100%
2006	97.8%	0.2%	2.1%	100%
2007	99.1%	0.0%	0.9%	100%
2008	93.6%	0.0%	6.4%	100%
2009	94.0%	0.0%	6.0%	100%
2010	97.0%	0.1%	2.9%	100%
2011	96.2%	0.0%	3.8%	100%
2012	96.5%	0.0%	3.5%	100%
2013	95.2%	0.0%	4.8%	100%
2014	93.9%	0.0%	6.1%	100%
2015	95.4%	0.0%	4.6%	100%
2016	97.0%	0.0%	3.0%	100%

Table 6 Southern silver hake estimated commercial landings by major gear group, in metric tons (left) and percentage of total annual landings, (right), 1994-2016

Year	Trawl	Scallop Dredge	Other	Total
1994	11288		871	12159
1995	10695	0	1367	12062
1996	12549		10	12559
1997	12744		17	12761
1998	12810	0	18	12828
1999	10566	0	9	10575
2000	9724		10	9734
2001	9365	1	6	9372
2002	5327		13	5340
2003	6816		17	6833
2004	7146		291	7436
2005	6212	11	448	6671
2006	4274	23	332	4629
2007	5186	67	119	5372
2008	5099	0	575	5673
2009	6260	21	469	6750
2010	6239	3	144	6385
2011	5786	1	43	5831
2012	5423	0	38	5461
2013	4794	0	18	4812
2014	4662	0	41	4703
2015	4258	0	5	4263
2016	3286	0	2	3289

Year	Trawl	Scallop Dredge	Other	Total
1994	92.8%	0.0%	7.2%	100%
1995	88.7%	0.0%	11.3%	100%
1996	99.9%	0.0%	0.1%	100%
1997	99.9%	0.0%	0.1%	100%
1998	99.9%	0.0%	0.1%	100%
1999	99.9%	0.0%	0.1%	100%
2000	99.9%	0.0%	0.1%	100%
2001	99.9%	0.0%	0.1%	100%
2002	99.8%	0.0%	0.2%	100%
2003	99.7%	0.0%	0.3%	100%
2004	96.1%	0.0%	3.9%	100%
2005	93.1%	0.2%	6.7%	100%
2006	92.3%	0.5%	7.2%	100%
2007	96.5%	1.2%	2.2%	100%
2008	89.9%	0.0%	10.1%	100%
2009	92.7%	0.3%	7.0%	100%
2010	97.7%	0.0%	2.2%	100%
2011	99.2%	0.0%	0.7%	100%
2012	99.3%	0.0%	0.7%	100%
2013	99.6%	0.0%	0.4%	100%
2014	99.1%	0.0%	0.9%	100%
2015	99.9%	0.0%	0.1%	100%
2016	99.9%	0.0%	0.1%	100%

Table 7 Northern red hake estimated commercial landings by major gear group, in metric tons (left) and percentage of total annual landings (right) ,1994-2016

Year	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	57.2	0.0	0.8	58
2015	81.9	0.0	0.4	82
2016	98.2	0.0	0.6	99

Year	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%
2015	99%	0%	1%	100%
2016	99%	0%	1%	100%

Table 8 Southern red hake estimated commercial landings by major gear group, in metric tons (left) and percentage of total annual landings (right) 1994-2016.

Year	Trawl	Scallop Dredge	Other	Total
1994	851		132	983
1995	987	0	436	1423
1996	694		5	700
1997	982		17	999
1998	1142		12	1154
1999	1337		14	1351
2000	1398		17	1415
2001	1437	0	26	1463
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	539.4	0.0	20.1	559
2015	374.9	0.0	13.2	388
2016	376.2	0.0	15.3	392

Year	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	96%	0%	4%	100%
2015	97%	0%	3%	100%
2016	96%	0%	4%	100%

Table 9 Northern and southern red hake total recreational catch in metric tons, 2004 to 2016, derived from the Marine Recreation Information Program (MRIP)

Year	North	South
2004	0.078	9.516
2005	0.001	105.853
2006	0.313	98.608
2007	0.270	23.456
2008	0.515	101.940
2009	1.114	152.605
2010	0.454	129.135
2011	0.535	123.729
2012	0.418	41.091
2013	3.484	68.117
2014	4.859	94.738
2015	2.018	27.034
2016	2.921	130.185

Table 10 Northern silver hake estimated commercial discards in metric tons (top) and percentage of total annual landings (bottom) by major gear group, 1989 to 2016

Year	Trawl large mesh	Trawl small mesh	Shrimp trawl	Scallop Dredge	Sink Gillnet	Longline	Total
1989	297.30	1188.33	771.71	0.00	34.35	0.00	2291.68
1990	681.51	857.32	550.96	0.00	87.64	0.00	2177.44
1991	391.55	486.51	294.21	0.00	43.75	0.00	1216.01
1992	371.60	583.05	427.10	5.19	42.41	0.00	1429.34
1993	1616.55	180.48	170.63	59.72	60.40	0.00	2087.78
1994	44.55	0.00	83.80	1.49	43.76	0.00	173.61
1995	115.83	22.89	456.12	6.15	29.08	0.00	630.08
1996	64.41	20.24	681.30	2.26	56.50	0.00	824.71
1997	56.68	1.98	126.35	7.03	27.42	0.00	219.45
1998	126.16	0.00	0.00	35.14	9.03	0.00	170.33
1999	166.15	395.59	0.00	11.10	18.10	0.00	590.94
2000	185.95	1.06	0.00	2.65	24.34	0.00	214.00
2001	401.92	17.69	39.42	1.73	12.52	0.00	473.29
2002	379.93	102.66	0.00	1.16	9.10	0.00	492.86
2003	75.20	90.58	22.05	2.50	10.12	0.00	200.46
2004	66.26	29.24	13.39	0.14	2.92	0.00	111.95
2005	40.11	9.20	10.25	1.44	0.99	0.02	62.01
2006	20.94	4.97	9.81	0.63	1.13	0.00	37.48
2007	19.34	640.11	11.83	1.63	1.46	0.00	674.38
2008	48.18	58.72	48.36	0.21	6.25	0.00	161.73
2009	67.14	135.19	49.28	4.50	6.72	0.00	262.83
2010	59.04	402.01	218.80	0.74	5.22	0.01	685.82
2011	70.02	34.06	0.00	8.91	4.66	0.01	117.65
2012	107.10	38.72	129.90	6.70	11.32	0.05	293.78
2013	158.43	37.96	33.15	10.47	6.38	0.00	246.39
2014	269.83	186.26	0.00	2.92	9.80	0.20	469.00
2015	277.55	14.48	0.00	4.17	12.95	0.00	309.15
2016	168.90	125.44	0.00	2.63	8.09	0.00	305.06

Year	Trawl large mesh	Trawl small mesh	Shrimp trawl	Scallop Dredge	Sink Gillnet	Longline	Total
1989	13%	52%	34%	0%	1%	0%	100%
1990	31%	39%	25%	0%	4%	0%	100%
1991	32%	40%	24%	0%	4%	0%	100%
1992	26%	41%	30%	0%	3%	0%	100%
1993	77%	9%	8%	3%	3%	0%	100%
1994	26%	0%	48%	1%	25%	0%	100%
1995	18%	4%	72%	1%	5%	0%	100%
1996	8%	2%	83%	0%	7%	0%	100%
1997	26%	1%	58%	3%	12%	0%	100%
1998	74%	0%	0%	21%	5%	0%	100%
1999	28%	67%	0%	2%	3%	0%	100%
2000	87%	0%	0%	1%	11%	0%	100%
2001	85%	4%	8%	0%	3%	0%	100%
2002	77%	21%	0%	0%	2%	0%	100%
2003	38%	45%	11%	1%	5%	0%	100%
2004	59%	26%	12%	0%	3%	0%	100%
2005	65%	15%	17%	2%	2%	0%	100%
2006	56%	13%	26%	2%	3%	0%	100%
2007	3%	95%	2%	0%	0%	0%	100%
2008	30%	36%	30%	0%	4%	0%	100%
2009	26%	51%	19%	2%	3%	0%	100%
2010	9%	59%	32%	0%	1%	0%	100%
2011	60%	29%	0%	8%	4%	0%	100%
2012	36%	13%	44%	2%	4%	0%	100%
2013	64%	15%	13%	4%	3%	0%	100%
2014	58%	40%	0%	1%	2%	0%	100%
2015	90%	5%	0%	1%	4%	0%	100%
2016	55%	41%	0%	1%	3%	0%	100%

Table 11 Southern silver hake estimated commercial discards in metric tons (top) and percentage of total annual landings(bottom) by major gear group, 1989 to 2016

Year	Trawl large mesh	Trawl small mesh	Scallop Dredge	Sink Gillnet	Longline	Total
1989	680.37	6389.56	0.00	0.00	0.00	7069.93
1990	2743.07	3172.70	0.00	0.00	0.00	5915.77
1991	1191.65	2020.27	5.72	0.09	0.00	3217.73
1992	654.51	2771.14	17.16	3.30	0.00	3446.11
1993	5959.62	4081.28	354.54	4.76	0.00	10400.20
1994	594.14	3984.24	27.35	0.69	0.00	4606.42
1995	161.89	1175.51	125.60	0.45	0.00	1463.45
1996	40.51	431.60	32.37	0.19	0.00	504.67
1997	1818.14	219.41	31.12	2.06	0.00	2070.72
1998	6327.50	237.05	49.34	0.45	0.00	6614.33
1999	1111.53	1156.22	27.21	0.89	0.00	2295.85
2000	4959.45	154.48	68.21	7.62	0.00	5189.75
2001	36.43	176.83	11.80	0.00	0.00	225.06
2002	172.54	259.56	14.00	0.44	0.00	446.53
2003	19.91	582.01	4.11	1.28	0.00	607.31
2004	579.41	1027.09	11.34	0.37	0.00	1618.21
2005	138.62	1476.13	8.11	0.24	0.00	1623.10
2006	52.46	133.58	7.44	0.01	0.07	193.56
2007	31.04	178.24	6.88	0.00	0.00	216.16
2008	88.00	751.36	6.65	0.03	0.58	846.60
2009	69.01	812.78	22.00	0.16	0.00	903.95
2010	73.97	742.39	17.45	0.30	0.00	834.11
2011	39.67	1723.98	54.91	0.67	0.00	1819.23
2012	21.13	985.00	12.05	0.28	0.00	1018.45
2013	23.08	589.89	20.02	0.20	0.00	633.20
2014	50.71	588.22	21.56	0.31	0.01	660.80
2015	31.04	251.81	8.66	0.67	0.00	292.18
2016	16.11	518.87	7.82	0.10	0.02	542.92

Year	Trawl large mesh	Trawl small mesh	Scallop Dredge	Sink Gillnet	Longline	Total
1989	10%	90%	0%	0%	0%	100%
1990	46%	54%	0%	0%	0%	100%
1991	37%	63%	0%	0%	0%	100%
1992	19%	80%	0%	0%	0%	100%
1993	57%	39%	3%	0%	0%	100%
1994	13%	86%	1%	0%	0%	100%
1995	11%	80%	9%	0%	0%	100%
1996	8%	86%	6%	0%	0%	100%
1997	88%	11%	2%	0%	0%	100%
1998	96%	4%	1%	0%	0%	100%
1999	48%	50%	1%	0%	0%	100%
2000	96%	3%	1%	0%	0%	100%
2001	16%	79%	5%	0%	0%	100%
2002	39%	58%	3%	0%	0%	100%
2003	3%	96%	1%	0%	0%	100%
2004	36%	63%	1%	0%	0%	100%
2005	9%	91%	0%	0%	0%	100%
2006	27%	69%	4%	0%	0%	100%
2007	14%	82%	3%	0%	0%	100%
2008	10%	89%	1%	0%	0%	100%
2009	8%	90%	2%	0%	0%	100%
2010	9%	89%	2%	0%	0%	100%
2011	2%	95%	3%	0%	0%	100%
2012	2%	97%	1%	0%	0%	100%
2013	4%	93%	3%	0%	0%	100%
2014	8%	89%	3%	0%	0%	100%
2015	11%	86%	3%	0%	0%	100%
2016	3%	96%	1%	0%	0%	100%

Table 12 Northern red hake estimated commercial discards in metric tons (top) and percentage of annual landings (bottom) by major gear group, 1989 to 2016

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	96.20	0.00	6.47	1.72	0.36	186.95
2015	119.60	134.30	0.00	11.50	1.55	0.00	266.95
2016	55.40	187.70	0.00	14.39	1.93	0.02	259.44

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%	51%	0%	3%	1%	0%	100%
2015	45%	50%	0%	4%	1%	0%	100%
2016	21%	72%	0%	6%	1%	0%	100%

Table 13 Southern red hake estimated commercial discards in metric tons (top) and percent age of annual landings (bottom) by major gear group, 1989 to 2016

Year	Trawl large mesh	Trawl small mesh	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	53.59	423.19	39.02	0.00	0.04	515.84
2015	22.22	788.00	35.40	0.02	0.20	845.83
2016	18.29	703.38	36.35	0.01	0.36	758.39

Year	Trawl large mesh	Trawl small mesh	Scallop Dredge	Sink Gillnet	Longline	Total
1989	12%	88%	0%	0%	0%	100%
1990	28%	72%	0%	0%	0%	100%
1991	17%	82%	0%	0%	1%	100%
1992	12%	87%	0%	0%	0%	100%
1993	56%	44%	0%	0%	0%	100%
1994	21%	78%	2%	0%	0%	100%
1995	8%	90%	2%	0%	0%	100%
1996	40%	57%	3%	0%	0%	100%
1997	33%	66%	1%	0%	0%	100%
1998	87%	13%	0%	0%	0%	100%
1999	91%	8%	1%	0%	0%	100%
2000	97%	2%	1%	0%	0%	100%
2001	86%	12%	2%	0%	0%	100%
2002	5%	90%	5%	0%	0%	100%
2003	6%	92%	2%	0%	0%	100%
2004	28%	68%	3%	0%	0%	100%
2005	13%	84%	4%	0%	0%	100%
2006	16%	74%	10%	0%	0%	100%
2007	10%	89%	1%	0%	0%	100%
2008	22%	69%	7%	0%	2%	100%
2009	14%	80%	6%	0%	0%	100%
2010	12%	84%	4%	0%	0%	100%
2011	2%	92%	6%	0%	0%	100%
2012	3%	85%	12%	0%	0%	100%
2013	1%	94%	5%	0%	0%	100%
2014	10%	82%	8%	0%	0%	100%
2015	3%	93%	4%	0%	0%	100%
2016	2%	93%	5%	0%	0%	100%

Table 14 Summary of NEFSC fall bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom-trawl survey biomass (kt/kg) for northern silver hake, 1955 to 2016. This assessment update was based on the most recent three-year average of both the NEFSC fall bottom-trawl survey biomass and the relative exploitation ratio from 2014-2016.

Year	Northern Fall Survey Arithmetic kg/tow	Northern Fall Survey 3-year Average	Northern Total Landings (000's mt)	Northern Discards (000's mt)	Northern Total Catch (000's mt)	Northern Exploitation Index (kg/000's mt)	Northern Exploitation Index 3-year Average
1955			53.36		53.36		
1956			42.15		42.15		
1957			62.75		62.75		
1958			49.90		49.90		
1959			50.61		50.61		
1960			45.54		45.54		
1961			39.69		39.69		
1962			79.00		79.00		
1963	23.10		73.92		73.92	3.20	
1964	4.34		94.46		94.46	21.77	
1965	7.06	11.50	45.28		45.28	6.41	10.46
1966	4.19	5.20	47.81		47.81	11.41	13.20
1967	2.27	4.51	33.37		33.37	14.70	10.84
1968	2.28	2.91	41.38		41.38	18.15	14.75
1969	2.41	2.32	24.06		24.06	9.98	14.28
1970	3.03	2.57	27.53		27.53	9.09	12.41
1971	2.67	2.70	36.40		36.40	13.63	10.90
1972	5.78	3.83	25.22		25.22	4.36	9.03
1973	4.12	4.19	32.09		32.09	7.79	8.60
1974	3.45	4.45	20.68		20.68	5.99	6.05
1975	8.09	5.22	39.87		39.87	4.93	6.24
1976	11.25	7.60	13.63		13.63	1.21	4.05
1977	6.72	8.69	12.46		12.46	1.85	2.66
1978	6.32	8.10	12.61		12.61	2.00	1.69
1979	6.18	6.41	3.42		3.42	0.55	1.47
1980	7.23	6.58	4.73		4.73	0.65	1.07
1981	4.52	5.98	4.42	2.64	7.05	1.56	0.92
1982	6.28	6.01	4.66	2.91	7.57	1.21	1.14
1983	8.76	6.52	5.31	2.64	7.95	0.91	1.22
1984	3.36	6.13	8.29	2.59	10.88	3.24	1.78
1985	8.28	6.80	8.30	2.56	10.86	1.31	1.82
1986	13.04	8.23	8.50	2.35	10.86	0.83	1.79
1987	9.79	10.37	5.66	2.11	7.77	0.79	0.98
1988	6.05	9.63	6.79	1.79	8.57	1.42	1.01
1989	10.53	8.79	4.65	2.32	6.96	0.66	0.96
1990	15.61	10.73	6.38	1.96	8.34	0.53	0.87
1991	10.52	12.22	6.06	1.26	7.31	0.69	0.63
1992	10.25	12.13	5.31	1.42	6.73	0.66	0.63
1993	7.50	9.42	4.36	0.69	5.05	0.67	0.67
1994	6.84	8.20	3.90	0.24	4.14	0.61	0.65
1995	12.89	9.08	2.59	0.63	3.22	0.25	0.51
1996	7.57	9.10	3.62	0.82	4.44	0.59	0.48
1997	5.66	8.71	2.80	0.24	3.05	0.54	0.46
1998	18.91	10.71	2.05	0.69	2.74	0.14	0.42
1999	11.15	11.91	3.45	0.74	4.19	0.38	0.35

Table14, continued. Summary of NEFSC fall bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom-trawl survey biomass) for northern silver hake, 1955-2016. Note: This assessment update was based on the most recent three-year average of both the NEFSC fall bottom-trawl survey biomass and the relative exploitation ratio from 2014-2016.

Year	Northern Fall Survey Arithmetic kg/tow	Northern Fall Survey 3-year Average	Northern Total Landings (000's mt)	Northern Discards (000's mt)	Northern Total Catch (000's mt)	Northern Exploitation Index (kg/000's mt)	Northern Exploitation Index 3-year Average
2000	13.51	14.52	2.59	0.36	2.95	0.22	0.25
2001	8.33	11.00	3.39	0.48	3.87	0.46	0.35
2002	7.99	9.94	2.59	0.51	3.11	0.39	0.36
2003	8.29	8.20	1.81	0.20	2.01	0.24	0.37
2004	3.28	6.52	1.05	0.12	1.16	0.35	0.33
2005	1.72	4.43	0.83	0.06	0.89	0.52	0.37
2006	3.69	2.90	0.90	0.04	0.94	0.26	0.38
2007	6.44	3.95	1.01	0.75	1.76	0.27	0.35
2008	5.27	5.13	0.62	0.17	0.79	0.15	0.23
2009	6.89	6.20	1.04	0.19	1.23	0.18	0.20
2010	13.35	8.50	1.69	0.79	2.48	0.19	0.17
2011	9.97	10.07	1.93	0.12	2.04	0.20	0.19
2012	20.43	14.58	1.95	0.29	2.24	0.11	0.17
2013	16.75	15.72	1.37	0.25	1.62	0.10	0.14
2014	18.77	18.65	2.55	0.47	3.02	0.16	0.12
2015	19.49	18.34	2.19	0.31	2.50	0.13	0.13
2016	21.51	19.92	3.07	0.31	3.37	0.16	0.15

Table 15 Summary of NEFSC fall bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom trawl survey biomass) for southern silver hake, 1955-2016. Note: This assessment update was based on the most recent three-year average of both the NEFSC fall bottom-trawl survey biomass and relative exploitation ratio from 2014-2016.

Year	Southern Fall Survey Arithmetic kg/tow	Southern Fall Survey 3-year Average	Southern Total Landings (000's mt)	Southern Discards (000's mt)	Southern Total Catch (000's mt)	Southern Exploitation Index (kg/000's mt)	Southern Exploitation Index 3-year Average
1955			13.26		13.26		
1956			14.24		14.24		
1957			16.43		16.43		
1958			12.90		12.90		
1959			16.39		16.39		
1960			8.82		8.82		
1961			12.65		12.65		
1962			17.94		17.94		
1963	4.66		89.43		89.43	19.19	
1964	4.06		147.05		147.05	36.22	
1965	5.28	4.67	294.12		294.12	55.70	37.04
1966	2.64	3.99	202.32		202.32	76.64	56.19
1967	2.44	3.45	87.38		87.38	35.81	56.05
1968	2.73	2.60	58.16		58.16	21.30	44.58
1969	1.26	2.14	74.89		74.89	59.44	38.85
1970	1.35	1.78	26.83		26.83	19.87	33.54
1971	2.21	1.61	70.51		70.51	31.90	37.07
1972	2.13	1.90	88.18		88.18	41.40	31.06
1973	1.70	2.01	102.08		102.08	60.05	44.45
1974	0.85	1.56	102.40		102.40	120.47	73.97
1975	1.79	1.45	72.16		72.16	40.31	73.61
1976	1.99	1.54	64.61		64.61	32.47	64.42
1977	1.68	1.82	57.16		57.16	34.02	35.60
1978	2.50	2.06	25.83		25.83	10.33	25.61
1979	1.68	1.95	16.40		16.40	9.76	18.04
1980	1.63	1.94	11.68		11.68	7.17	9.09
1981	1.12	1.48	13.43	3.50	16.93	15.12	10.68
1982	1.56	1.44	14.15	4.65	18.80	12.05	11.44
1983	2.57	1.75	11.86	4.81	16.67	6.49	11.22
1984	1.40	1.84	12.96	4.88	17.84	12.74	10.43
1985	3.55	2.51	12.82	3.87	16.69	4.70	7.98
1986	1.45	2.13	9.70	4.33	14.03	9.68	9.04
1987	1.95	2.32	9.55	4.25	13.80	7.08	7.15
1988	1.78	1.73	8.95	4.50	13.45	7.56	8.10
1989	1.87	1.87	13.00	6.57	19.57	10.47	8.37
1990	1.52	1.72	13.02	5.97	18.99	12.49	10.17
1991	0.85	1.41	9.74	3.08	12.82	15.08	12.68
1992	0.99	1.12	10.53	3.45	13.98	14.12	13.90
1993	1.28	1.04	12.49	5.17	17.66	13.80	14.33
1994	0.79	1.02	12.18	5.94	18.12	22.94	16.95
1995	1.59	1.22	11.99	1.40	13.39	8.42	15.05
1996	0.45	0.94	12.13	0.48	12.61	28.02	19.79
1997	0.83	0.96	12.55	0.62	13.17	15.87	17.44
1998	0.57	0.62	12.56	0.53	13.09	22.96	22.28
1999	0.82	0.74	10.42	3.55	13.97	17.04	18.62

Table15, continued. Summary of NEFSC fall bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom trawl survey biomass) for southern silver hake, 1955-2016. Note: This assessment update was based on the most recent three-year average of both the NEFSC fall bottom-trawl survey biomass and relative exploitation ratio from 2014-2016.

Year	Southern Fall Survey Arithmetic kg/tow	Southern Fall Survey 3-year Average	Southern Total Landings (000's mt)	Southern Discards (000's mt)	Southern Total Catch (000's mt)	Southern Exploitation Index (kg/000's mt)	Southern Exploitation Index 3-year Average
2000	0.72	0.70	9.47	0.33	9.80	13.61	17.87
2001	2.04	1.19	8.88	0.19	9.07	4.45	11.70
2002	1.18	1.31	4.89	0.41	5.30	4.49	7.52
2003	1.42	1.55	6.28	0.60	6.88	4.85	4.59
2004	1.24	1.28	6.97	1.20	8.17	6.59	5.31
2005	0.94	1.20	6.40	1.58	7.98	8.49	6.64
2006	1.42	1.20	4.58	0.16	4.74	3.34	6.14
2007	0.87	1.08	5.07	0.15	5.22	6.00	5.94
2008	1.36	1.22	5.58	1.03	6.61	4.86	4.73
2009	1.10	1.11	6.75	0.84	7.59	6.90	5.92
2010	2.82	1.76	6.39	0.78	7.17	2.54	4.77
2011	1.77	1.90	5.75	1.81	7.56	4.27	4.57
2012	1.98	2.19	5.43	1.02	6.45	3.25	3.35
2013	1.33	1.70	4.79	0.64	5.42	4.07	3.86
2014	1.44	1.58	4.71	0.66	5.37	3.74	3.69
2015	0.42	1.06	4.26	0.29	4.56	10.87	6.22
2016	1.30	1.05	3.29	0.54	3.83	2.95	5.85

Table 16 Summary of NEFSC spring bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom trawl survey biomass for northern red hake, 1955-2017. Note: This assessment update was based on the most recent three-year average of both the NEFSC spring bottom-trawl survey biomass (2015-2017) and relative exploitation ratio from 2014-2016.

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)	Northern Exploitation Index 3-year Average (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	4.10
1971	0.65	0.61	4.81	1.16	0.00	5.97	9.21	6.02
1972	1.56	0.92	15.03	0.96	0.00	15.99	10.25	7.80
1973	4.31	2.17	15.29	0.91	0.00	16.20	3.76	7.74
1974	2.43	2.77	7.22	0.82	0.00	8.04	3.31	5.77
1975	4.25	3.67	8.70	1.20	0.00	9.90	2.33	3.13
1976	3.37	3.35	6.34	0.93	0.00	7.26	2.15	2.60
1977	2.66	3.43	0.89	1.08	0.00	1.98	0.74	1.74
1978	2.57	2.87	1.22	1.12	0.00	2.34	0.91	1.27
1979	2.04	2.42	1.52	1.22	0.01	2.75	1.35	1.00
1980	3.88	2.83	1.03	1.37	0.00	2.40	0.62	0.96
1981	6.35	4.09	1.25	1.32	0.03	2.60	0.41	0.79
1982	2.13	4.12	1.21	1.46	0.00	2.67	1.26	0.76
1983	3.70	4.06	0.90	1.35	0.00	2.25	0.61	0.76
1984	2.98	2.94	1.06	1.33	0.00	2.39	0.80	0.89
1985	3.91	3.53	0.99	1.27	0.00	2.26	0.58	0.66
1986	3.26	3.39	1.46	1.19	0.00	2.65	0.81	0.73
1987	2.94	3.37	1.01	1.05	0.00	2.07	0.70	0.70
1988	2.00	2.73	0.86	0.90	0.00	1.76	0.88	0.80
1989	1.65	2.20	0.78	1.45	0.00	2.22	1.35	0.98
1990	1.33	1.66	0.83	0.60	0.00	1.43	1.07	1.10
1991	1.62	1.53	0.74	0.82	0.00	1.56	0.96	1.13
1992	2.50	1.82	0.92	0.73	0.00	1.65	0.66	0.90
1993	2.82	2.32	0.77	0.08	0.00	0.85	0.30	0.64
1994	1.59	2.31	0.73	0.08	0.00	0.81	0.51	0.49
1995	1.97	2.13	0.19	0.06	0.00	0.25	0.13	0.31
1996	1.79	1.79	0.41	0.66	0.01	1.07	0.60	0.41
1997	1.81	1.86	0.34	0.13	0.00	0.46	0.26	0.33
1998	2.52	2.04	0.19	0.13	0.00	0.32	0.13	0.33
1999	2.32	2.22	0.22	0.47	0.00	0.69	0.30	0.23

Table 16, continued. Summary of NEFSC spring bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom trawl survey biomass for northern red hake, 1955-2017. Note: This assessment update was based on the most recent three-year average of both the NEFSC spring bottom-trawl survey biomass (2015-2017) and relative exploitation ratio (2014-2016).

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)	Northern Exploitation Index 3-year Average (kg/000's mt)
2000	3.19	2.68	0.20	0.06	0.00	0.25	0.08	0.17
2001	3.58	3.03	0.22	0.14	0.00	0.36	0.10	0.16
2002	4.46	3.74	0.28	0.10	0.00	0.38	0.08	0.09
2003	1.00	3.01	0.21	0.09	0.00	0.30	0.30	0.16
2004	1.77	2.41	0.10	0.06	0.00	0.16	0.09	0.16
2005	1.10	1.29	0.10	0.06	0.00	0.15	0.14	0.18
2006	0.91	1.26	0.10	0.18	0.00	0.28	0.30	0.18
2007	2.06	1.36	0.07	0.13	0.00	0.20	0.10	0.18
2008	3.49	2.15	0.05	0.06	0.00	0.11	0.03	0.14
2009	1.75	2.43	0.09	0.10	0.00	0.18	0.10	0.08
2010	2.02	2.42	0.07	0.24	0.00	0.31	0.15	0.10
2011	2.18	1.98	0.14	0.10	0.00	0.24	0.11	0.12
2012	1.73	1.98	0.10	0.19	0.00	0.29	0.17	0.14
2013	1.35	1.75	0.10	0.22	0.00	0.31	0.23	0.17
2014	3.02	2.03	0.07	0.19	0.01	0.27	0.09	0.16
2015	6.27	3.55	0.10	0.27	0.00	0.37	0.06	0.13
2016	4.46	4.58	0.14	0.26	0.00	0.41	0.09	0.08
2017	4.66	5.13						

Table 17 Summary of NEFSC spring bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom trawl survey biomass for southern red hake, 1955-2017. Note: This assessment update was based on the most recent three-year average of both the NEFSC spring bottom-trawl survey biomass (2015-2017) and relative exploitation ratio (2014-2016).

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)	Southern Exploitation Index 3-year Average (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	26.29
1971	3.49	2.10	35.13	2.31	0.29	37.73	10.82	24.08
1972	3.59	2.93	61.19	2.10	0.18	63.47	17.68	12.40
1973	3.99	3.69	51.36	2.24	0.32	53.92	13.51	14.00
1974	2.84	3.47	26.64	2.16	0.19	28.99	10.22	13.80
1975	3.18	3.34	19.98	1.76	0.05	21.79	6.85	10.19
1976	5.31	3.78	22.47	1.83	0.65	24.94	4.69	7.25
1977	2.30	3.60	7.06	1.82	0.75	9.63	4.19	5.24
1978	7.65	5.09	5.46	2.44	0.97	8.87	1.16	3.35
1979	1.51	3.82	7.59	2.67	0.25	10.50	6.94	4.09
1980	2.38	3.85	4.08	2.70	0.14	6.93	2.91	3.67
1981	4.61	2.84	2.32	2.72	0.18	5.21	1.13	3.66
1982	3.34	3.45	3.17	3.78	0.03	6.98	2.09	2.04
1983	2.21	3.39	1.44	3.89	0.14	5.47	2.48	1.90
1984	1.33	2.29	1.27	3.91	0.55	5.73	4.30	2.96
1985	1.39	1.64	0.90	2.97	0.03	3.90	2.80	3.19
1986	1.73	1.49	0.69	3.39	0.21	4.29	2.47	3.19
1987	0.88	1.33	0.94	3.31	0.47	4.73	5.38	3.55
1988	1.01	1.21	0.87	3.46	0.25	4.58	4.56	4.14
1989	0.49	0.79	0.93	5.01	0.44	6.37	13.09	7.68
1990	0.71	0.73	0.80	4.75	0.51	6.06	8.57	8.74
1991	0.61	0.60	0.93	2.61	0.29	3.82	6.26	9.30
1992	0.47	0.59	1.25	6.34	0.19	7.78	16.74	10.52
1993	0.42	0.50	0.92	5.31	0.09	6.32	14.91	12.63
1994	0.68	0.52	0.98	1.72	0.07	2.77	4.11	11.92
1995	0.52	0.54	1.43	1.33	0.05	2.80	5.43	8.15
1996	0.45	0.55	0.70	0.38	0.02	1.10	2.43	3.99
1997	1.16	0.71	1.00	2.42	0.17	3.59	3.10	3.65
1998	0.21	0.61	1.15	0.74	0.05	1.95	9.10	4.87
1999	0.46	0.61	1.35	1.06	0.05	2.46	5.42	5.87

Table 17, continued. Summary of NEFSC spring bottom-trawl survey biomass in Albatross units (kg/tow), total catch (kt), and index of relative exploitation (ratio of total catch to the NEFSC fall bottom trawl survey biomass for southern red hake, 1955-2017. Note: This assessment update was based on the most recent three-year average of both the NEFSC spring bottom-trawl survey biomass (2015-2017) and relative exploitation ratio (2014-2016).

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)	Southern Exploitation Index 3-year Average (kg/000's mt)
2000	0.42	0.36	1.42	0.25	0.04	1.71	4.04	6.19
2001	0.64	0.51	1.47	0.14	0.02	1.63	2.54	4.00
2002	0.54	0.54	0.66	0.33	0.01	1.00	1.85	2.81
2003	0.21	0.46	0.62	0.35	0.02	0.99	4.79	3.06
2004	0.15	0.30	0.59	0.62	0.01	1.21	7.88	4.84
2005	0.38	0.25	0.36	1.01	0.06	1.42	3.77	5.48
2006	0.38	0.30	0.38	0.67	0.05	1.10	2.90	4.85
2007	0.86	0.54	0.47	1.55	0.02	2.04	2.37	3.02
2008	0.47	0.57	0.58	0.81	0.07	1.47	3.10	2.79
2009	1.34	0.89	0.58	0.87	0.10	1.54	1.15	2.21
2010	0.92	0.91	0.58	0.74	0.09	1.41	1.52	1.93
2011	1.79	1.35	0.50	1.01	0.115	1.62	0.91	1.19
2012	1.06	1.26	0.75	0.65	0.037	1.44	1.36	1.26
2013	0.64	1.16	0.44	0.58	0.076	1.10	1.71	1.32
2014	0.63	0.78	0.56	0.52	0.09	1.16	1.85	1.69
2015	0.58	0.62	0.39	0.85	0.03	1.26	2.17	1.95
2016	0.31	0.51	0.39	0.76	0.13	1.28	4.13	2.72
2017	0.25	0.38						

Table 18 Risk of exceeding FMSY proxy over a range of catches (ABC and OFL estimate from the probability distribution (in blue) for northern silver 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 is slightly different from the point estimate due to skewness in the distribution.

Pctile of OFL	FY 2016-2017 Catch (kt)	% of OFL (58.35 kt)	% of 2016-2017 FY Catch	Prob. ($F > FMSY_{Proxy}$)
5	12.73	22%	372%	0%
10	17.67	30%	517%	0%
20	26.56	46%	777%	0%
25	**31.03**	**53%**	**908%**	**0%**
30	35.69	61%	1044%	0%
40	45.95	79%	1344%	0%
45	51.81	89%	1515%	17%
50	**58.35**	**100%**	**1707%**	**75%**
60	74.01	127%	2165%	97%
70	95.68	164%	2798%	97%
80	129.94	223%	3801%	97%

Table 19 Risk of exceeding FMSY proxy over a range of catches (ABC and OFL estimate from the distribution (in blue) for southern silver 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 is slightly different from the point estimate due to skewness in the distribution.

Pctile of OFL distr.	FY 2016-2017 Catch (kt)	% of OFL (37.11 kt)	% of 2016 Catch	Prob. ($F > FMSY_{Proxy}$)
5	7.74	21%	201%	0%
10	10.84	29%	282%	0%
20	16.55	45%	431%	0%
25	**20.17**	**54%**	**525%**	**0%**
30	22.45	60%	584%	0%
40	29.14	79%	758%	7%
45	32.91	89%	856%	26%
50	**37.11**	**100%**	**966%**	**59%**
60	47.41	128%	1234%	97%
70	61.79	167%	1608%	97%
80	84.59	228%	2201%	97%

Table 20 Risk of exceeding FMSY proxy over a range of catches (ABC and OFL estimate from the probability distribution (in blue) 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 OFL from the distribution is slightly different from the point estimate due to skewness in the distribution.

Pctile of OFL	FY 2016-2017 Catch (kt)	% of OFL (0.807 kt)	% of 2016-2017 FY Catch	Prob. ($F > FMSY_{Proxy}$)
5	0.192	24%	47%	0%
10	0.343	42%	85%	0%
20	0.510	63%	126%	0%
25	0.571	71%	141%	0%
30	0.625	77%	154%	0%
40	**0.720**	**89%**	**178%**	**10%**
45	0.764	95%	189%	21%
50	**0.807**	**100%**	**199%**	**37%**
60	0.894	111%	221%	70%
70	0.988	122%	244%	93%
80	1.097	136%	271%	93%

Table 21 Risk of exceeding FMSY proxy over a range of catches (ABC and OFL estimate from the distribution (in blue) for 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 is slightly different from the point estimate due to skewness in the distribution.

Pctile of OFL distr.	FY 2016-2017 Catch (kt)	% of OFL (1.12 kt)	% of 2016 Catch	Prob. ($F > FMSY_{Proxy}$)
5	0.75	66%	68%	0%
10	0.83	74%	76%	0%
20	0.93	83%	86%	4%
25	0.97	86%	89%	8%
30	1.00	89%	92%	12%
40	**1.06**	**94%**	**97%**	**23%**
45	1.09	97%	100%	31%
50	**1.12**	**100%**	**103%**	**39%**
60	1.18	105%	108%	56%
70	1.24	111%	114%	72%
80	1.32	118%	121%	87%

Table 22 Summary stock status and overfishing limit (OFL) for specification year 2015-2017 for northern and southern silver hake stocks, including Allowable Biological Catch (ABC) estimate, (the 25th percentile of OFL distribution) and associated risk of exceeding FMSY proxy

	North	South
3-year Average Fall Index 2014-2016 (kg/tow)	19.92	1.05
BMSY Proxy Threshold (kg/tow)	3.21	0.83
Ratio of 3-year average Fall index (2014-2016) to BMSY Proxy	6.21	1.27
3-Year Average Relative Exploitation Index 2014-2016 (kt/kg)	0.15	5.85
FMSY Proxy 1973-1982 (kt/kg)	2.78	34.18
Ratio of 3-year average Exploitation index (2014-2016) to FMSY Proxy	0.05	0.17
OFL (000's mt) based on median of probability value from the OFL distribution	58.35	37.11
ABC (000's mt) = 25th Percentile of OFL distribution	31.03	20.17*
ACL (000's mt) = 95% of ABC	29.48	19.16
ACL/OFL	0.51	0.52
Pr (F > FMSY) @ ACL	0%	0%

*Silver hake ABC in the southern region accounts for a 4% buffer of offshore hake that are mixed in the catch.

Table 23 Summary stock status and overfishing limit (OFL) for specification year 2015-2017 for northern and southern red hake stocks, including Allowable Biological Catch (ABC) estimate,(40th percentile of OFL distribution) and associated risk of exceeding FMSY proxy

	North	South
3-year Average Spr. Index 2015-2017 (kg/tow)	5.13	0.38
BMSY Proxy Threshold (kg/tow)	1.27	**0.51**
Biomass Stock Status - Ratio of recent 3-year average Spr. index to BMSY Proxy	4.06	0.75
2016 Relative Exploitation Index (kt/kg)	0.09	4.03
FMSY Proxy 1982-2010 (kt/kg)	0.16	3.04
Overfishing Stock Status - Annual Exploitation index (204-2016) to FMSY Proxy	0.55	**1.33**
OFL (000's mt) based on median of probability value from the OFL distribution	0.81	1.12
ABC (000's mt) = 40th Percentile of OFL distribution	0.72	1.06
ACL (000's mt) = 95% of ABC	0.68	1.01
ACL/OFL	0.85	0.90
Pr (F > FMSY) @ ACL	4%	23%

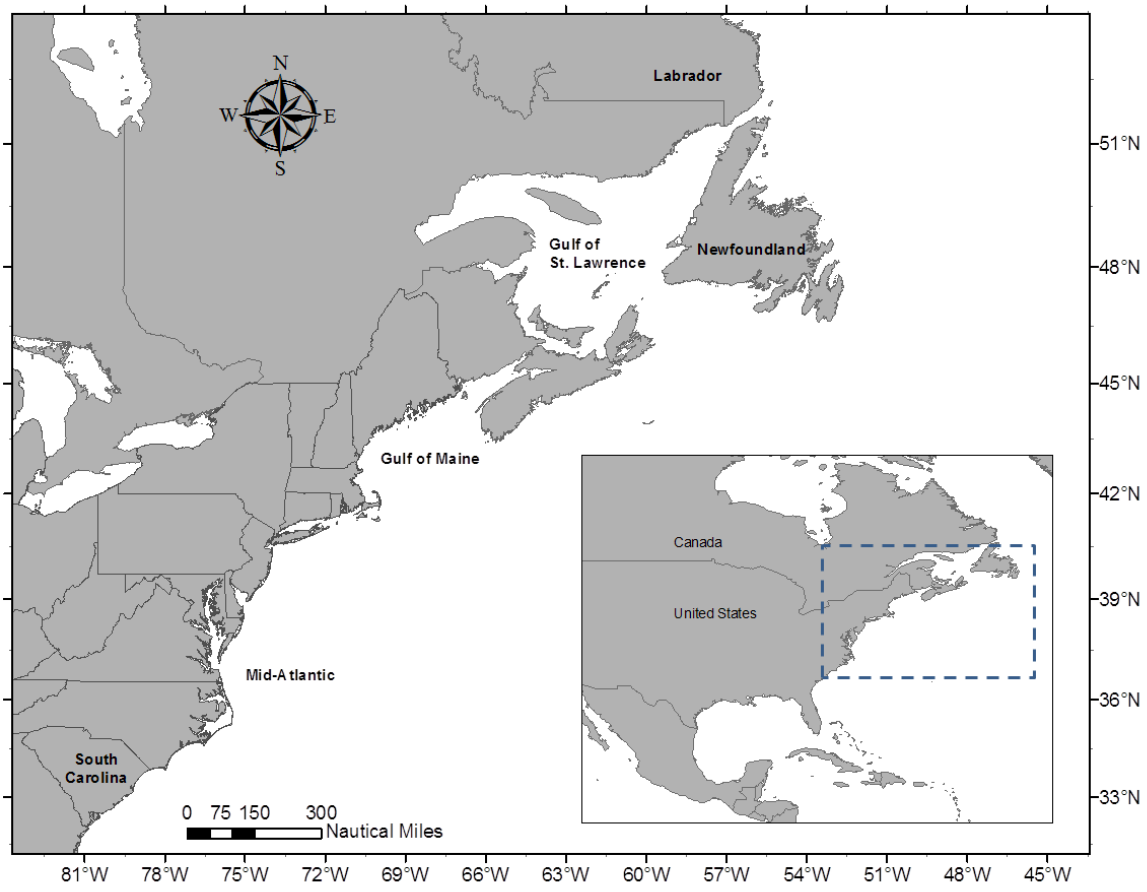


Figure 1 Map of the northwest Atlantic, inset shows geographic range for silver and red hake

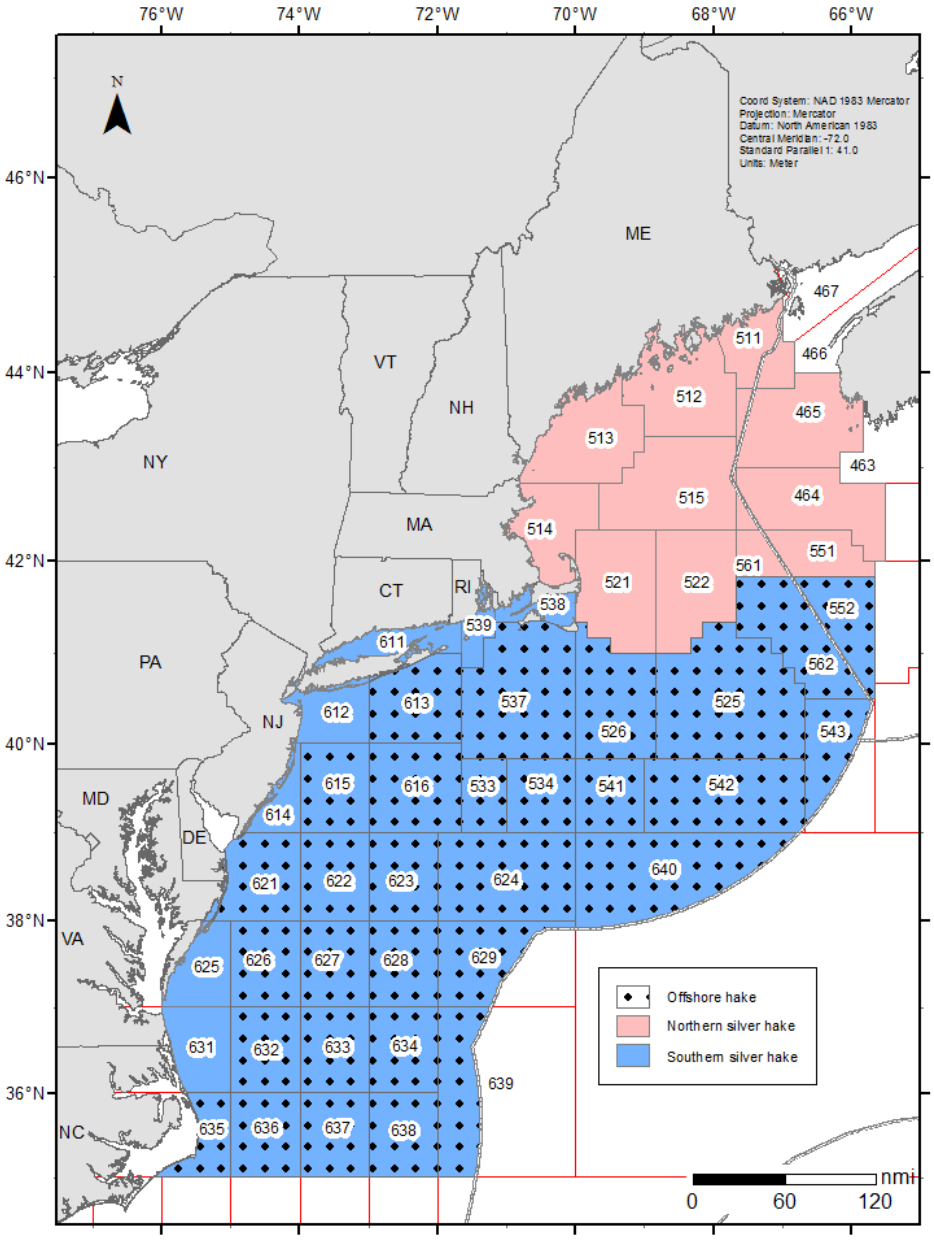


Figure 2 Chart showing management and assessment area for silver hake and offshore hake stocks

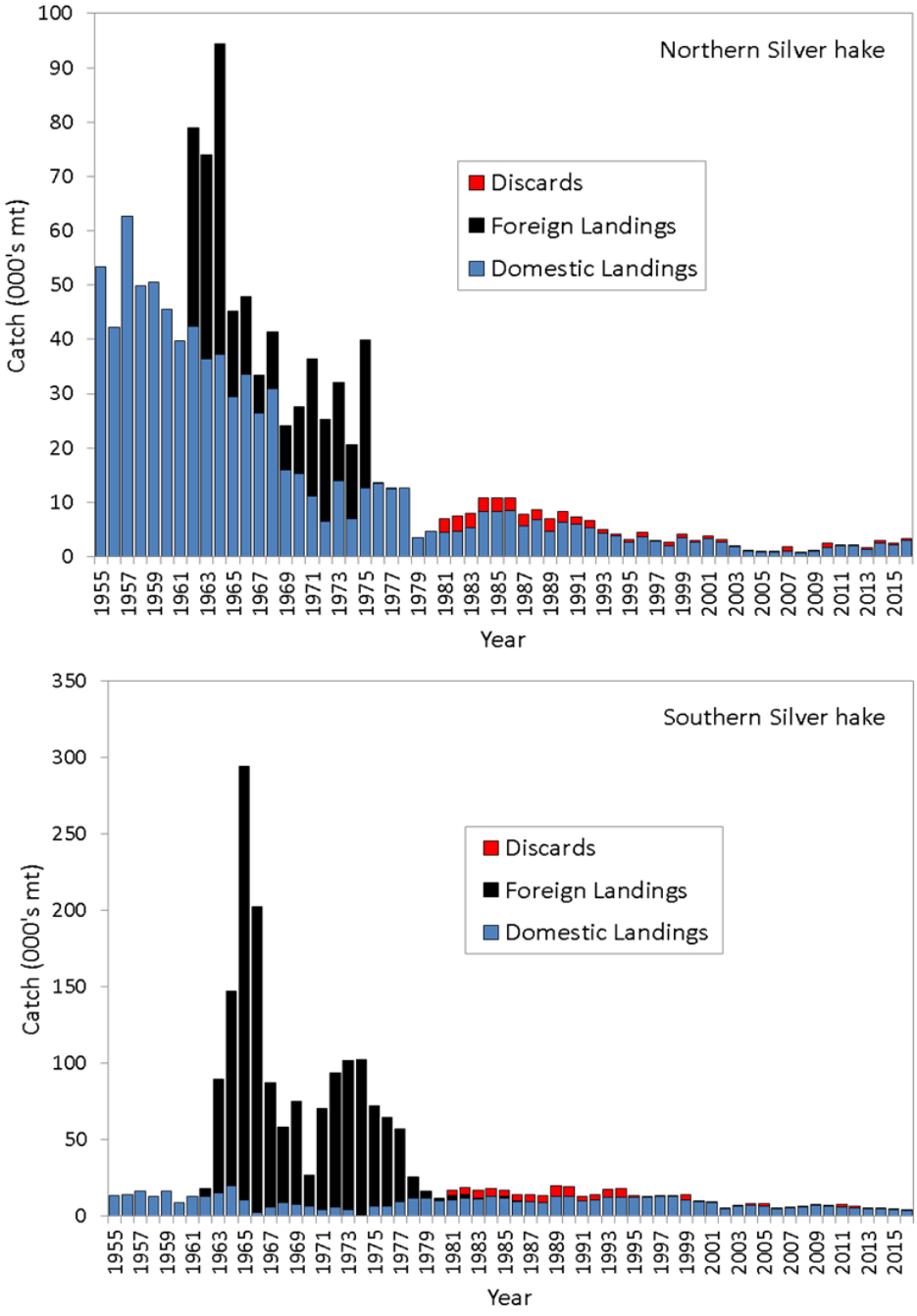


Figure 3 Summary of total catch (landings and discards, mt) for northern and southern silver hake stocks, 1955-2016. Note: Landings include vessel trip reported bait landings, and are not disaggregated in order to preserve confidentiality of business data.

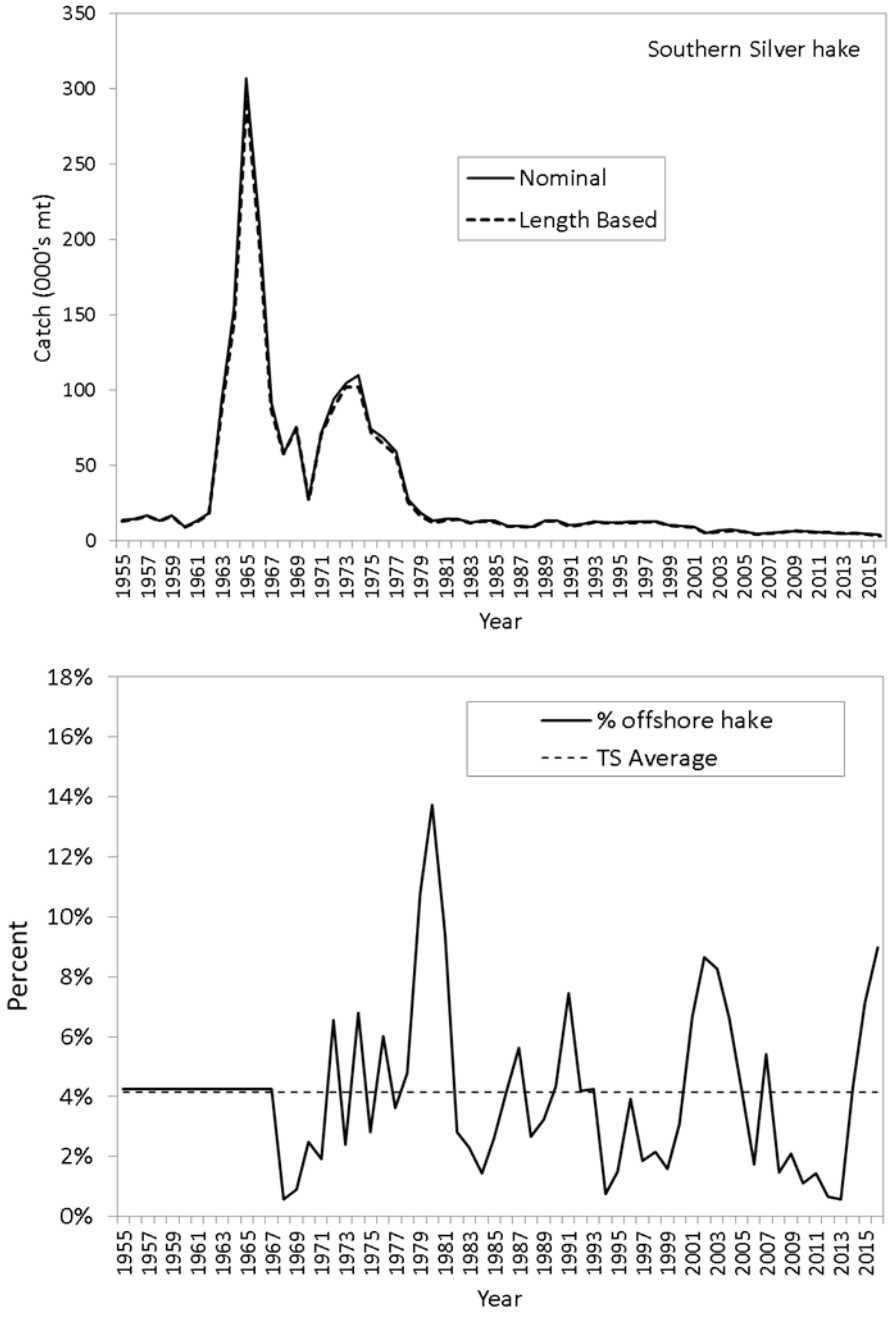


Figure 4 Comparison of model-based landings to dealer reported landings of silver hake (mt), including percentage of offshore hake estimated to be included in southern silver hake landings, derived from the length-based algorithm for 1955-2016

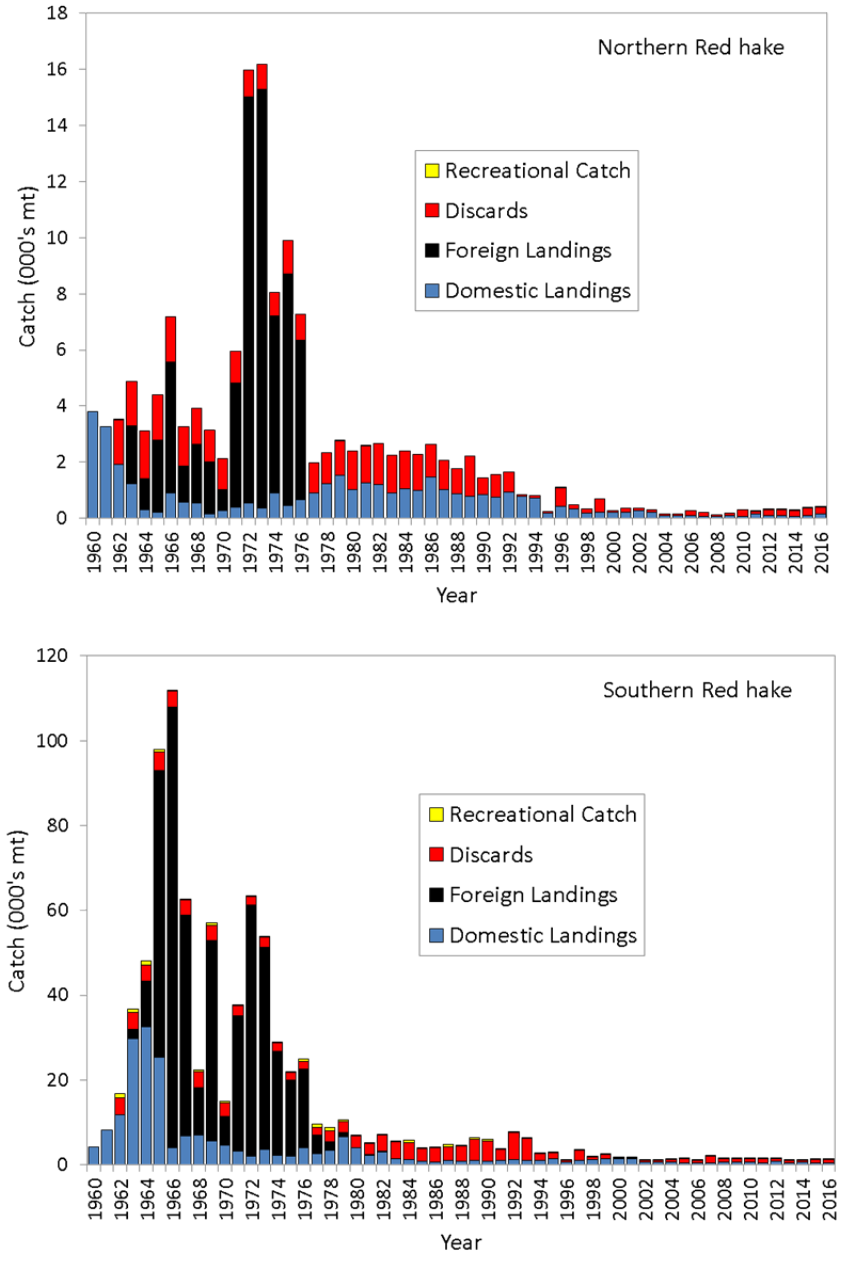


Figure 5 Total catches (landings and discards, mt) of northern and southern red hake stocks, 1960-2016

Northern

Southern

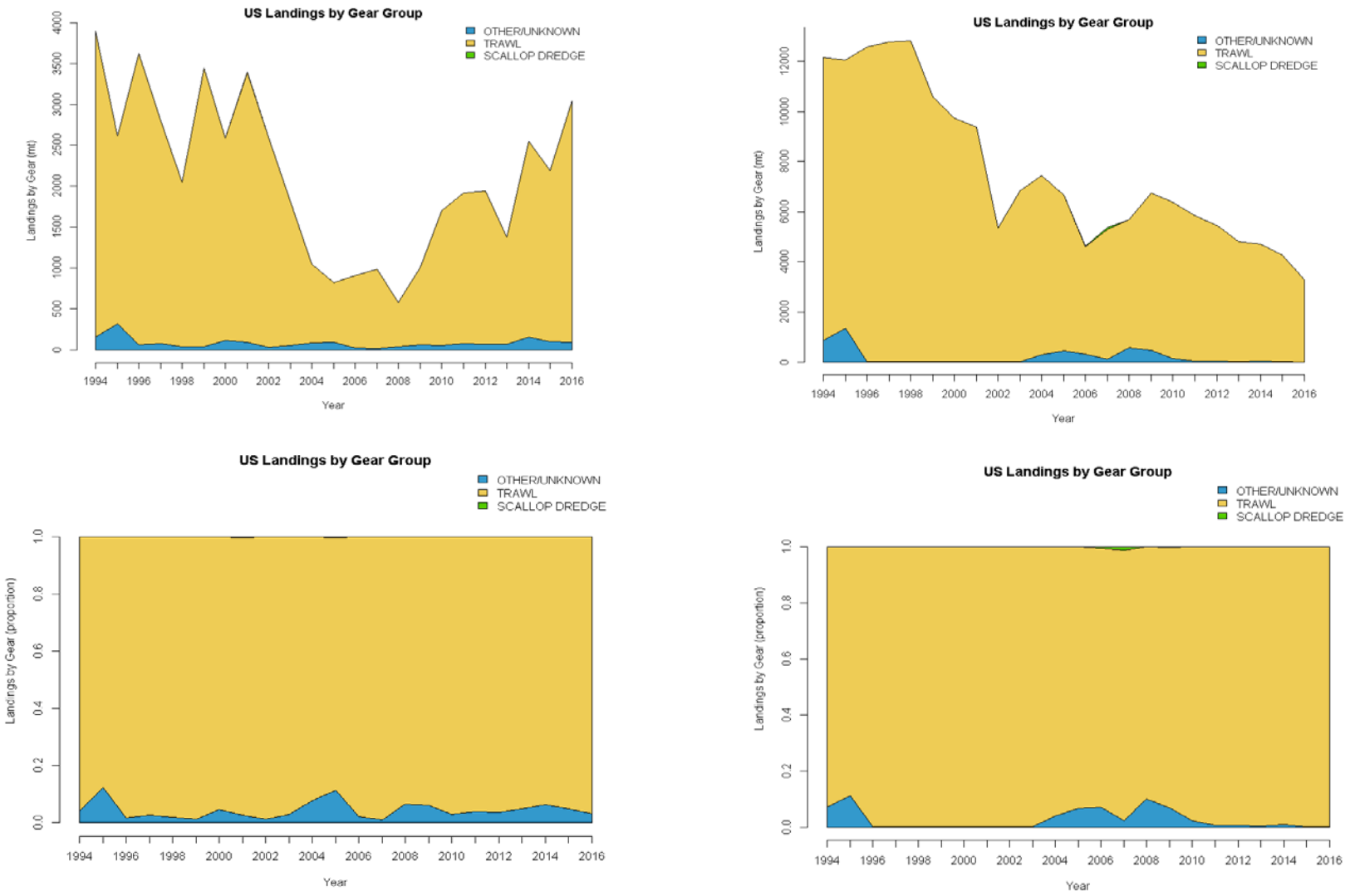


Figure 6 Estimated commercial landings of northern and southern silver hake by major gear groupings, by weight and percentage of total landings, 1994-2016

Northern

Southern

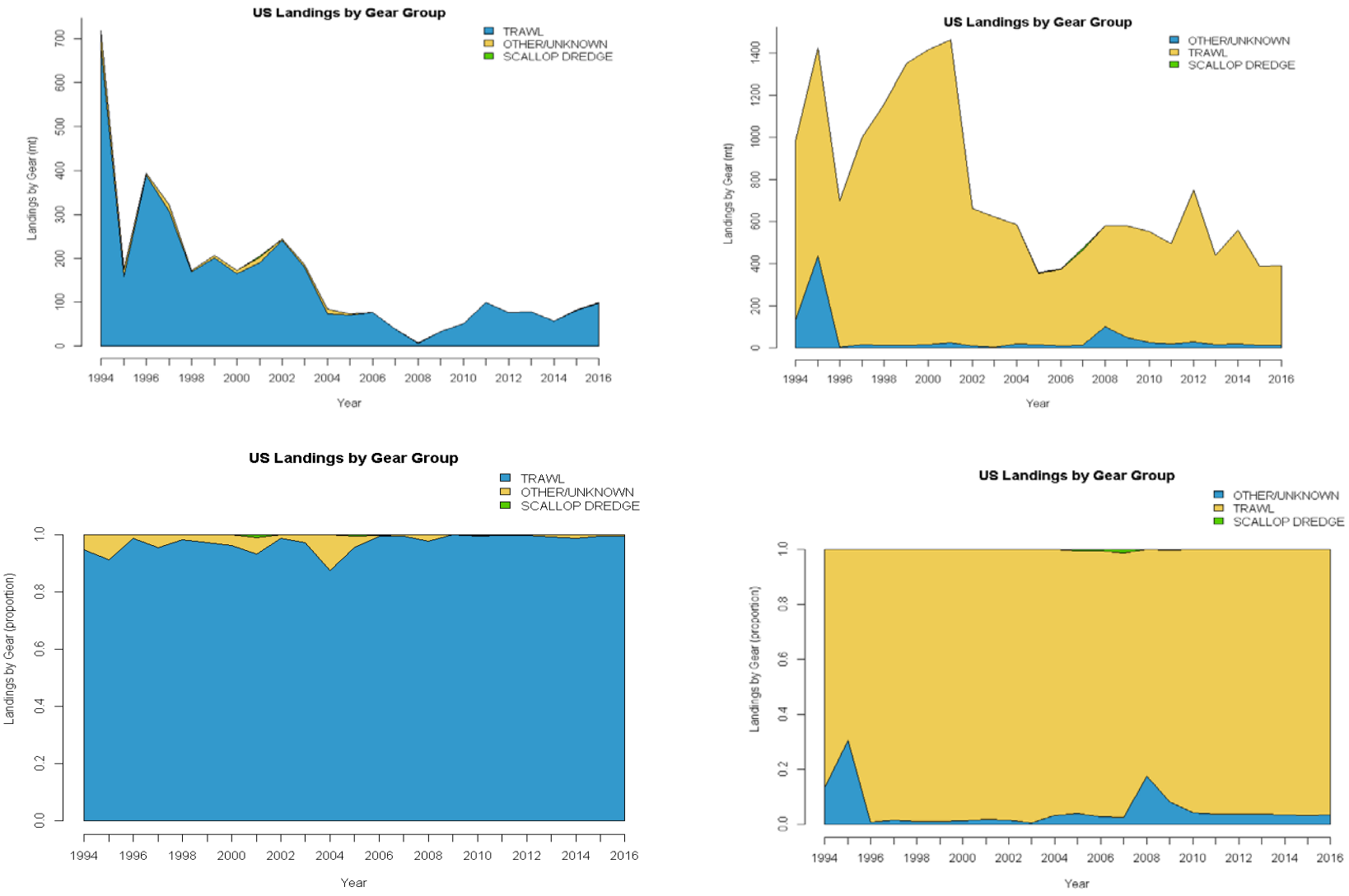


Figure 7 Estimated commercial landings of northern and southern red hake by major gear groupings, by weight and percentage of total landings, 1994-2016

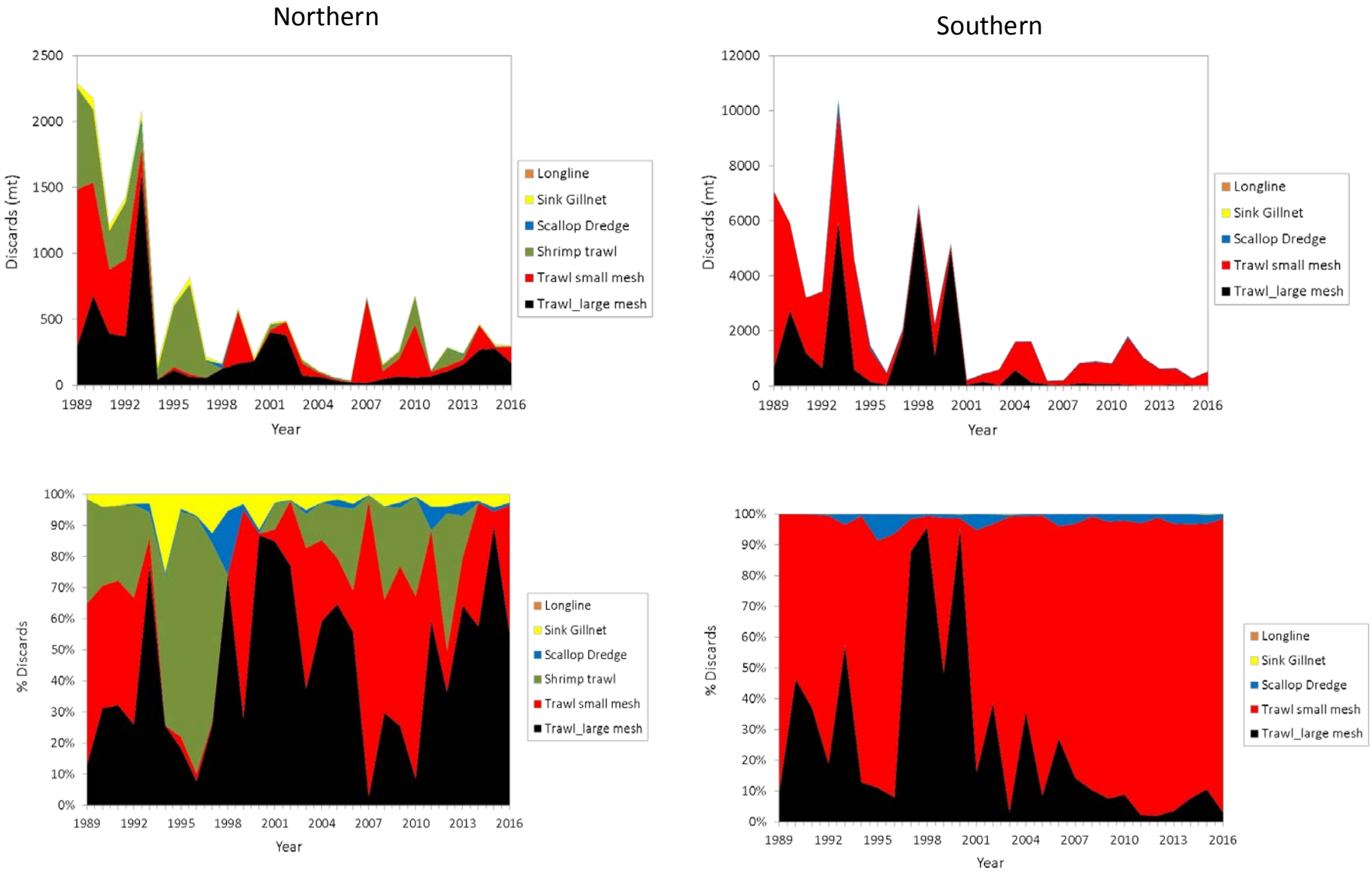


Figure 8 Estimated commercial discards of northern and southern silver hake by major gear groupings, by weight and percentage of discard, 1989-2016

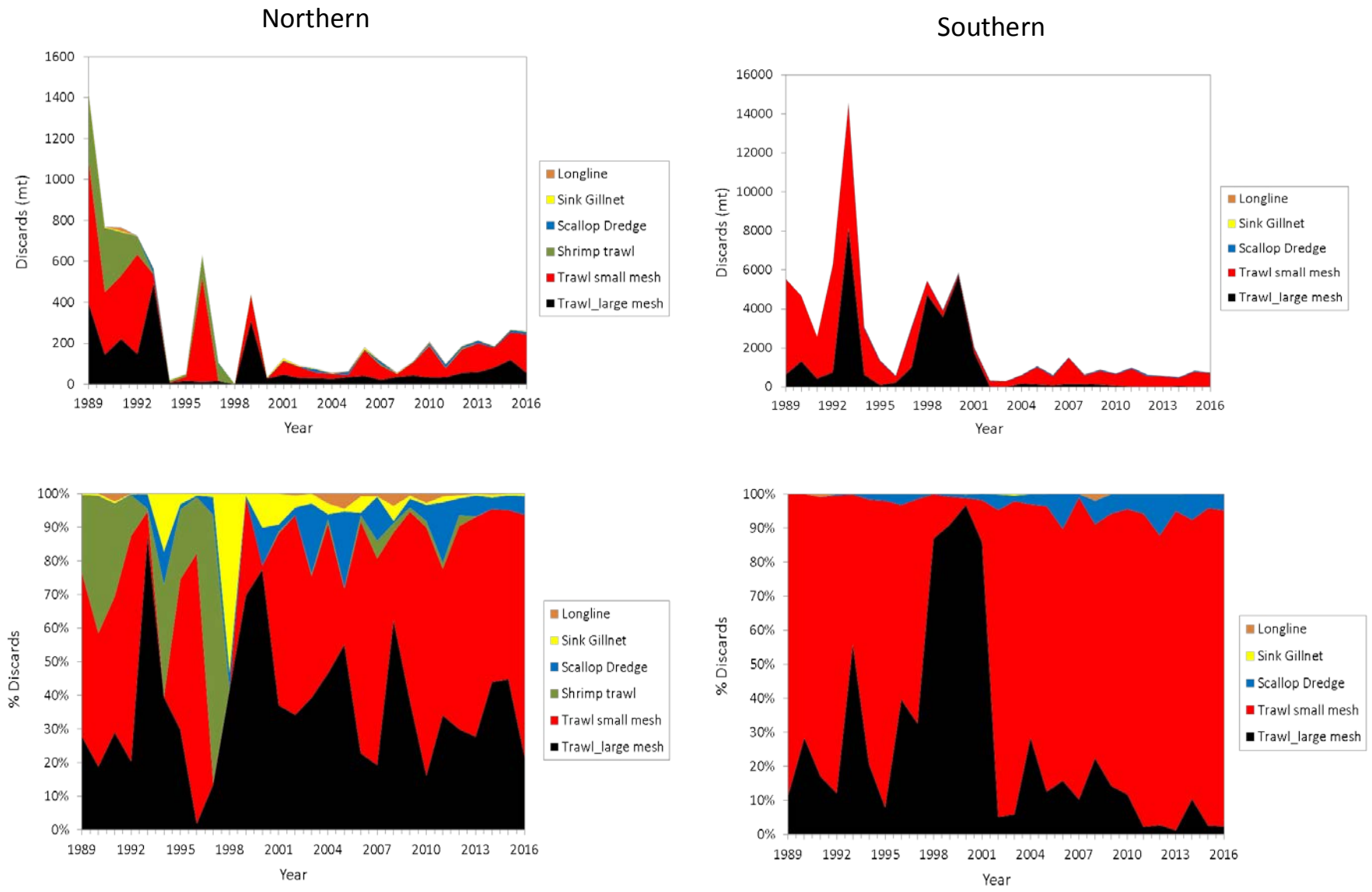


Figure 9 Commercial discards of northern and southern red hake by major gear groupings, by weight and percentage of total discards, 1989-2016

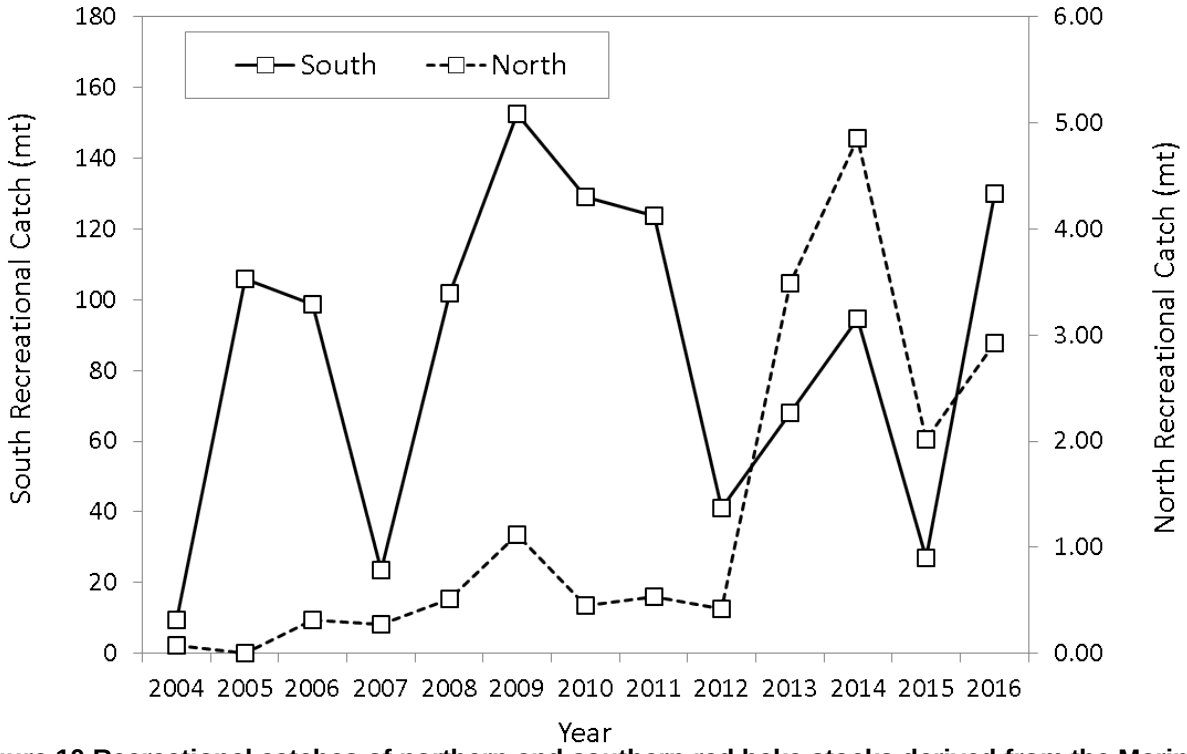


Figure 10 Recreational catches of northern and southern red hake stocks derived from the Marine Recreation Information Program, 2004-2016

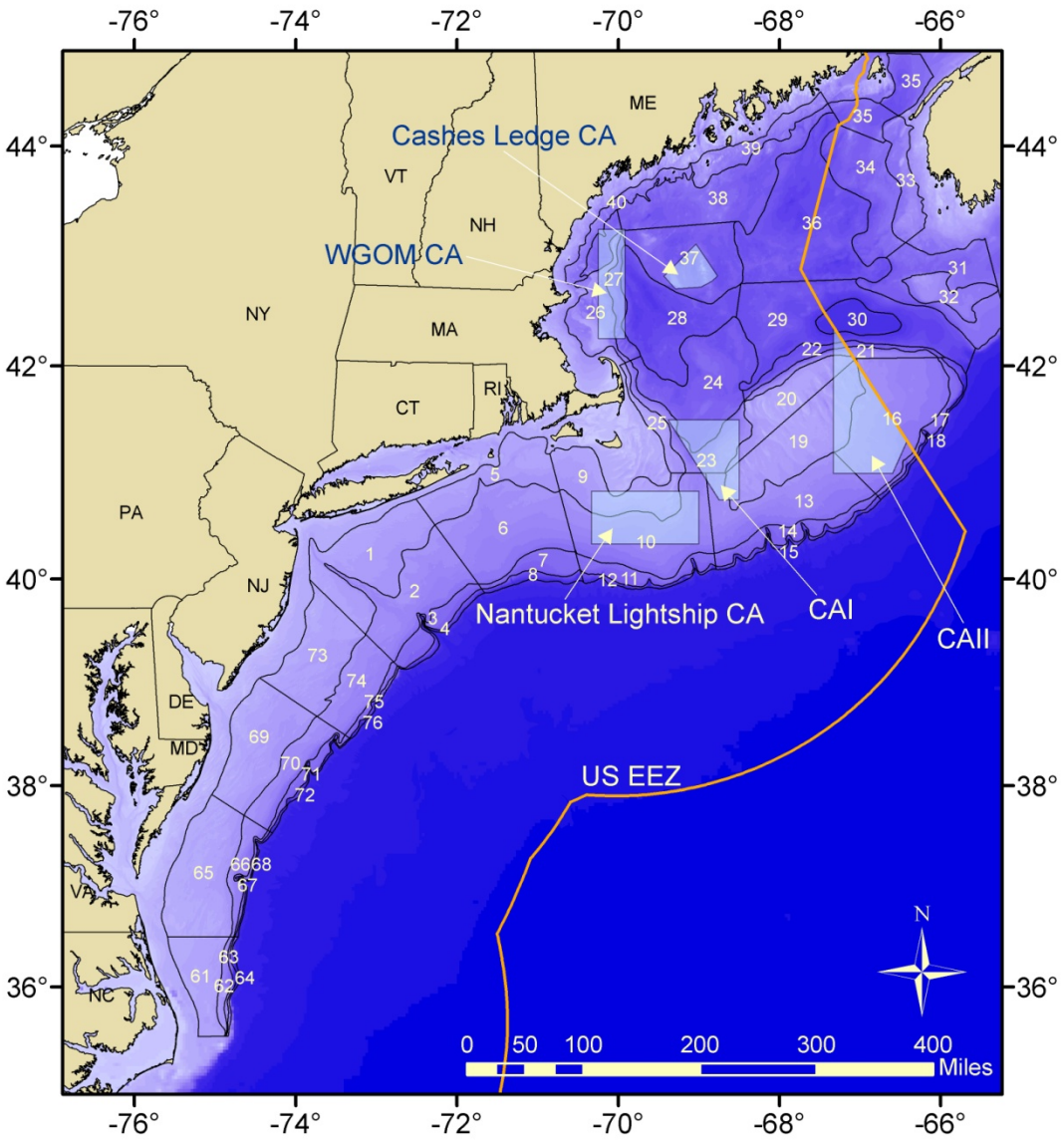


Figure 11 Chart of the Northeast Fisheries Science Center bottom-trawl survey strata included in the northern (strata 20-30 and 36-40) and southern (strata 01-19 and 61-76) silver and red hake stock assessment update and previous assessments

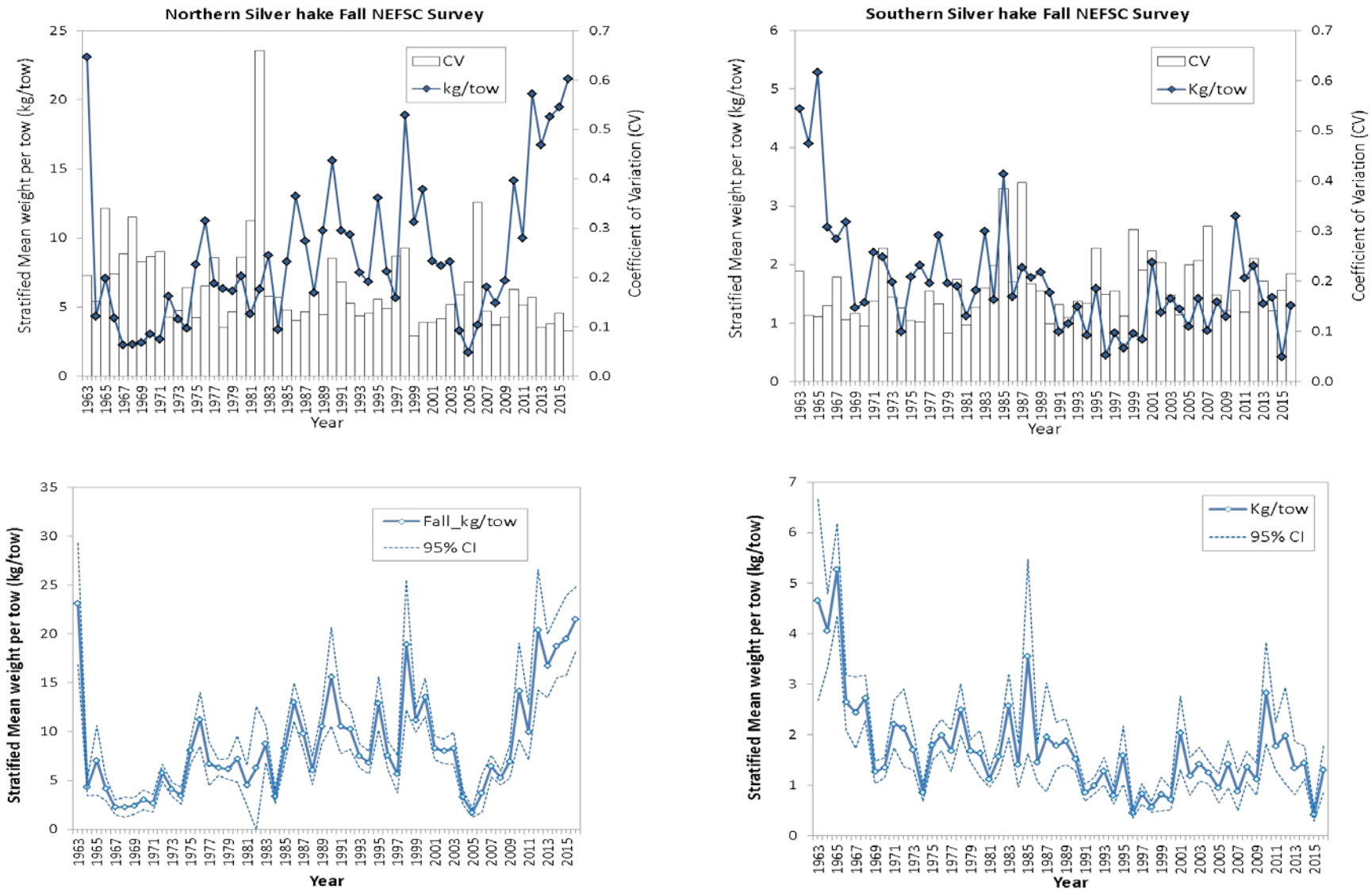


Figure 12 Northern (left) and southern (right) silver hake index of biomass (kg/tow) from the Northeast Fisheries Science Center fall bottom-trawl survey, and estimated coefficient of variation (CV) in Albatross units, 1963-2016. Bottom panels show estimated index and the 95% confidence intervals.

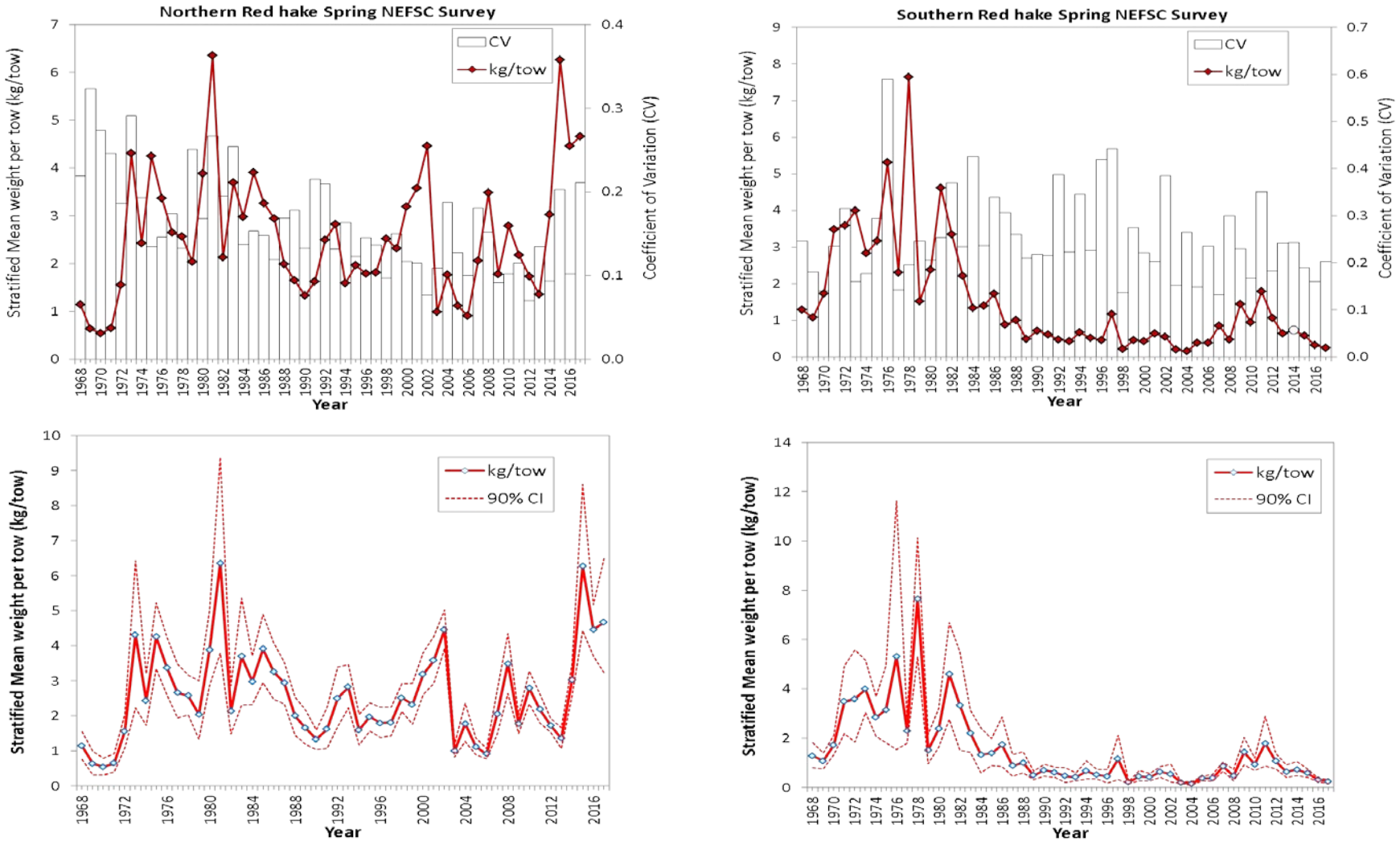


Figure 13 Northern (left) and southern (right) red hake index of biomass (kg/tow) from the Northeast Fisheries Science Center spring bottom-trawl survey, and estimated coefficient of variation (CV) in Albatross units, 1968-2017. Bottom panels show estimated index and the 95% confidence intervals.

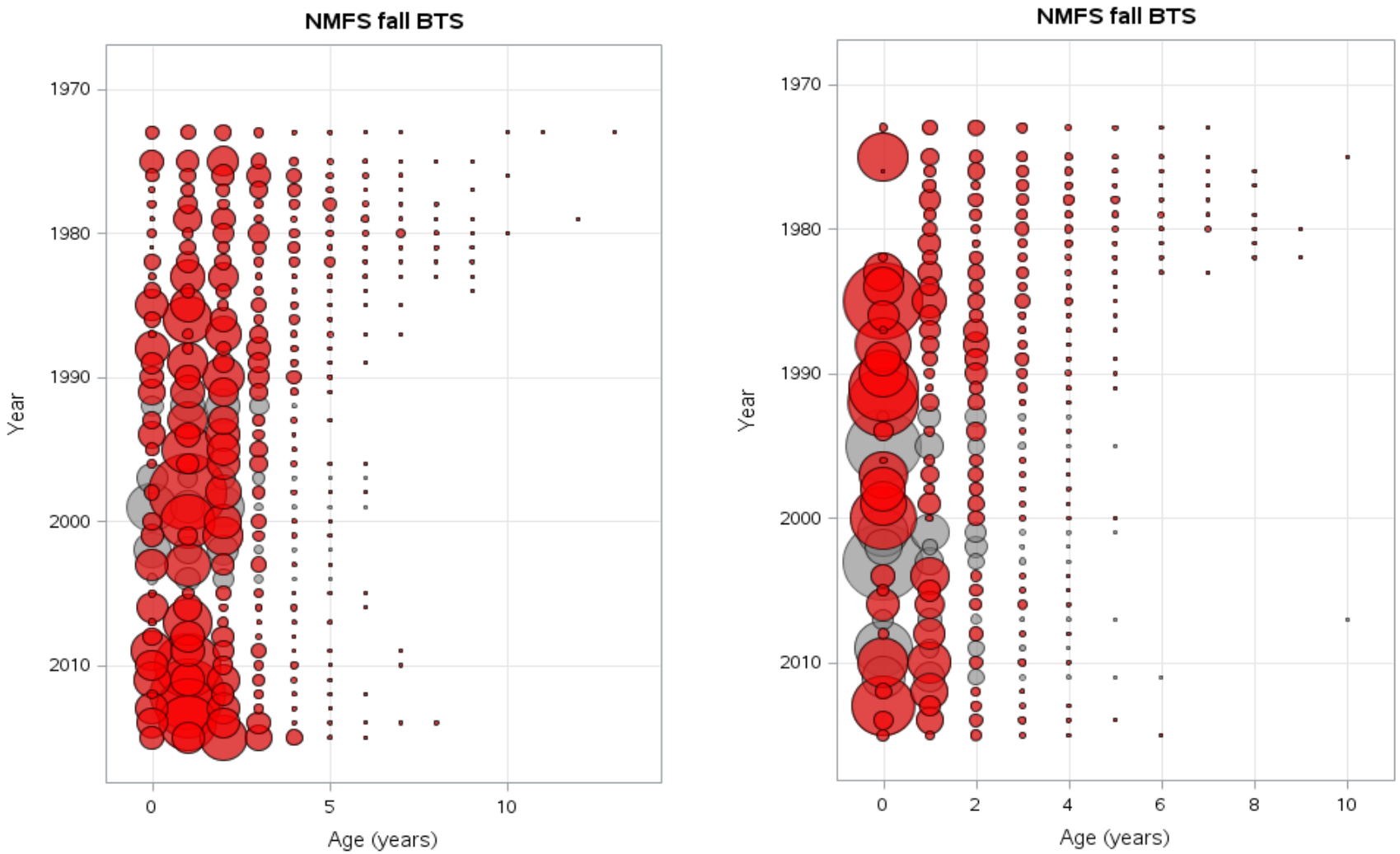


Figure 14a Northern (left) and southern (right) silver hake numbers-at-age from the NEFSC autumn bottom-trawl survey, 1963 to 2015. Note: Age samples for 2016 were not available for this update.

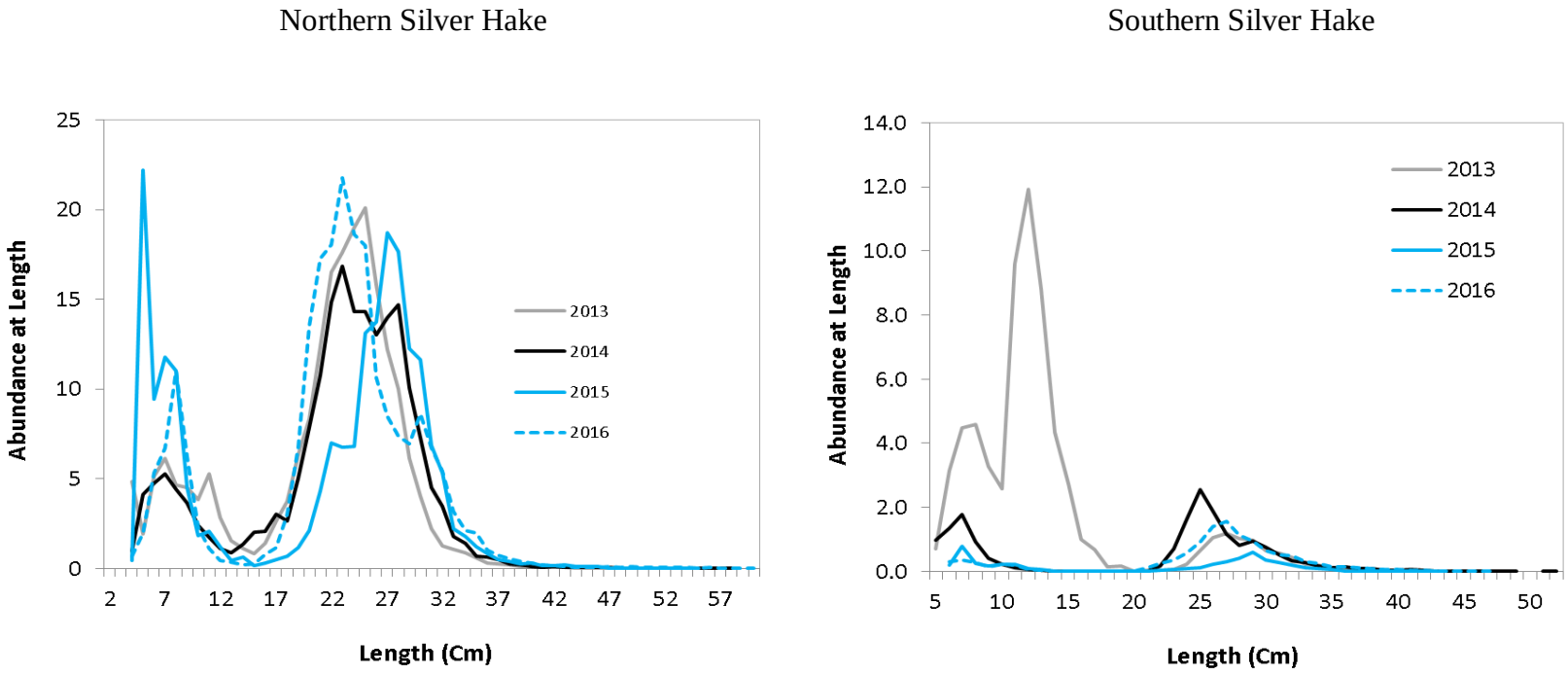


Figure 14b Northern and southern silver hake size-frequency distribution from the NEFSC fall bottom-trawl survey, 2013-2016

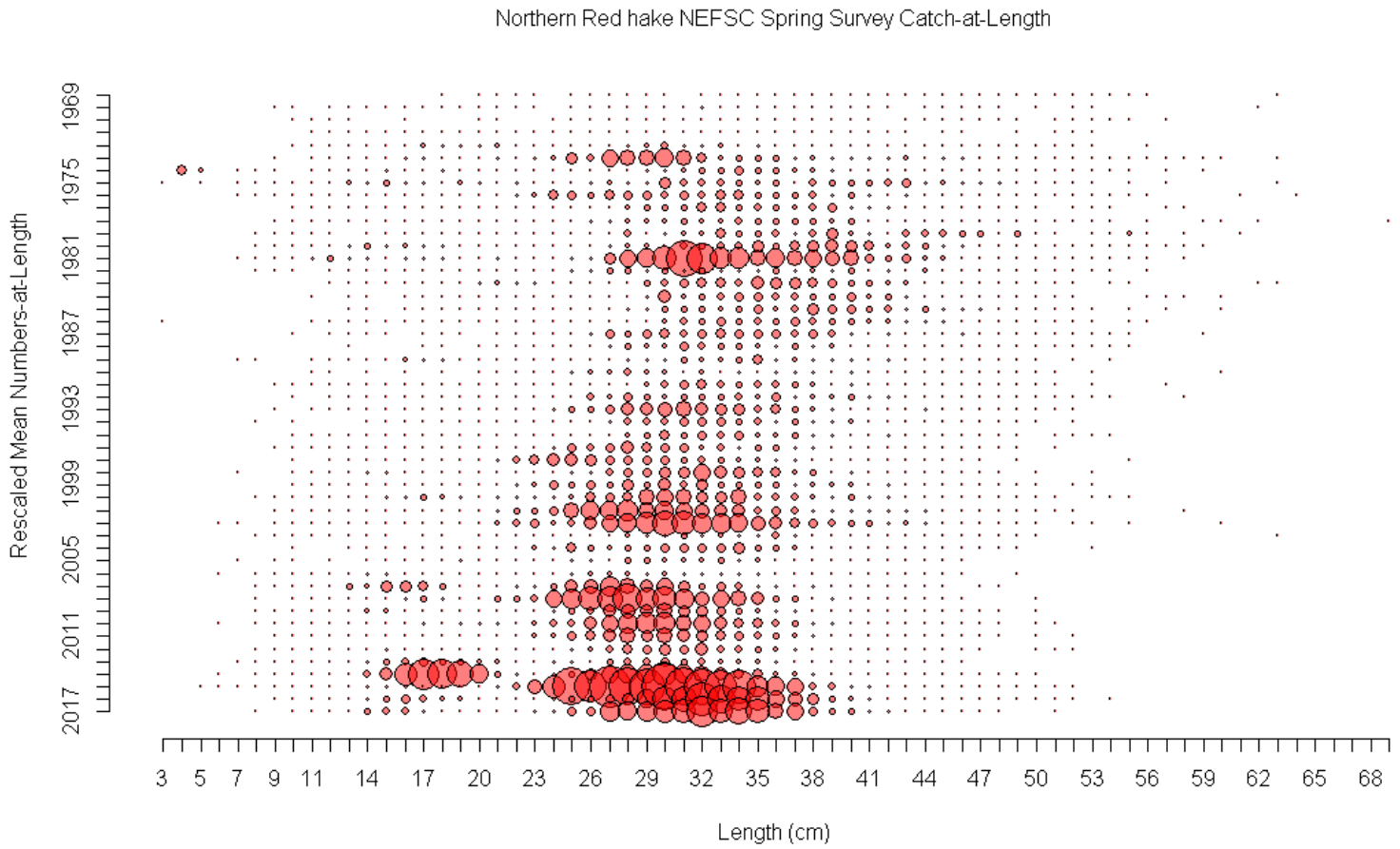


Figure 15a Northern red hake catch-at-length from the NEFSC spring bottom-trawl survey, 1968-2017

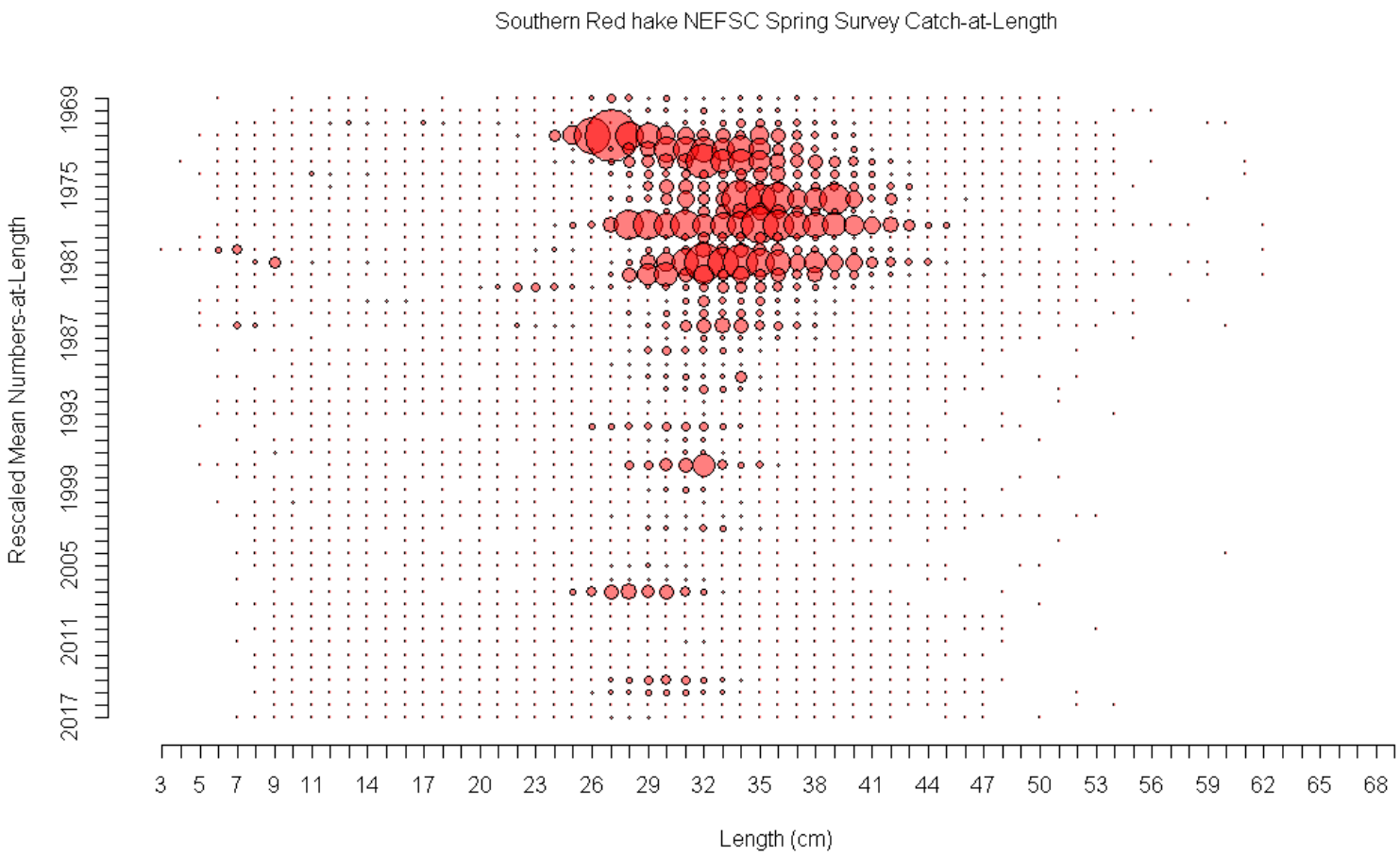


Figure 15b Southern red hake catch-at-length from the NEFSC spring bottom-trawl survey, 1968 to 2017

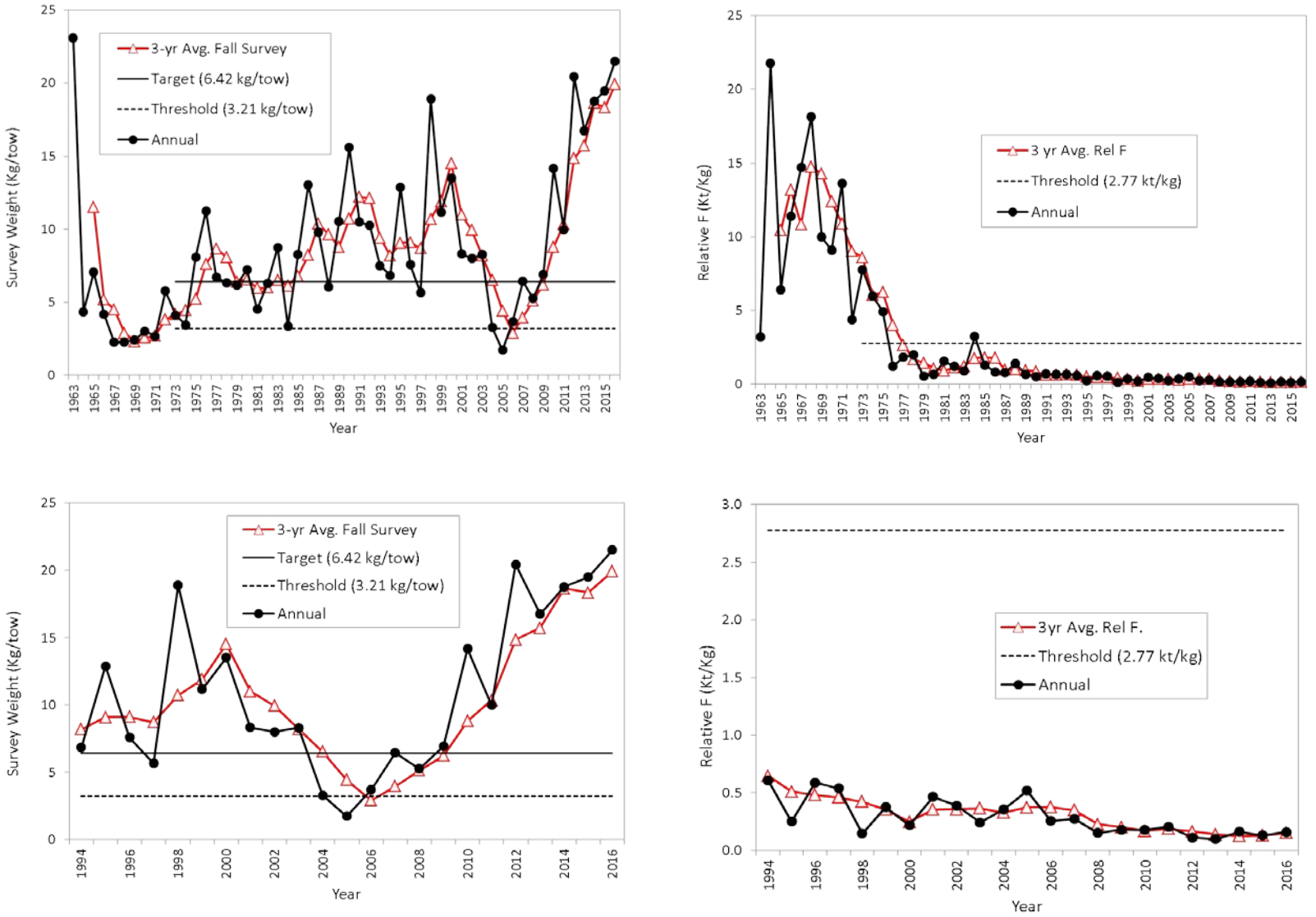


Figure 16 Northern silver hake NEFSC fall bottom- trawl survey biomass (left) and relative exploitation ratios (right) of the total catch to the fall survey indices and associated 3-yr moving averages (red lines). The horizontal dashed lines represent the biomass and overfishing thresholds. The solid line is the biomass target.

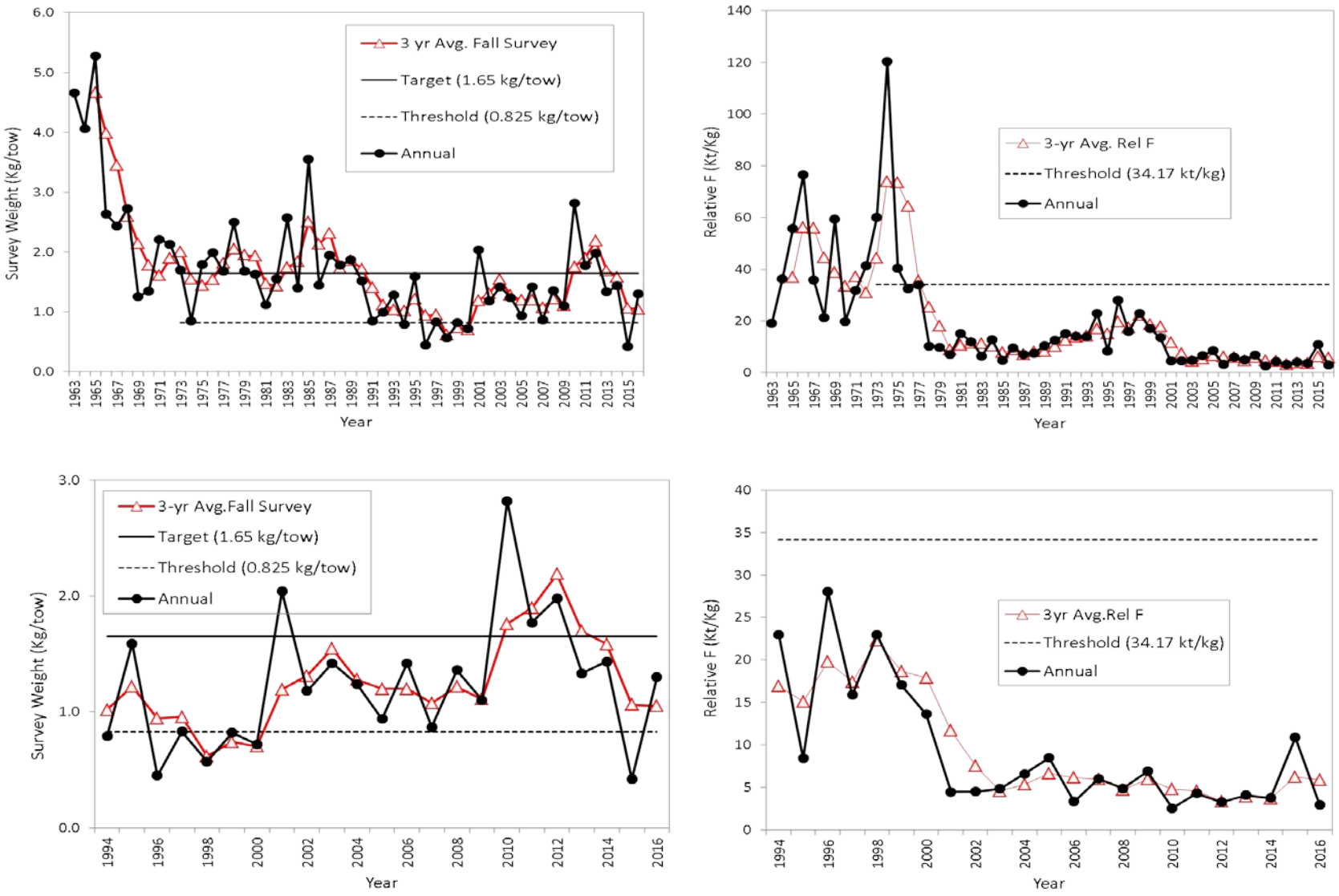


Figure 17 Southern silver hake fall NEFSC bottom-trawl survey biomass (left) and relative exploitation ratios (right) of the total catch to the fall survey indices, and associated 3-year moving averages (red lines). The horizontal dashed lines represent the biomass and overfishing thresholds. The solid line is the biomass target.

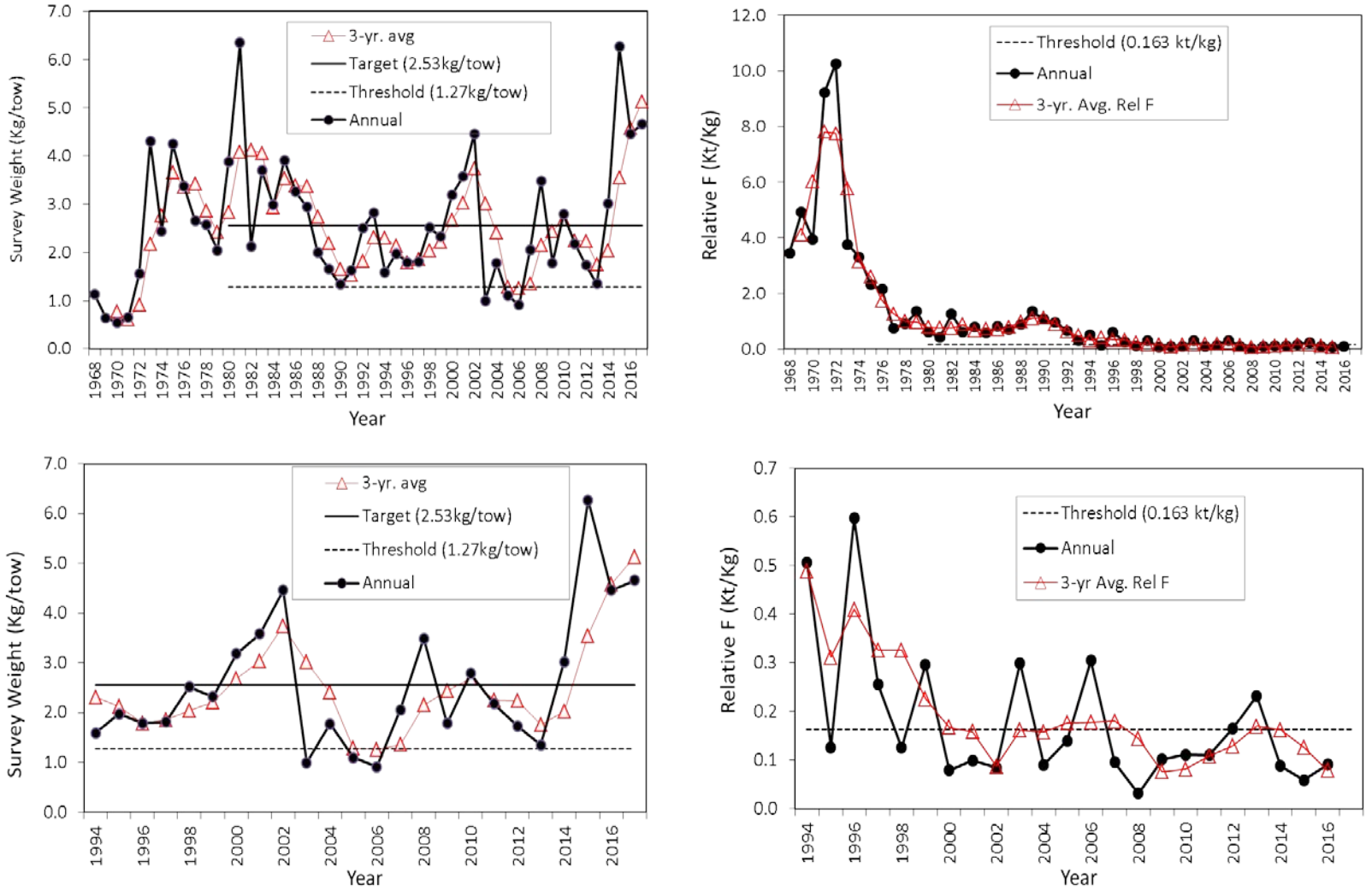


Figure 18 Northern red hake NEFSC spring bottom-trawl survey biomass (left) and relative exploitation ratios (right) of the total catch to the spring survey indices, and associated 3-year moving averages (red lines). The horizontal dashed lines represent the biomass and overfishing thresholds. The solid line represents the biomass target.

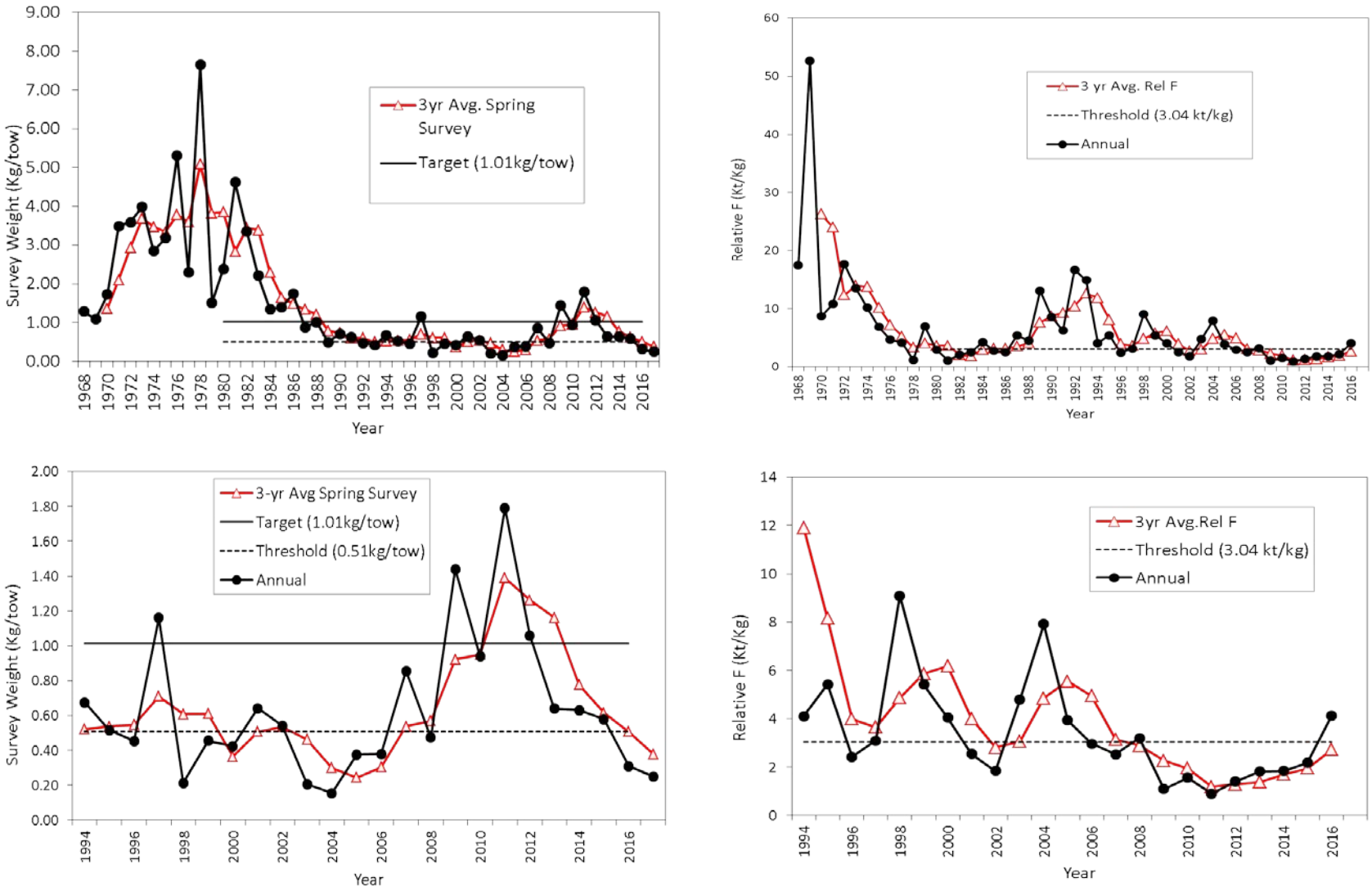


Figure 19 Southern red hake NEFSC spring bottom-trawl survey biomass (left) and relative exploitation ratios (right) of the total catch to the spring survey indices, and associated 3-year moving averages (red lines). The horizontal dashed lines represent the biomass and overfishing thresholds. The solid line represents the biomass target.

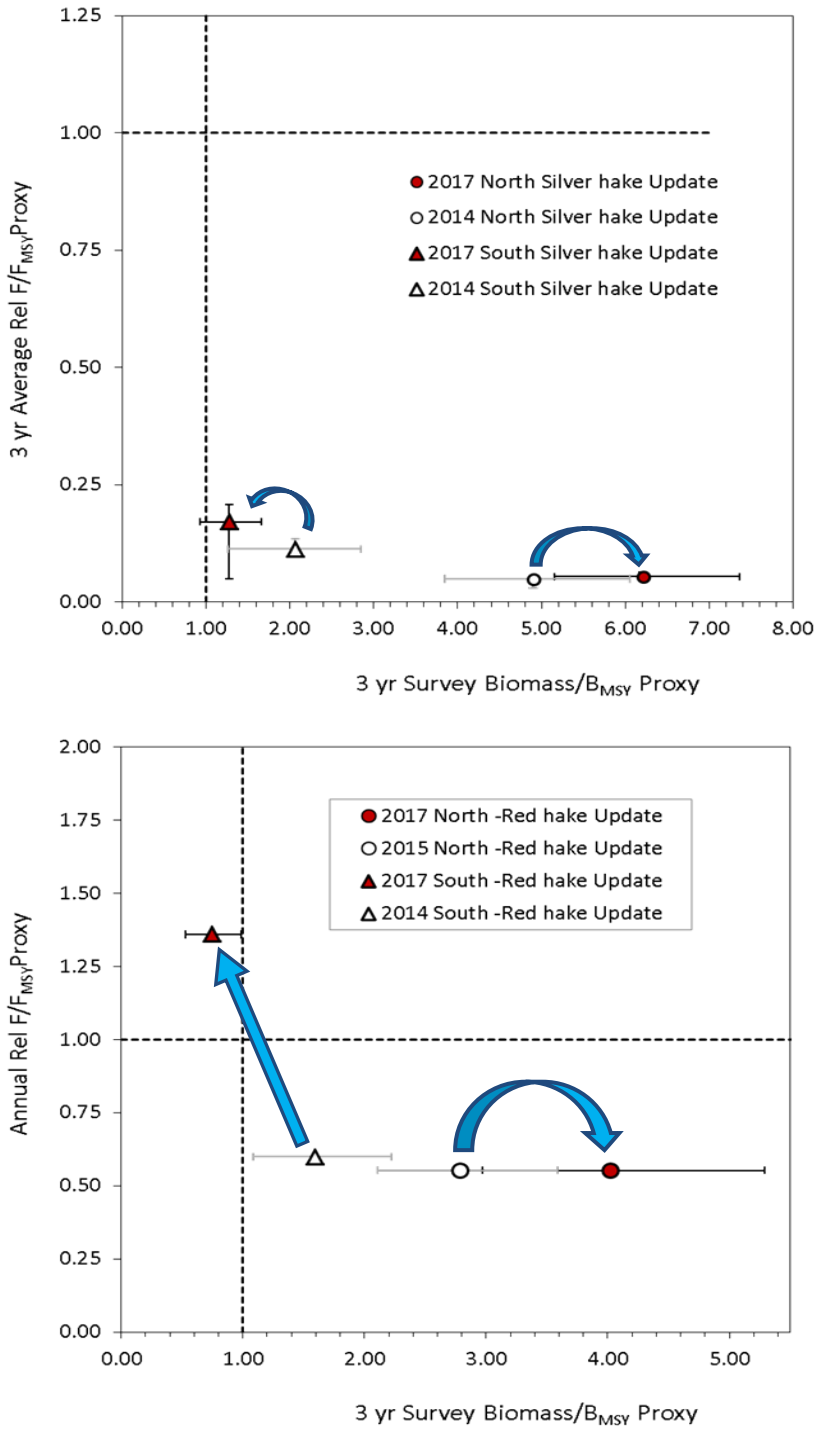


Figure 20 Silver hake (top) and red hake (bottom) biomass and fishing stock status plots based on assessment updates for years 2014, 2015 and 2017 and associated 95% confidence intervals. The triangle and circle symbols are point estimates derived from the ratio of the most recent 3-year-average index to proxy reference points. The 95% confidence intervals were calculated from the 5th and 95th percentile of the cumulative distribution of the recent 3-year index of biomass and relative fishing mortality (F; Silver Only).

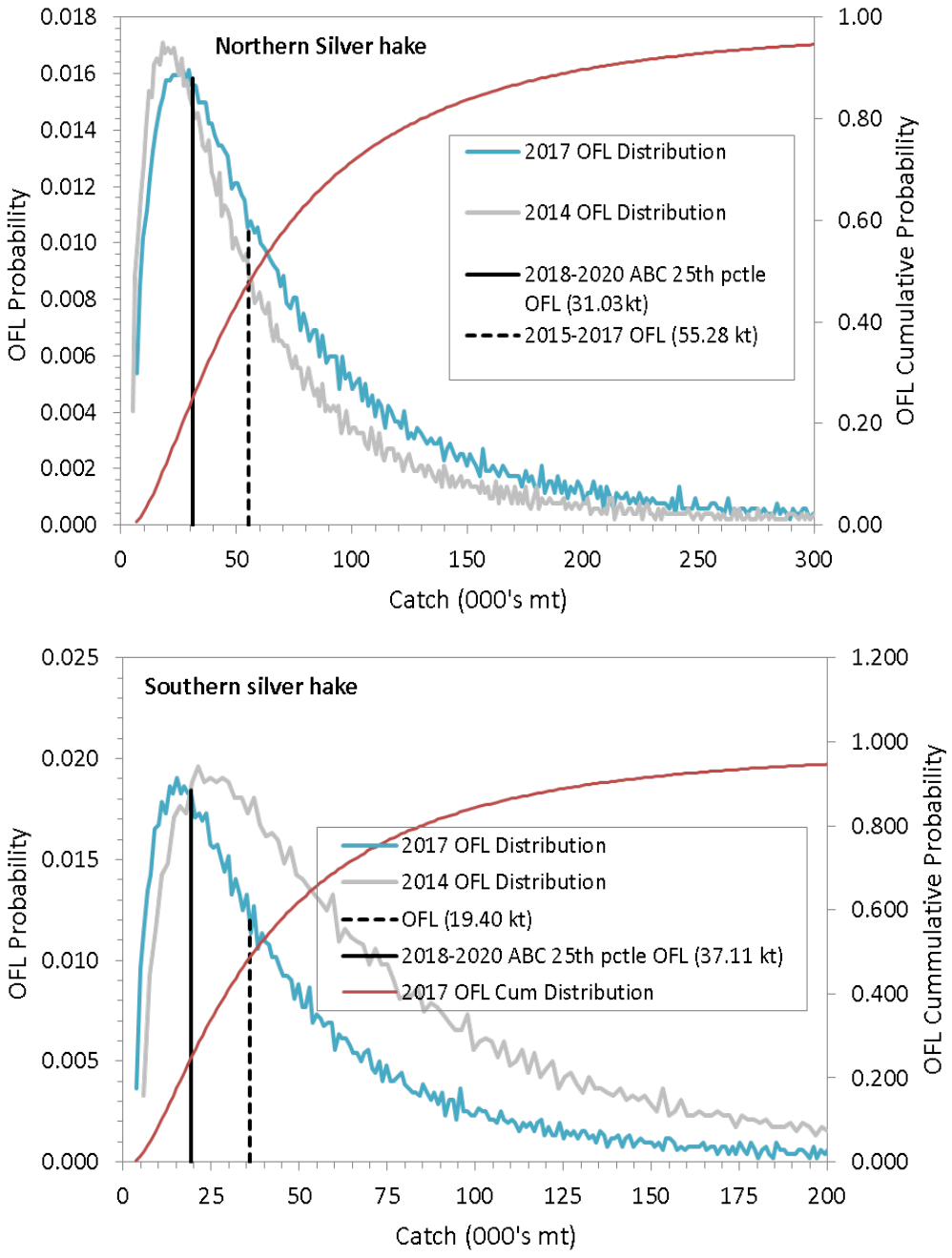
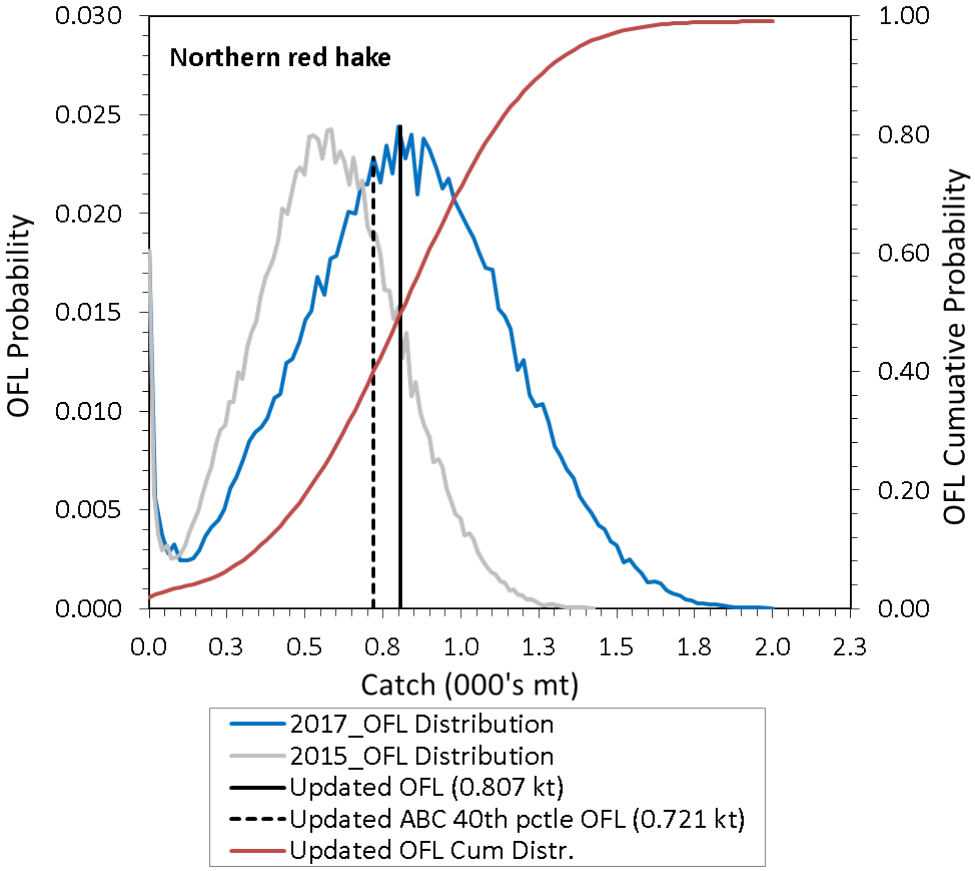


Figure 21 2014 updated overfishing limit (OFL) frequency distribution for northern and southern silver hake stocks, derived as a cross-product of the NEFSC fall bottom-trawl survey and relative exploitation probability distributions. The fall survey probability distributions were derived from the most recent 3-year mean and variance and assume a normal error structure. Distribution of relative exploitation was calculated as the average of the ratios of catch to the NEFSC fall bottom trawl survey biomass from 1973-1982 with a lognormal error structure.



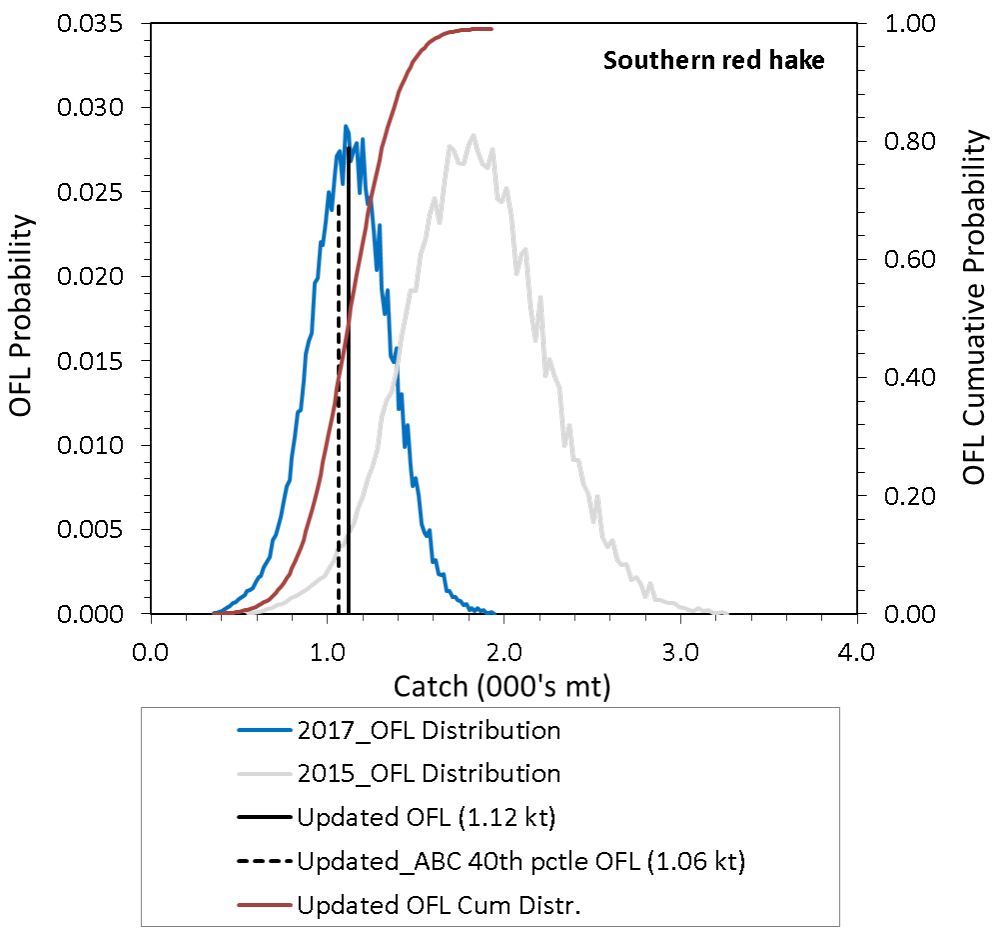


Figure 22 2014 overfishing limit (OFL) frequency distribution for the northern and southern red hake stocks, derived as a cross-product of the NEFSC spring bottom-trawl survey and relative exploitation probability distributions. The spring survey probability distributions were derived from the most recent 3-year mean and variance, and assume a normal error structure. Distribution of relative exploitation was calculated as the average of the ratios of catch to the NEFSC spring bottom-trawl survey biomass, 1982-2010, with a normal error structure.

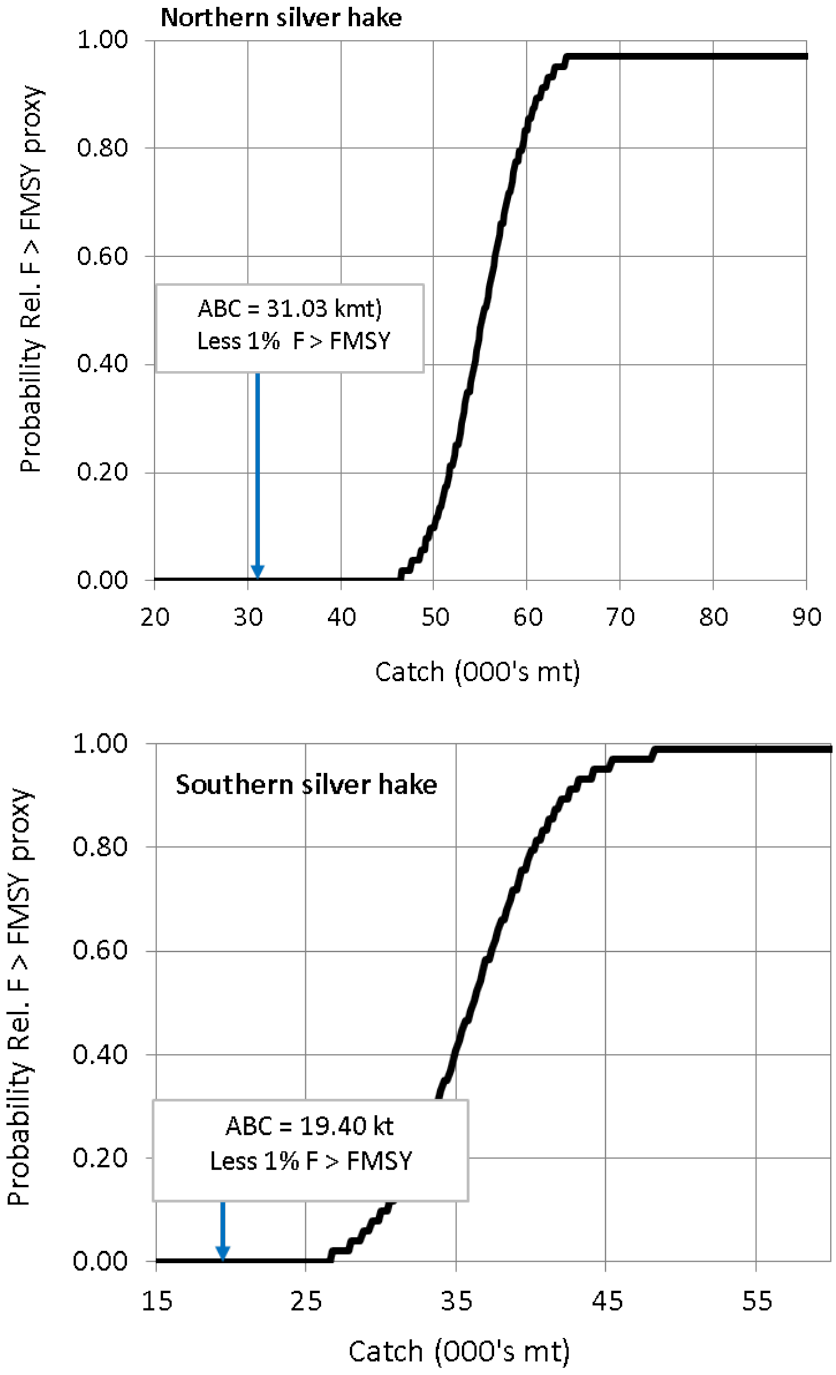


Figure 23 Probability of exceeding FMSY proxy for the northern and southern silver hake stocks based on the updated 2014 overfishing limit (OFL). The risk of overfishing is a product of the probability of relative F > FMSY proxy for each survey realization and the survey probability distributions.

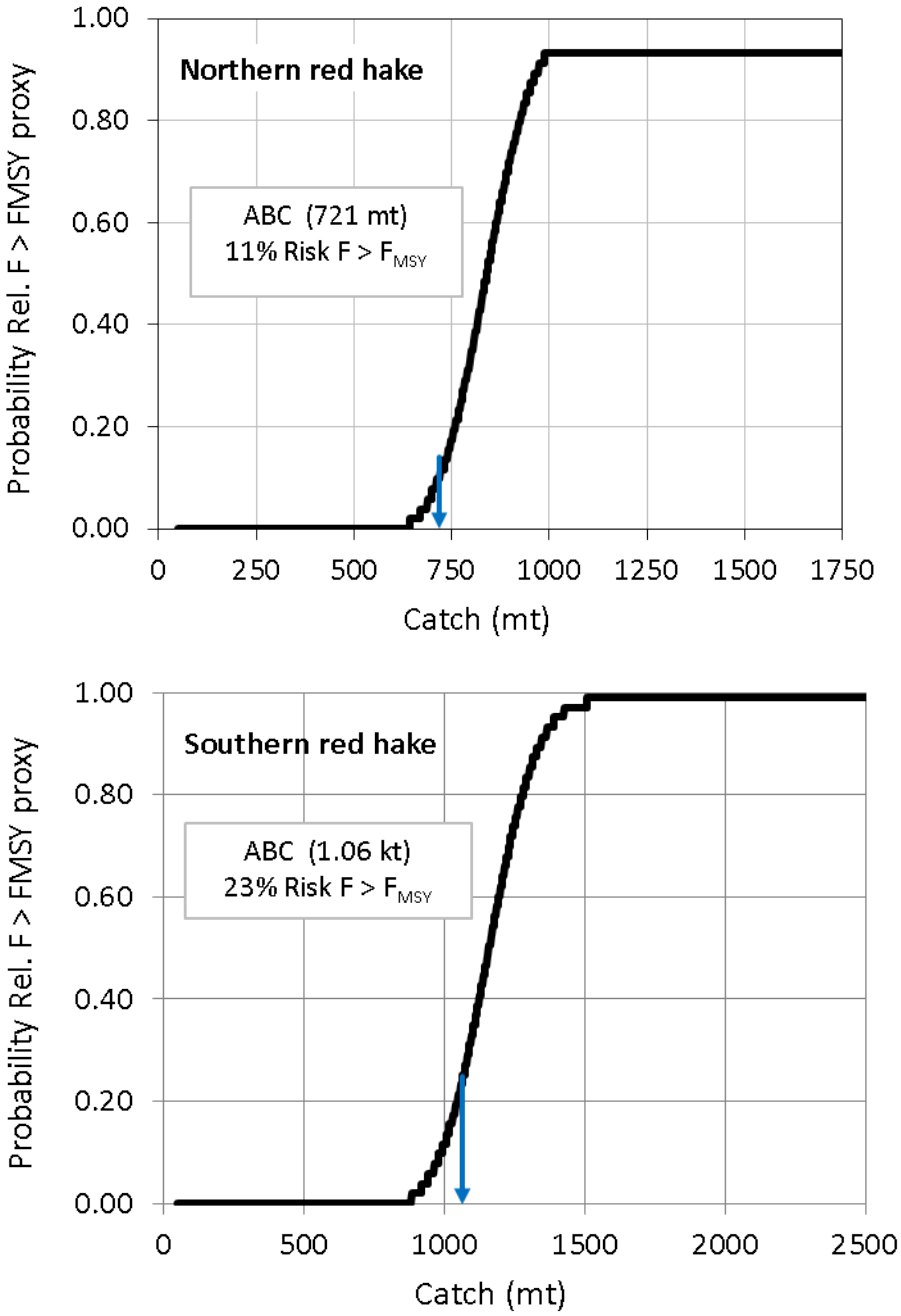


Figure 24 Probability of exceeding FMSY proxy for the northern and southern red hake stocks based on the updated 2014 overfishing limit (OFL). The risk of overfishing is a product of the probability of relative F > FMSY proxy for each survey realization and the survey probability distributions.

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