WP: D. Monk (7/23/2019)

D. Monkfish Operational Assessment for 2019

Northeast Fisheries Science Center

Executive Summary

Assessment data for northern and southern management units of monkfish were updated with minmal changes to the approaches of the previous index-based assessment (NEFSC 2016). No age data are available for monkfish, and the assessment does not include analytic models.

TOR 1. Update fishery-dependent and fishery-independent data from previous assessment.
Commercial fishery statistics for monkfish were updated for 2015-2018. In the north, landings and catch have fluctuated around a steady level since 2009, but increased after 2015. In the south, landings and catch had been declining since around 2000, but catch increased after 2015 due to discarding of a strong 2015 year class.

Survey data updated through 2018 indicate an increasing trend in biomass in both management areas since 2014; exploitable biomass (43+cm total length) indices have more than doubled in both areas since 2015, reflecting growth of the strong 2015 year class. Abundance also increased, and remains relatively high but has been decreasing in most series since 2016. Recruitment indices were high in the north in 2015 and 2016, and in the south in 2015.

New estimates of area-swept minimum biomass and abundance were developed using results from a study of relative efficiency of chain and rock-hopper sweeps on the net used for NEFSC bottom trawl surveys.The area-swept estimates are approximately 5 times higher than the un-adjusted estimates, but follow the same trends.

TOR 2. Prepare an approach to providing scientific advice to management in the absence of an analytical model.
The monkfish assessment does not include an analytical model because the aging method has been invalidated, thus invalidating the growth model that is the foundation for the previously-approved model.

A simple model-free method previously used to derive Georges Bank cod catch limits was applied to current monkfish data. The method calculates the proportional rate of change in smoothed survey indices over the most recent 3 years for potential application to revising catch limits. In the NMA, the estimated rate of change was 1.2-1.3 depending on which surveys were included, and in the SMA, the estimated rate of change was 0.96-1.04.

TOR 3. Update the values of biological reference points (BRPs) for this stock.
BRPs defined in the management plan are dependent on output from the now-invalidated population model, therefore they have not been updated.

TOR 4. Include qualitative descriptions of stock status based on simple indicators/metrics.
Strong recruitment in 2015 fueled an increase in stock biomass in 2016-2018, though abundance has since declined as recruitment returned to average levels. Biomass increases were greater in the northern area than in the southern area, and biomass has declined somewhat in the south.

TOR 5. Perform short-term (2-year) population projections.

Not relevant to this assessment.

6. Comment on research areas or data issues that might lead to improvements in future stock assessments.

Development of a growth curve and/or an accurate aging method would allow application of age-based models. A better understanding of stock structure and movement patterns, especially mxing between management areas, would be helpful.

Introduction

Life History

The monkfish (*Lophius americanus*), also called goosefish, is distributed in the Northwest Atlantic from the Grand Banks and northern Gulf of St. Lawrence south to Cape Hatteras, North Carolina (Collette and Klein-Macphee 2002). Monkfish may be found from inshore areas to depths of at least 900 m (500 fathoms). Seasonal onshore-offshore migrations occur and appear to be related to spawning and possibly food availability (Collette and Klein-MacPhee 2002).

Monkfish rest partially buried on soft bottom substrates and attract prey using a modified first dorsal fin ray that resembles a fishing pole and lure. Monkfish are piscivorous and can eat prey as large as themselves. Despite the behavior of monkfish as a demersal 'sit-and-wait' predator, recent information from electronic tagging suggests seasonal off-bottom movements which may be related to migration (Rountree et al. 2006).

Growth rates of monkfish are not well understood and recent studies call into question the growth curves used in prior assessments (2007, 2010, 2013). One recent study has shown that the method currently used to age monkfish in the U.S. (counting rings on vertebrae) does not consistently identify the correct number of presumed-annual rings at the margin of the vertebra (Bank 2016). Further work conducted at the NEFSC has confirmed this using samples from the strong 2015 yearclass at presumed ages 1, 2 and 3 (Sandy Sutherland, NEFSC, personal communication). In addition, it appears that growth of immature monkfish may be much faster than previously understood. Growth estimated by modal progression of the 2015 yearclass suggests that monkfish may grow to ~25 cm by age 1 and reach the size at maturity (approximately 40 cm) by age two (Figure 1).

The estimated size at 50% maturity of monkfish is 41 cm for females and 37 cm for males (Richards et al. 2008). Few males are found larger than 70 cm, but females can reach sizes greater than 130 cm. Spawning takes place from spring through early autumn, progressing from south to north, with most spawning occurring during the spring and early summer (Richards et al. 2008). Females lay a buoyant mucoid egg raft or veil which can be as large as 12 m long and 1.5 m wide and only a few mm thick. The eggs are arranged in a single layer in the veil, and the larvae hatch after about 1-3 weeks, depending on water temperature. Females likely produce more than one egg veil per year (McBride et al. 2017). The larvae and juveniles spend several months in a pelagic phase before settling to a benthic existence at a size of about 8 cm (Collette and Klein-MacPhee 2002).

Stock Structure

The Fishery Management Plan (FMP) defines two management areas for monkfish (northern management area (NMA) and southern management area (SMA)), divided roughly by a line bisecting Georges Bank (Figure 2). The two assessment and management areas for monkfish were defined in the 1999 FMP based on differences in temporal patterns of recruitment (estimated from NEFSC surveys), perceived differences in growth patterns, and differences in the contribution of fishing gear types (mainly trawl, gill net, and dredge) to the landings. Since then, genetic studies using mitochondrial DNA have suggested a homogeneous population of monkfish off the U.S. east coast (Chikarmane et al. 2000; Johnson et al. in prep.); however research in progress using microsatellite DNA suggests a possible delination off Delaware Bay in the Mid-Atlantic Bight (Housbrouck et al. 2015).

Monkfish larvae are distributed over deep (< 300 m) offshore waters of the Mid-Atlantic Bight in March-April, and across the continental shelf (30 to 90 m) later in the year, but relatively few larvae have been sampled in the northern management area (Steimle et al. 1999). NEFSC surveys continue to indicate different recruitment patterns in the two management units in recent years.

The perceived differences in growth in the two management areas were based on studies about 10 years apart and under different stock conditions (Armstrong et al. 1992: Georges Bank to Mid-Atlantic Bight, 1982-1985; Hartley 1995: Gulf of Maine, 1992-1993). Age, growth, and maturity information from the NEFSC surveys and the 2001, 2004 and 2009 cooperative monkfish surveys indicated only minor differences in age, growth, and maturity between the areas (Richards et al., 2008; Johnson et al., 2008). However these growth studies used the vertebral aging method which is now called into question.

The southern deepwater extent of the range of American monkfish (*L. americanus*) overlaps with the northern extent of the range of blackfin monkfish (*L. gastrophysus*; Caruso 1983). These two species are morphologically similar, which may create a problem in identification of survey catches and landings from the southern extent of the range of monkfish. The potential for a problem however is believed to be small. The NEFSC closely examined winter and spring 2000 survey catches for the presence of blackfin monkfish and found none. The cooperative monkfish survey conducted in 2001 caught only eight blackfin monkfish of a total of 6,364 monkfish captured in the southern management area.

Fisheries Management

Commercial fisheries for monkfish occur year-round using gillnets, trawls and scallop dredges. No significant recreational fishery exists. The primary monkfish products are tails, livers and whole gutted fish. Peak fishing activity occurs during November through June, and value of the catch is highest in the fall due to the high quality of livers during this season.

U.S. fisheries for monkfish are managed in the Exclusive Economic Zone (EEZ) through a joint New England Fishery Management Council - Mid-Atlantic Fishery Management Council Monkfish Fishery Management Plan (FMP). The primary goals of the Monkfish FMP are to end and prevent overfishing and to optimize yield and economic benefits to various fishing sectors involved with the monkfish fisheries (NEFMC and MAFMC 1998; Haring and Maguire 2008).

Current regulatory measures vary with type of permit but include limited access, limitations on days at sea, mesh size restrictions, trip limits, minimum size limits and annual catch limits (Tables 1 and 2).

Biological reference points for monkfish were established in the original Fishery Management Plan (FMP), but were revised after SAW 34 (NEFSC 2002), after the Data Poor Stocks Working Group (DPSWG) in 2007 (NEFSC 2007a), and after SAW 50 in 2010. The overfishing definition on record is F_{max}. Prior to 2007, $B_{threshold}$ was defined as one-half of the median of the 1965-1981 3-year average NEFSC autumn trawl survey catch (kg) per tow). After acceptance of an analytical assessment in 2007 (NEFSC 2007a), B_{target} was redefined as the average of total biomass for the model time period (1980-2006) and $B_{threshold}$ as the lowest observed value in the total biomass time series from which the stock had then increased (termed "B_{Loss}"). According to the earlier (survey index-based) reference points, monkfish were overfished and overfishing status could not be determined (NEFSC 2005); however, with adoption of the analytical assessment in 2007, monkfish status was changed to no longer overfished and overfishing was not occurring. Assessments in 2010 and 2013 (NEFSC 2010; 2013) also concluded that both stocks were not overfished and overfishing was not occurring, while recognizing the continuing significant uncertainty in the determination. With the invalidation of the growth curve and analytic assessment model, the estimated BRPs are no longer relevant.

TOR 1.

TOR 1. Update fishery-dependent data (landings, discards, catch-at-age, etc.) and fishery-independent data (research survey information) that had been used in the previous accepted assessment. Also, describe and present any new or revised data sets that are being used in the assessment.

Fishery-Dependent Data

Landings

Landings of monkfish tails are converted from landed weight to live weight, because a substantial fraction of the landings occur as tails only (or other parts). The conversion of landed weight of tails to live weight of monkfish in the NEFSC weigh-out database is made by multiplying landed tail weight by a factor of 3.32.

Early catch statistics (before ~1980) are uncertain, because much of the monkfish catch was sold outside of the dealer system or used for personal consumption until the mid-1970s. For 1964 through 1989, there are two potential sources of landings information for monkfish; the NEFSC 'weigh-out' database, which consists of fish dealer reports of landings, and the 'general canvass' database, which contains landings data collected by NMFS port agents (for ports not included in the weigh-out system) or reported by states not included in the weigh-out system (Table 3). All landings of monkfish are reported in the general canvass data as 'unclassified tails.' Consequently, some landed weight attributable to livers or whole fish in the canvass data may be inappropriately converted to live weight. This is not an issue for 1964-1981 when only tails were recorded in both databases. For 1982-1989, the weigh-out database contains market category information that allows for improved conversions from landed to live weight. The two data sources produce the same trends in landings, with general canvass landings slightly greater than weigh-out landings. It is not known which of the two measures more accurately reflects landings, but the additional data sources suggest that the general canvass is most reliable for 1964-1981 landings, whereas the availability of market category details suggests that the weigh-out database is most reliable for 1982-1989.

Beginning in 1990, most of the extra sources of landings in the general canvass database were incorporated into the NEFSC weigh-out database. However, North Carolina reported landings of monkfish to the Southeast Fisheries Science Center and until 1997 these landings were not added to the NEFSC general canvass database. Since these landings most likely come from the southern management area, they have been added to the weigh-out data for the southern management area for 1977-1997 for the landings statistics used for stock assessment.

Beginning in July 1994, the NEFSC commercial landings data collection system was redesigned to consist of vessel trip reports (VTR) and dealer weigh-out records. The VTRs include area fished for each trip which is used to apportion dealer-reported landings to statistical areas. The northern management area includes statistical areas 511-515, 521-523 and 561; and the southern management area includes areas 525-526, 562, 537-543 and 611-636 (Figure 2).

Total U.S. landings (live weight) remained at low levels until the mid-1970s, increasing from less than 1,000 mt to around 6,000 mt in 1978 (Table 3, Figure 3). Annual landings remained stable at between 8,000 and 10,000 mt until the late 1980s. Landings increased from the late 1980s to over 20,000 mt per year during 1992-2004, peaking at 28,500 mt in 1997. Landings declined steadily after 2003, and stabilized around an average of 8,600 mt during 2009-2015. During 2008-2015, fishing year landings in the NMA remained well below the TAL, but during 2016-2018 were close to or higher than the TAL (Table 2). In the SMA, fishing year landings have been below the TAL since 2009. The most recent TALs are ~50% higher in the SMA than in the NMA.

Monkfish landings began to increase in the northern management region in the mid-1970s and in the late 1970s in the southern area. Most of the increase in landings during the late 1980s through mid-1990s was from the southern area. Historical under-reporting of landings should be considered in the interpretation of this series.

Trawls, scallop dredges and gill nets are the primary gear types that land monkfish (Table 4, Figure 4). Trawls have been the predominant gear in the north, accounting for approximately 75% of the landings on average. In the south, trawls and dredges dominated the landings before about 2002, but were subsequently replaced by gillnets as regulations changed. Gillnets accounted for about 75% of the landings from the southern management area during 2016-2018. Until the late 1990s, total U.S. landings were dominated by landings of monkfish tails. From 1964 to 1980 landings of tails rose from 19mt to 2,302mt, and peaked at 7,191mt in 1997 (Tables 5, 6). Landings of tails declined after 1997, but are still an important component of the landings. Landings of gutted whole fish have increased steadily since the early 1990s and are now the largest market category on a landed-weight basis. On a regional basis, more tails were landed from the northern area than the southern area prior to the late 1970s (Tables 5 and 6). From 1979 to 1989, landings of tails were about equal from both areas. In the 1990's, landings of tails from the south predominated, but since 2000, landings of tails have been greater in the north. Beginning in 1982, several market categories were added to the system (Tables 5, 6). Tails were broken down into large (> 2.0 lbs), small (0.5 to 2.0 lbs), and unclassified categories and the liver market category was added. In 1989, unclassified round fish were added, in 1991 peewee tails (<0.5 lbs) and cheeks, in 1992 belly flaps, and in 1993 whole gutted fish were added. Landings of unclassified round (whole) or gutted whole fish jumped in 1994 to 2,045 mt and 1,454 mt, respectively; landings of gutted fish continued to increase through 2003. The tonnage of peewee tails landed increased through 1995 to 364 mt and then declined to 153 mt in 1999 and 4 mt in 2000 when the category was essentially eliminated by regulations.

Foreign Landings

Landings (live wt) from NAFO areas 5 and 6 by countries other than the US are shown in Table 3 and Figure 3. Reported landings were high but variable in the 1960s and 1970s with a peak in 1973 of 6,818 mt. Landings were low but variable in the 1980s, declined in the early 1990s, and have generally been below 300 mt since 1996. NAFO data for monkfish were not updated for this assessment update.

Discard Estimates

Catch data from the fishery observer, dealer and VTR databases were used to investigate discarding frequencies and rates using standardized bycatch reporting methodology (SBRM, Rago et al. 2005; Wigley et al. 2007). The number of trips with monkfish discards available for analysis varied widely among management areas and gear types (Tables 7, 8). As in previous monkfish assessments (NEFSC 2007a, NEFSC 2010, NEFSC 2013, NEFSC 2016), monkfish discards were estimated on a gear, half-year and management area basis using observed discard-per-kept-monkfish to expanded to total discards for otter trawls and gillnets, and observed discard-per-all-kept-catch to expand for scallop dredges and shrimp trawls. Discards for 1980-1988 (before observer sampling) were estimated by applying average discard ratios by management area and gear type (trawl, shrimp trawl, gillnet, dredge) from 1989-1991 to landings for 1980-1988 as follows:

Area	Shrimp Trawls	Trawls	Gillnets	Dredges
North				
Years included	1989-1991	1989-1991	1989-1991	1992-1997
Number of trips	124	253	1191	54
South				
Years included	n/a	1989-1991	1991-1992	1991-1993
Number of trips		334	177	32

The proportion of discards in the northern area catch was about 13% in the 1980s, 7% during 2002-2006, became slightly higher on average (12%) during 2007-2009, was 14% for 2010-2015 and 18% during 2016-2018 (Table 9, Figures 5, 6). The proportion of discards in the southern area catch has generally increased since the 1980s (average 16% 1980-1989), with an annual average of 29% during 2002-2006, 24% during 2007-2009, and 27% in 2010-2015 (Table 9, Figures 5 and 6). During 2016-2018, the proportion of discards in the catch was 51%, and estimated discards (mt) exceeded landings in 2017 and 2018. These high discard rates are due primarily to regulatory discards in the scallop dredge fishery (Table 8). Gill nets consistently have had the lowest discard ratios in both areas.

Overall, discarding has increased steadily in both management areas since 2015 (Table 9). In 2015, a large increase in discarding of small fish was observed in southern area dredge and trawl fisheries (Figure 8), reflecting the strong 2015 recruitment event. This yearclass now appears to have grown into the exploitable size range (43+cm) (Figure 1).

Size Composition of U.S. Catch

Tail lengths were converted to total lengths using relations developed by Almeida et al. (1995). As in previous assessments, (NEFSC 2007a and later), length composition of landings and discard were estimated from fishery observer samples by management area, gear-type (trawls, dredges and gillnets), catch disposition (kept or discarded) and variable time periods (Table 11). Landings in unknown gear categories were allocated proportionately to the 3 major gear types before assigning lengths. The estimated length composition of landings and discard is shown in Figures 7-10. Age composition of the catch was not estimated.

Effort and CPUE

Evaluating trends in effort or catch rates in the monkfish fishery is difficult for several reasons. Much of the catch is taken in multi-species fisheries, and defining targeted monkfish trips is difficult. There have been programmatic changes in data collection from port interviews (1980-1993) to logbooks (1994-2009), and comparison of effort statistics among programs is difficult. Catch rates may not reflect patterns of abundance, because they have been affected by regulatory changes (e.g., 1994 closed areas, 2000 trip limits, 2006 reductions in trip limits).

CPUE data have not been used in the assessment model for monkfish, therefore they were not examined for this assessment update.

Fishery-Independent Data

Resource surveys used in the 2016 assessment were updated, including NEFSC spring and autumn offshore surveys, ASMFC northern shrimp surveys (NFMA only), ME/NH spring and fall inshore surveys, and scallop dredge surveys conducted by NEFSC and Viginia Institute of Marine Science (VIMS) (SMA only). Very few strata in the SMA were sampled during the 2017 fall survey, so indices were not calculated for the 2017 fall survey in the SMA.

The NEFSC survey strata used to define the northern and southern management areas are:

Survey	Northern Area	Southern Area
NEFSC offshore bottom trawl	20-30, 34-40	1-19, 61-76
ASMFC Shrimp	1,3,5-8	
Shellfish		6,7,10,11,14,15,18,19,22-31,33-35,46,47,55,58-61,621,631

NEFSC spring and autumn bottom trawl survey indices for 1963-2008 were standardized to adjust for statistically significant effects of trawl type (Sissenwine and Bowman 1977) on catch rates. The trawl conversion coefficients apply only to the spring survey during 1973-1981.

NEFSC indices derived from surveys on the FSV Henry Bigelow (starting spring 2009) were adjusted using calibration coefficients estimated during experimental work (Miller et al. 2009). The FSV *Henry B. Bigelow*, which became the main platform for NEFSC research surveys in spring 2009, has significantly different size, towing power, and fishing gear characteristics than the previous survey platform (*Albatross IV)*, resulting in different fishing power and catchability for most species. Calibration experiments to estimate these differences were conducted during 2008 (Brown 2009, NEFSC 2007b,). Following guidelines developed by a peer-review panel (Anonymous 2009), monkfish catches were converted using a simple ratio estimator without a seasonal (spring vs. fall) or length-specific correction. The low catch rates of monkfish in the Albatross series made development of more detailed coefficients infeasible. The overall coefficients for monkfish were 7.1295 for numbers and 8.0618 for biomass (kg) (Anonymous 2009; Miller et al. 2009). The Bigelow time series is also presented as an independent, uncalibrated series.

NEFSC spring and fall survey estimates of minimum biomass and abundance were derived using relative efficiency estimates for monkfish from a set of paired-tow experiments comparing chain sweep (industry standard on soft bottom) vs. rock hopper gear (used on all tows on the FSV Bigelow) (Miller et al. 2017a, 2017b, 2018).

Northern Management Area (NMA)

Biomass indices from NEFSC autumn and spring research trawl surveys fluctuated without trend between 1963 and 1975, increased briefly in the late 1970's, but declined thereafter to near historic lows during the 1990's (Tables 12-13, Figures 11 and 12). From 2000 to 2003, indices increased, reflecting recruitment of a relatively strong 1999 yearclass. Subsequently, biomass indices declined and remained relatively low until 2016, when both biomass and abundance began to increase. Abundance declined slightly in 2017 and 2018 but biomass indices continued to increase in the fall survey (Figure 12). Exploitable biomass (43+cm) has increased steadily since 2014 (fall survey) or 2016 (spring survey) (Figure 13). ME-NH survey data has shown similar trends in total biomass and abundance as the NEFSC surveys (Figure 14).

Length composition of NEFSC and ME/NH fall survey catches (Figures15 and 18) suggest production of relatively strong yearclasses in 2015 and 2016; however, strong recruitment was not apparent in the spring or summer shrimp surveys (Figures 16 and 17).

Recruitment indices (abundance) were estimated for monkfish of lengths corresponding to presumed young-of-year (YOY, age 0). The size ranges used were based on length frequencies observed for the strong 2015 yearclass, and were adopted in the 2016 assessment, as follows:

	2013 Putative		2016 Putative	
North	age	cm range	age	cm range
Fall NEFSC	1	11-19	0	6-18
Fall ME-NH	1	11-19	0	8-18
South				
Spring/summer scallop	1	11-19	0	7-18
Fall NEFSC	1	11-17	0	12-28

Based on the recruitment indices (Figure 20), the frequency of recruitment events in the northern area has increased since the late 1980s, with strong yearclasses produced in 1993, 1994, 2000, 2015 and 2016. There appears to be a negative relationship between recruitment and size of monkfish in the NMA (Figure 20). One possible interpretation is that that cannibalism plays a role in stock dyanmics. Armstrong et al (1996) and Johnson et al. (2008) both found higher rates of cannibalism in relatively large monkfish.

Additional surveys that catch monkfish in portions of the northern area include the ASMFC shrimp survey, the Massachusetts Division of Marine Fisheries fall and spring surveys, and ME/NH inshore surveys (Table 15, Figures 11, 14, 17-19). The shrimp survey samples the western Gulf of Maine during summer and caught more monkfish than the spring or fall surveys prior to 2009 (when the FSV Bigelow survey series began). Patterns of abundance and biomass have been relatively consistent among the NEFSC spring and fall, ME-NH, and shrimp surveys (Figure 21). The Massachusetts surveys catch few monkfish and were not considered to reflect patterns of abundance for the entire management area (NEFSC 2007a); therefore have not been included in recent assessments.

Figure 22 shows the distribution of monkfish in surveys in the northern management area.

Southern Management Area

Inconsistent geographic coverage should be considered in the interpretation of southern survey indices. The NEFSC fall survey did not sample south of Hudson Canyon until 1967. The NEFSC scallop dredge survey has been limited to the southern flank of Georges Bank since 2014, and NEFSC sampling intensity over the entire mid-Atlantic Bight declined starting in 2011. The Virginia Institute of Marine Science VIMS is now conducting the scallop dredge survey in the areas south of Georges Bank (beginning in 2012), but the data are not incorporated into the NEFSC survey data base. In addition, the timing of the scallop dredge survey shifted in 2009 from mid-summer to late spring. NEAMAP inshore surveys in the Mid-Atlantic catch relatively few monkfish, so are not included here.

Biomass and abundance indices from NEFSC spring and autumn research surveys were high during the mid-1960s, fluctuated around an intermediate level during the 1970s-mid 1980s, and have been relatively low since the late 1980s (Tables 16-17, Figures 23 and 24). A sharp increase in abundance was observed in the 2015 scallop and fall surveys and in the 2016 spring survey (Tables 16-18 Figure 23), reflecting an apparent recruitment event in 2015. Exploitable biomass

(43+cm) increased in the spring survey in 2017 and 2018, likely as a result of the growth of the 2015 yearclass (Figure 25). The fall survey also showed elevated exploitable biomass in 2018 (no survey in 2017).

Length distributions from the southern area show truncation over time but somewhat less dramatically than in the north (Figures 25-27). As in the northern area, fish greater than 60 cm have been rare since the 1980s, especially when compared to the 1960s. Recruitment indices (presumed YOY) (Figure 29) indicate two exceptional recruitment events in the south, occurring in 1972 and 2015. The negative relationship between median size in the population and recruitment seen in the north is not evident in the SMA (Figure 29); however, the median size has generally been lower in the south than in the north. Distribution plots suggest that the 2015 recruits were broadly distributed in the SMA (Figure 32).

TOR 2a.

TOR 2a.) Estimate annual fishing mortality, recruitment, and stock size for the time series ("Plan A"). Include estimates of uncertainty, retrospective analyses (both historical and within-model), and bridge runs to sequentially document any changes from the previously accepted model to the updated model proposed for this peer review.

In the absence of an approved model, this TOR was not addressed through modeling efforts; however relative exploitation rates were calculated from landings or catch and survey estimates of minimum area-swept abundance or biomass estimated using adjustments for the rockhopper sweep (Miller et al. 2017a, 2017b, 2018) (Table 19, Figures 33-34). The area-swept estimates do not account for missed strata and assume that 100% of the monkfish encountered by the trawl are captured. Missing strata in monkfish assessment areas and total area of sampled strata during 2009-2018 were the following:

North	Missing strata	Area surveyed nmi2	South Missing strata	Area surveyed nmi2
2009		26,265	68	37,029
2010		26,265		37,081
2011	20, 25	24,654	17, 66	36,166
2012	25	25,875		37,081
2013	25	25,875	18	36,909
2014	20, 40	24,466	8	36,851
2015		26,265		37,081
2016		26,265		37,081
2017		26,265	1-12, 61-76	9,226
2018	30, 34, 351,39	22,617		37,081

TOR 2b.

TOR 2b.) Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management. "Plan B" will be presented for peer review only if the "PlanA" assessment were to not pass review.

A model-free method used to derive Georges Bank cod catch limits in 2015 (NEFSC 2015) was applied to monkfish in the northern and southern management areas in the 2016 assessment (NEFSC 2016) and is updated here. The method calculates the rate and direction of change in survey indices using the slope of a log-linear regression of LOESS-smoothed survey indices during the most recent three years. In the case of cod, the proportional change in the indices (re-transformed slope, "catch multiplier") was applied to average cod catch in the three previous years to derive new cod catch limits.

The monkfish analysis calculated the catch multiplier using biomass indices from either the NEFSC fall survey only or the average of the NEFSC spring and fall surveys. The missing 2017 fall survey index for the south was interpolated by averaging 2016 and 2018 biomass indices for the south. The spring survey may be affected more strongly than the fall survey by availability of monkfish to the gear due to timing of seasonal migrations. Biomass indices for 1986-2018 in each area were LOESS-smoothed (smoothing parameter=0.30, 9.9 year smoothing window) before being entered into a log-linear regression to estimate the proportional change during 2016-2018. The estimated proportional change (catch multiplier) for monkfish in the north was 1.26 (fall survey only, 26% increase) or 1.22 (spring and fall surveys combined, 22% increase). In the south, the proportional change was 0.96 (fall survey only, 4% decrease) or 1.04 (spring and fall surveys combined, 4% increase) (Figure 35).

TOR 3. Update the values of biological reference points (BRPs) for this stock.

Biological reference points specified in the management plan are no longer relevant due to invalidation of the growth model, therefore they were not updated for this assessment update.

TOR 4a.

TOR 4a. Recommend what stock status appears to be based on comparison of assessment results to BRP estimates.

This TOR was not addressed because monkfish BRPs have been invalidated.

TOR 4b.

TOR 4b. Include qualitative descriptions of stock status based on simple indicators/metrics (e.g.,age- and size-structure, temporal trends in population size or recruitment indices, etc.).

Based on trends in survey results, monkfish stock status has been improving (north) or remained steady (south) in both management regions in the past three years, likely due primarily to the 2015 recruitment event. Biomass continued to increase in the north in 2018 while abundance dropped, reflecting an increase in the proportion of large individuals in the population (likely of the 2015 year class). In the south, biomass increased after the 2015 recruitment event, but was lower in 2018 (fall 2017 data missing), as abundance of the 2015 year class declined.

Recruitment has returned to average levels in the south, and in the north, to average levels observed since the late 1980s. Abundance and biomass patterns may be influenced by movement of monkfish between the management areas, which is poorly understood.

TOR 5.

TOR 5. Perform short-term (2-year) population projections. The projection results should include an estimate of the catch at FMSY or at an FMSY proxy (i.e. this catch represents the overfishing level, OFL) as well as its statistical distribution (i.e., probability density function).

Not relevant to this assessment.

TOR 6.

TOR 6. Comment on research areas or data issues to consider that might lead to improvements when this stock is assessed again in the future.

A benchmark assessment should consider the feasibility of using both observer and port samples in estimating length composition of commercial landings.

Ongoing research on age and growth of monkfish may lead to an acceptable growth curve, even if not an aging method that could be used for routine aging. If so, age structured models could be explored assuming static growth.

A better understanding of monkfish movements and stock structure would be helpful to interpretation of monkfish population data.

Future modeling efforts may want to consider the possible role of cannibalism in stock dynamics of monkfish in light of the strong negative relationship observed in the north between median size of monkfish in the population and recruitment indices.

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Tables

Table 1. Timeline of fishery management actions for monkfish.

(http://www.greateratlantic.fisheries.noaa.gov/sustainable/species/monkfish/)

1999 – Monkfish FMP was implemented which included a limited access permit program, a DAS management system, trip limits, and minimum size limits.

1999 – Amendment 1 (FR Notice) approved to ensure compliance with essential fish habitat requirements of the Magnuson-Stevens Act.

2002 – Framework Adjustment 1 (FR Notice) was disapproved by NMFS. NMFS instead published an emergency rule that implemented measures based upon the best available science to temporarily suspend the restrictive Year 4 default management measures that would have become effective May 1, 2002.

2003 –Framework Adjustment 2 (FR Notice) modified the overfishing definition and implemented annual adjustments to the management measures.

2003 - Final rule implemented a series of seasonal closures that prohibited the use of large mesh gillnets in Federal waters off the coast of Virginia and North Carolina to reduce the impact of the monkfish fishery on endangered and threatened species of sea turtles.

2005 – Amendment 2 (FR Notice) addressed essential fish habitat, bycatch concerns, and issues raised by public comments.

2006 – Framework Adjustment 3 (FR Notice) implemented to prohibit targeting monkfish on Multispecies B-regular DAS.

2007 – Interim management measures Framework 4 (FR Notice) adopted in May to address overfishing while NMFS conducted a stock assessment. Framework 4 was implemented in October to establish 3-year target total allowable catches (TACs), a target TAC backstop provision, and adjustments to DAS allocations and trip limits.

2007 – Amendment 3 (FR Notice) was implemented as an Omnibus Amendment to standardize bycatch reporting methodology for monkfish and other fisheries.

2008 – NMFS implemented Framework 5 (FR Notice) to ensure the Monkfish FMP succeeds in keeping landings within the target total allowable catch levels. Measures include reduction in carryover DAS, reduction in bycatch or incidental catch limits, and revision in the biological reference points used to determine if the stock is overfished.

2008 – Framework 6 (FR Notice) eliminated the backstop provision adopted in Framework Adjustment 4 to the FMP, October 2007.

Table 1, continued.

2011 – Amendment 5 (FR Notice) implemented a suite of measures including annual catch limits and accountability measures, measures to promote efficiency and reduce waste, and bring the biological reference points into compliance.

2011 – Framework Adjustment 7 (FR Notice) implemented measures that were disapproved in Amendment 5 due to newly available science. Specifically, DAS allocations, trip limits, and an annual catch target for the Northern Area.

2012 – Amendment 6 is still being developed in considering a catch shares management system for the fishery. Information on Amendment 6 is located here.

2013 - NMFS implements an emergency action (FR Notice) to suspend the monkfish possession limits in the Northern Fishery Management Area for monkfish permit categories C and D under a monkfish DAS.

2014 - Framework Adjustment 8 (FR Notice) implemented measures to incorporate results of latest stock assessment, increase monkfish day-at-sea allocations and landing limits to better achieve optimum yield, and increase operational flexibility by allowing all limited access monkfish vessels to use an allocated monkfish-only day-at-sea at any time throughout the fishing year and Category H vessels to fish throughout the Southern Fishery Management Area.

2016 – Framework Adjustment 9 (FR Notice) implemented measures to increase landings in the NFMA by eliminating the possession limit while fishing under both a NE multispecies and monkfish day-at-sea and increasing flexibility in the SFMA by reducing the minimum mesh size for roundfish gillnets.

2017 – Framework Adjustment 10 (FR Notice) implemented measures to incorporate results of the 2016 operational assessment, increase monkfish day-at-sea allocations and possession limits.

Table 2. Management measures for monkfish, fishing years 2000-2018. Regulations pertain to fishing years (FY, May 1- April 30), thus landings do not correspond to calendar year landings in Table 3. Trip limits apply to vessels fishing on declared monkfish days at sea.

Northern Fishery Management Area

		Trip Limits*	Trip Limits*			
Fishing Year	Target TAC/TAL	Cat. A & C	Cat. B & D	DAS Restrict	FY Landings (mt)	Percent of TAC
2000	5,673	n/a	n/a	40	11,859	209%
2001	5,673	n/a	n/a	40	14,853	262%
2002	11,674	n/a	n/a	40	14,491	124%
2003	17,708	n/a	n/a	40	14,155	80%
2004	16,968	n/a	n/a	40	11,750	69%
2005	13,160	n/a	n/a	40	9,533	72%
2006	7,737	n/a	n/a	40	6,677	86%
2007	5,000	1,250	470	31	5,050	101%
2008	5,000	1,250	470	31	3,528	71%
2009	5,000	1,250	470	31	3,344	67%
2010	5,000	1,250	470	31	2,834	57%
2011	5,854	1,250	600	40	3,699	63%
2012	5,854	1,250	600	40	3,920	67%
2013	5,854	1,250	600	40	3,596	61%
2014	5,854	1,250	600	45	3,403	58%
2015	5,854	1,250	600	45	4,080	70%
2016	5,854	1,250	600	45	5,447	93%
2017	6,338	1,250	600	45	6,807	107%
2018	6,338	1,250	600	45	6,168	97%

Southern Fishery Management Area

		Trip Limits*	Trip Limits*			
Fishing Year	Target TAC/TAL	Cat. A,C,G	Cat. B, D, H	DAS Restrict	FY Landings (mt)	Percent of TAC
2000	6,024	1,500	1,000	40	7,960	132%
2001	6,024	1,500	1,000	40	11,069	184%
2002	7,921	550	450	40	7,478	94%
2003	10,211	1,250	1,000	40	12,198	119%
2004	6,772	550	450	28	6,223	92%
2005	9,673	700	600	39.3	9,656	100%
2006	3,667	550	450	12	5,909	161%
2007	5,100	550	450	23	7,180	141%
2008	5,100	550	450	23	6,751	132%
2009	5,100	550	450	23	4,800	94%
2010	5,100	550	450	23	4,484	88%
2011	8,925	550	450	28	5,801	65%
2012	8,925	550	450	28	5,184	58%
2013	8,925	550	450	28	5,088	57%
2014	8,925	610	500	32	5,415	61%
2015	8,925	610	500	32	4,733	53%
2016	8,925	700	575	37	4,345	49%
2017	9,011	700	575	37	3,802	42%
2018	9,011	700	575	37	4,600	51%

Table 3. Landings (calculated live weight, mt) of monkfish as reported in NEFSC weigh-out data base (1964-1993) and vessel trip reports (1994-2014) (North = SA 511-523, 561; South = SA 524-639 excluding 551-561 plus landings from North Carolina for years 1977-1995); General Canvas database (1964-1989, North = ME, NH, northern weigh out proportion of MA; South = Southern weigh-out proportion of MA, RI-VA); Foreign landings from NAFO database areas 5 and 6. Shaded cells denote suggested source for landings which are used in the total column at the far right (see text for details).

	Weigh Out Plus NC			General Canvas				
Year	US North	US South	US Total	US North	US South	US Total	Foreign	Total
1964	45	19	64	45	61	106	0	106
1965	37	17	54	37	79	115	0	115
1966	299	13	312	299	69	368	2,397	2765
1967	539	8	547	540	59	598	11	609
1968	451	2	453	449	36	485	2,231	2716
1969	258	4	262	240	43	283	2,249	2532
1970	199	12	211	199	53	251	477	728
1971	213	10	223	213	53	266	3,659	3925
1972	437	24	461	437	65	502	4,102	4604
1973	710	139	848	708	240	948	6,818	7766
1974	1,197	101	1,297	1,200	183	1,383	727	2110
1975	1,853	282	2,134	1,877	417	2,294	2,548	4842
1976	2,236	428	2,663	2,256	608	2,865	341	3206
1977	3,137	830	3,967	3,167	1,314	4,481	275	4756
1978	3,889	1,384	5,273	3,976	2,073	6,049	38	6087
1979	4,014	3,534	7,548	4,068	4,697	8,765	70	8835
1980	3,695	4,232	7,927	3,623	6,035	9,658	132	9790
1981	3,217	2,380	5,597	3,171	4,142	7,313	381	7694
1982	3,860	3,722	7,582	3,757	4,492	8,249	310	7,892
1983	3,849	4,115	7,964	3,918	4,707	8,624	80	8,044
1984	4,202	3,699	7,901	4,220	4,171	8,391	395	8,296
1985	4,616	4,262	8,878	4,452	4,806	9,258	1,333	10,211
1986	4,327	4,037	8,364	4,322	4,264	8,586	341	8,705
1987	4,960	3,762	8,722	4,995	3,933	8,926	748	9,470
1988	5,066	4,595	9,661	5,033	4,775	9,809	909	10,570
1989	6,391	8,353	14,744	6,263	8,678	14,910	1,178	15,922
1990	5,802	7,204	13,006				1,557	14,563
1991	5,693	9,865	15,558				1,020	16,578
1992	6,923	13,942	20,865				473	21,338
1993	10,645	15,098	25,743				354	26,097
1994	10,950	12,126	23,076				543	23,619
1995	11,970	14,361	26,331				418	26,749
1996	10,791	15,715	26,507				184	26,691
1997	9,709	18,462	28,172				189	28,361
1998	7,281	19,337	26,618				190	26,808
1999	9,128	16,085	25,213				151	25,364
2000	10,729	10,147	20,876				176	21,052
2001	13,341	9,959	23,301				142	23,443
2002	14,011	8,884	22,896				294	23,190
2003	14,991	11,095	26,086				309	26,395
2004	13,209	7,978	21,186				166	21,352
2005	10,140	9,177	19,317				206	19,523
2006	6,974	7,980	14,955				279	15,234
2007	4,953	7,388	12,341					12,341
2008	3,942	7,250	11,192					11,192
2009	3,210	5,532	8,742					8,742
2010	2,424	4,996	7,420					7,420
2011	3,227	5,371	8,599					8,599
2012	4,033	5,724	9,757					9,757
2013	3,332	5,253	8,586					8,586
2014	3,402	5,135	8,537					8,537
2015	4,027	4,609	8,636					8,636
2016	4,633	4,422	9,055					9,055
2017	7,008	3,893	10,901					10,901
2018	5,954	4,465	10,419					10,419

Table 4. U.S. landings of monkfish (calculated live weight, mt) by gear type.

	North					South					Regions Combined				
Year	Trawl	Gill Net	Scallop Dredge	Other	Total	Trawl	Gill Net	Scallop Dredge	Other	Total	Trawl	Gill Net	Scallop Dredge	Other	Total
1964	45	0			45	19				19	64	0			64
1965	36	0			37	17				17	53	0			53
1966	299	0		0	299	13			0	13	311	0		0	312
1967	532		8		539	8				8	540		8		547
1968	447		4		451	2				2	449		4		453
1969	253	1	4		258	4				4	257	1	4		262
1970	198	0		0	199	12				12	210	0		0	211
1971	213		0		213	10				10	223		0		223
1972	426	8	1	2	437	24				24	451	8	1	2	461
1973	661	29	12	8	710	132		5	1	137	794	29	17	9	848
1974	1,060	105	7	25	1,197	98			0	98	1,160	105	7	25	1,297
1975	1,712	123	10	9	1,853	265	0	2	2	269	1,990	123	12	10	2,135
1976	2,031	143	47	15	2,236	333		7	0	340	2,459	143	54	15	2,670
1977	2,737	230	142	28	3,137	508		57	26	591	3,487	230	202	53	3,973
1978	3,255	368	212	54	3,889	605	0	507	26	1,138	4,016	368	774	80	5,238
1979	2,967	393	584	71	4,014	944	6	1,015	16	1,981	3,989	399	2,070	87	6,545
1980	2,526	518	596	56	3,696	1,139	10	1,274	7	2,429	3,723	528	2,276	62	6,589
1981	2,266	461	443	47	3,217	1,100	16	782	105	2,003	3,483	477	1,399	152	5,512
1982	3,040	421	367	32	3,860	1,806	12	1,507	27	3,352	4,998	433	2,061	60	7,551
1983	3,233	314	266	37	3,849	1,819	11	2,119	17	3,966	5,166	325	2,431	56	7,977
1984	3,648	315	196	43	4,202	1,714	15	1,704	18	3,452	5,513	330	1,968	61	7,871
1985	3,982	315	264	55	4,616	1,739	17	2,347	3	4,106	5,757	332	2,611	58	8,758
1986	3,412	326	553	36	4,327	1,841	32	2,068	12	3,954	5,318	358	2,621	48	8,345
1987	3,853	374	695	38	4,960	1,680	26	1,997	3	3,707	5,561	400	2,692	41	8,694
1988	3,554	304	1,172	36	5,066	1,828	58	2,594	3	4,483	5,399	363	3,765	39	9,567
1989	3,429	349	2,584	30	6,391	3,240	17	5,036	3	8,297	6,679	366	7,620	33	14,698
1990	3,298	338	2,141	25	5,802	2,361	32	4,744	5	7,142	5,697	372	6,885	30	12,984
1991	3,299	338	2,033	24	5,694	5,515	363	3,907	16	9,800	8,847	700	5,941	39	15,528
1992	4,330	359	2,211	24	6,923	6,528	977	6,409	11	13,925	10,860	1,336	8,619	35	20,850
1993	5,890	695	4,034	26	10,645	5,987	1,722	7,158	192	15,059	11,879	2,417	11,192	218	25,707
1994	7,574	1,571	1,808	86	11,039	5,233	2,342	3,995	556	12,126	12,707	3,884	5,759	638	22,988
1995	9,119	1,531	1,266	54	11,970	5,785	3,800	4,030	746	14,361	14,905	5,331	5,296	800	26,331
1996	8,445	1,389	913	45	10,791	7,141	4,211	4,330	33	15,715	15,586	5,599	5,243	78	26,507
1997	7,363	988	1,318	40	9,709	8,161	5,203	4,890	208	18,462	15,524	6,192	6,208	249	28,172
1998	5,421	885	948	27	7,281	7,815	6,198	5,190	134	19,337	13,236	7,083	6,138	161	26,618
1999	7,037	1,470	598	24	9,128	6,364	6,187	3,481	54	16,085	13,401	7,656	4,079	78	25,213
2000	8,234	2,102	316	76	10,729	4,018	4,005	1,975	150	10,147	12,252	6,107	2,291	226	20,876
2001	9,990	2,959	381	11	13,341	3,091	5,119	1,719	30	9,959	13,081	8,078	2,100	41	23,301
2002	10,839	2,978	181	13	14,011	1,584	5,410	1,847	43	8,884	12,423	8,389	2,028	56	22,896
2003	12,028	2,488	222	254	14,991	2,034	7,262	1,717	83	11,095	14,062	9,750	1,939	336	26,086
2004	9,918	2,866	14	411	13,209	1,228	4,605	671	1,474	7,978	11,145	7,471	685	1,885	21,186
2005	6,876	2,567	99	598	10,140	1,706	4,673	1,581	1,216	9,177	8,582	7,241	1,680	1,814	19,317
2006	5,054	1,573	185	162	6,974	1,457	3,970	1,532	1,022	7,980	6,511	5,542	1,717	1,184	14,955
2007	3,482	1,172	243	56	4,953	1,084	3,782	1,594	928	7,388	4,566	4,954	1,837	984	12,341
2008	3,055	802	52	34	3,942	1,041	4,098	1,370	741	7,250	4,095	4,900	1,422	775	11,192
2009	2,491	651	21	47	3,210	721	3,117	826	868	5,532	3,212	3,768	847	915	8,742
2010	1,947	460	12	6	2,424	590	2,738	579	1,089	4,996	2,537	3,198	590	1,094	7,420
2011	2,696	482	45	5	3,227	1,178	3,480	565	149	5,371	3,874	3,962	609	153	8,599
2012	3,551	347	134	1	4,033	1,144	3,688	739	153	5,724	4,695	4,035	873	154	9,757
2013	2,799	421	112	0	3,332	1,112	3,366	599	176	5,253	3,911	3,787	711	176	8,586
2014	2,950	418	33	0	3,402	1,028	3,142	879	86	5,135	3,978	3,560	912	87	8,537
2015	3,256	670	100	1	4,027	673	3,308	538	91	4,610	3,929	3,978	638	92	8,637
2016	3,937	608	86	2	4,633	578	3,332	349	162	4,421	4,515	3,940	435	164	9,054
2017	6,030	946	32	0	7,008	550	2,832	400	112	3,894	6,580	3,778	432	112	10,902
2018	4,935	860	151	8	5,954	496	3,404	471	93	4,464	5,431	4,264	622	101	10,418

Table 5. Landed weight (mt) of monkfish by market category for the northern management area.

Year	Belly Flaps	Cheeks	Livers	Head on, Gutted	Round	Dressed	Heads	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	0	0	0	0	0	0	0	14	0	0	0	14
1965	0	0	0	0	0	0	0	11	0	0	0	11
1966	0	0	0	0	0	0	0	90	0	0	0	90
1967	0	0	0	0	0	0	0	163	0	0	0	163
1968	0	0	0	0	0	0	0	136	0	0	0	136
1969	0	0	0	0	0	0	0	78	0	0	0	78
1970	0	0	0	0	0	0	0	60	0	0	0	60
1971	0	0	0	0	0	0	0	64	0	0	0	64
1972	0	0	0	0	0	0	0	132	0	0	0	132
1973	0	0	0	0	0	0	0	214	0	0	0	214
1974	0	0	0	0	0	0	0	360	0	0	0	360
1975	0	0	0	0	0	0	0	558	0	0	0	558
1976	0	0	0	0	0	0	0	673	0	0	0	673
1977	0	0	0	0	0	0	0	945	0	0	0	945
1978	0	0	0	0	0	0	0	1,171	0	0	0	1,171
1979	0	0	0	0	0	0	0	1,209	0	0	0	1,209
1980	0	0	0	0	0	0	0	1,113	0	0	0	1,113
1981	0	0	0	0	0	0	0	969	0	0	0	969
1982	0	0	10	0	0	0	0	1,146	15	2	0	1,163
1983	0	0	9	0	0	0	0	1,152	5	2	0	1,159
1984	0	0	15	0	0	0	0	1,262	4	0	0	1,266
1985	0	0	11	0	0	0	0	1,386	2	3	0	1,390
1986	0	0	14	0	0	0	0	1,303	0	0	0	1,303
1987	0	0	24	0	0	0	0	1,492	2	1	0	1,494
1988	0	0	47	0	0	0	0	1,517	6	3	0	1,526
1989	0	0	59	0	11	0	0	1,465	327	130	0	1,922
1990	0	0	78	0	30	0	0	1,174	411	154	0	1,738
1991	0	3	70	0	0	0	0	1,014	539	153	9	1,715
1992	0	1	83	0	0	0	0	911	590	505	79	2,085
1993	0	1	208	98	351	0	0	1,034	868	1,062	103	3,067
1994	0	1	208	533	981	0	0	403	1,206	1,075	136	2,820
1995	0	1	46	1,224	1,113	0	0	362	1,180	1,003	304	2,850
1996	0	0	65	1,116	745	0	0	90	930	1,399	224	2,643
1997	0	0	51	634	244	0	0	26	1,126	1,361	119	2,633
1998	0	0	24	551	144	0	0	16	1,055	810	79	1,960
1999	0	0	40	1,701	511	0	0	28	996	848	139	2,012
2000	0	0	94	3,213	912	0	0	17	783	1,050	3	1,853
2001	0	0	93	3,084	231	0	0	128	1,115	1,647	0	2,890
2002	0	0	75	3,789	24	0	0	80	1,055	1,777	0	2,912
2003	0	0	61	2,364	14	0	0	95	1,573	2,032	0	3,699
2004	0	0	56	647	960	0	0	3	1,883	1,580	1	3,467
2005	0	0	42	1,706	22	0	0	3	1,440	1,017	2	2,462
2006	0	0	22	1,622	20	0	0	9	899	627	3	1,538
2007	0	0	13	682	0	0	1	9	870	378	1	1,258
2008	0	0	5	391	0	4	0	1	739	311	0	1,051
2009	0	0	2	290	0	11	0	2	560	299	0	861
2010	0	0	1	208	0	0	0	2	396	261	0	658
2011	0	17	72	187	44	0	8	1	527	367	1	896
2012	0	24	89	142	0	0	3	1	609	556	2	1,168
2013	0	0	76	137	0	0	4	1	549	407	3	960
2014	0	0	71	117	0	0	25	2	560	423	4	988
2015	0	0	73	179	0	0	31	2	594	556	0	1,151
2016	0	0	86	105	0	0	127	4	672	683	0	1,359
2017	0	0	114	151	0	0	140	13	1006	1041	0	2,060
2018	0	0	73	195	1		174	3	931	792	0	1,726

Table 6. Landed weight (mt) of monkfish by market category for the southern management area.

Year	Belly Flaps	Cheeks	Livers	Head on, Gutted	Round	Dressed	Heads	Tails Unc.	Tails Large	Tails Small	Tails Peewee	All Tails
1964	0	0	0	0	0	0	0	6	0	0	0	6
1965	0	0	0	0	0	0	0	5	0	0	0	5
1966	0	0	0	0	0	0	0	4	0	0	0	4
1967	0	0	0	0	0	0	0	2	0	0	0	2
1968	0	0	0	0	0	0	0	1	0	0	0	1
1969	0	0	0	0	0	0	0	1	0	0	0	1
1970	0	0	0	0	0	0	0	4	0	0	0	4
1971	0	0	0	0	0	0	0	3	0	0	0	3
1972	0	0	0	0	0	0	0	7	0	0	0	7
1973	0	0	0	0	0	0	0	42	0	0	0	42
1974	0	0	0	0	0	0	0	30	0	0	0	30
1975	0	0	0	0	0	0	0	85	0	0	0	85
1976	0	0	0	0	0	0	0	129	0	0	0	129
1977	0	0	0	0	0	0	0	250	0	0	0	250
1978	0	0	0	0	0	0	0	403	0	0	0	403
1979	0	0	0	0	0	0	0	1,016	0	0	0	1,016
1980	0	0	0	0	0	0	0	1,189	0	0	0	1,189
1981	0	0	0	0	0	0	0	685	0	0	0	685
1982	0	0	0	0	0	0	0	912	138	51	0	1,102
1983	0	0	2	0	0	0	0	858	237	136	0	1,231
1984	0	0	10	0	0	0	0	860	183	45	0	1,087
1985	0	0	17	0	0	0	0	1,081	85	71	0	1,237
1986	0	0	23	0	0	0	0	1,063	76	52	0	1,191
1987	0	0	330	0	0	0	0	972	138	6	0	1,116
1988	0	0	65	0	0	0	0	1,129	190	32	0	1,350
1989	0	0	88	0	5	0	0	2,037	230	230	0	2,498
1990	0	0	102	0	187	0	0	1,428	443	223	0	2,095
1991	0	5	200	0	415	0	0	1,215	1,123	461	28	2,827
1992	0	3	239	0	386	0	0	1,868	1,318	788	104	4,078
1993	0	1	252	0	178	0	0	2,469	1,065	789	159	4,483
1994	0	4	251	921	1,064	0	0	854	1,025	989	122	2,989
1995	2	0	451	1,529	1,539	0	0	518	1,341	1,419	59	3,337
1996	0	0	504	2,352	318	0	0	996	1,160	1,629	46	3,830
1997	0	0	577	2,559	551	0	0	647	1,924	1,913	32	4,516
1998	0	0	582	3,036	438	0	0	842	1,952	1,840	16	4,650
1999	0	0	558	4,047	621	0	0	509	1,393	1,352	14	3,268
2000	0	4	530	3,701	179	0	0	276	797	657	2	1,732
2001	0	0	466	3,944	300	0	0	217	844	494	0	1,555
2002	0	0	433	4,013	551	0	0	167	629	336	0	1,132
2003	0	1	426	4,959	667	0	0	242	790	405	1	1,438
2004	0	2	355	2,758	1,066	8	0	186	671	274	0	1,130
2005	0	55	330	3,695	187	18	0	105	771	550	2	1,428
2006	0	108	293	3,351	27	20	5	69	658	506	1	1,233
2007	0	44	258	3,030	107	12	0	88	727	329	1	1,145
2008	0	5	253	3,008	44	13	1	61	768	300	0	1,130
2009	1	0	199	2,540	4	9	11	47	505	235	0	788
2010	0	0	188	2,117	9	4	27	61	476	235	0	772
2011	0	0	154	2,195	491	6	31	47	422	243	0	713
2012	0	0	110	2,921	0	4	40	44	405	269	1	720
2013	1	0	130	2,247	5	4	106	58	462	286	2	809
2014	0	0	111	2,049	2	14	116	45	540	250	3	837
2015	0	0	99	2,339	2	18	96	43	358	174	0	574
2016	0	0	86	2,399	`1	10	104	56	295	151	0	502
2017	0	0	72	2020	6	10	83	45	246	180	0	471
2018	0	0	93	2022	10	10	105	84	406	152	0	642

Table 7. Estimated monkfish discards (live weight) in the northern management region. Dredge and shrimp trawl discards are based on SBRM monkfish discards relative to kept of all species; trawl and gillnet are based on monkfish discards relative to monkfish kept.

North		Trawl					Gillnet					Scallop Dredge					Shrimp Trawl				
Year	Half	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)
1989	1	30	0.037	0.58	1,550	58	1	0.036		84	3		0.001		18,213	17	31	0.002	0.33	3,412	5.5
	2	63	0.141	0.44	1,830	257	103	0.027	0.32	265	7		0.008		24,053	185	9	0.001	0.62	931	1.2
1990	1	16	0.082	0.60	1,562	128	73	0.036	0.41	121	4		0.001		9,864	9	27	0.002	0.34	4,494	8.1
	2	36	0.039	0.45	1,690	66	65	0.029	0.37	219	6		0.008		19,293	149	4	0.058	1.01	620	35.8
1991	1	27	0.042	0.45	1,233	52	191	0.030	0.47	120	4		0.001		16,608	16	46	0.004	0.19	3,536	12.8
	2	81	0.167	0.25	1,999	334	758	0.036	0.10	213	8	1	0.002		21,312	40	7	0.046	0.40	340	15.7
1992	1	51	0.122	0.30	1,674	203	403	0.065	0.16	105	7	3	0.000	0.98	14,179	1	76	0.003	0.23	3,285	9.6
	2	35	0.224	0.43	2,624	587	618	0.040	0.24	248	10	6	0.001	0.41	20,033	26	6	0.003	0.28	161	0.4
1993	1	19	0.067	0.30	2,821	189	271	0.086	0.21	119	10	7	0.002	0.26	13,702	25	78	0.001	0.26	1,890	2.5
	2	19	0.084	0.26	3,032	254	338	0.032	0.24	560	18	4	0.018	0.45	12,674	230	4	0.001	0.70	316	0.3
1994	1	18	0.035	0.29	3,273	115	65	0.065	0.29	270	18	2	0.001	1.21	5,486	5	71	0.002	0.38	2,443	5.9
	2	6	0.024	0.59	4,385	107	44	0.055	0.19	779	43	5	0.010	0.38	6,230	59	6	0.001	0.44	906	0.7
1995	1	30	0.164	0.36	4,643	762	38	0.141	0.30	469	66	1	0.014		2,318	32	64	0.000	0.23	4,452	1.8
	2	48	0.090	0.31	4,478	403	69	0.088	0.23	1,023	90	5	0.018	0.50	6,544	119	9	0.001	0.43	1,377	0.7
1996	1	21	0.190	0.23	4,294	814	28	0.137	0.43	340	47	8	0.003	0.94	5,338	14	30	0.000	0.34	7,580	0.8
	2	49	0.132	0.57	4,057	534	34	0.132	0.19	934	123	5	0.022	0.40	11,375	246	5	0.000	0.79	1,418	0.4
1997	1	13	0.100	0.49	3,795	378	19	0.036	0.32	329	12	4	0.004	0.48	10,567	42	17	0.000	0.61	5,416	0.9
	2	7	0.076	0.23	3,225	244	26	0.194	0.84	742	144	4	0.020	0.76	9,148	180		0.001		649	0.4
1998	1	7	0.124	0.37	3,150	392	39	0.028	0.41	238	7	2	0.004	0.32	7,482	28		0.001		3,095	2.7
	2	3	0.093	0.10	2,398	223	72	0.043	0.28	606	26	7	0.014	0.16	6,400	90		0.001		168	0.1
1999	1	3	0.098	0.04	3,947	388	36	0.067	0.65	282	19	2	0.004	0.65	8,347	29		0.001		1,407	1.2
	2	42	0.069	0.21	3,011	207	66	0.036	0.51	1,051	38	6	0.004	0.44	6,797	30		0.001		33	0.0
2000	1	80	0.069	0.32	3,916	271	58	0.041	0.30	501	21		0.004		6,993	31		0.001		2,068	1.8
	2	61	0.088	0.31	3,798	333	65	0.077	0.24	2,033	157	95	0.004	0.13	13,019	56		0.001		35	0.0
2001	1	61	0.102	0.20	5,088	518	41	0.061	0.69	880	53	17	0.003	0.42	14,926	41	3	0.000	0.14	813	0.1
	2	113	0.066	0.10	4,588	303	33	0.108	0.93	2,208	238		0.005		11,525	60		0.001			0.0
2002	1	47	0.076	0.25	5,634	428	33	0.045	0.39	760	34		0.005		8,712	45		0.001		308	0.3
	2	274	0.100	0.10	4,532	455	67	0.053	0.27	2,230	118	10	0.008	0.97	11,533	88		0.001			0.0
2003	1	206	0.101	0.14	6,642	671	112	0.037	0.24	628	23	5	0.001	0.89	16,053	9	15	0.000	1.01	855	0.0
	2	218	0.055	0.12	4,721	261	273	0.058	0.13	1,570	91	8	0.015	0.41	10,361	157		0.001			0.0
2004	1	163	0.042	0.12	5,307	225	212	0.021	0.22	739	16	3	0.000	0.69	5,633	0	12	0.000	0.25	1,069	0.1
	2	377	0.036	0.10	4,039	147	728	0.059	0.09	1,788	105	19	0.096	0.48	3,705	355		0.001		44	0.0
2005	1	500	0.047	0.07	3,971	187	153	0.098	0.26	516	51	20	0.001	0.57	5,745	6	17	0.000	0.52	836	0.1
	2	601	0.057	0.10	3,038	174	660	0.074	0.12	1,450	108	39	0.008	0.21	23,131	184		0.001		40	0.0
2006	1	292	0.055	0.08	2,852	158	93	0.063	0.41	262	17	5	0.001	0.42	20,833	14	17	0.000	0.56	847	0.0
	2	201	0.071	0.11	2,285	162	80	0.080	0.17	1,025	82	39	0.021	0.32	14,291	305	3	0.000	0.10	449	0.2
2007	1	221	0.050	0.10	2,075	104	42	0.061	0.32	228	14	28	0.002	0.22	11,600	26	14	0.001	0.72	1,899	1.0
	2	303	0.072	0.10	1,448	104	190	0.062	0.16	693	43	68	0.021	0.18	23,644	487		0.001		333	0.2
2008	1	277	0.088	0.10	1,821	160	61	0.076	0.28	141	11	25	0.001	0.22	7,065	11	16	0.000	0.77	1,834	0.9
	2	383	0.082	0.10	1,045	86	156	0.051	0.22	541	28	22	0.011	0.34	3,696	42	3	0.001	0.90	167	0.1
2009	1	351	0.166	0.13	1,666	276	129	0.209	0.46	149	31	7	0.001	0.47	1,960	3	7	0.001	0.61	998	0.8
	2	408	0.079	0.11	832	66	195	0.119	0.27	467	55	22	0.003	0.26	11,642	34	5	0.000	0.92	347	0.0
2010	1	339	0.097	0.08	1,537	149	305	0.056	0.15	112	6	16	0.001	0.80	3,350	4	11	0.000	1.00	2,911	0.1
	2	671	0.090	0.07	857	77	1364	0.102	0.07	303	31	25	0.003	0.31	15,930	50	4	0.000	0.91	780	0.0
2011	1	671	0.120	0.07	1,461	175	554	0.050	0.10	120	6	23	0.002	0.80	6,660	16	1	0.000		3,745	0.0
	2	743	0.058	0.08	1,174	69	1244	0.080	0.10	361	29	81	0.004	0.13	35,600	158		0.001		78	0.0
2012	1	739	0.057	0.06	1901	108	548	0.047	0.17	93	4	54	0.003	0.31	21,717	67	19	0.000	0.49	1,761	0.2
	2	664	0.078	0.05	1446	112	900	0.060	0.07	184	11	90	0.010	0.24	28,609	300				132	0.0
2013	1	471	0.125	0.07	1669	208	172	0.044	0.14	98	4	131	0.003	0.22	43,664	118	24	0.001	0.79	195	0.1
	2	440	0.097	0.10	1073	104	567	0.083	0.11	323	27	67	0.010	0.35	12,980	128					
2014	1	405	0.143	0.07	1908	272	278	0.090	0.30	82	7	66	0.000	0.33	10,688	4					
	2	528	0.100	0.09	927	93	830	0.062	0.11	336	21	61	0.029	0.21	5,406	155					
2015	1	298	0.155	0.10	1891	294	87	0.056	0.21	120	7	77	0.002	0.49	12,489	28					
	2	381	0.117	0.11	1223	143	475	0.063	0.12	549	34	50	0.020	0.16	4,912	96					
2016	1	253	0.121	0.09	2058	249	82	0.064	0.32	94	6	79	0.013	0.37	12,841	170					
	2	237	0.141	0.10	1702	241	201	0.094	0.21	514	48	43	0.038	0.27	4,300	162					
2017	1	186	0.156	0.13	3002	467	36	0.018	0.28	152	3	45	0.000	0.36	10,814	5					
	2	340	0.052	0.12	2814	147	245	0.035	0.15	794	28	19	0.157	0.32	1,502	235					
2018	1	255	0.088	0.11	2841	250	72	0.031	0.35	136	4	78	0.011	0.27	18,115	203					
	2	263	0.072	0.14	1980	142	124	0.079	0.24	719	57	48	0.079	0.17	19,019	1,504					

Table 8. Estimated monkfish discards (live weight) in the southern management region. Dredge discards are based on SBRM monkfish discards relative to kept of all species; trawl and gillnet are based on monkfish discards relative to monkfish kept.

South		Trawl					Gillnet					Scallop Dredge				
Year	Half	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)
1989	1	46	0.709	0.50	2,195	1,556		0.031		12	0		0.010	0.010	59,696	577
	2	53	0.169	0.59	733	124	3	0.054		5	0		0.015	0.015	35,498	528
1990	1	50	0.064	0.26	1,567	100	1	0.031		14	0		0.010		64,314	622
	2	35	0.118	0.32	759	90	13	0.054		18	0		0.015		53,040	789
1991	1	73	0.258	0.30	1,257	324	3	0.031		209	2		0.010		67,829	656
	2	77	0.020	0.39	3,831	78	8	0.000		154	0	2	0.001	0.07	36,015	19
1992	1	62	0.061	0.38	3,947	239	94	0.011	0.31	786	8	7	0.001	0.69	48,686	29
	2	41	0.028	0.83	2,135	60	72	0.020	0.20	176	3	7	0.012	0.50	39,126	460
1993	1	40	0.092	0.68	2,598	238	78	0.034	0.70	1,306	44	12	0.008	0.30	23,971	197
	2	34	0.028	0.49	1,301	36	87	0.061	0.20	341	21	4	0.032	0.53	18,379	587
1994	1	43	0.095	0.29	2,925	277	124	0.079	0.33	1,565	124	10	0.020	0.26	26,657	538
	2	30	0.323	0.56	2,027	655	173	0.056	0.18	967	55	10	0.015	0.29	24,222	370
1995	1	61	0.175	0.55	2,789	488	260	0.044	0.20	2,758	121	14	0.030	0.17	34,108	1,011
	2	103	0.115	0.57	2,946	340	170	0.050	0.34	1,172	59	9	0.050	0.45	18,456	917
1996	1	56	0.164	0.36	3,187	523	226	0.077	0.27	2,615	202	19	0.020	0.23	27,505	547
	2	85	0.095	0.18	4,021	380	134	0.052	0.28	1,434	75	15	0.029	0.26	19,621	562
1997	1	60	0.025	0.47	4,130	102	238	0.067	0.34	3,089	206	16	0.028	0.18	19,067	543
	2	29	0.089	0.15	4,215	374	106	0.015	0.34	1,313	20	8	0.041	0.39	14,997	612
1998	1	31	0.108	0.33	3,991	431	228	0.070	0.20	3,606	252	8	0.008	0.24	17,094	136
	2	28	0.027	0.52	3,946	108	64	0.062	0.44	2,053	128	15	0.012	0.57	15,300	177
1999	1	39	0.045	0.30	4,370	195	52	0.052	0.34	4,207	220	13	0.010	0.26	30,059	291
	2	34	0.214	0.57	2,306	494	35	0.046	0.57	1,917	88	56	0.004	0.16	34,102	150
2000	1	67	0.786	0.32	2,255	1,773	60	0.063	0.30	2,683	170	38	0.014	0.16	47,847	666
	2	47	0.107	0.62	1,709	182	44	0.051	0.81	1,157	59	133	0.009	0.16	43,879	382
2001	1	61	0.946	0.47	1,703	1,611	57	0.030	0.42	2,248	67	42	0.015	0.11	64,029	972
	2	96	0.404	0.73	1,348	545	35	0.033	0.38	2,788	92	48	0.014	0.15	70,044	973
2002	1	50	0.338	0.38	1,123	379	34	0.017	0.80	3,590	61	34	0.019	0.09	83,888	1,571
	2	94	0.327	0.39	566	185	40	0.063	0.44	1,967	124	61	0.018	0.10	81,620	1,475
2003	1	120	0.331	0.36	1,172	388	50	0.016	0.35	4,452	69	46	0.014	0.15	82,660	1,192
	2	99	0.406	0.45	1,177	478	56	0.070	0.31	2,849	199	71	0.017	0.12	91,638	1,542
2004	1	237	0.240	0.44	1,012	243	78	0.073	0.22	3,441	252	82	0.014	0.08	107,728	1,543
	2	436	0.300	0.31	733	220	74	0.089	0.22	1,043	93	193	0.015	0.10	95,117	1,432
2005	1	534	0.175	0.14	945	165	100	0.104	0.22	3,217	334	108	0.014	0.18	99,628	1,419
	2	654	0.064	0.11	1,588	102	82	0.081	0.20	1,372	111	174	0.019	0.19	67,548	1,290
2006	1	327	0.180	0.19	1,008	181	43	0.054	0.19	2,865	155	43	0.009	0.31	87,842	767
	2	277	0.055	0.15	1,010	56	35	0.082	0.32	967	79	166	0.022	0.14	99,456	2,210
2007	1	335	0.125	0.25	741	93	59	0.220	0.37	2,139	471	138	0.010	0.14	103,992	1,083
	2	420	0.159	0.40	657	104	45	0.054	0.33	1,569	84	156	0.013	0.15	68,914	920
2008	1	343	0.098	0.19	744	73	54	0.108	0.25	2,882	311	374	0.006	0.11	106,134	686
	2	316	0.017	0.31	594	10	39	0.104	0.29	993	104	245	0.010	0.13	74,506	717
2009	1	414	0.080	0.30	646	52	62	0.052	0.19	2,438	128	370	0.006	0.08	122,576	725
	2	529	0.088	0.31	280	25	32	0.074	0.24	610	45	103	0.009	0.15	73,175	652
2010	1	569	0.248	0.24	474	118	114	0.060	0.21	2,034	122	132	0.010	0.11	108,617	1,098
	2	545	0.190	0.51	369	70	95	0.077	0.18	695	54	174	0.008	0.12	81,139	648
2011	1	573	0.123	0.13	634	78	178	0.078	0.12	2,357	185	156	0.010	0.13	107,870	1,132
	2	601	0.088	0.11	598	53	84	0.122	0.19	1,066	130	150	0.010	0.12	62,873	623
2012	1	476	0.147	0.13	812	119	203	0.051	0.13	3,015	153	205	0.016	0.08	98,241	1,545
	2	337	0.180	0.18	366	66	32	0.058	0.18	576	33	130	0.017	0.15	46,675	797
2013	1	594	0.117	0.24	720	84	60	0.058	0.15	2,142	124	154	0.017	0.17	49,832	864
	2	500	0.053	0.28	447	24	34	0.101	0.37	1,168	118	177	0.016	0.13	45,168	709
2014	1	633	0.171	0.22	616	105	126	0.056	0.16	2,249	127	174	0.014	0.09	62,720	892
	2	700	0.107	0.15	518	56	131	0.030	0.28	861	26	188	0.012	0.14	44,960	518
2015	1	563	0.179	0.15	487	87	225	0.022	0.16	2,403	52	227	0.008	0.12	56,595	464
	2	527	0.521	0.12	318	165	273	0.027	0.20	823	22	202	0.008	0.14	58,643	444
2016	1	557	0.381	0.26	521	198	361	0.023	0.15	2,627	62	306	0.018	0.1	60,595	1,100
	2	854	0.838	0.24	227	191	343	0.041	0.27	564	23	237	0.017	0.13	69,514	1,204
2017	1	819	1.155	0.25	510	589	448	0.036	0.16	2,211	79	337	0.025	0.12	95,113	2,364
	2	1088	0.402	0.23	245	98	372	0.065	0.24	543	35	253	0.025	0.13	83,173	2,084
2018	1	591	0.594	0.21	395	235	302	0.041	0.16	2,494	102	211	0.030	0.11	91,400	2,759
	2	925	0.774	0.17	198	153	332	0.048	0.44	832	40	241	0.021	0.09	86,776	1,861

Table 9. Estimated annual catch (landings plus discards) of monkfish by management region and combined.

	North			South			Areas Combined				
Year	Landings	Discard	Total (mt)	Landings	Discard	Total (mt)	Landings	Discard	Total (mt)	Foreign	Total (mt)
1980	3,623	635	4,258	6,035	563	6,598	9,658	1,197	10,855	132	10,987
1981	3,171	754	3,925	4,142	451	4,593	7,313	1,204	8,517	381	8,898
1982	3,860	699	4,559	3,722	586	4,308	7,582	1,285	8,867	310	9,177
1983	3,849	664	4,513	4,115	659	4,774	7,964	1,323	9,287	80	9,367
1984	4,202	616	4,818	3,699	684	4,383	7,901	1,301	9,202	395	9,597
1985	4,616	640	5,256	4,262	636	4,898	8,878	1,276	10,154	1,333	11,487
1986	4,327	548	4,875	4,037	618	4,655	8,364	1,166	9,530	341	9,871
1987	4,960	766	5,726	3,762	1,039	4,801	8,722	1,805	10,527	748	11,275
1988	5,066	784	5,850	4,595	1,030	5,625	9,661	1,814	11,475	909	12,384
1989	6,391	534	6,925	8,353	2,786	11,139	14,744	3,320	18,064	1,178	19,242
1990	5,802	406	6,208	7,204	1,602	8,806	13,006	2,008	15,014	1,557	16,571
1991	5,693	481	6,174	9,865	1,080	10,945	15,558	1,561	17,119	1,020	18,139
1992	6,923	844	7,767	13,942	801	14,743	20,865	1,644	22,509	473	22,982
1993	10,645	730	11,375	15,098	1,123	16,221	25,743	1,853	27,596	354	27,950
1994	10,950	353	11,303	12,126	2,019	14,145	23,076	2,372	25,448	543	25,991
1995	11,970	1,475	13,445	14,361	2,935	17,297	26,331	4,410	30,741	418	31,159
1996	10,791	1,780	12,572	15,715	2,289	18,004	26,507	4,069	30,576	184	30,760
1997	9,709	1,002	10,712	18,462	1,856	20,318	28,172	2,858	31,030	189	31,219
1998	7,281	769	8,050	19,337	1,231	20,568	26,618	2,000	28,618	190	28,808
1999	9,128	713	9,841	16,085	1,438	17,523	25,213	2,151	27,364	151	27,515
2000	10,729	871	11,599	10,147	3,232	13,379	20,876	4,103	24,979	176	25,155
2001	13,341	1,213	14,554	9,959	4,260	14,219	23,301	5,473	28,773	142	28,915
2002	14,011	1,169	15,180	8,884	3,796	12,680	22,896	4,964	27,860	294	28,154
2003	14,991	1,212	16,203	11,095	3,869	14,964	26,086	5,080	31,167	309	31,476
2004	13,209	847	14,056	7,978	3,782	11,760	21,186	4,629	25,816	166	25,982
2005	10,140	711	10,851	9,177	3,421	12,597	19,317	4,132	23,449	206	23,655
2006	6,974	738	7,712	7,980	3,448	11,428	14,955	4,186	19,140	279	19,419
2007	4,953	778	5,732	7,388	2,755	10,143	12,341	3,533	15,875	8	15,883
2008	3,942	338	4,280	7,250	1,901	9,151	11,192	2,240	13,432	2	13,434
2009	3,210	465	3,675	5,532	1,626	7,158	8,742	2,092	10,833		10,833
2010	2,424	317	2,741	4,996	2,109	7,105	7,420	2,426	9,846		9,846
2011	2,362	452	2,814	6,344	2,200	8,545	8,707	2,652	11,359		11,359
2012	4,033	602	4,635	5,724	2,714	8,438	9,757	3,316	13,073		13,073
2013	3,332	589	3,922	5,253	1,922	7,176	8,586	2,512	11,097		11,097
2014	3,402	552	3,954	5,135	1,724	6,859	8,537	2,276	10,813		10,813
2015	4,027	603	4,630	4,609	1,235	5,844	8,636	1,838	10,474		10,474
2016	4,633	875	5,508	4,422	2,777	7,199	9,055	3,652	12,707		12,707
2017	7,008	886	7,894	3,893	5,250	9,143	10,901	6,136	17,037		17,037
2018	5,954	2161	8,115	4,465	5,150	9,615	10,419	7,311	17,730		17,730

Table 10. Number of length samples available for kept and discarded monkfish from observer database.

		North						South					
Trawl		Kept Lengths			Discard Lengths			Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1	16	54	751	24	65	1393	14	27	86	11	22	216
	2	19	57	548	19	46	1046	16	32	306	14	40	181
2001	1	14	41	578	11	40	487	12	26	126	12	56	338
	2	26	74	659	28	45	1621	9	13	42	2	4	103
2002	1	7	28	391	12	32	342	16	37	85	2	4	11
	2	77	274	3452	153	388	7038	22	54	367	10	32	255
2003	1	74	333	4648	100	361	6340	62	196	1397	36	123	975
	2	72	308	4193	81	363	4387	38	141	740	23	43	359
2004	1	67	226	3156	81	294	4278	98	304	2301	66	275	2051
	2	141	505	6122	179	657	5059	129	494	2983	124	444	3406
2005	1	177	751	8255	238	1426	14806	234	794	5760	184	759	8029
	2	214	841	7698	228	827	8134	218	982	9097	203	656	4960
2006	1	100	403	4960	126	672	7238	154	574	5490	126	498	4184
	2	71	333	2828	100	529	5615	92	337	3501	87	299	2330
2007	1	60	257	2580	98	555	4507	121	467	3078	72	426	1648
	2	118	554	3432	140	714	4992	102	236	1658	76	207	1198
2008	1	75	320	2973	121	657	6748	97	291	3024	88	265	2018
	2	98	341	2244	154	664	5705	77	239	2567	36	87	529
2009	1	70	194	1869	113	502	4978	64	190	1286	36	118	694
	2	83	181	1474	99	257	1762	68	161	1036	49	105	629
2010	1	55	224	2875	68	303	3736	65	166	1265	72	187	1777
	2	23	72	906	42	140	960	40	113	585	50	160	694
2011	1	35	83	1076	73	259	3389	47	109	569	66	165	1145
	2	34	82	795	60	147	1311	41	86	823	64	167	2160
2012	1	25	60	853	76	262	2460	36	100	732	65	212	2250
	2	23	44	556	87	203	2270	13	31	176	19	63	342
2013	1	12	31	260	38	102	1253	19	34	411	32	99	823
	2	13	47	307	60	154	1552	17	33	204	33	88	463
2014	1	32	61	596	79	227	2993	28	54	235	69	158	1143
	2	12	20	190	40	103	925	27	60	314	46	144	949
2015	1	8	13	116	73	198	3021	23	44	210	59	125	758
	2	9	30	185	64	173	1244	22	45	200	52	171	1405
2016	1	5	6	42	19	46	853	24	61	224	87	226	1476
	2	11	26	204	24	59	573	23	51	115	82	283	2047
2017	1	8	15	96	39	167	1864	50	104	334	120	284	1944
	2	13	35	435	54	163	1859	46	104	304	82	225	838
2018	1	14	29	429	67	198	3061	60	107	448	113	240	881
	2	10	21	90	32	92	720	45	94	289	115	412	2539
Gillnet													
2000	1	37	49	311	9	14	59	70	94	2854	7	18	95
	2	66	110	2708	8	16	87	22	42	952	3	4	47
2001	1	27	45	362	4	8	12	216	253	8634	3	4	9
	2	50	76	1940	4	12	27	20	38	1543			
2002	1	29	50	976	10	18	60	58	88	2981	2	6	65
	2	60	115	2493	25	47	198	13	15	391	2	3	39
2003	1	51	163	2564	30	72	321	45	112	3937	6	14	35
	2	131	341	5099	58	121	696	60	192	6047	13	35	113
2004	1	70	220	2212	27	49	133	130	335	11691	36	103	747
	2	434	1314	15334	138	243	672	68	195	4337	11	20	174
2005	1	29	54	459	8	10	32	113	253	8853	14	31	215
	2	399	1251	14565	81	129	413	90	253	6705	16	31	120
2006	1	43	102	651	5	8	15	153	216	7833	10	15	30
	2	57	152	1404	12	15	26	25	36	1290	5	7	10
2007	1	14	27	262	4	10	16	115	189	4789	15	35	245
	2	134	415	3442	22	28	45	52	96	1966	2	3	3
2008	1	19	55	320	6	7	22	94	179	3976	9	24	333
	2	75	174	909	13	17	35	40	90	1485	6	9	14
2009	1	9	32	48	4	7	13	89	189	3819	7	13	45
	2	67	128	899	11	12	30	23	62	938	4	11	58
2010	1	31	88	677	8	9	11	69	154	3398	4	4	20
	2	63	120	773	22	32	78	43	95	1883	5	7	9
2011	1	9	13	38	3	4	4	56	125	2775	5	11	29
	2	65	123	583	14	22	37	15	27	605	2	4	75
2012	1	20	44	118	11	18	22	42	78	1304	4	4	14
	2	52	87	331	25	33	58	13	39	425	4	5	7
2013	1	13	29	163	7	8	9	41	75	1480	3	3	5
	2	64	125	469	27	41	64	18	39	414	0	0	0
2014	1	27	72	148	11	25	35	101	205	2463	5	10	30
	2	64	113	542	32	47	72	48	98	819	2	2	6
2015	1	13	26	164	7	10	12	117	244	2903	15	31	84
	2	69	149	1501	19	42	121	51	99	820	4	5	7
2016	1	10	20	142	5	6	8	153	287	3255	8	9	31
	2	52	68	474	8	14	29	75	152	1595	13	15	24
2017	1	6	9	82	2	3	6	180	383	4134	31	49	120
	2	83	162	1306	8	10	14	72	122	1366	4	5	22
2018	1	10	12	66	5	15	30	119	252	2382	12	17	48
	2	50	76	396	6	10	17	44	85	641	3	7	16

Table 10, continued

		North						South					
Dredge		Kept Lengths			Discard Lengths			Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1							12	415	2481	9	340	2317
	2	3	29	89	3	19	29	7	49	186	10	90	464
2001	1	1	2	8	1	3	4	5	52	215	6	65	303
	2							3	14	33	3	14	250
2002	1												
	2	4	66	191	4	9	28	7	60	155	16	141	675
2003	1				1	5	9	16	171	395	24	250	1115
	2	5	48	161	4	49	321	18	100	268	34	270	1215
2004	1				1	2	2	33	449	1205	50	767	5615
	2	4	10	13	11	42	120	63	1010	2962	157	2500	15145
2005	1	1	18	27	5	29	109	51	697	1782	67	901	5268
	2	6	25	113	27	192	979	88	377	1300	111	929	6274
2006	1	2	4	4	2	18	26	12	49	341	26	125	794
	2	15	76	356	29	170	711	57	465	1607	92	741	4625
2007	1	4	20	25	16	58	106	46	318	746	98	804	3384
	2	23	212	1094	50	368	2082	48	308	1144	116	900	4386
2008	1	1	3	3	9	48	70	96	443	1137	272	1492	4593
	2	6	22	96	15	45	158	60	370	1053	175	1131	3702
2009	1				3	7	12	109	727	1796	219	1549	4461
	2	5	9	90	12	77	219	34	235	808	62	502	2364
2010	1				3	7	10	50	360	615	89	915	4094
	2	1	8	12	8	41	100	41	283	703	117	898	3612
2011	1	2	2	3	3	6	27	36	342	940	104	951	5053
	2	14	44	120	57	178	559	38	167	565	110	536	2622
2012	1	1	1	1	24	134	481	58	257	855	162	1160	7150
	2	27	107	294	56	280	1340	28	106	634	75	328	2549
2013	1	3	4	9	44	203	495	41	139	438	91	483	2264
	2	7	24	53	28	73	213	75	286	948	108	531	2398
2014	1	4	4	5	13	25	34	72	255	630	119	704	3868
	2	4	8	23	35	79	349	63	238	746	123	720	3014
2015	1	3	5	11	19	38	105	56	189	463	127	659	2362
	2	9	29	70	34	102	409	46	226	557	134	831	3218
2016	1	7	42	118	7	42	118	59	208	405	59	208	405
	2	10	41	87	10	41	87	36	211	472	36	211	472
2017	1	2	5	7	2	5	7	59	173	441	59	173	441
	2	4	7	26	4	7	26	36	79	244	36	79	244
2018	1	4	5	15	4	5	15	38	105	428	38	105	428
	2	6	14	46	6	14	46	34	68	222	34	68	222

Table 11. Temporal stratification used in expanding landings and discards to length composition of the monkfish catch. Unless otherwise indicated, sampling was expanded within gear type and area.

	Trawl		Gillnet		Dredge	
North	**Kept**	**Discarded**	**Kept**	**Discarded**	**Kept**	**Discarded**
1994	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1995	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1996	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1997	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1998	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1999	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
2000	annual	annual	annual	2000-2002 N+S	annual N+S	annual N+S
2001	annual	annual	annual	2000-2002 N+S	annual N+S	annual N+S
2002	annual	annual	annual	2000-2002 N+S	annual N+S	annual N+S
2003	half-year	half-year	annual	annual N+S	annual N+S	annual N+S
2004	half-year	half-year	annual	annual N+S	annual N+S	annual N+S
2005	half-year	half-year	annual	annual N+S	annual N+S	annual N+S
2006	half-year	half-year	annual	2006-2008 N+S	annual N+S	annual N+S
2007	half-year	half-year	annual	2006-2008 N+S	annual N+S	annual N+S
2008	half-year	half-year	annual	2006-2008 N+S	annual N+S	annual N+S
2009	half-year	half-year	annual	2009-2011 N+S	annual N+S	annual N+S
2010	half-year	half-year	annual	2009-2011 N+S	annual N+S	annual N+S
2011	half-year	half-year	annual	2009-2011 N+S	annual N+S	annual N+S
2012	half-year	half-year	annual	2012-2014 N+S	annual N+S	annual N+S
2013	half-year	half-year	annual	2012-2014 N+S	annual N+S	annual N+S
2014	half-year	half-year	annual	2012-2014 N+S	annual N+S	annual N+S
2015	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S
2016	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S
2017	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S
2018	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S
South						
1994	annual		annual	annual	annual	annual
1995	annual		annual	annual	annual	annual
1996	annual		annual	annual	annual	annual
1997	annual		annual	annual	annual	annual
1998	annual		annual	annual	annual	annual
1999	annual		annual	annual	annual	annual
2000	annual N+S	annual N+S	annual	2000-2002 N+S	annual	annual
2001	annual N+S	annual N+S	annual	2000-2002 N+S	2000-2002	2000-2002
2002	annual N+S	annual N+S	annual	2000-2002 N+S	2000-2002	2000-2002
2003	annual	half-year	annual	annual N+S	annual	annual
2004	annual	half-year	annual	annual N+S	annual	annual
2005	annual	half-year	annual	annual N+S	annual	annual
2006	annual	half-year	annual	2006-2008 N+S	annual	annual
2007	annual	half-year	annual	2006-2008 N+S	annual	annual
2008	annual	half-year	annual	2006-2008 N+S	annual	annual
2009	annual	half-year	annual	2009-2011 N+S	annual	annual
2010	annual	half-year	annual	2009-2011 N+S	annual	annual
2011	annual	half-year	annual	2009-2011 N+S	annual	annual
2012	annual	half-year	annual	2012-2014 N+S	annual	annual
2013	annual	half-year	annual	2012-2014 N+S	annual	annual
2014	annual	half-year	annual	2012-2014 N+S	annual	annual
2015	annual	half-year	annual	annual N+S	annual	annual
2016	annual	half-year	annual	annual N+S	annual	annual
2017	annual	half-year	annual	annual N+S	annual	annual
2018	annual	half-year	annual	annual N+S	annual	annual

Table 12a. Survey results from NEFSC offshore autumn bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values from 2009 forward are adjusted for change in survey methods. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1963	3.79	0.17	2.79	4.87	0.81	0.15	0.62	1.02
1964	1.89	0.21	1.30	2.54	0.39	0.20	0.26	0.52
1965	2.52	0.20	1.73	3.41	0.35	0.15	0.26	0.44
1966	3.33	0.15	2.52	4.16	0.51	0.14	0.39	0.64
1967	1.24	0.33	0.65	1.96	0.19	0.26	0.11	0.27
1968	2.05	0.34	1.01	3.41	0.29	0.27	0.17	0.41
1969	3.69	0.23	2.36	5.15	0.42	0.15	0.31	0.53
1970	2.32	0.26	1.33	3.42	0.40	0.20	0.27	0.53
1971	2.90	0.21	1.93	3.93	0.49	0.17	0.36	0.63
1972	1.39	0.25	0.87	2.02	0.32	0.18	0.22	0.42
1973	3.19	0.20	2.16	4.36	0.53	0.19	0.38	0.72
1974	2.02	0.21	1.38	2.78	0.32	0.19	0.22	0.44
1975	1.71	0.19	1.20	2.25	0.30	0.18	0.21	0.39
1976	3.22	0.21	2.16	4.41	0.42	0.20	0.28	0.56
1977	5.43	0.17	3.94	6.99	0.76	0.12	0.50	0.75
1978	4.73	0.13	3.77	5.84	0.70	0.13	0.47	0.71
1979	4.91	0.14	3.83	6.04	0.55	0.11	0.39	0.57
1980	4.04	0.20	2.75	5.48	0.64	0.14	0.41	0.67
1981	1.98	0.18	1.39	2.59	0.45	0.13	0.32	0.49
1982	0.94	0.25	0.57	1.32	0.14	0.22	0.09	0.19
1983	1.61	0.19	1.11	2.13	0.47	0.18	0.34	0.61
1984	2.82	0.20	1.95	3.82	0.49	0.14	0.38	0.59
1985	1.48	0.33	0.75	2.40	0.37	0.22	0.24	0.52
1986	2.23	0.22	1.47	3.10	0.61	0.17	0.45	0.78
1987	0.88	0.33	0.42	1.38	0.26	0.26	0.16	0.38
1988	1.53	0.31	0.78	2.40	0.31	0.27	0.18	0.47
1989	1.32	0.30	0.77	2.03	0.51	0.18	0.31	0.55
1990	1.01	0.28	0.56	1.48	0.71	0.15	0.44	0.74
1991	1.20	0.24	0.75	1.67	0.70	0.17	0.42	0.74
1992	1.12	0.23	0.74	1.57	0.94	0.17	0.67	1.21
1993	1.10	0.34	0.58	1.80	1.23	0.16	0.75	1.31
1994	0.90	0.23	0.58	1.26	1.34	0.12	1.08	1.61
1995	1.60	0.23	1.00	2.20	0.93	0.12	0.74	1.11
1996	1.07	0.25	0.66	1.55	0.63	0.17	0.46	0.81
1997	0.67	0.23	0.43	0.92	0.50	0.18	0.36	0.66
1998	0.96	0.20	0.65	1.26	0.62	0.19	0.44	0.82
1999	0.78	0.22	0.51	1.06	1.08	0.15	0.82	1.36
2000	2.41	0.20	1.66	3.22	2.34	0.14	1.84	2.88
2001	1.84	0.16	1.38	2.33	1.61	0.11	1.31	1.91
2002	1.83	0.17	1.35	2.34	1.28	0.13	1.01	1.56
2003	1.81	0.18	1.30	2.33	1.07	0.12	0.86	1.28
2004	0.64	0.27	0.38	0.96	0.52	0.19	0.36	0.68
2005	1.01	0.23	0.64	1.38	0.60	0.18	0.42	0.79
2006	1.04	0.23	0.66	1.46	0.77	0.15	0.58	0.98
2007	1.08	0.28	0.62	1.62	0.64	0.15	0.48	0.80
2008	0.99	0.29	0.54	1.48	0.79	0.21	0.53	1.10
2009	0.44	0.17	0.32	0.57	0.39	0.10	0.32	0.45
2010	0.64	0.14	0.49	0.78	0.51	0.09	0.44	0.58
2011	0.88	0.15	0.68	1.10	0.67	0.07	0.60	0.74
2012	0.81	0.12	0.65	0.96	0.68	0.07	0.61	0.76
2013	0.62	0.11	0.50	0.73	0.73	0.07	0.65	0.81
2014	0.76	0.08	0.66	0.86	0.95	0.09	0.81	1.09
2015	1.14	0.11	0.92	1.34	1.22	0.09	1.03	1.39
2016	1.50	0.10	1.25	1.76	1.84	0.07	1.63	2.07
2017	1.78	0.09	1.52	2.04	1.47	0.09	1.25	1.68
2018	2.16	0.07	1.92	2.42	1.29	0.06	1.16	1.42

Table 12b. Survey results from NEFSC offshore autumn bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values are indices calculated without adjustment for change in survey methods in 2009. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	3.55	0.18	2.51	4.58	2.78	0.10	2.33	3.22
2010	5.13	0.15	3.88	6.38	3.65	0.09	3.13	4.17
2011	7.09	0.15	5.32	8.86	4.77	0.06	4.26	5.28
2012	6.50	0.11	5.33	7.68	4.88	0.07	4.34	5.41
2013	4.97	0.11	4.05	5.90	5.21	0.07	4.64	5.79
2014	6.11	0.09	5.23	6.98	6.79	0.09	5.82	7.76
2015	9.20	0.11	7.47	10.93	8.71	0.09	7.41	10.02
2016	12.11	0.10	10.08	14.14	13.09	0.07	11.52	14.66
2017	14.38	0.09	12.30	16.46	10.45	0.08	9.01	11.88
2018	17.39	0.07	15.33	19.45	9.20	0.06	8.23	10.17

Table 13a. Survey results from NEFSC offshore spring bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values from 2009 forward are adjusted for change in survey methods. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1968	1.007	0.33	0.503	1.585	0.168	0.29	0.092	0.252
1969	1.341	0.42	0.536	2.373	0.18	0.36	0.087	0.302
1970	2.02	0.26	1.166	2.943	0.344	0.18	0.243	0.443
1971	1.048	0.29	0.612	1.585	0.162	0.29	0.093	0.249
1972	4.626	0.15	3.445	5.846	0.651	0.15	0.499	0.812
1973	1.885	0.21	1.228	2.53	0.437	0.23	0.274	0.598
1974	1.492	0.20	1.044	1.992	0.44	0.14	0.348	0.55
1975	0.942	0.17	0.687	1.208	0.341	0.15	0.26	0.426
1976	2.507	0.13	1.942	3.017	0.667	0.13	0.531	0.814
1977	0.932	0.18	0.656	1.194	0.259	0.19	0.185	0.342
1978	0.565	0.20	0.38	0.749	0.141	0.16	0.105	0.178
1979	0.671	0.21	0.446	0.917	0.139	0.14	0.109	0.171
1980	1.434	0.18	1	1.868	0.383	0.13	0.296	0.471
1981	1.669	0.20	1.16	2.246	0.376	0.12	0.301	0.444
1982	2.968	0.25	1.802	4.258	0.345	0.25	0.217	0.498
1983	1.53	0.31	0.846	2.383	0.418	0.24	0.269	0.596
1984	1.567	0.27	0.928	2.313	0.331	0.22	0.219	0.459
1985	2.119	0.22	1.388	2.942	0.346	0.20	0.239	0.46
1986	2.128	0.26	1.212	3.094	0.341	0.20	0.238	0.454
1987	1.727	0.27	0.949	2.476	0.245	0.20	0.168	0.33
1988	2.03	0.23	1.297	2.892	0.607	0.17	0.443	0.79
1989	1.604	0.30	0.895	2.462	0.619	0.21	0.413	0.814
1990	1.014	0.30	0.563	1.561	0.283	0.21	0.184	0.384
1991	1.611	0.24	0.986	2.233	0.592	0.18	0.416	0.767
1992	0.886	0.57	0.236	1.916	0.493	0.31	0.267	0.765
1993	1.157	0.19	0.823	1.554	0.681	0.13	0.527	0.822
1994	0.979	0.30	0.505	1.424	0.453	0.18	0.313	0.583
1995	1.835	0.28	1.035	2.721	1.009	0.16	0.753	1.286
1996	0.976	0.24	0.597	1.364	0.666	0.22	0.43	0.918
1997	0.546	0.36	0.248	0.91	0.342	0.25	0.212	0.496
1998	0.445	0.27	0.257	0.652	0.416	0.14	0.318	0.518
1999	1.15	0.19	0.796	1.529	0.827	0.16	0.616	1.039
2000	1.399	0.18	1.026	1.829	1.132	0.12	0.912	1.359
2001	1.851	0.28	1.07	2.83	1.669	0.12	1.358	2.008
2002	1.927	0.13	1.538	2.348	1.743	0.10	1.456	2.039
2003	1.874	0.20	1.295	2.508	0.813	0.20	0.563	1.092
2004	2.263	0.26	1.313	3.307	0.907	0.17	0.667	1.153
2005	1.472	0.21	0.994	2.018	0.718	0.16	0.534	0.918
2006	0.93	0.40	0.393	1.613	0.367	0.27	0.219	0.531
2007	1.047	0.41	0.394	1.815	0.548	0.23	0.355	0.766
2008	1.286	0.30	0.697	1.903	0.674	0.17	0.485	0.864
2009	0.472	0.15	0.361	0.58	0.331	0.10	0.274	0.388
2010	0.631	0.14	0.49	0.778	0.382	0.14	0.301	0.469
2011	0.893	0.15	0.69	1.125	0.465	0.13	0.373	0.571
2012	0.607	0.13	0.475	0.743	0.538	0.14	0.425	0.671
2013	0.583	0.11	0.477	0.691	0.551	0.07	0.488	0.613
2014	0.629	0.16	0.46	0.806	0.614	0.12	0.501	0.737
2015	0.732	0.16	0.555	0.933	0.537	0.09	0.459	0.623
2016	0.744	0.09	0.639	0.845	0.685	0.07	0.612	0.764
2017	1.134	0.13	0.888	1.393	0.681	0.10	0.574	0.793
2018	1.65	0.07	1.474	1.833	1.041	0.08	0.91	1.168
2019	1.323	0.08	1.159	1.511	0.874	0.08	0.759	0.996

Table 13b. Survey results from NEFSC offshore spring bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values are indices calculated without adjustment for change in survey methods in 2009. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	3.80	0.14	2.91	4.70	2.36	0.10	1.96	2.76
2010	5.08	0.14	3.89	6.27	2.72	0.13	2.12	3.32
2011	7.20	0.16	5.31	9.08	3.31	0.14	2.55	4.07
2012	4.90	0.14	3.79	6.00	3.83	0.13	3.00	4.67
2013	4.70	0.11	3.82	5.57	3.93	0.07	3.48	4.38
2014	5.07	0.16	3.77	6.38	4.38	0.12	3.52	5.23
2015	5.90	0.16	4.33	7.47	3.83	0.09	3.24	4.41
2016	6.00	0.08	5.21	6.79	4.88	0.06	4.37	5.40
2017	9.14	0.14	7.03	11.25	4.86	0.10	4.08	5.64
2018	13.30	0.07	11.81	14.79	7.42	0.07	6.52	8.32
2019	10.66	0.08	9.26	12.07	6.23	0.08	5.41	7.05

Table 14. Survey results from ASMFC summer shrimp surveys in the northern management region (strata 1, 3, 5, 6-8). Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1991	1.88	0.17	1.40	2.45	2.88	0.10	2.45	3.36
1992	2.69	0.16	2.04	3.46	2.90	0.10	2.45	3.42
1993	3.07	0.25	1.85	4.39	3.70	0.13	2.93	4.52
1994	1.66	0.21	1.11	2.25	3.42	0.13	2.70	4.20
1995	1.55	0.23	0.95	2.15	2.08	0.18	1.44	2.71
1996	3.36	0.31	1.83	5.30	2.99	0.13	2.37	3.69
1997	2.08	0.21	1.36	2.84	1.57	0.14	1.21	1.94
1998	2.27	0.29	1.24	3.36	2.12	0.13	1.70	2.58
1999	6.26	0.09	5.56	7.57	6.75	0.08	6.00	7.89
2000	3.84	0.16	2.87	4.84	5.72	0.13	4.49	7.09
2001	7.27	0.11	6.02	8.58	10.89	0.09	9.29	12.54
2002	12.44	0.10	10.25	14.51	11.65	0.09	9.99	13.33
2003	7.36	0.16	5.68	9.74	5.80	0.12	4.82	7.23
2004	4.45	0.10	3.70	5.17	3.38	0.10	2.85	3.92
2005	7.25	0.13	5.73	8.87	5.25	0.10	4.45	6.08
2006	6.54	0.12	5.29	7.77	4.31	0.07	3.82	4.80
2007	4.10	0.21	2.69	5.52	4.46	0.13	3.53	5.37
2008	3.79	0.19	2.62	5.03	2.82	0.12	2.29	3.37
2009	3.21	0.19	2.23	4.25	3.12	0.11	2.57	3.72
2010	2.76	0.21	1.89	3.76	2.54	0.15	1.96	3.14
2011	2.66	0.15	2.04	3.37	2.25	0.09	1.93	2.62
2012	3.14	0.16	2.34	3.97	3.55	0.12	2.85	4.31
2013	4.07	0.16	3.05	5.20	4.13	0.13	3.30	5.12
2014	3.31	0.15	2.57	4.19	4.94	0.09	4.23	5.68
2015	1.45	0.23	0.91	2.00	2.76	0.21	1.79	3.69
2016	5.01	0.13	3.98	6.17	6.61	0.07	5.83	7.43
2017	4.78	0.16	3.56	5.99	4.63	0.10	3.90	5.39
2018	5.36	0.25	3.34	7.83	4.88	0.13	3.86	6.02

Table 15. Monkfish indices from Maine-New Hampshire inshore surveys, strata 1-4, regions 1-5.

Fall

Year	Mean Weight	CV	L95%	U95%	Mean Number	CV	L95%	U95%
2000	1.6	0.39	1.1	2.2	4.8	0.29	3.6	6.0
2001	4.7	0.20	3.9	5.6	10.7	0.21	8.5	13.0
2002	3.4	0.66	1.2	5.7	4.1	0.56	1.8	6.3
2003	3.6	0.38	2.0	5.2	3.7	0.31	2.4	5.0
2004	3.6	0.41	1.9	5.3	2.9	0.31	1.9	4.0
2005	2.0	0.35	1.1	3.0	1.8	0.22	1.3	2.3
2006	1.8	0.23	1.4	2.2	2.9	0.22	2.3	3.5
2007	2.1	0.32	1.4	2.8	3.1	0.26	2.3	4.0
2008	2.9	0.27	2.1	3.8	4.1	0.33	2.7	5.5
2009	1.9	0.59	0.9	3.0	2.0	0.45	1.2	2.8
2010	0.7	0.35	0.5	0.9	1.0	0.32	0.7	1.4
2011	1.1	0.38	0.7	1.5	1.0	0.37	0.6	1.3
2012	0.5	0.51	0.2	0.8	0.8	0.35	0.5	1.1
2013	0.6	0.59	0.3	1.0	0.8	0.39	0.5	1.1
2014	0.3	0.43	0.2	0.4	1.0	0.32	0.8	1.3
2015	1.6	0.30	1.2	2.1	7.0	0.33	4.9	9.1
2016	1.3	0.33	0.9	1.7	6.8	0.21	5.4	8.1
2017	2.2	0.33	1.6	2.8	4.1	0.30	3.2	5.1
2018	2.3	0.31	1.6	3.1	2.9	0.24	2.2	3.5

Spring

Year	Mean Weight	CV	L95%	U95%	Mean Number	CV	L95%	U95%
2000								
2001	1.0	0.35	0.7	1.3	6.0	0.35	4.2	7.9
2002	1.1	0.37	0.8	1.5	2.4	0.31	1.7	3.0
2003	0.6	0.52	0.3	1.0	1.0	0.26	0.7	1.2
2004	0.4	0.60	0.2	0.6	1.4	0.23	1.1	1.7
2005	0.8	0.35	0.5	1.1	1.1	0.22	0.8	1.4
2006	0.1	0.45	0.1	0.2	0.3	0.42	0.2	0.4
2007	0.4	0.49	0.2	0.6	1.1	0.30	0.8	1.5
2008	0.5	0.30	0.3	0.7	1.4	0.26	1.0	1.7
2009	0.2	0.44	0.1	0.3	0.8	0.31	0.6	1.0
2010	0.2	0.49	0.1	0.3	0.6	0.41	0.4	0.8
2011	0.2	0.69	0.1	0.3	0.3	0.35	0.2	0.4
2012	0.3	0.95	0.0	0.5	0.4	0.36	0.2	0.5
2013	0.2	1.01	0.0	0.3	0.4	0.45	0.2	0.5
2014	0.2	0.97	0.0	0.4	0.9	0.39	0.6	1.1
2015	0.2	0.32	0.1	0.2	1.1	0.28	0.8	1.3
2016	0.5	0.31	0.4	0.6	2.5	0.28	1.9	3.0
2017	0.4	0.64	0.2	0.6	1.2	0.28	0.9	1.4
2018	0.3	0.36	0.2	0.4	1.5	0.27	1.2	1.8

Table 16a. Survey results from NEFSC offshore autumn bottom trawl surveys in the southern management region (strata 1-19, 61-76). Strata 61-76 were not sampled until 1967; survey sampled only a small portion of the southern management area in 2017, therefore indices were not calculated for 2017. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1963	3.60	0.24	2.30	5.09	1.20	0.18	0.87	1.58
1964	5.50	0.17	3.89	7.19	1.64	0.15	1.17	1.98
1965	4.90	0.17	3.60	6.41	1.15	0.15	0.90	1.44
1966	7.01	0.12	5.71	8.61	1.93	0.14	1.53	2.41
1967	1.14	0.22	0.74	1.56	0.52	0.17	0.37	0.66
1968	0.91	0.22	0.60	1.25	0.40	0.21	0.28	0.56
1969	1.34	0.30	0.75	2.06	0.54	0.21	0.37	0.76
1970	1.29	0.22	0.79	1.77	0.35	0.16	0.26	0.44
1971	0.79	0.36	0.38	1.30	0.28	0.21	0.18	0.37
1972	4.89	0.14	3.83	6.05	4.11	0.22	2.48	5.26
1973	1.83	0.16	1.33	2.27	1.18	0.11	0.95	1.35
1974	0.72	0.26	0.43	1.06	0.22	0.21	0.15	0.30
1975	2.00	0.16	1.50	2.54	0.75	0.16	0.50	0.84
1976	1.00	0.18	0.72	1.30	0.31	0.19	0.23	0.43
1977	1.88	0.18	1.37	2.45	0.45	0.14	0.29	0.46
1978	1.40	0.18	1.00	1.83	0.31	0.16	0.19	0.33
1979	1.93	0.16	1.45	2.45	0.84	0.13	0.55	0.85
1980	1.85	0.17	1.35	2.38	0.87	0.16	0.51	0.87
1981	2.26	0.17	1.66	2.90	1.16	0.16	0.72	1.23
1982	0.65	0.21	0.43	0.88	0.61	0.18	0.44	0.79
1983	1.76	0.21	1.18	2.40	0.78	0.17	0.57	0.99
1984	0.77	0.40	0.34	1.36	0.31	0.31	0.17	0.49
1985	1.29	0.19	0.93	1.72	0.62	0.16	0.40	0.68
1986	0.55	0.27	0.33	0.81	0.36	0.23	0.22	0.46
1987	0.28	0.29	0.16	0.42	0.48	0.18	0.35	0.63
1988	0.55	0.28	0.32	0.83	0.23	0.26	0.14	0.33
1989	0.62	0.25	0.37	0.87	0.46	0.22	0.24	0.51
1990	0.37	0.32	0.20	0.58	0.35	0.27	0.17	0.43
1991	0.77	0.29	0.45	1.19	0.83	0.28	0.40	1.08
1992	0.32	0.22	0.22	0.44	0.34	0.16	0.25	0.43
1993	0.27	0.34	0.14	0.44	0.35	0.23	0.19	0.41
1994	0.55	0.23	0.35	0.75	0.60	0.19	0.42	0.79
1995	0.39	0.27	0.23	0.57	0.49	0.21	0.33	0.68
1996	0.39	0.21	0.26	0.53	0.23	0.21	0.16	0.32
1997	0.59	0.19	0.42	0.79	0.31	0.17	0.23	0.39
1998	0.50	0.24	0.32	0.72	0.33	0.24	0.21	0.46
1999	0.30	0.15	0.23	0.38	0.45	0.12	0.36	0.54
2000	0.47	0.20	0.32	0.63	0.42	0.17	0.31	0.54
2001	0.65	0.18	0.47	0.85	0.38	0.17	0.27	0.49
2002	1.25	0.18	0.88	1.61	0.83	0.14	0.64	1.02
2003	0.82	0.15	0.61	1.04	0.95	0.17	0.71	1.24
2004	0.74	0.18	0.53	0.97	0.47	0.20	0.32	0.62
2005	0.77	0.23	0.50	1.09	0.58	0.20	0.41	0.80
2006	0.76	0.24	0.49	1.07	0.45	0.19	0.33	0.60
2007	0.50	0.24	0.31	0.71	0.20	0.22	0.12	0.27
2008	0.41	0.35	0.19	0.68	0.20	0.25	0.12	0.29
2009	0.24	0.12	0.19	0.28	0.22	0.13	0.17	0.27
2010	0.36	0.17	0.27	0.47	0.40	0.19	0.29	0.54
2011	0.30	0.12	0.24	0.36	0.62	0.13	0.48	0.75
2012	0.43	0.14	0.33	0.54	0.28	0.14	0.22	0.34
2013	0.27	0.15	0.21	0.34	0.29	0.17	0.21	0.37
2014	0.15	0.18	0.11	0.19	0.16	0.12	0.13	0.19
2015	0.37	0.22	0.25	0.51	1.96	0.28	1.20	3.05
2016	0.42	0.23	0.27	0.59	0.63	0.20	0.44	0.84
2017								
2018	0.26	0.13	0.21	0.32	0.47	0.17	0.35	0.62

Table 16b. Survey results from NEFSC offshore autumn bottom trawl surveys in the southern management region (strata 1-19, 61-76). Values are indices calculated without adjustment for change in survey methods in 2009. Only a small portion of the southern management area was sampled in 2017, therefore indices were not calculated for 2017. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	1.92	0.13	1.52	2.33	1.56	0.15	1.18	1.93
2010	2.92	0.18	2.04	3.79	2.87	0.21	1.89	3.85
2011	2.42	0.13	1.89	2.95	4.36	0.15	3.27	5.44
2012	3.50	0.18	2.46	4.53	1.96	0.16	1.45	2.47
2013	2.19	0.17	1.58	2.81	2.07	0.18	1.44	2.69
2014	1.20	0.23	0.75	1.65	1.14	0.15	0.86	1.42
2015	2.96	0.23	1.82	4.10	13.96	0.31	6.85	21.06
2016	3.37	0.22	2.14	4.61	4.46	0.19	3.06	5.85
2017								
2018	2.13	0.13	1.66	2.60	3.38	0.17	2.45	4.31

Table 17a. Survey results from NEFSC offshore spring bottom trawl surveys in the southern m*a*nagement region (strata 1-19, 61-76). Strata 61-76 were not sampled until 1967. Indices are
Table 17a. Survey results from NEFSC offshore spring bottom trawl surveys in the southern m*a*nagement region (strata 1-19, 61-76). Strata 61-76 were not sampled until 1967. Indices are
arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1968	1.16	0.23	0.77	1.61	0.21	0.19	0.15	0.28
1969	0.92	0.23	0.58	1.31	0.23	0.20	0.15	0.30
1970	1.00	0.25	0.58	1.40	0.18	0.19	0.12	0.23
1971	0.76	0.29	0.43	1.15	0.21	0.25	0.13	0.29
1972	1.88	0.18	1.36	2.47	0.36	0.12	0.29	0.44
1973	1.82	0.08	1.59	2.06	1.04	0.08	0.91	1.17
1974	1.16	0.16	0.87	1.47	0.49	0.11	0.40	0.57
1975	0.91	0.15	0.70	1.15	0.44	0.12	0.36	0.54
1976	1.13	0.11	0.91	1.33	0.41	0.12	0.33	0.48
1977	1.16	0.14	0.90	1.45	0.30	0.10	0.25	0.35
1978	0.73	0.13	0.58	0.89	0.34	0.09	0.28	0.39
1979	0.70	0.17	0.51	0.90	0.27	0.15	0.21	0.34
1980	0.74	0.15	0.56	0.92	0.45	0.10	0.38	0.53
1981	1.74	0.15	1.33	2.20	0.77	0.12	0.62	0.92
1982	2.60	0.17	1.92	3.33	0.93	0.12	0.75	1.11
1983	0.95	0.26	0.58	1.35	0.27	0.16	0.20	0.35
1984	0.74	0.31	0.36	1.12	0.18	0.23	0.11	0.25
1985	0.33	0.32	0.17	0.52	0.16	0.25	0.10	0.23
1986	0.83	0.28	0.48	1.23	0.28	0.27	0.18	0.43
1987	0.50	0.48	0.17	0.95	0.11	0.23	0.07	0.15
1988	0.43	0.13	0.34	0.52	0.44	0.16	0.33	0.55
1989	0.36	0.16	0.27	0.47	0.20	0.23	0.13	0.28
1990	1.00	0.20	0.67	1.34	0.21	0.11	0.17	0.24
1991	0.58	0.24	0.37	0.82	0.32	0.25	0.20	0.46
1992	0.22	0.33	0.11	0.34	0.18	0.25	0.11	0.25
1993	0.26	0.28	0.15	0.39	0.20	0.23	0.12	0.28
1994	0.33	0.28	0.19	0.50	0.11	0.23	0.07	0.16
1995	0.52	0.39	0.20	0.90	0.20	0.20	0.13	0.27
1996	0.28	0.20	0.19	0.38	0.14	0.20	0.09	0.18
1997	0.13	0.22	0.09	0.18	0.12	0.21	0.08	0.16
1998	0.28	0.15	0.22	0.35	0.25	0.14	0.20	0.31
1999	0.64	0.20	0.44	0.86	0.34	0.14	0.26	0.42
2000	0.30	0.18	0.21	0.39	0.24	0.17	0.18	0.31
2001	0.26	0.31	0.14	0.41	0.24	0.20	0.16	0.31
2002	0.38	0.30	0.21	0.60	0.32	0.33	0.18	0.52
2003	1.38	0.15	1.03	1.72	0.31	0.16	0.23	0.39
2004	0.18	0.27	0.11	0.27	0.12	0.25	0.07	0.17
2005	0.37	0.16	0.28	0.47	0.26	0.27	0.16	0.39
2006	0.54	0.27	0.32	0.78	0.17	0.20	0.12	0.23
2007	0.55	0.22	0.37	0.77	0.26	0.16	0.20	0.33
2008	0.39	0.31	0.22	0.60	0.19	0.31	0.11	0.29
2009	0.30	0.15	0.23	0.38	0.16	0.14	0.12	0.19
2010	0.22	0.19	0.15	0.29	0.16	0.21	0.11	0.22
2011	0.42	0.11	0.34	0.50	0.28	0.14	0.22	0.34
2012	0.35	0.11	0.29	0.42	0.30	0.09	0.26	0.34
2013	0.34	0.14	0.27	0.44	0.20	0.17	0.15	0.26
2014	0.25	0.19	0.17	0.33	0.14	0.13	0.11	0.17
2015	0.20	0.18	0.14	0.26	0.11	0.16	0.08	0.14
2016	0.28	0.11	0.23	0.32	0.46	0.10	0.38	0.54
2017	0.49	0.16	0.37	0.62	0.46	0.18	0.33	0.59
2018	0.63	0.16	0.46	0.78	0.33	0.16	0.24	0.41
2019	0.36	0.10	0.30	0.42	0.29	0.11	0.24	0.34

Table 17b. Survey results from NEFSC offshore spring bottom trawl surveys in the southern management region (strata 1-19, 61-76). Values are indices calculated without adjustment for change in survey methods in 2009. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	2.45	0.16	1.81	3.09	1.11	0.15	0.85	1.38
2010	1.73	0.19	1.19	2.28	1.15	0.22	0.73	1.56
2011	3.41	0.11	2.80	4.01	1.99	0.14	1.54	2.44
2012	2.86	0.11	2.36	3.35	2.14	0.09	1.83	2.45
2013	2.76	0.14	2.10	3.42	1.43	0.17	1.03	1.82
2014	2.03	0.19	1.41	2.65	1.03	0.13	0.80	1.25
2015	1.58	0.17	1.14	2.02	0.77	0.15	0.58	0.97
2016	2.22	0.10	1.85	2.59	3.25	0.11	2.68	3.82
2017	3.93	0.16	2.92	4.94	3.25	0.18	2.26	4.24
2018	5.04	0.16	3.72	6.36	2.36	0.16	1.73	2.99
2019	2.89	0.10	2.42	3.36	2.07	0.11	1.70	2.43

Table 18. Survey results from NEFSC (1984-2011) and NEFSC and VIMS (2012-2018) offshore scallop dredge surveys in the southern management region (shellfish strata 6, 7, 10, 11, 14, 15, 18, 19, 22-31, 33-35, 46, 47, 55, 58-61, 621, 631). The survey vessel used by NEFSC and survey timing change in 2009. VIMS conducted an increasing portion of the survey starting in 2012. Indices are arithmetic stratified means with bootstrapped variance estimates (where available).

	Abundance Index			
	Mean	CV	L90%	U90%
1984	1.34	0.1	1.17	1.51
1985	1.57	0.1	1.37	1.79
1986	1.29	0.1	1.12	1.46
1987	3.17	0.1	2.89	3.46
1988	1.69	0.1	1.49	1.89
1989	1.00	0.1	0.88	1.13
1990	1.53	0.1	1.40	1.69
1991	2.26	0.1	2.05	2.46
1992	1.95	0.1	1.75	2.18
1993	2.83	0.0	2.62	3.06
1994	3.33	0.1	3.06	3.62
1995	2.26	0.1	2.03	2.49
1996	2.01	0.1	1.80	2.23
1997	1.12	0.1	0.99	1.26
1998	1.06	0.1	0.95	1.18
1999	2.57	0.1	2.28	2.89
2000	2.29	0.1	2.04	2.58
2001	1.73	0.1	1.56	1.92
2002	1.70	0.1	1.54	1.86
2003	2.75	0.1	2.48	3.01
2004	2.89	0.1	2.59	3.23
2005	2.01	0.1	1.81	2.21
2006	1.44	0.1	1.31	1.57
2007	0.83	0.1	0.73	0.94
2008	1.03	0.1	0.89	1.17
2009	0.78	9.8	0.65	0.92
2010	0.74	9.9	0.61	0.87
2011	0.94	12.5	0.73	1.12
2012	1.00			
2013	0.81			
2014	0.55			
2015	2.29			
2016	2.17			
2017	1.62			
2018	0.99			

Table 19. Area-swept estimates of minimum abundance and biomass, and relative exploitation indices for monkfish from NEFSC fall surveys. Estimates are adjusted for sweep type (adjusted to chain sweep), assume that 100% of monkfish encountered by the trawl are captured and do not account for missed strata in some years.

North	Catch (millions of fish)	Landings (millions of fish)	Catch mt	adjusted AS total abund	adjusted AS 43 cm+ abund	adjusted AS Biomass mt	C/Total N Rel F	L/43+cm Rel F	C mt/ B mt Rel F
2009	1.559	1.066	3,675	36,717,874	8,662,877	32,406	0.04	0.12	0.11
2010	1.169	0.819	2,741	40,524,791	10,999,269	42,178	0.03	0.07	0.06
2011	1.445	0.970	2,814	51,328,487	14,797,117	49,936	0.03	0.07	0.06
2012	1.995	1.390	4,635	57,008,552	13,828,353	51,063	0.04	0.10	0.09
2013	1.724	1.109	3,922	60,967,483	8,414,414	40,838	0.03	0.13	0.10
2014	1.865	1.139	3,954	84,100,939	13,314,746	54,125	0.02	0.09	0.07
2015	2.137	1.395	4,630	105,281,189	17,990,848	77,578	0.02	0.08	0.06
2016	2.552	1.670	5,508	174,643,487	26,516,683	103,686	0.01	0.06	0.05
2017	3.222	2.478	7,894	115,927,590	39,300,789	113,147	0.03	0.06	0.07
2018	3.210	2.090	8,115	100,164,292	35,993,154	140,801	0.03	0.06	0.06

South	Catch (millions of fish)	Landings (millions of fish)	Catch mt	adjusted AS total abund	adjusted AS 43 cm+ abund	adjusted AS Biomass mt	C/Total N Rel F	L/43+cm Rel F	C mt/ B mt Rel F
2009	2.14	1.282	7,158	26,947,935	4,900,883	20,592	0.08	0.26	0.35
2010	2.64	1.095	7,105	47,905,108	8,873,105	32,509	0.06	0.12	0.22
2011	2.66	1.236	8,545	62,976,941	6,254,672	25,878	0.04	0.20	0.33
2012	3.35	1.439	8,438	24,635,364	7,309,501	31,016	0.14	0.20	0.27
2013	2.46	1.398	7,176	36,089,410	7,908,464	23,849	0.07	0.18	0.30
2014	2.49	1.243	6,859	25,860,088	4,769,114	20,359	0.10	0.26	0.34
2015	2.29	1.057	5,844	298,342,595	3,536,976	50,510	0.01	0.30	0.12
2016	4.51	0.971	7,199	77,586,702	5,136,276	52,014	0.06	0.19	0.14
2017	2.96	0.934	9,143						
2018	2.98	1.112	9,615	67,592,308	6,726,308	26,619	0.04	0.17	0.36

Figures

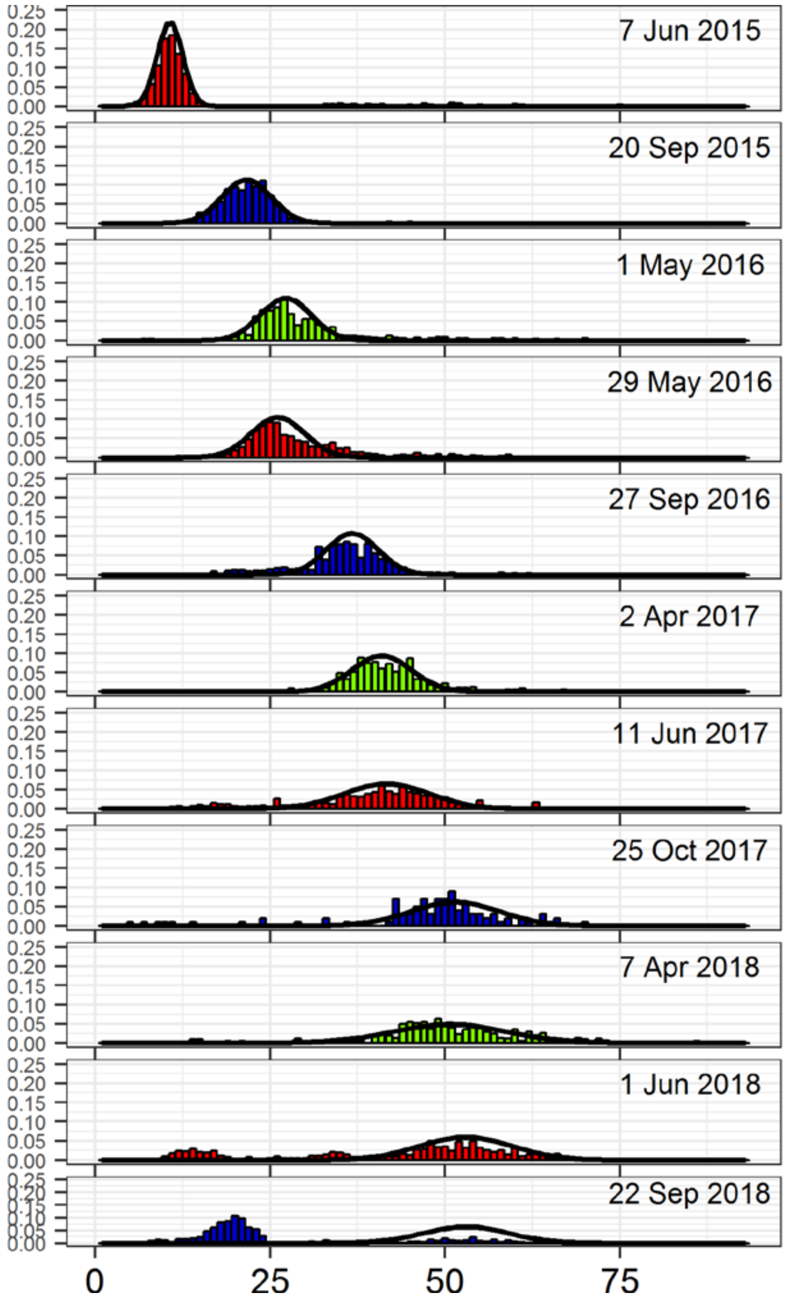


Figure 1. Length frequency distributions of monkfish in southern management area from NEFSC spring (green), scallop dredge (NEFSC and VIMS, red), and NEFSC fall surveys (blue) illustrating growth rates of presumed 2015 year class of monkfish. Normal curves fit using NORMSEP. Monkfish settle to the benthos at about 8 cm. Geographic scope of sampling was limited to southern flank of Georges Bank in fall 2017.

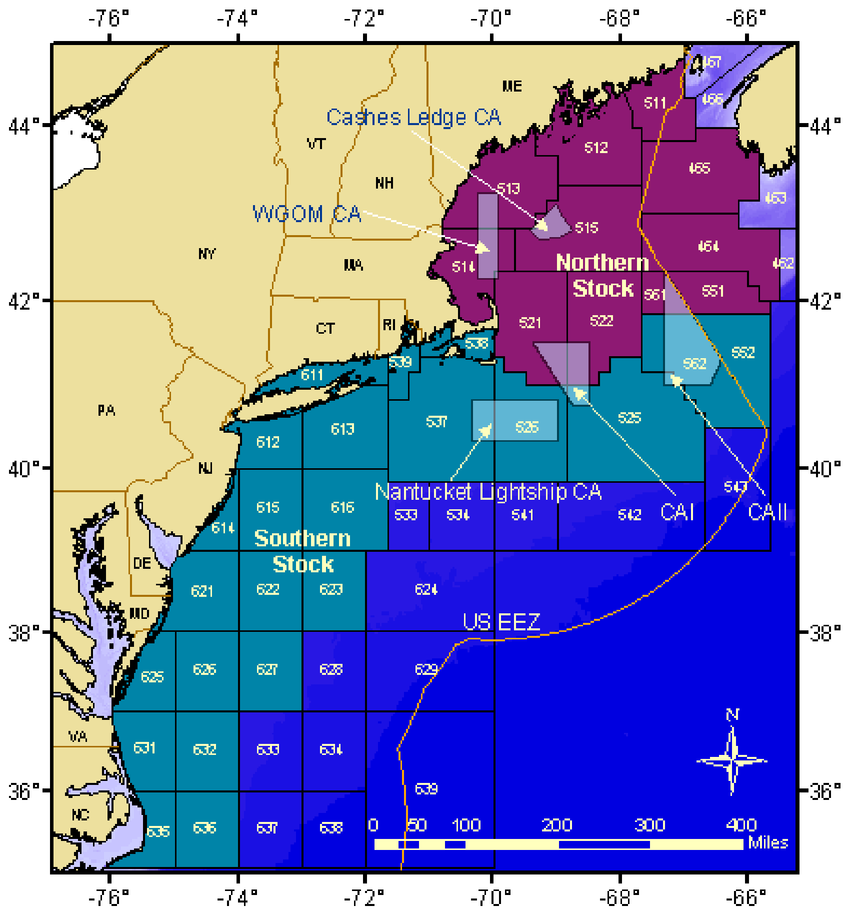


Figure 2. Fishery statistical areas used to define northern and southern monkfish management areas.

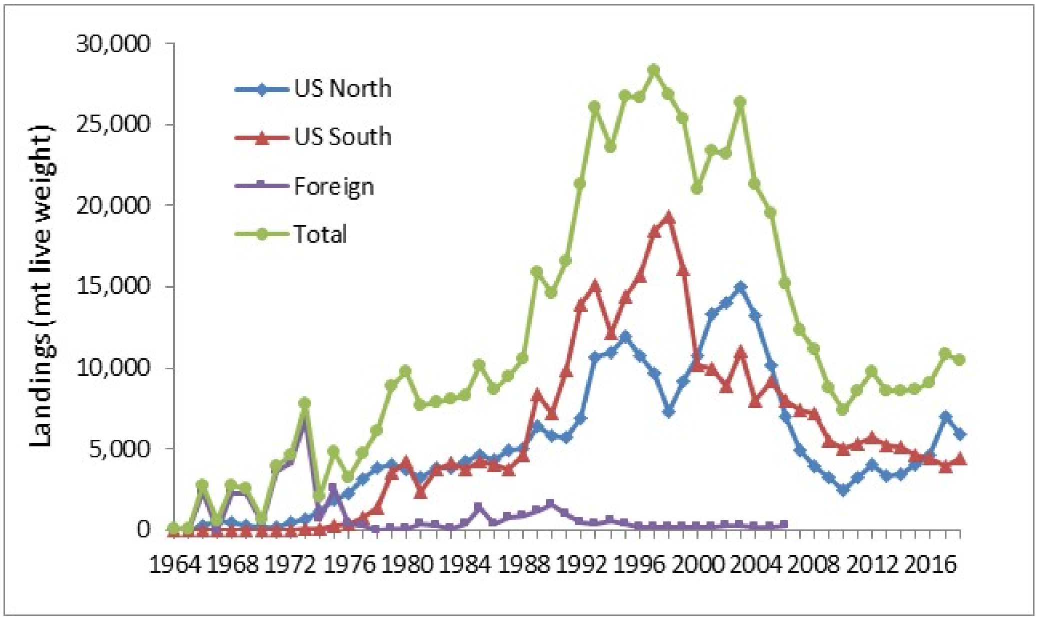
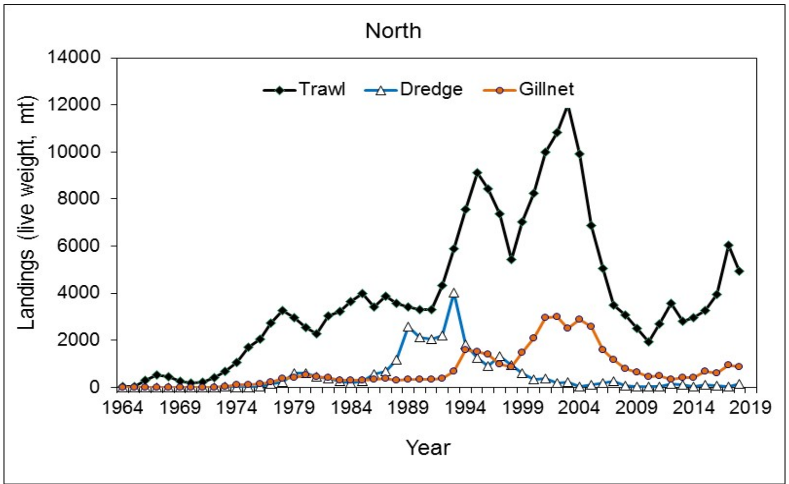
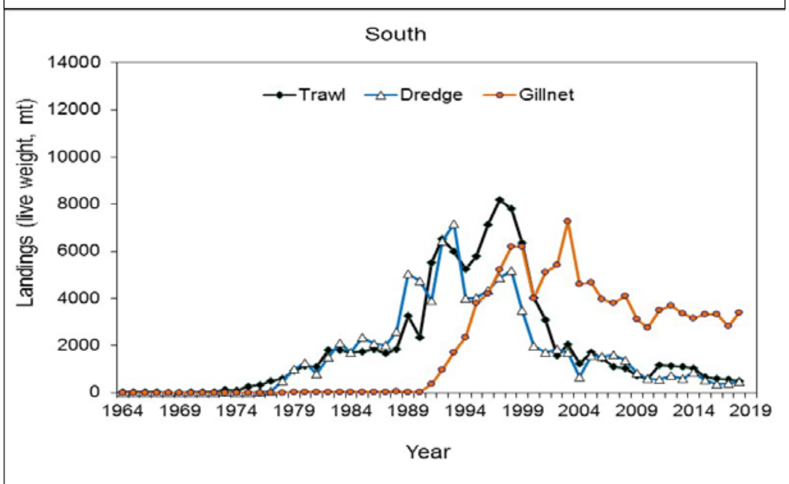


Figure 3. Monkfish landings by management area and combined areas, 1964-2018.

A.



B.



C.

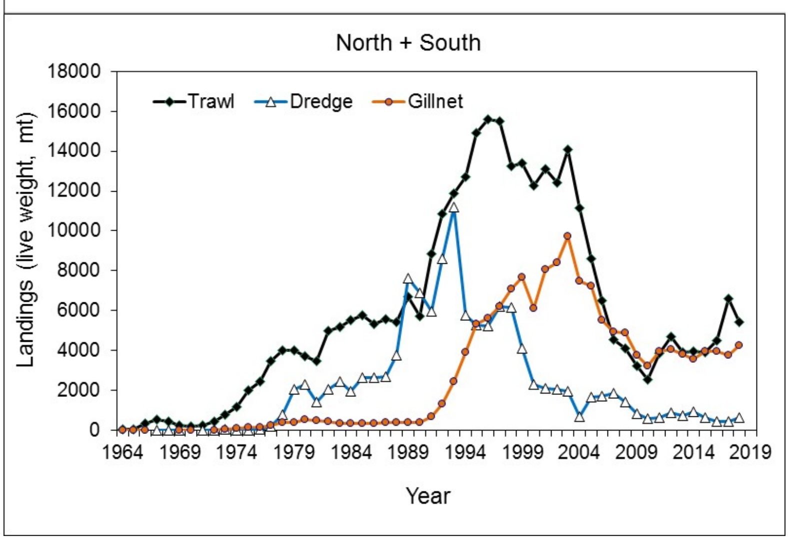


Figure 4. Commercial landings of monkfish by gear type and management area, 1964-2018. A. Northern management area, B. Southern management area, C. Management areas combined.

North South

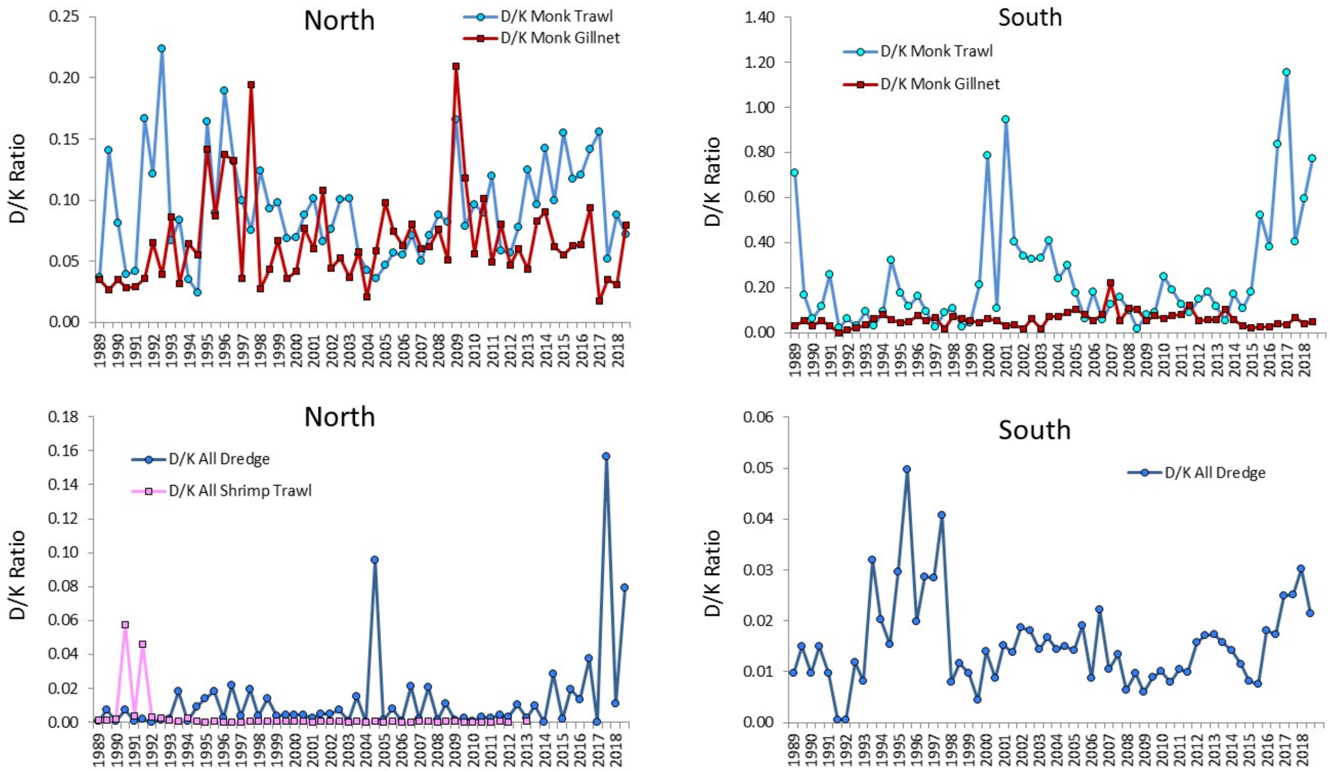


Figure 5. Discard ratios by half year for trawls and gillnets (top panels), and dredges and shrimp trawls (bottom panels) for North (left column) and South (right column). Trawls and gillnets ratios were based on kept monkfish; dredge and shrimp trawl were based on kept of all species.

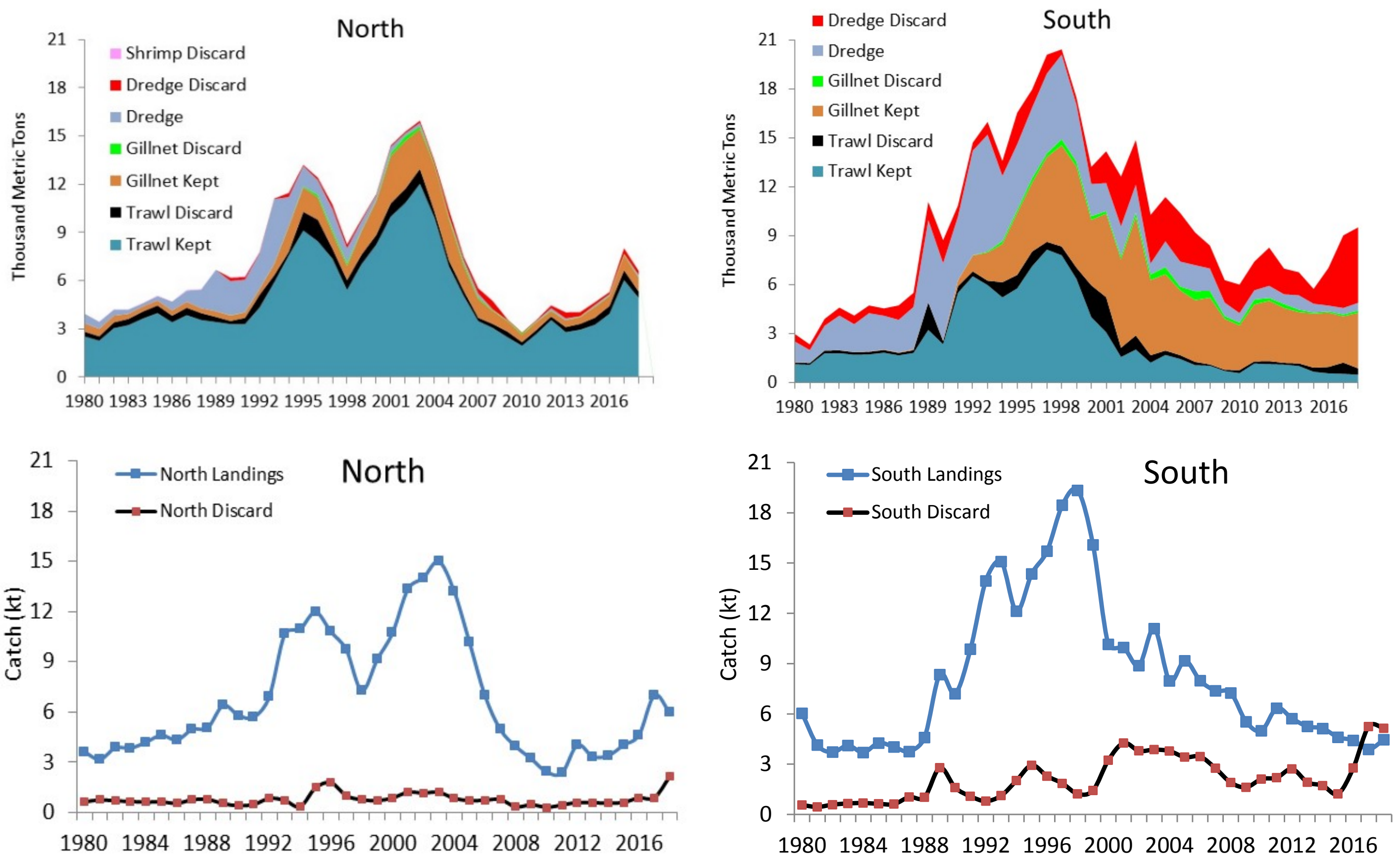


Figure 6. Monkfish landings and discard by gear type (top panels) and total (bottom panels) for North (left) and South (right).

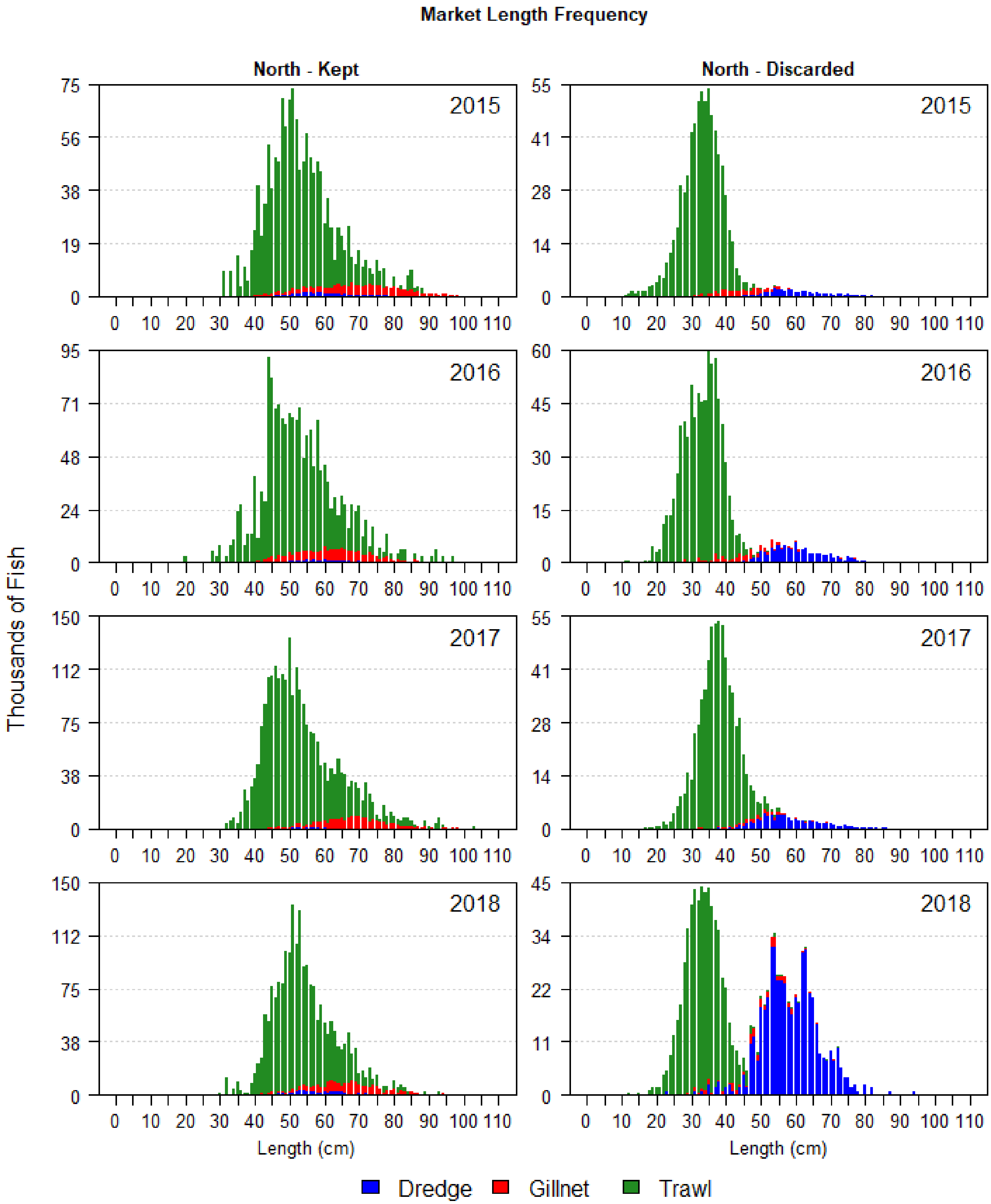


Figure 7. Estimated length composition of kept and discarded monkfish by gear type in the northern management area.

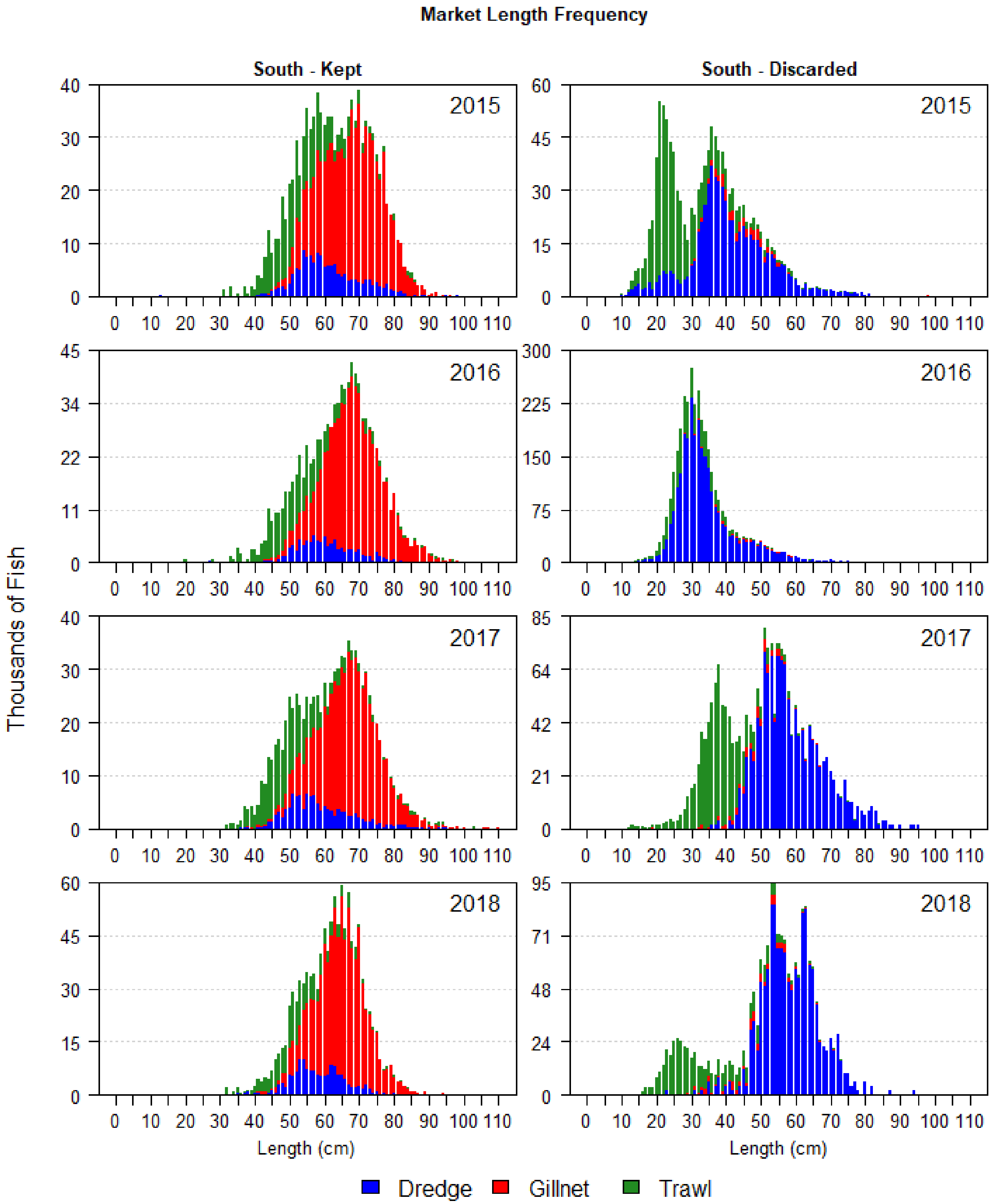


Figure 8. Estimated length composition of kept and discarded monkfish by gear type in the southern management area.

North Y-axis scale variable Y-axis scale standardized

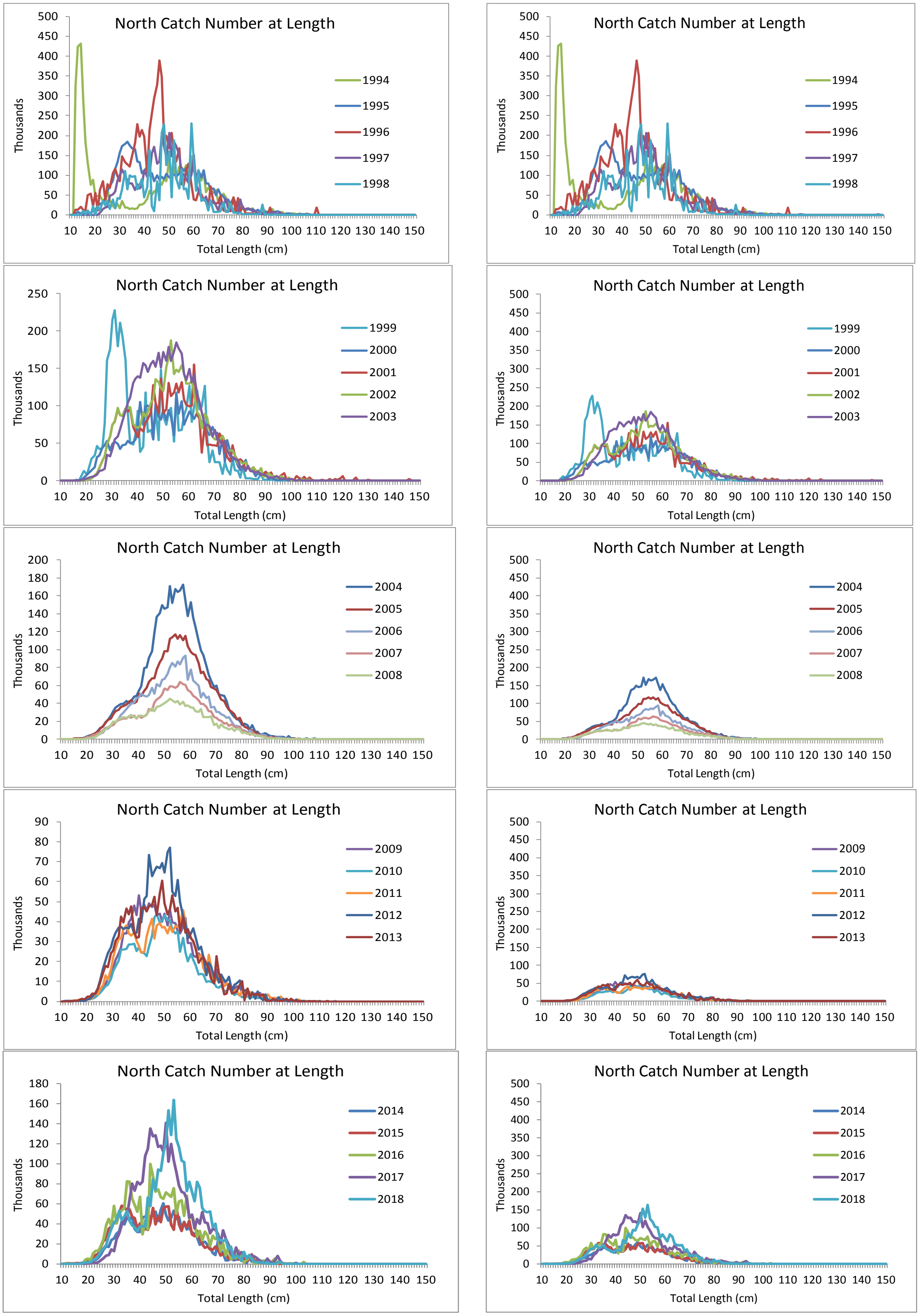


Figure 9. Estimated length composition of commercial monkfish catch, northern management area.

South Y-axis scale variable Y-axis scale standardized

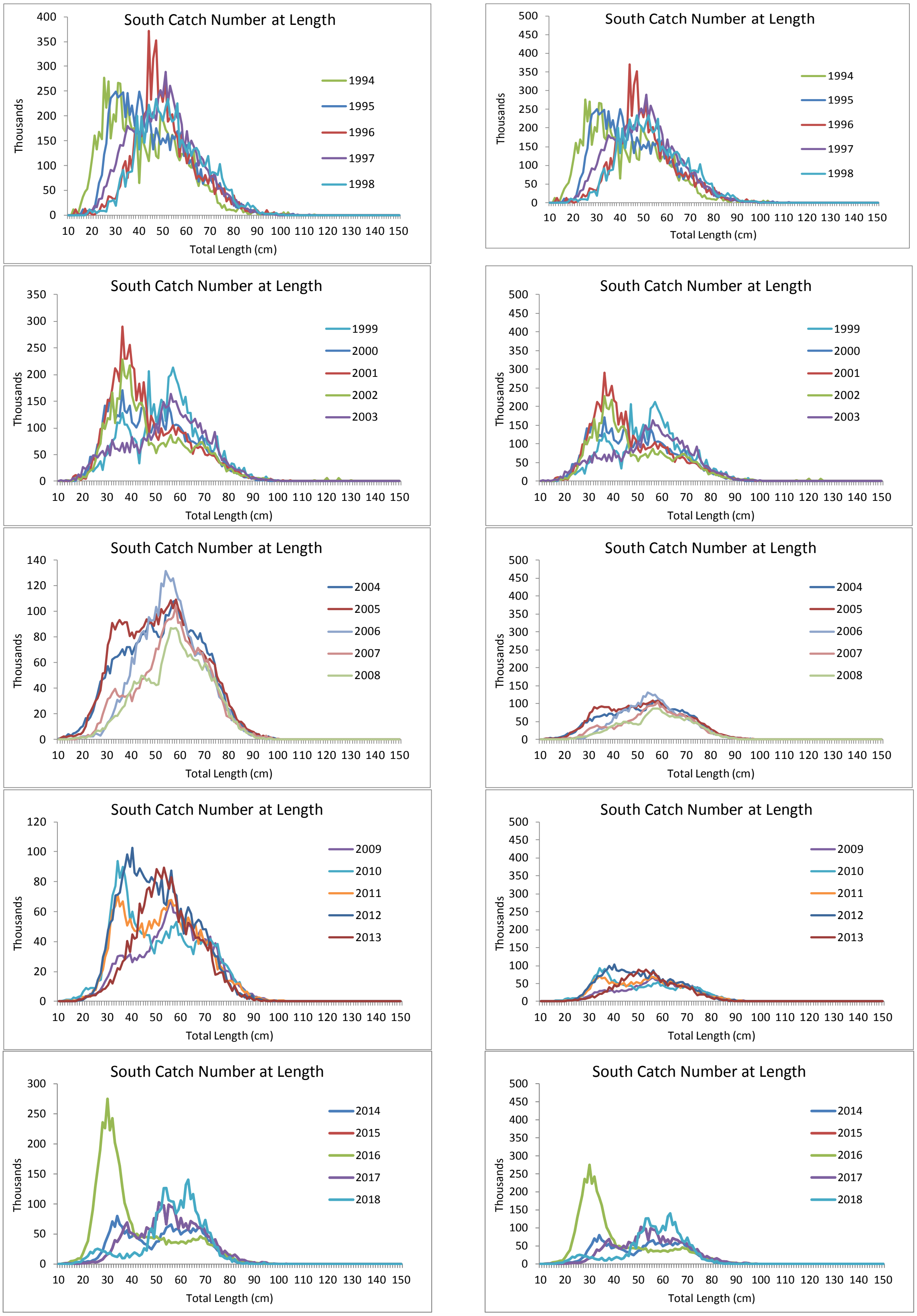


Figure 10. Length composition of monkfish commercial catch estimated using length frequency data collected by fishery observers in the southern management area.

North

Biomass Abundance

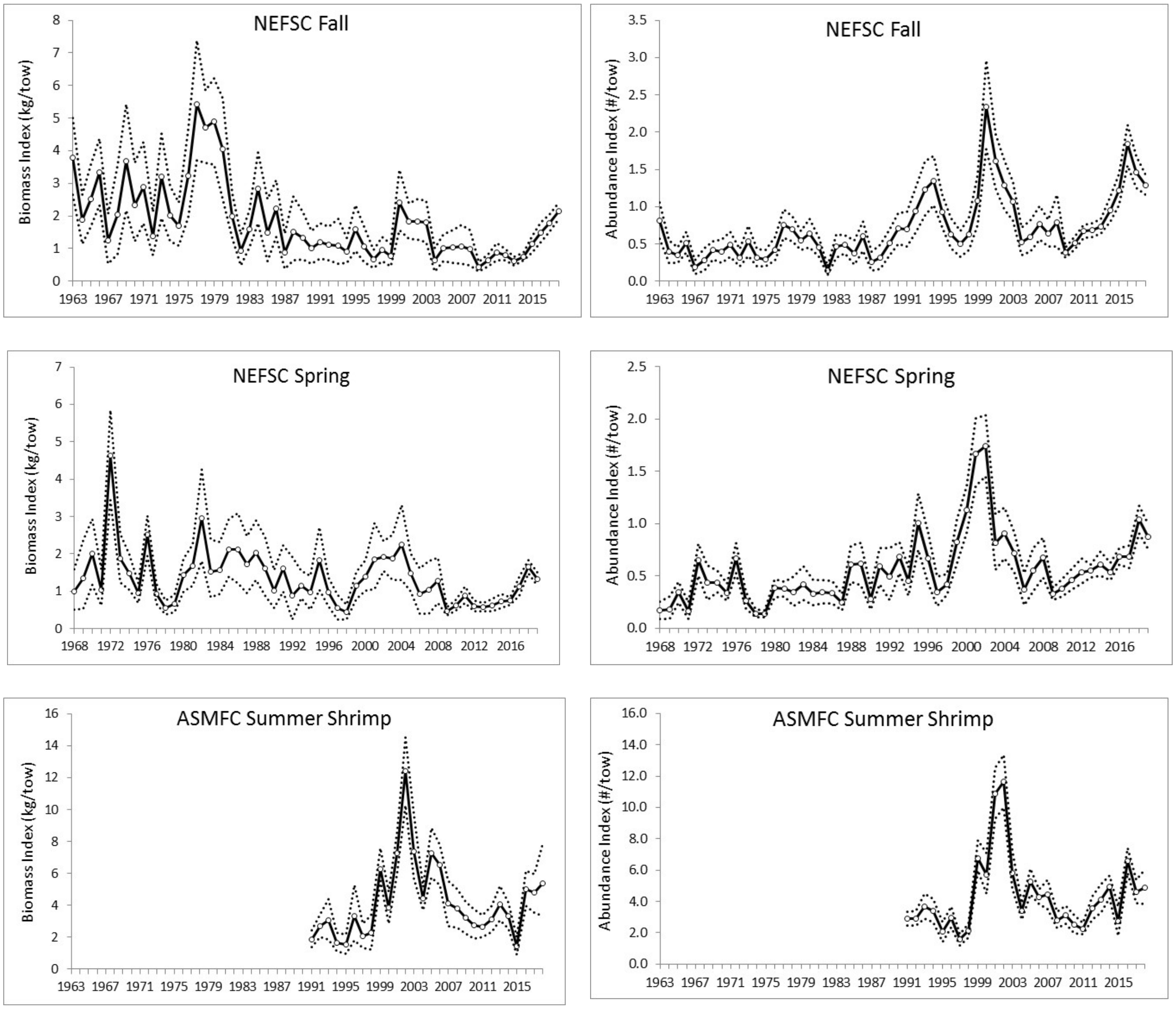


Figure 11. Survey indices for monkfish in the northern management area. Points after 2008 in spring and fall surveys are from surveys conducted on the FSV Bigelow, converted to Albatross units as described in the text.

North

Biomass Abundance

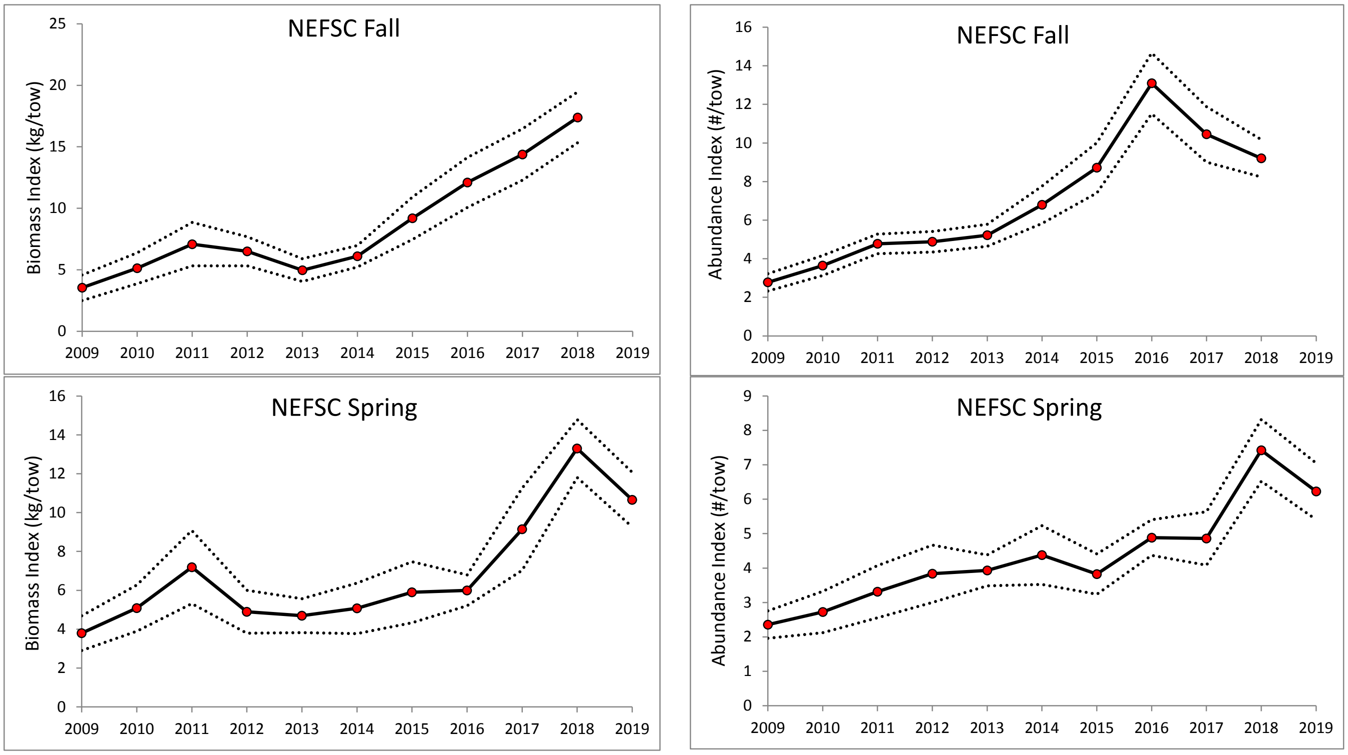


Figure 12. Survey indices from surveys conducted on the FRSV Bigelow in the northern management area, not converted to Albatross units. Note: y-axis scale varies.

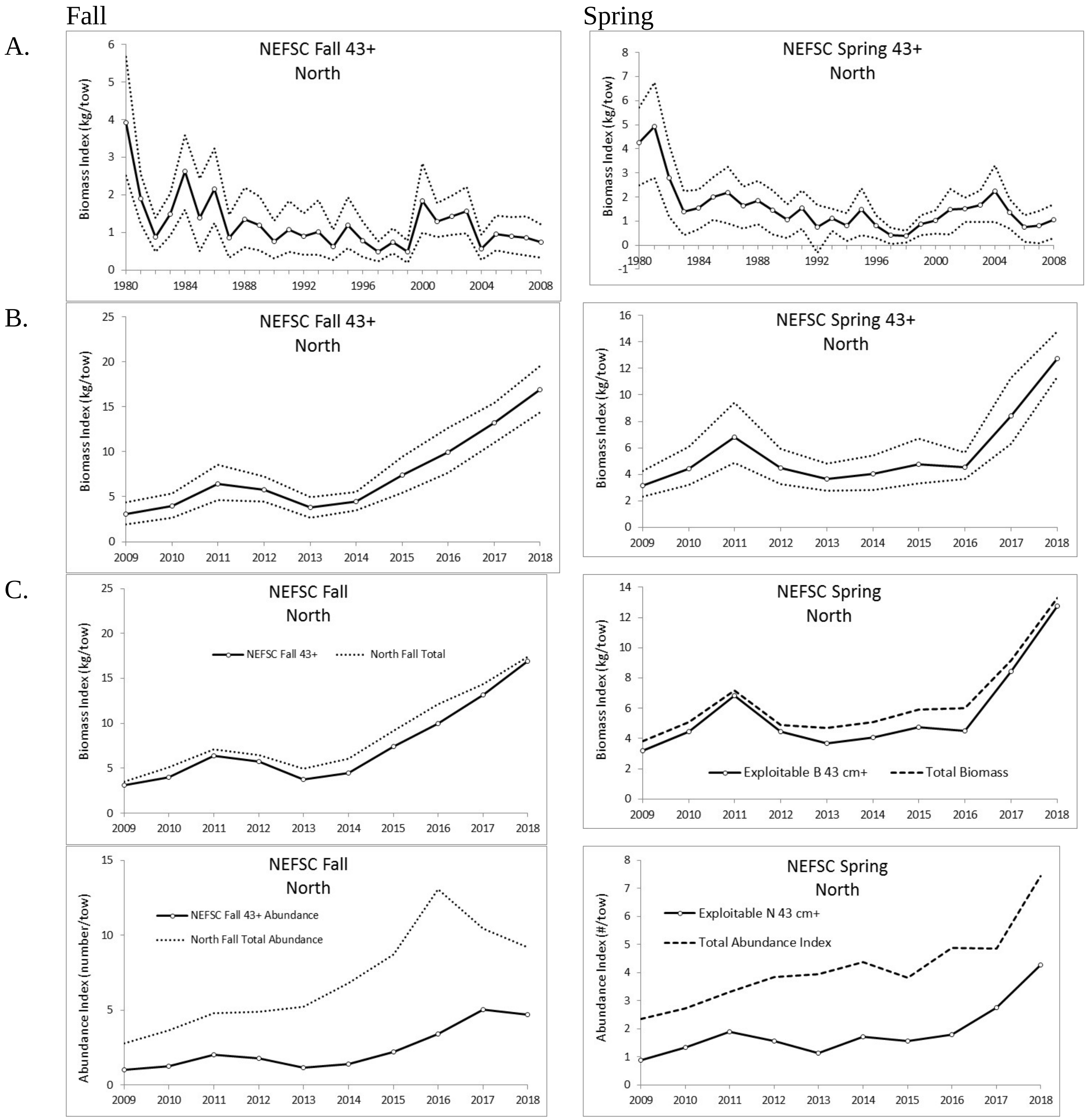


Figure 13. Exploitable biomass (> 43 cm total length) indices for monkfish from fall and spring surveys in the NMA. A. Exploitable biomass indices with 95% confidence intervals, 1980-2008 (surveys conducted on RV Albatross). B. Exploitable biomass indices with 95% confidence intervals, 2009-2018 (surveys conducted on RV H.B. Bigelow) C. Total biomass vs. exploitable biomass indices, 2009-2018, D. total abundance vs. exploitable abundance, 2009-2018.

North

Biomass

Abundance

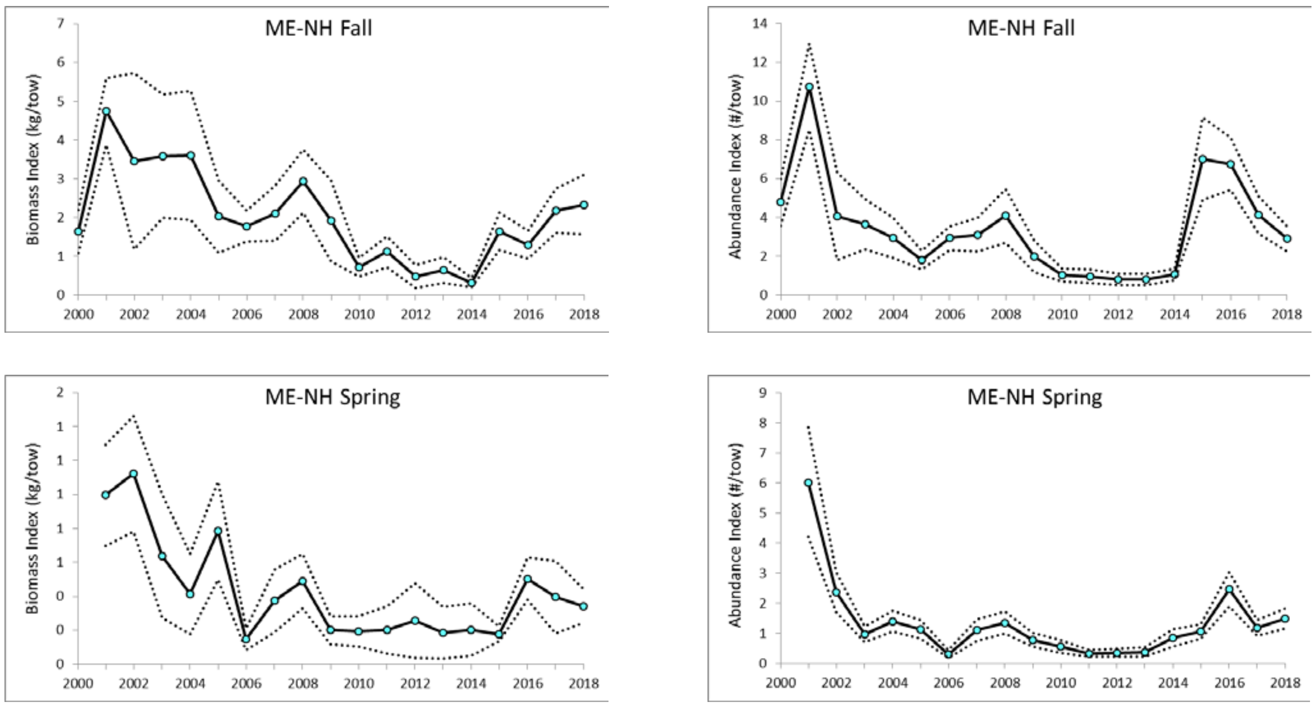


Figure 14. Survey indices for monkfish from Maine-New Hampshire inshore surveys. Data courtesy of Maine Department of Marine Resources.

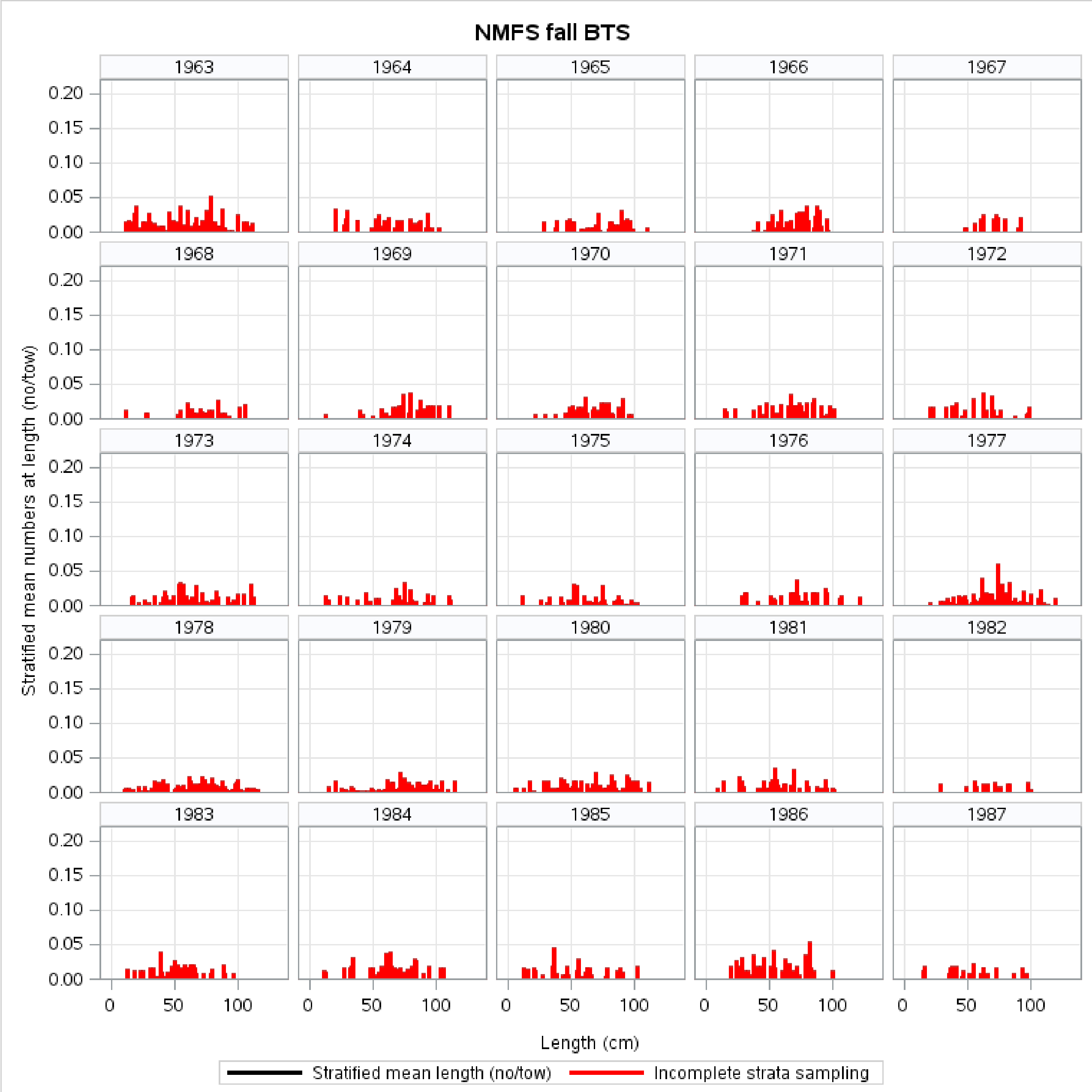
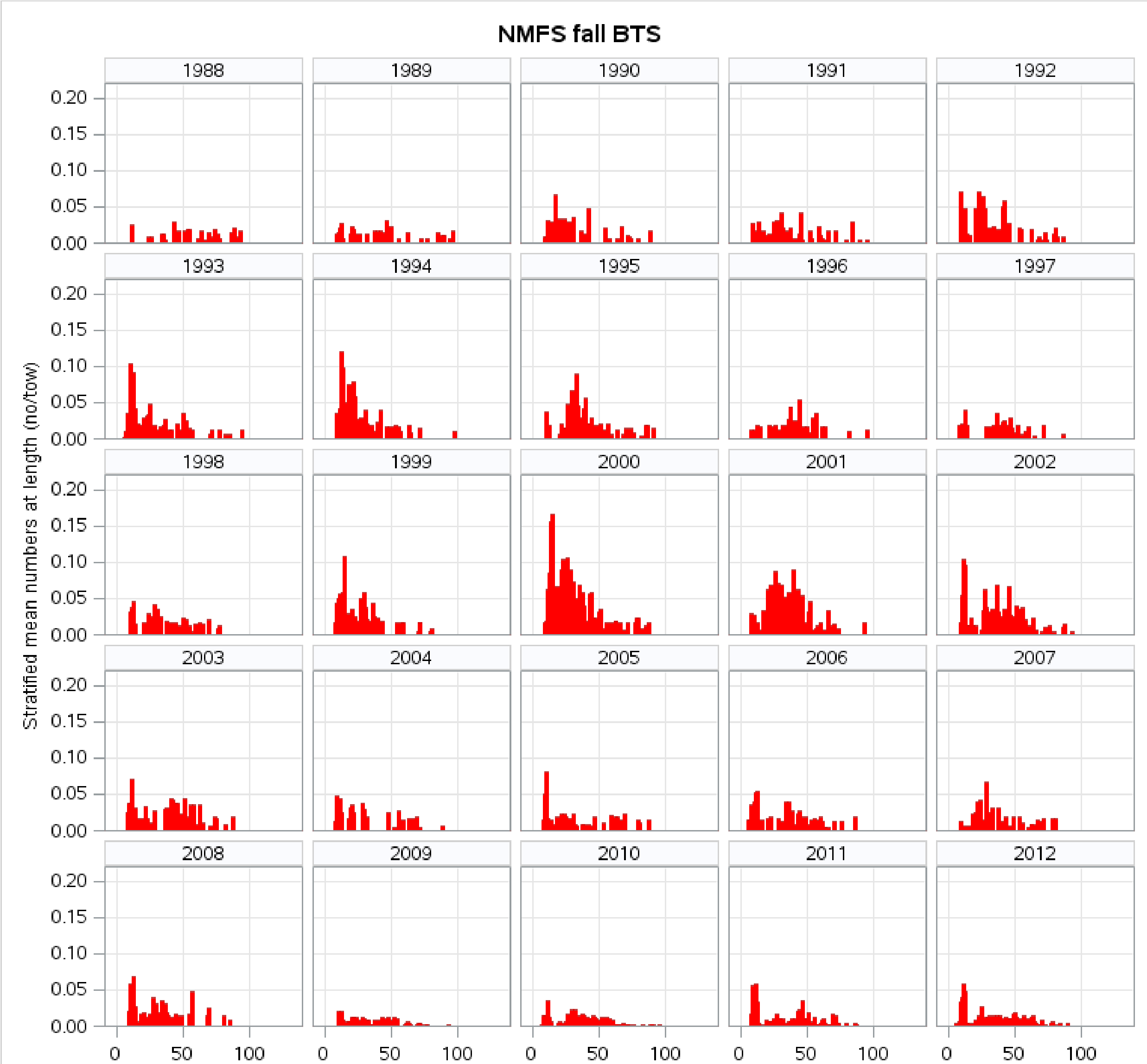


Figure 15. Abundance at length from NEFSC fall surveys in the northern management area.



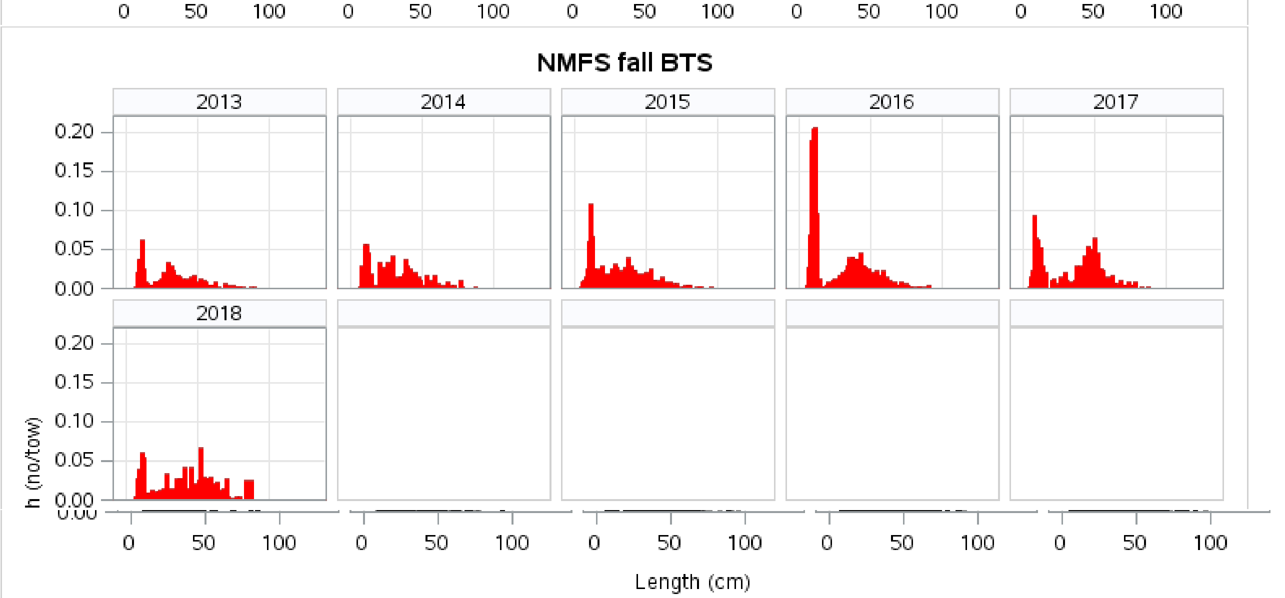


Figure 15, cont’d. (fall surveys, north)

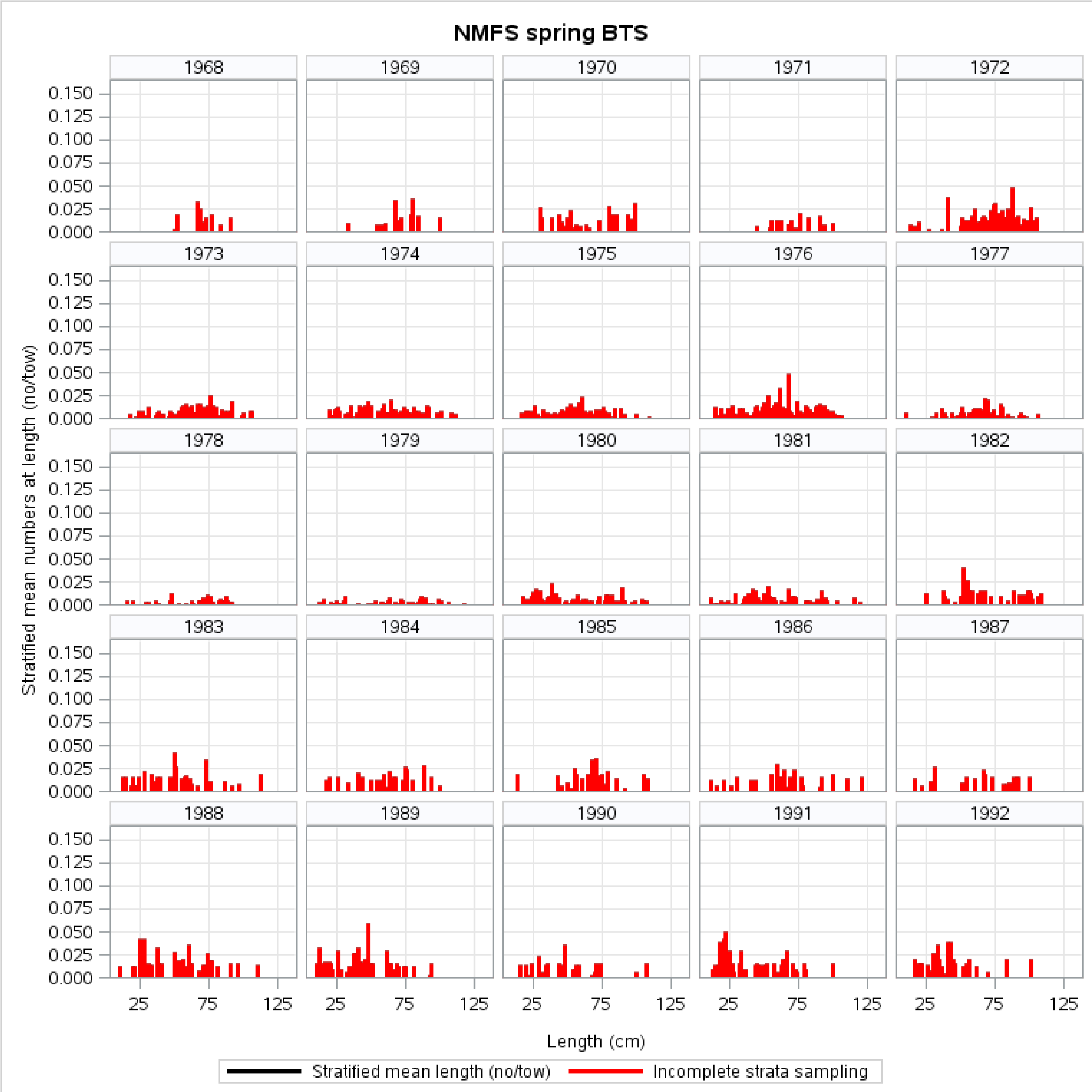


Figure 16. Abundance at length from NEFSC spring surveys in the northern management area.

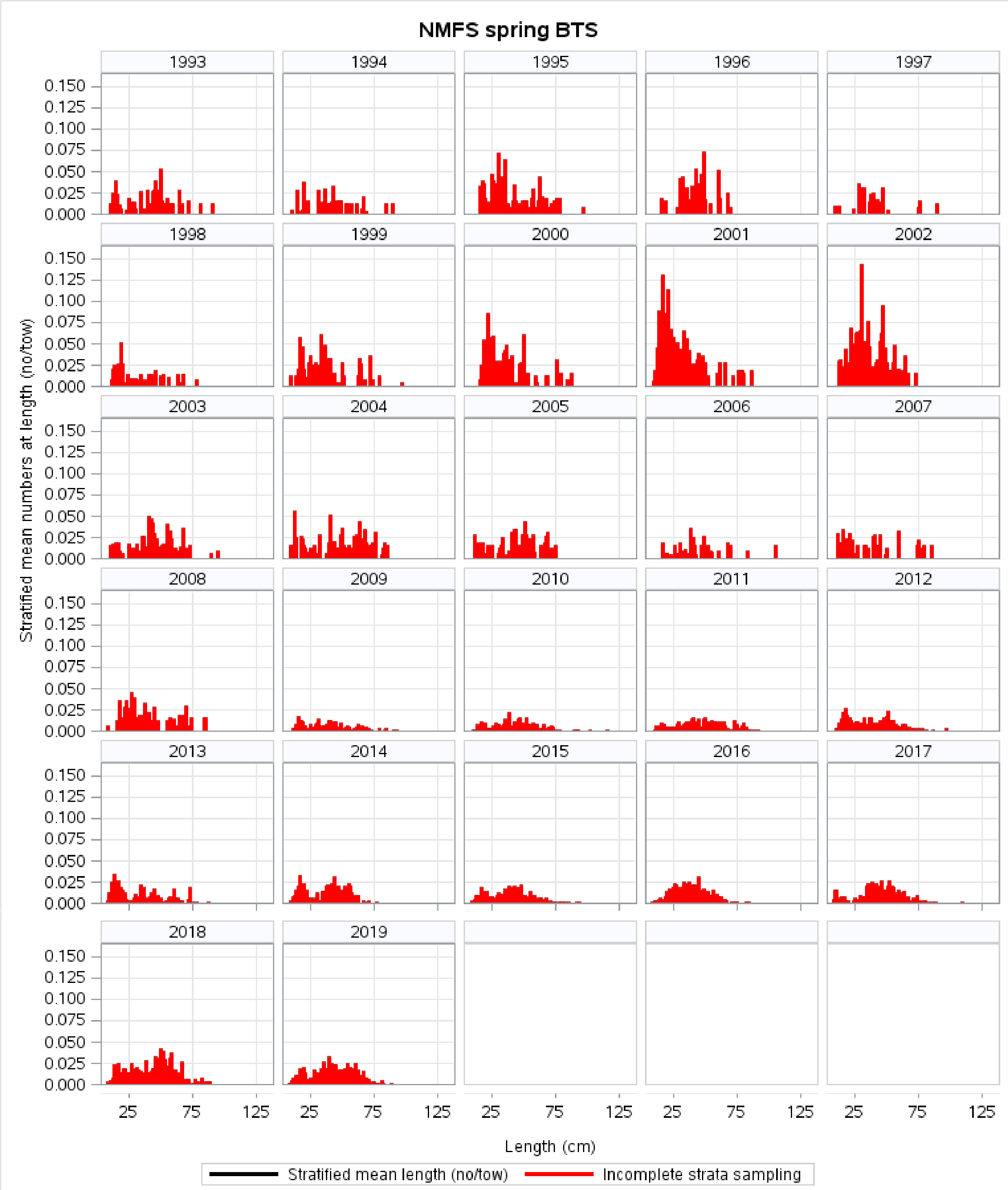


Figure 16, cont'd. (spring surveys, north)

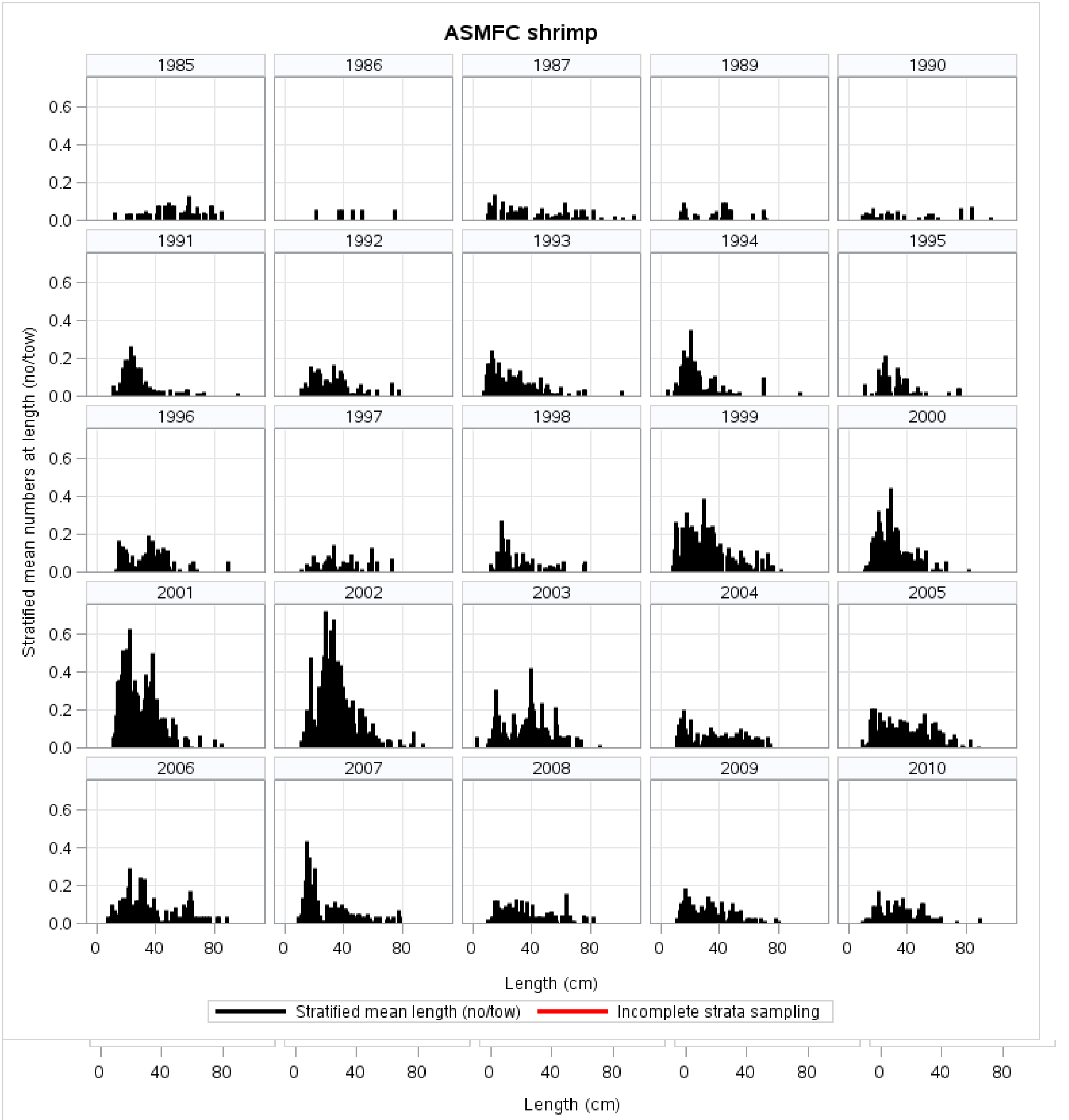


Figure 17. Abundance at length from ASMFC summer shrimp surveys in the northern management area.

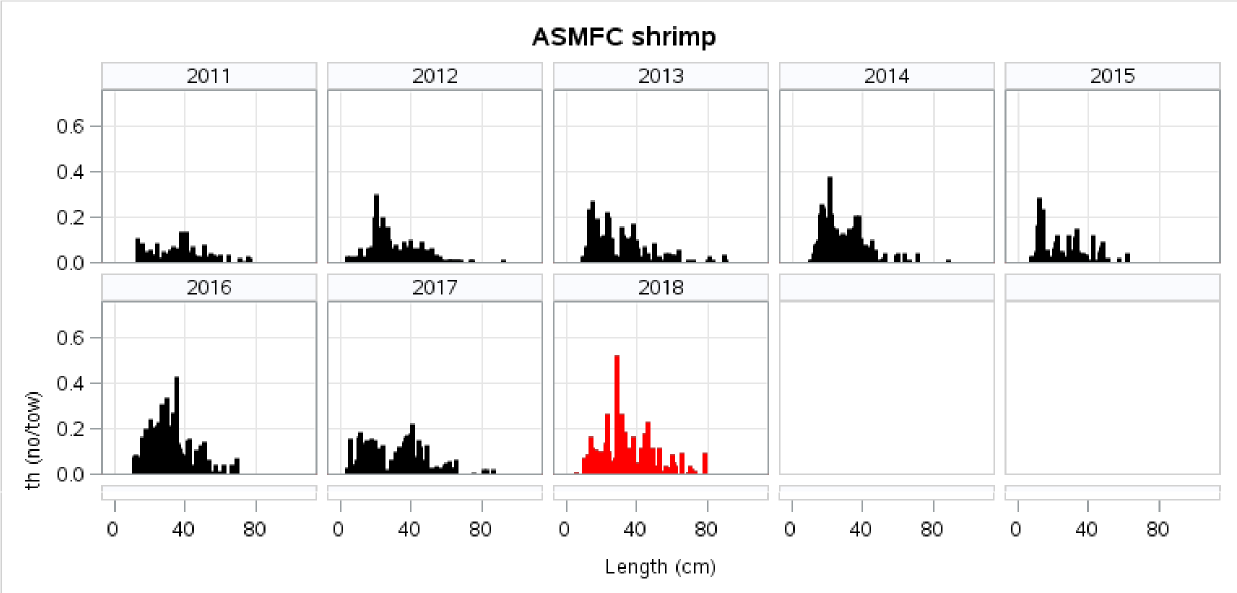


Figure 17, continued (shrimp surveys, north)

Fall

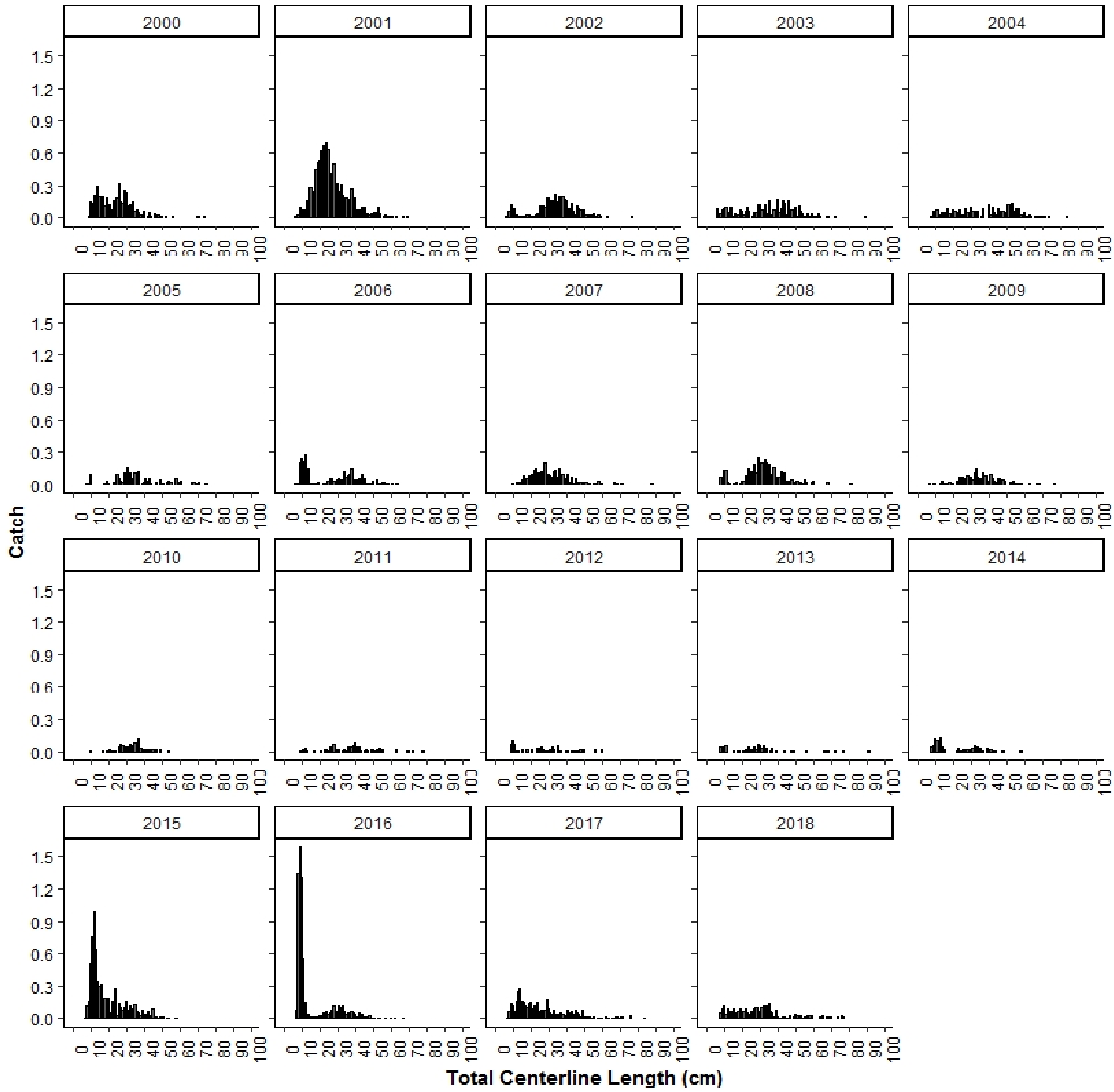


Figure 18. Abundance at length from ME/NH fall inshore trawl surveys in the northern management area. Data courtesy of Maine Department of Marine Resources.

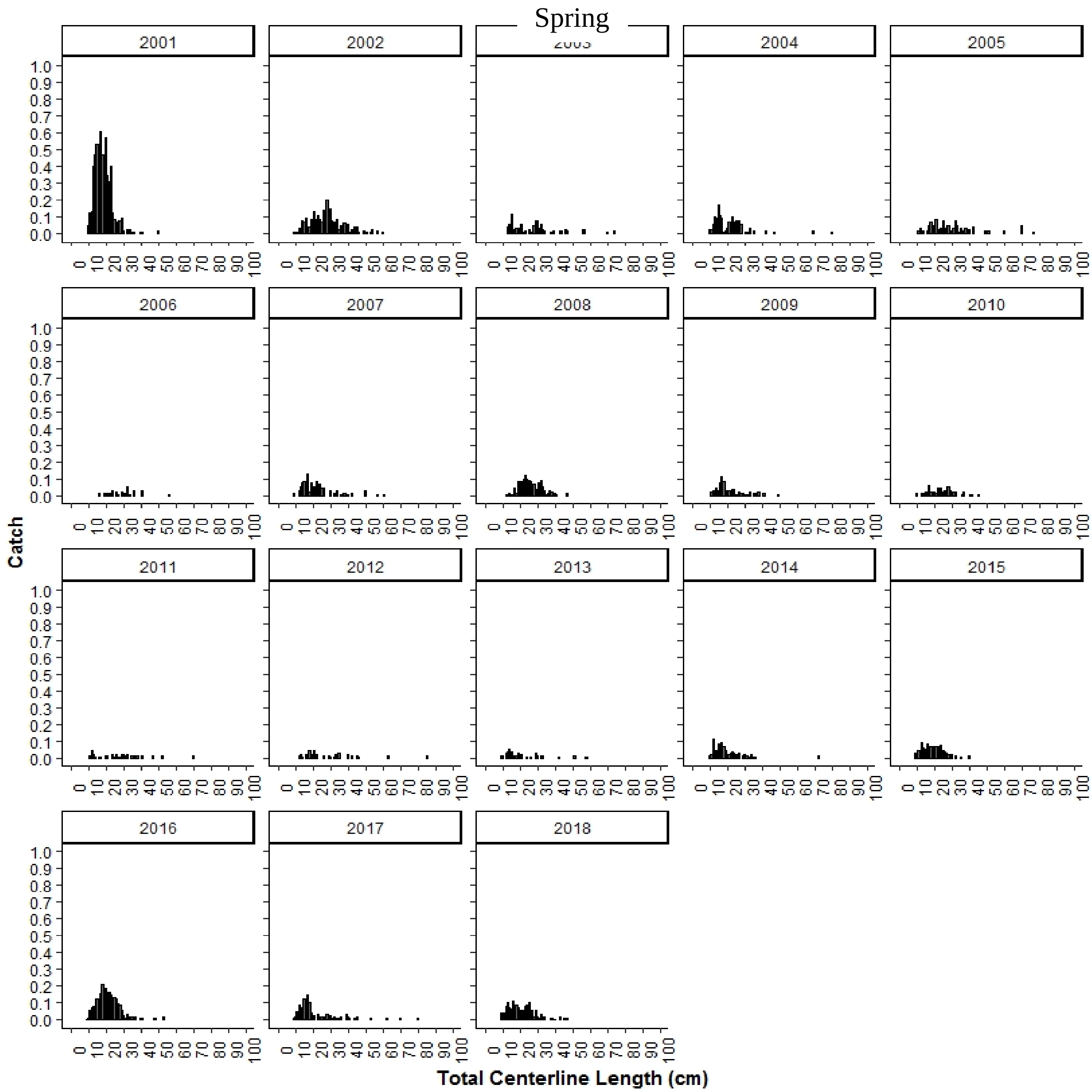


Figure 19. Abundance at length from ME/NH spring inshore trawl surveys in the northern management area. Data courtesy of Maine Department of Marine Resources.

A.

B.

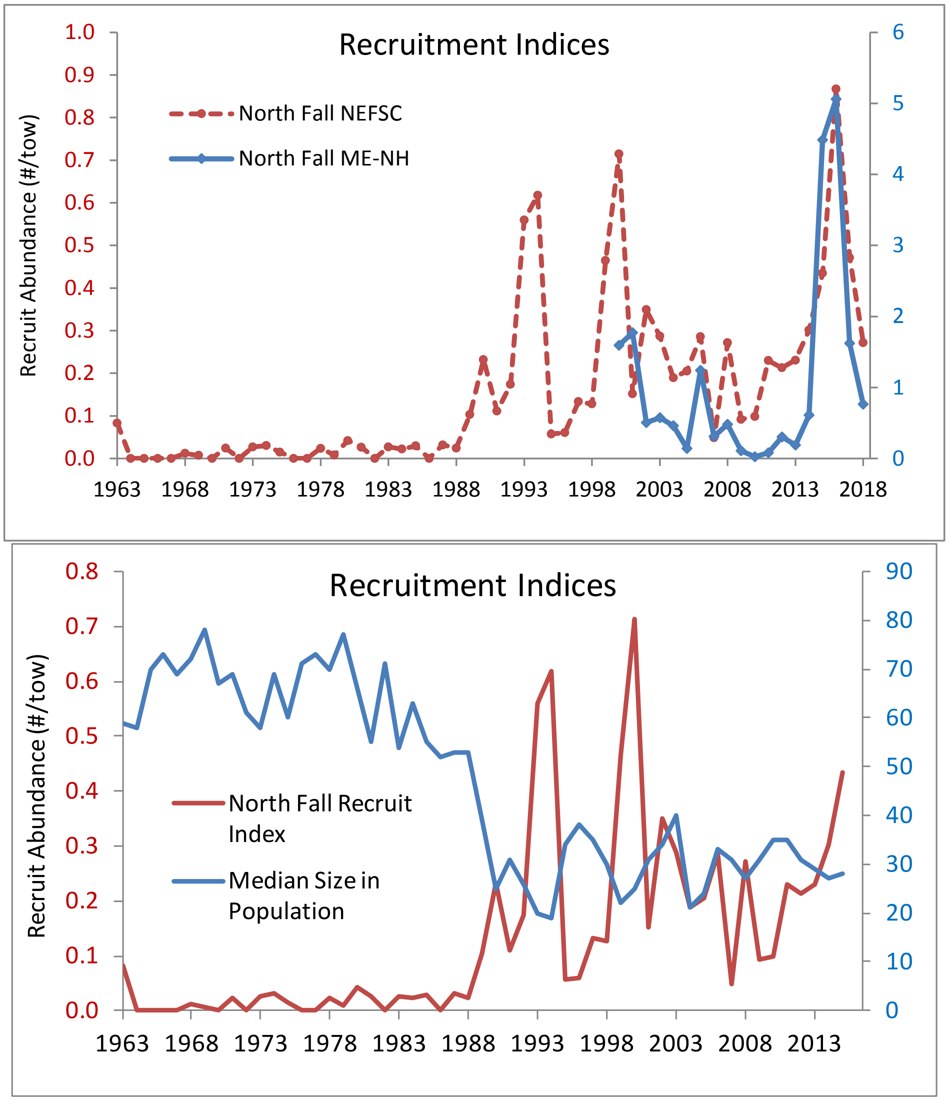


Figure 20. A. Recruitment indices for monkfish in the northern management area. Indices include monkfish in size ranges thought to represent young-of-year (age 0) in each area and season. B. Recruitment indices vs. median size of monkfish in the population (based on NEFSC fall surveys).

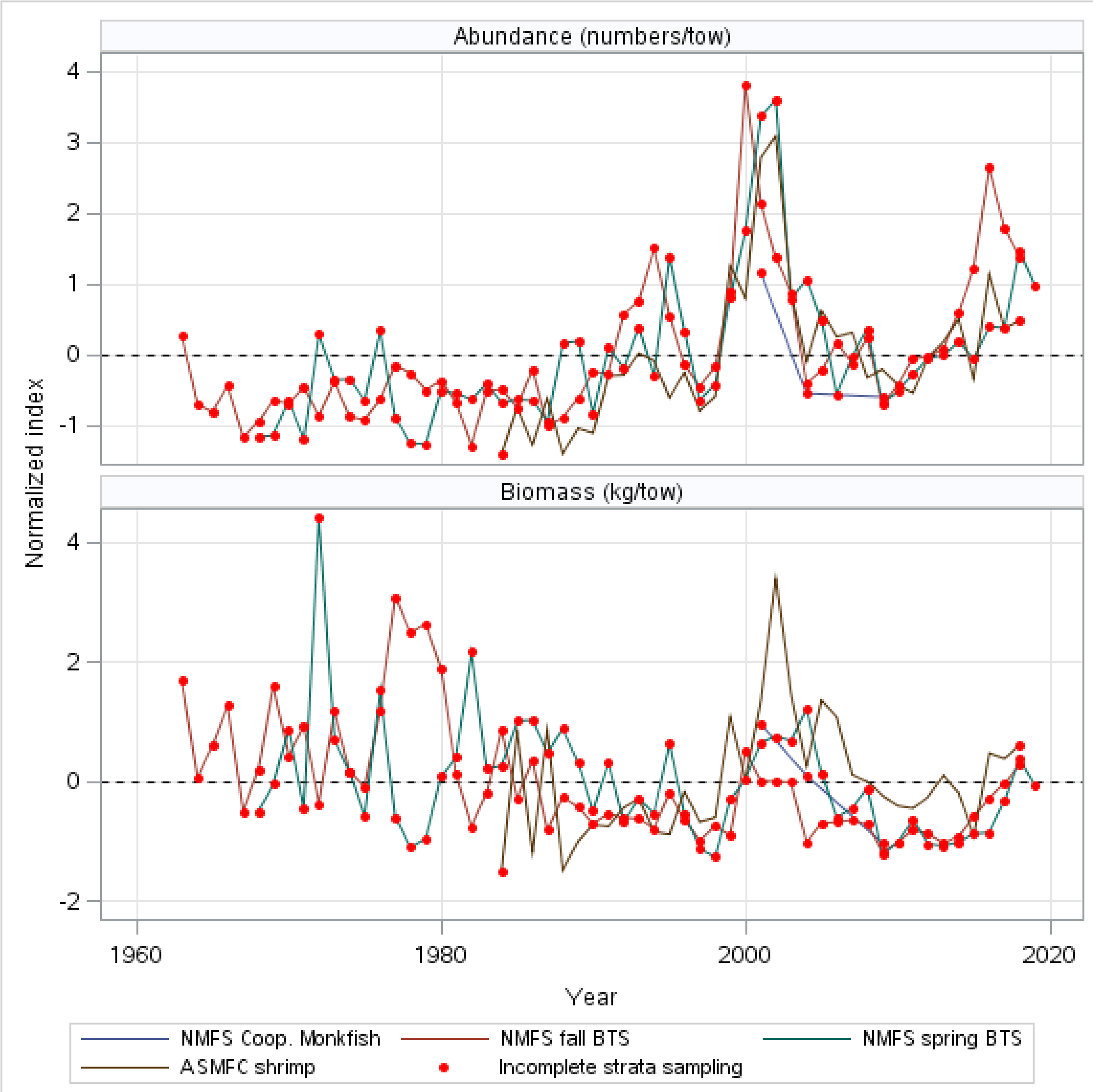


Figure 21. Normalized surveys for monkfish in the NMA.

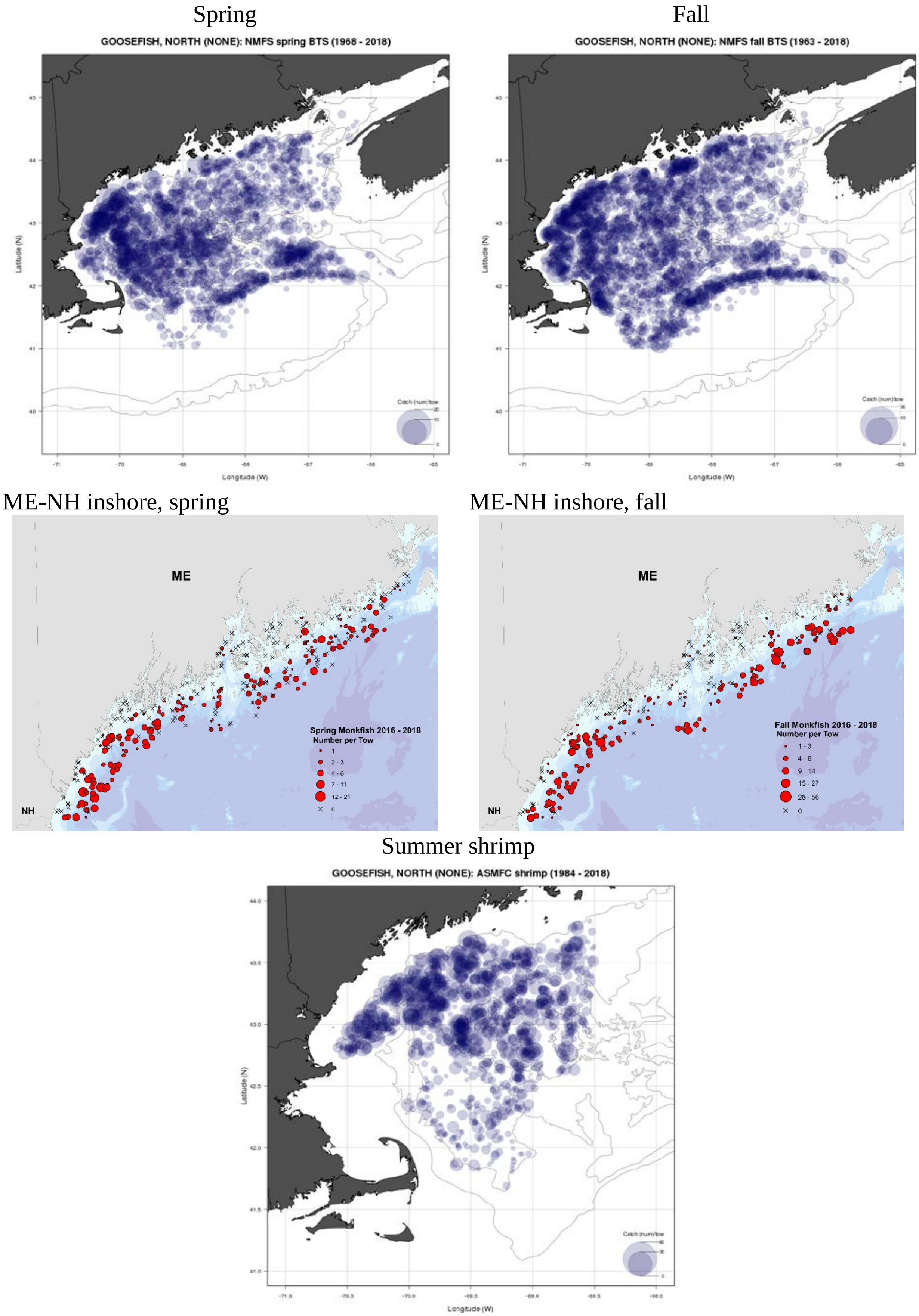


Figure 22. Distribution of monkfish in surveys in the northern management area.

South Biomass Abundance

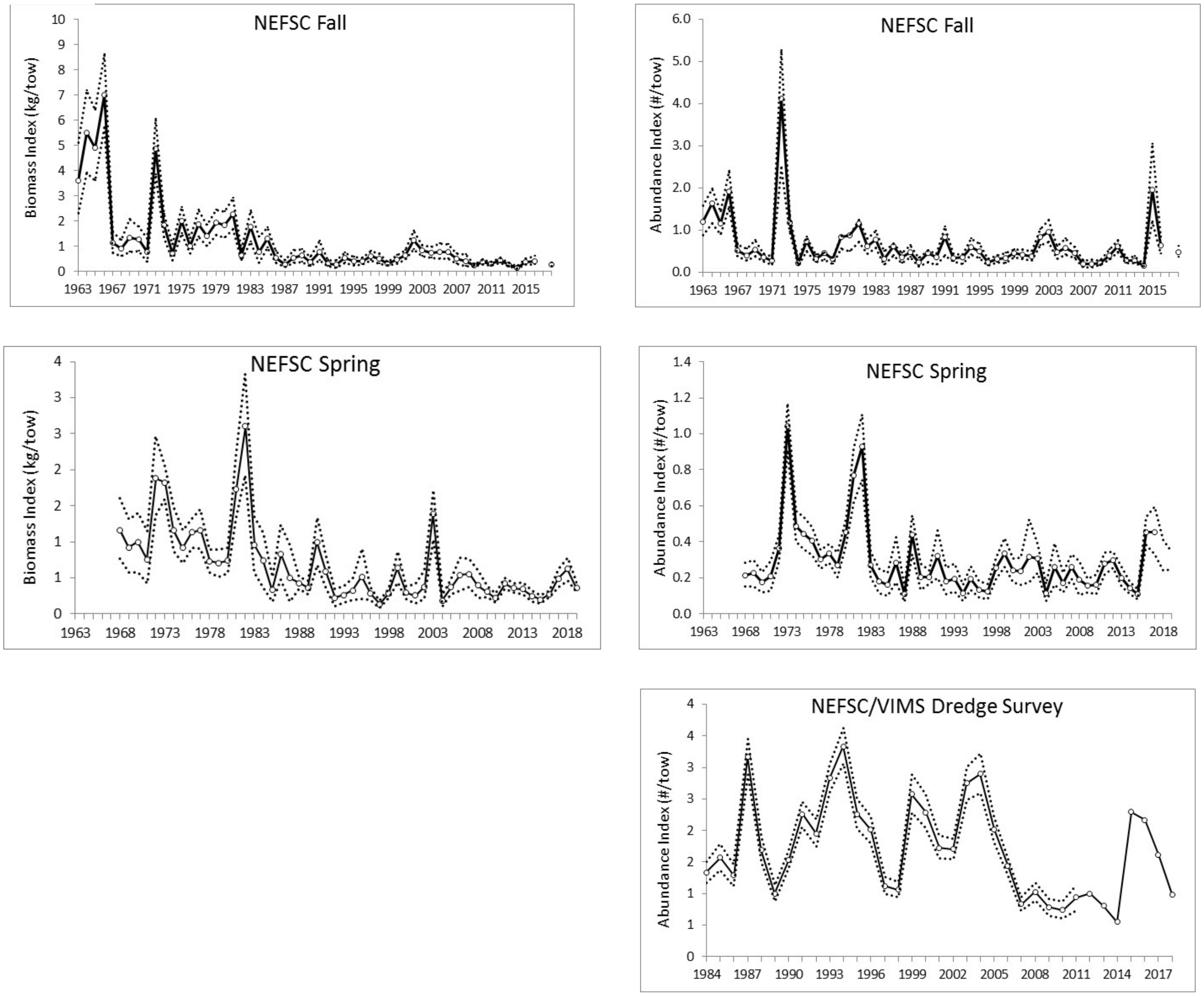


Figure 23. Survey indices for monkfish in the southern management area. Points after 2008 for NEFSC trawl surveys were conducted on the FSV Bigelow, converted to Albatross units as described in the text. Scallop dredge survey indices after 2011 were calculated from combined data from surveys conducted by NEFSC and Virginia Institute of Marine Science.

South

Biomass | Abundance

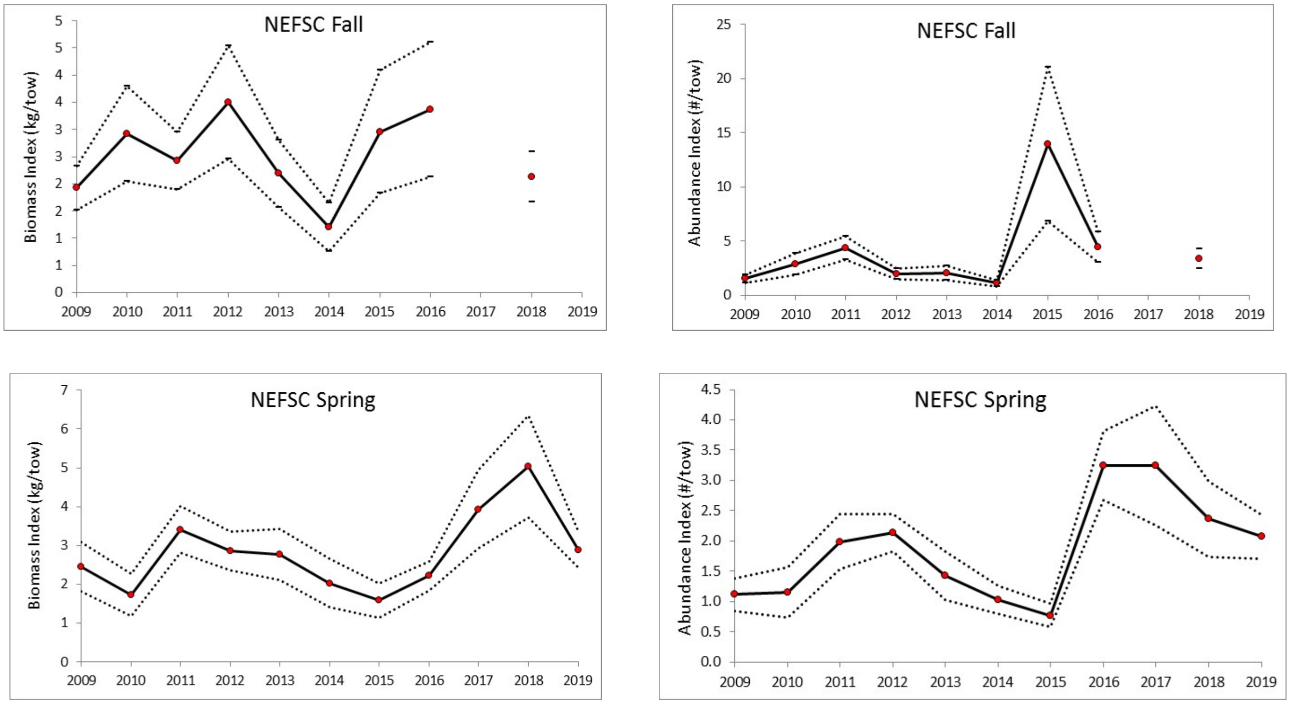


Figure 24. Survey indices from surveys conducted on the FRSV Bigelow in the southern management area, not converted to Albatross units.

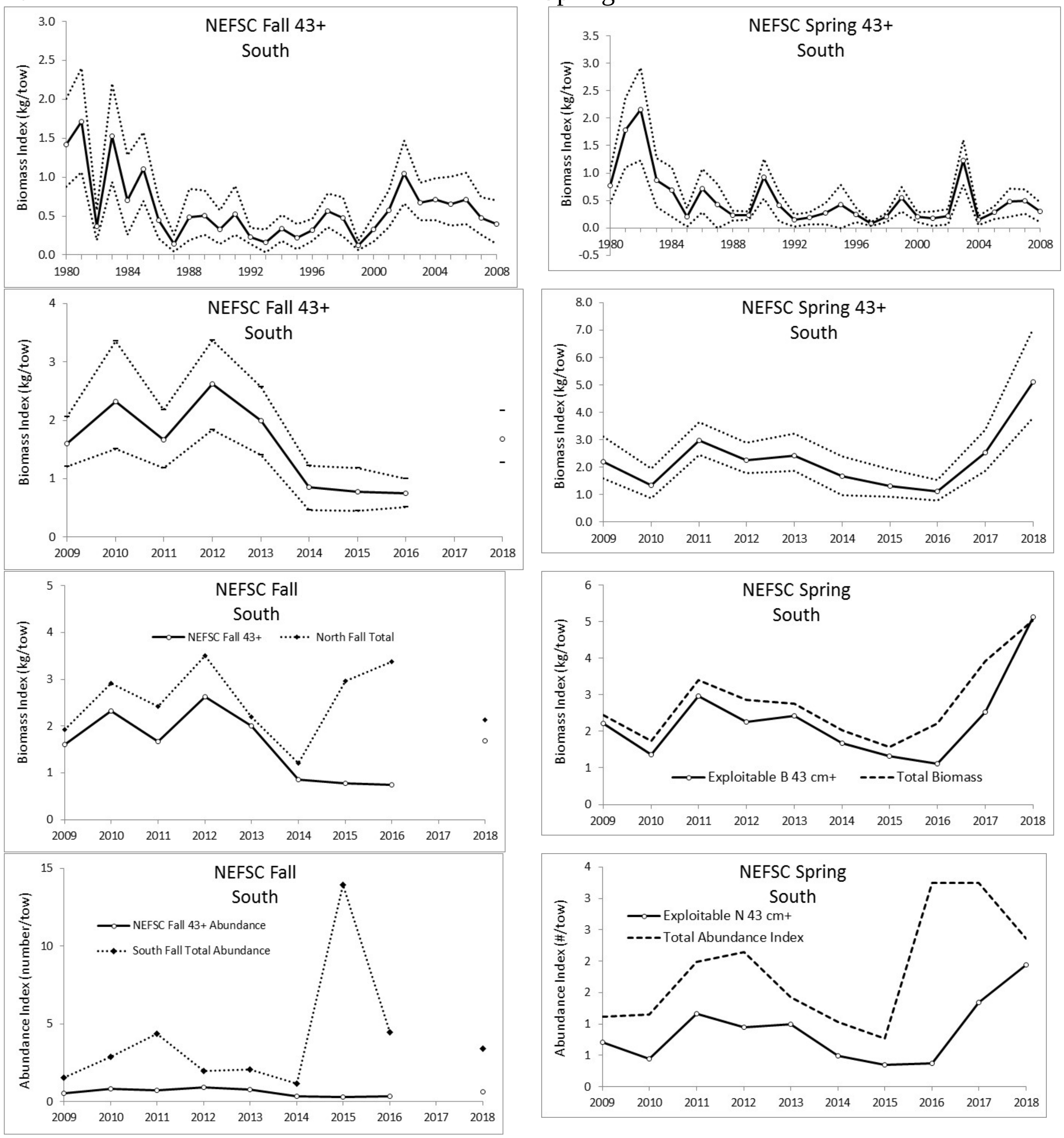


Figure 25. Exploitable biomass ($\geq$ 43 cm total length) indices for monkfish from fall and spring surveys in the SMA. A. Exploitable biomass indices with 95% confidence intervals, 1980-2008 (surveys conducted on RV Albatross). B. Exploitable biomass indices with 95% confidence intervals, 2009-2018 (surveys conducted on RV H.B. Bigelow) C. Total biomass vs. exploitable biomass indices, 2009-2018, D. total abundance vs. exploitable abundance, 2009-2018.

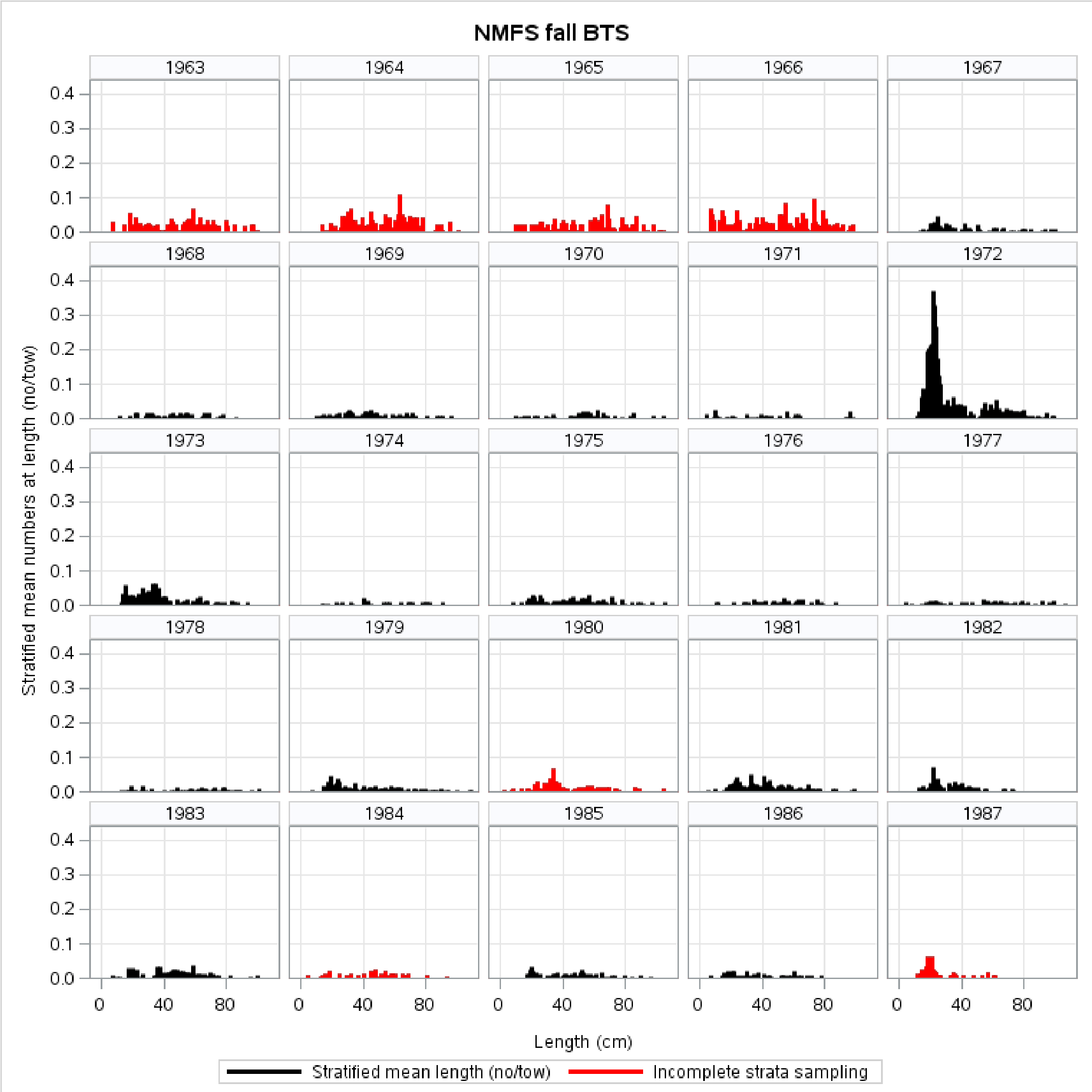


Figure 26. NEFSC fall survey indices of abundance at length, southern management area.

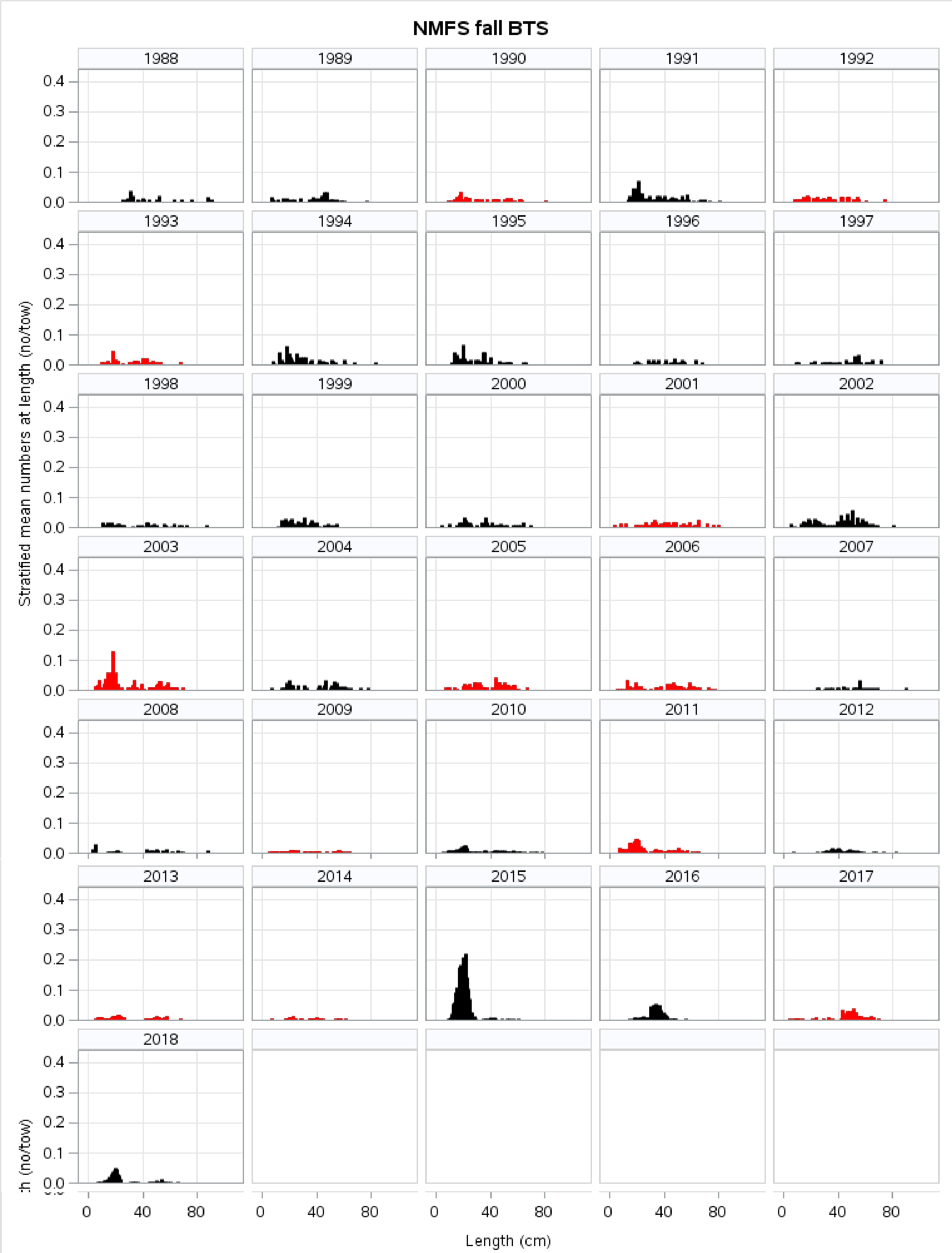


Figure 26, cont'd. (fall survey, south)

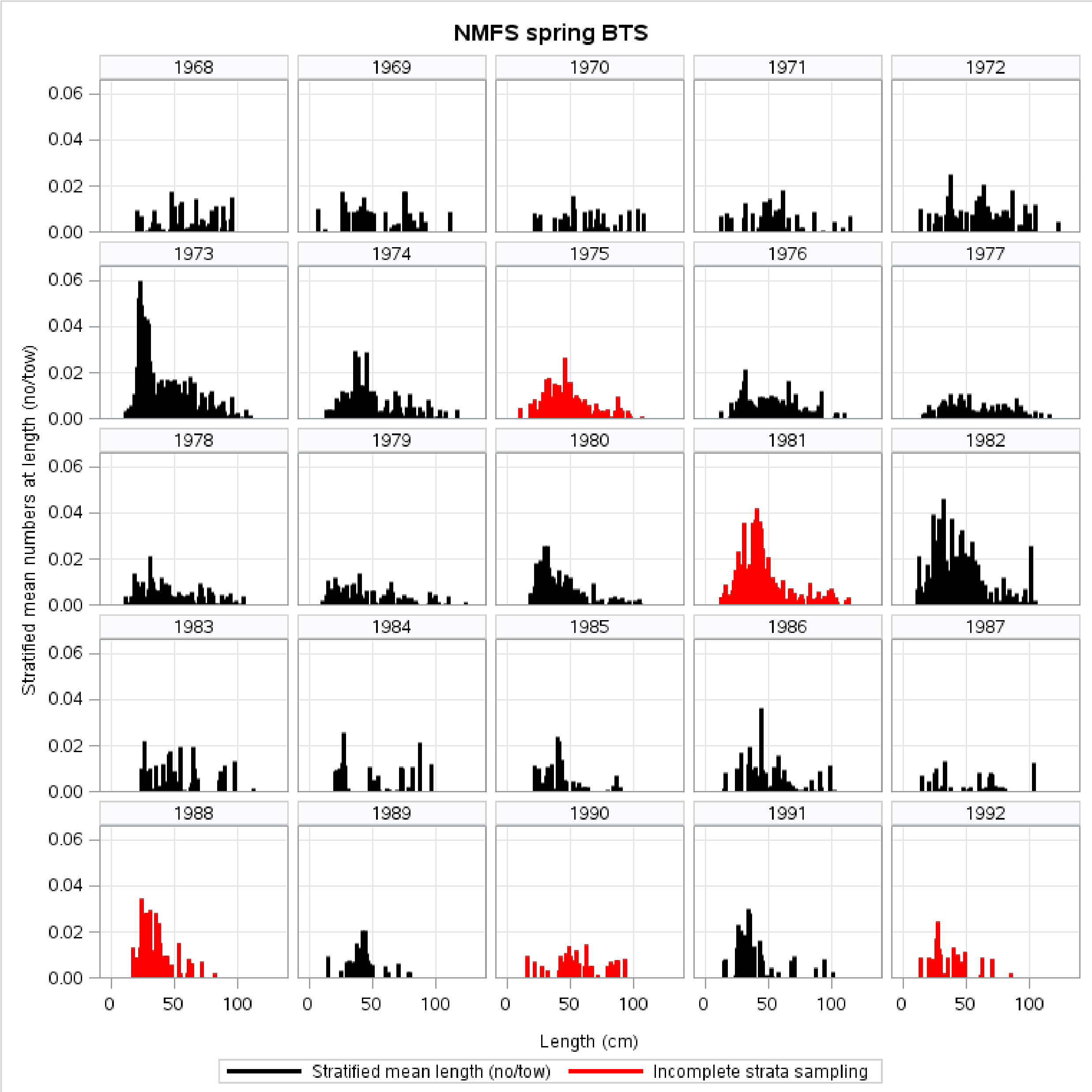


Figure 27. NEFSC spring survey indices of abundance at length, southern management area.

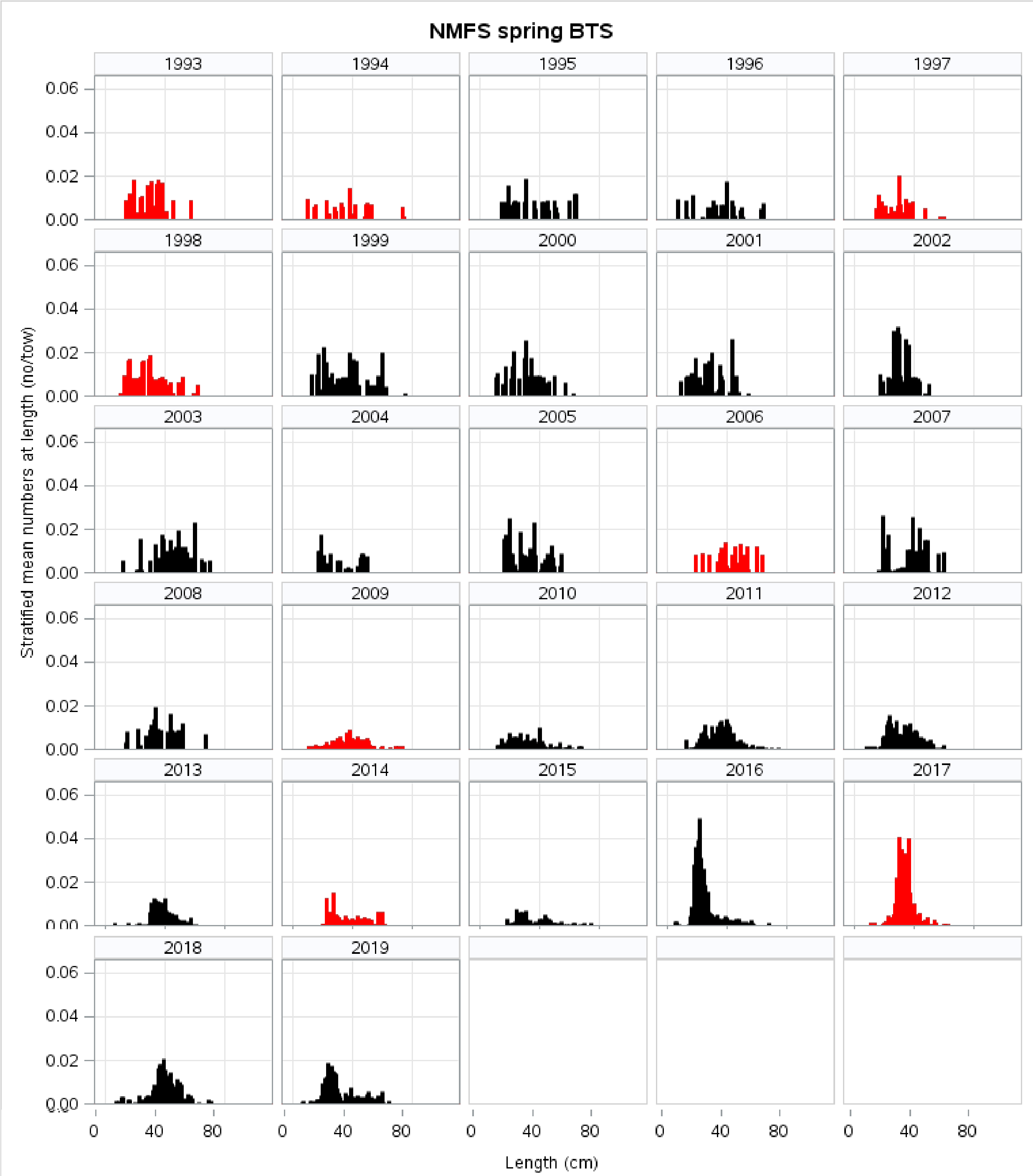


Figure 27, cont'd. (spring survey, south)

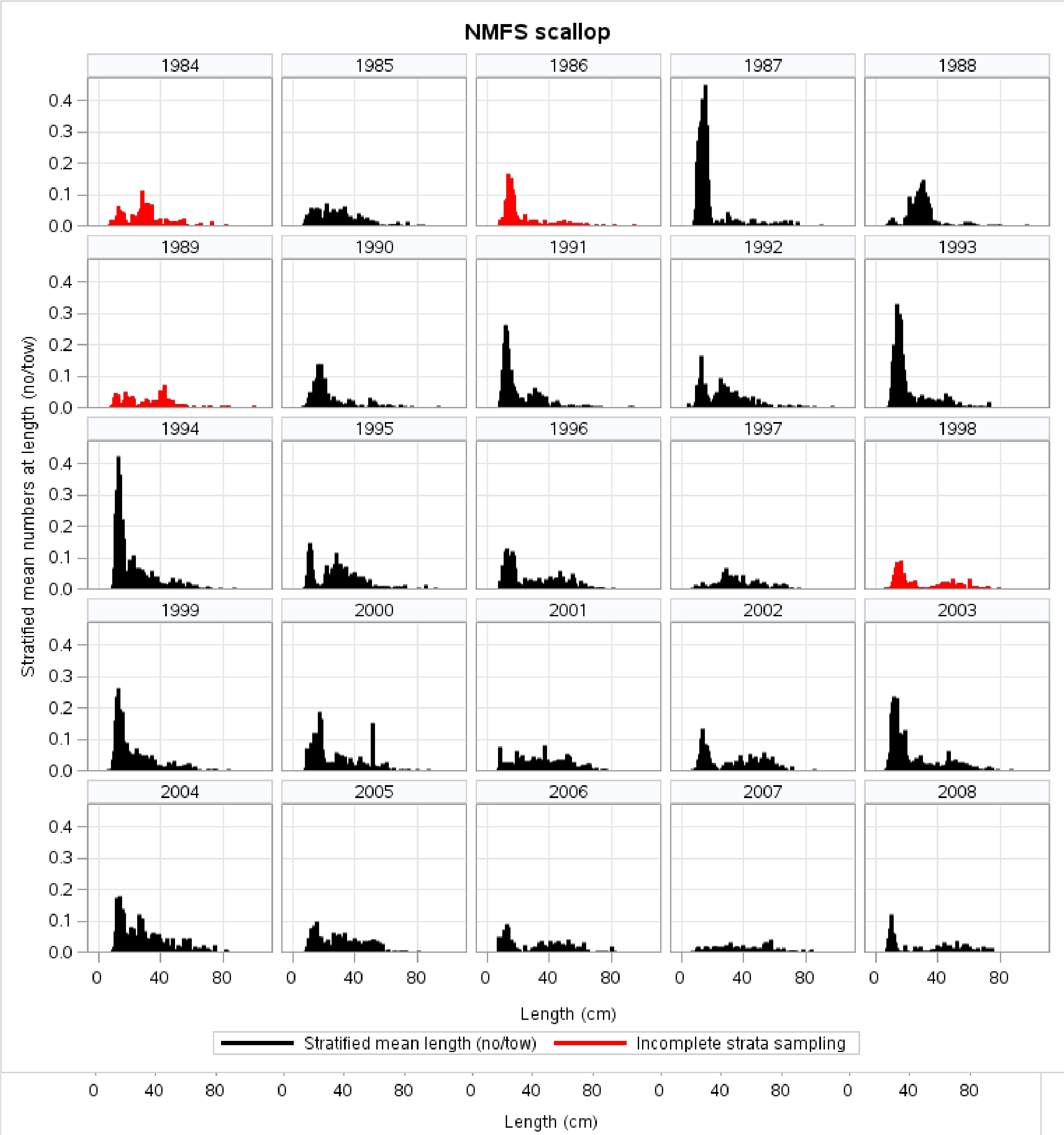


Figure 28. NEFSC spring/summer scallop dredge surveys. Survey timing shifted from summer to spring in 2009. These plots do not include sampling conducted by VIMS after 2011 (see Figure 23).

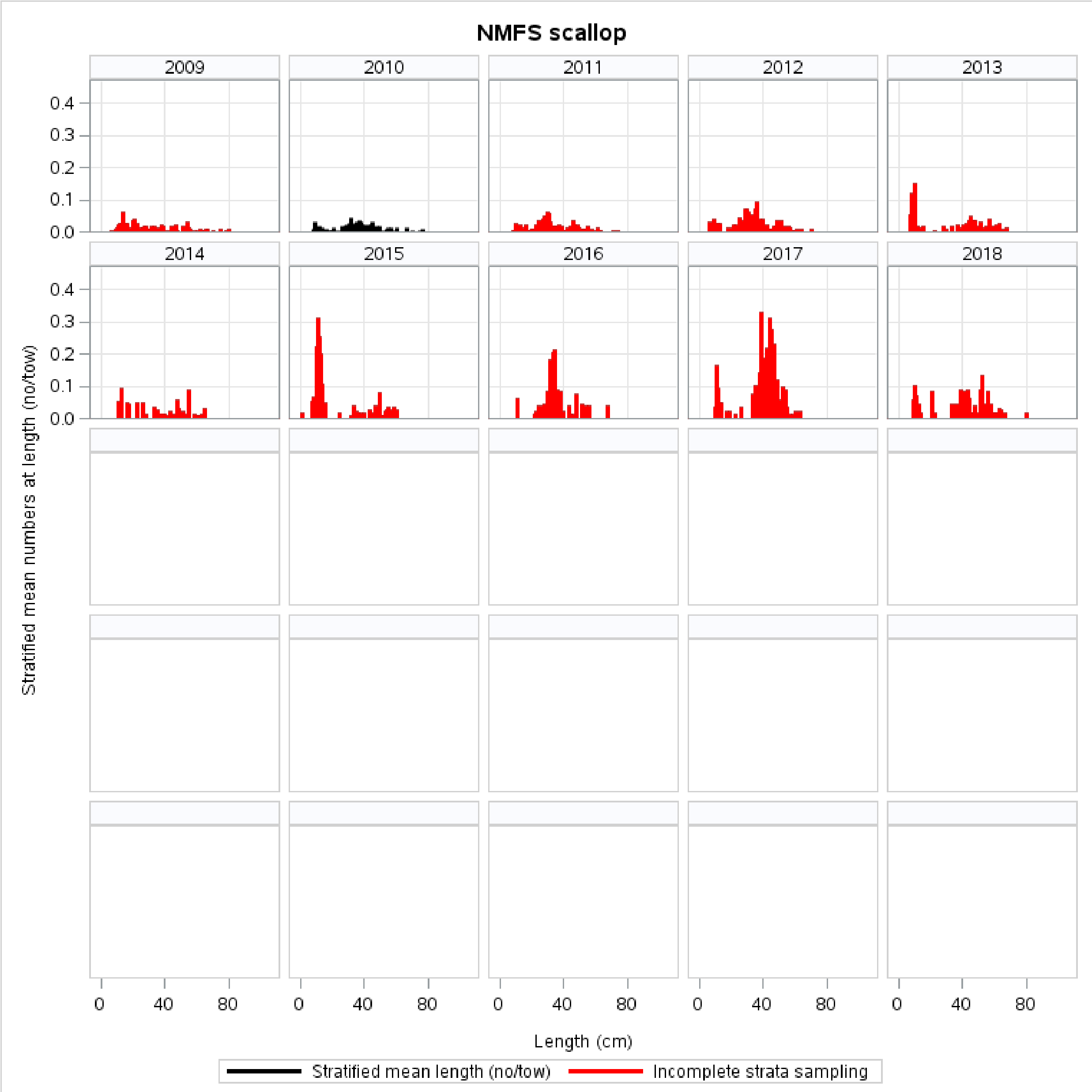


Figure 28, continued (NEFSC scallop dredge survey, south)

A.

B.

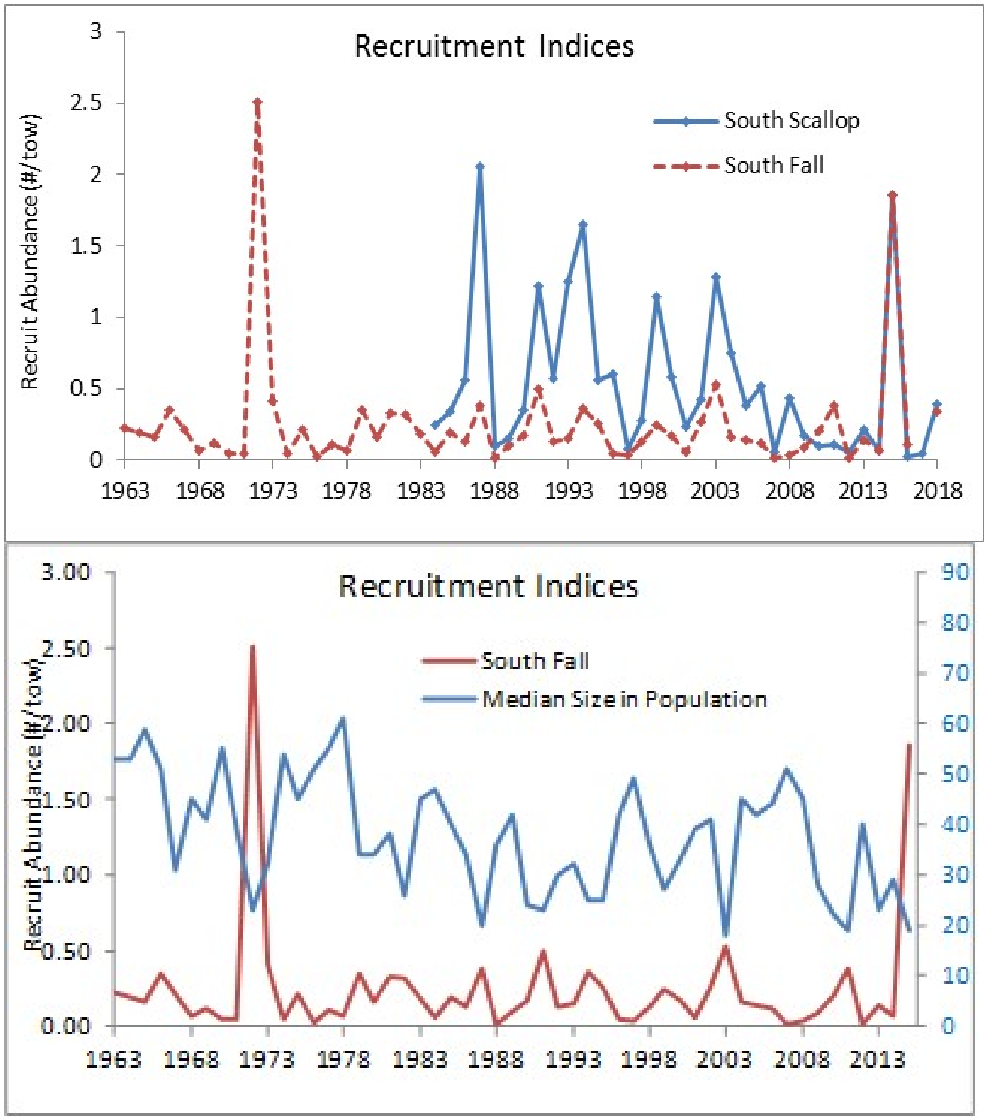


Figure 29. A. Recruitment indices for monkfish in the southern management area. Indices include monkfish in size ranges currently thought to represent young-of-year (age 0) in each season. There are no data for the fall survey in 2017 for the SMA. B. Recruitment indices vs. median size of monkfish in the population (based on NEFSC fall surveys).

D. Monkfish

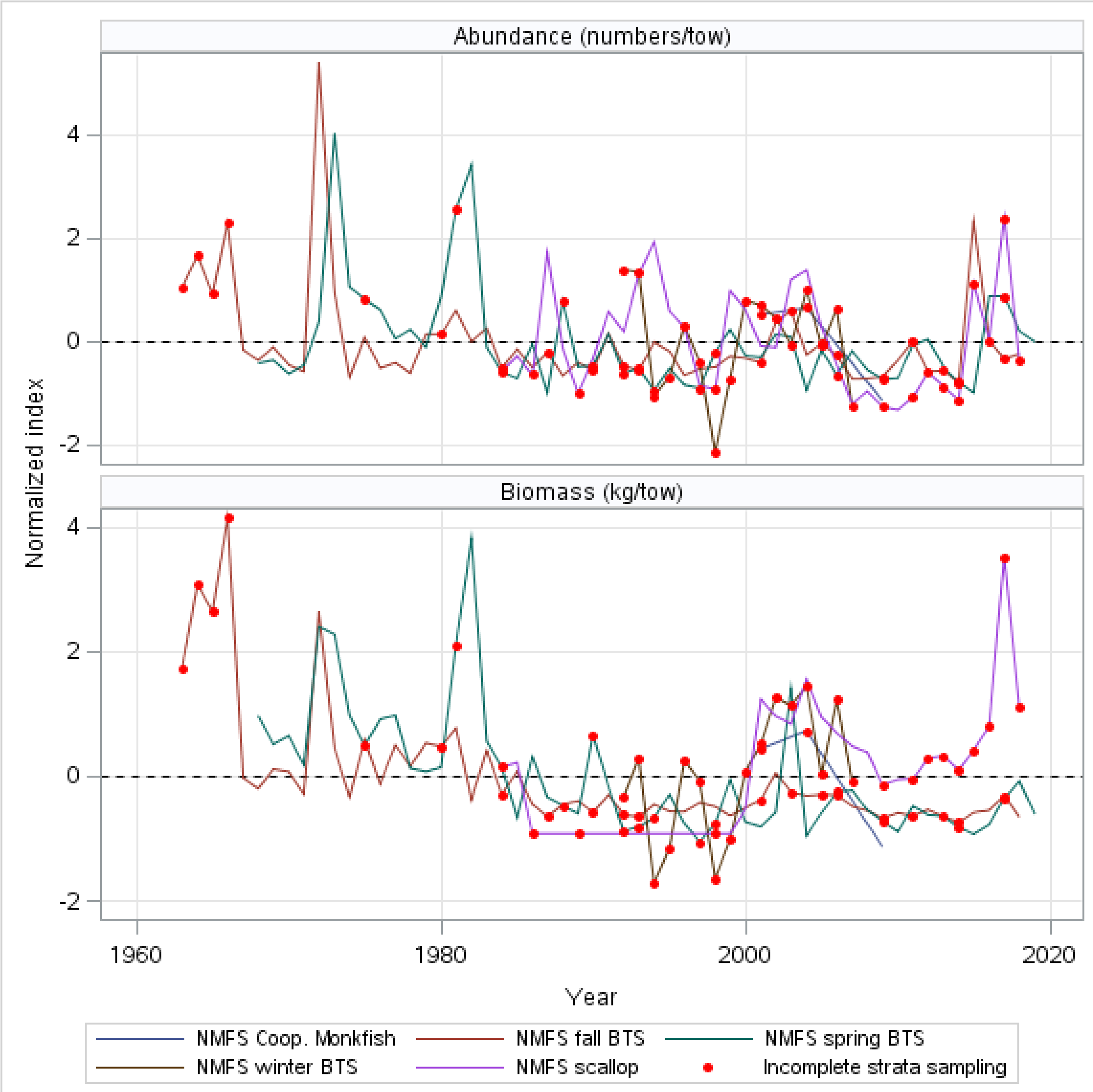


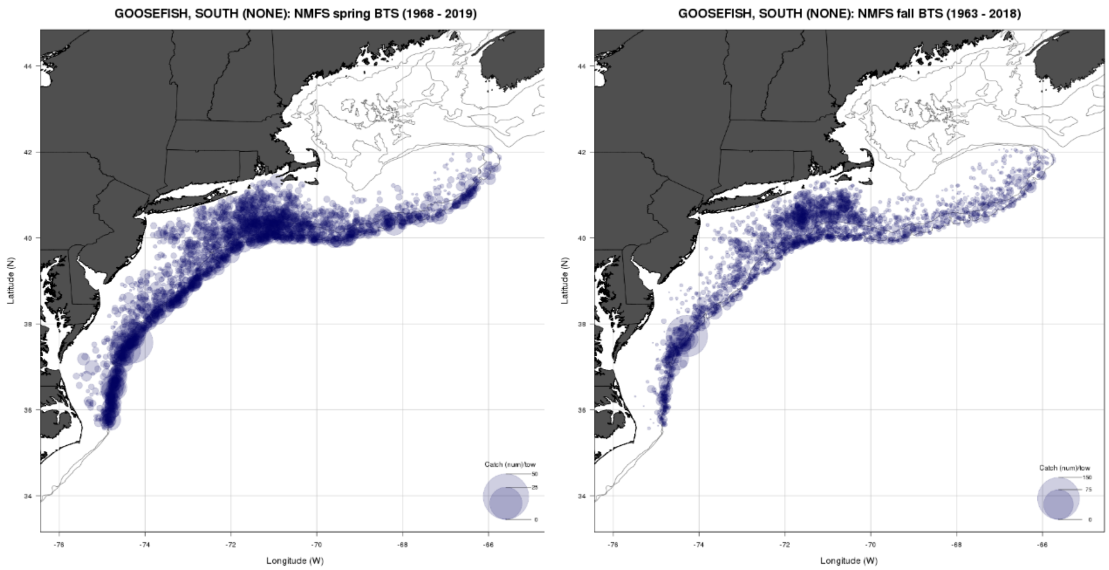
Figure 30. Normalized survey indices for monkfish in the southern management area. Scallop survey indices do not include VIMS portion of the survey starting in 2012.

D. Monkfish

Spring

Fall

NEFSC bottom trawl surveys



Spring/Summer Scallop Survey

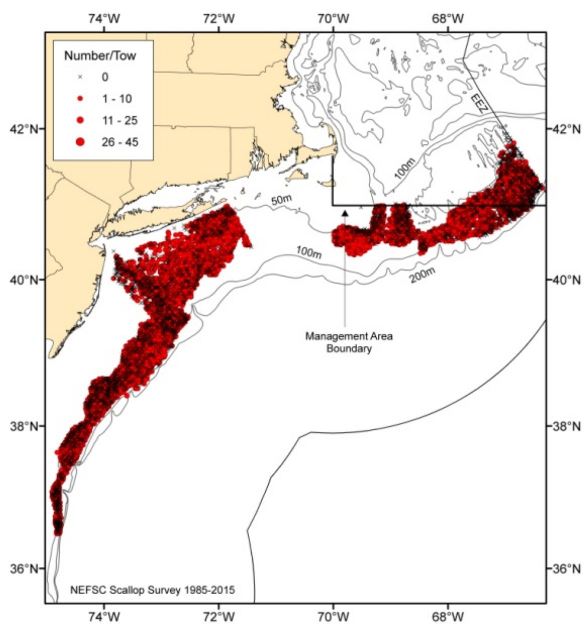
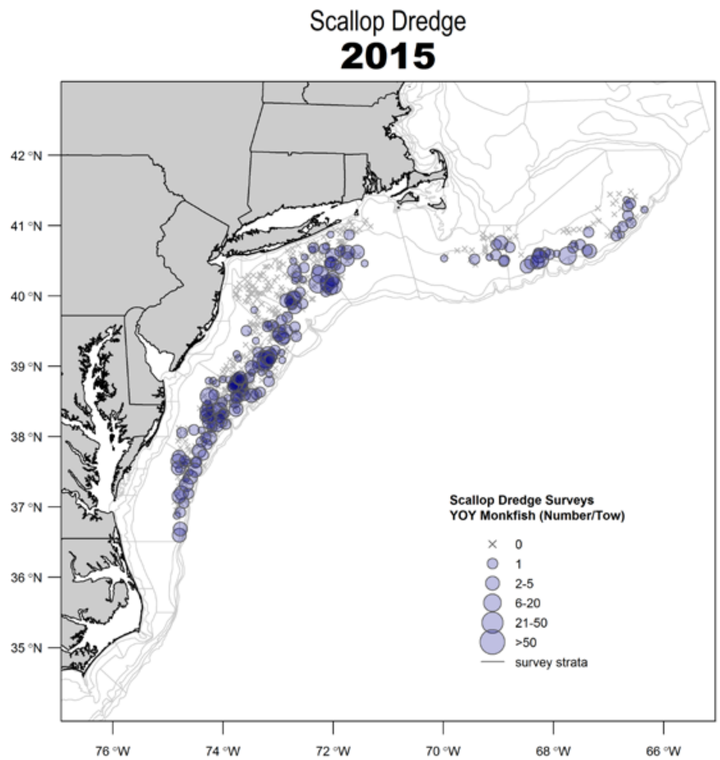


Figure 31. Distribution of monkfish in the southern management area from NEFSC spring (1968-2019) and fall (1963-2018) bottom trawl surveys and NEFSC and NEFSC/VIMS spring/summer scallop dredge surveys (1984-2015).

D. Monkfish

A.



B.

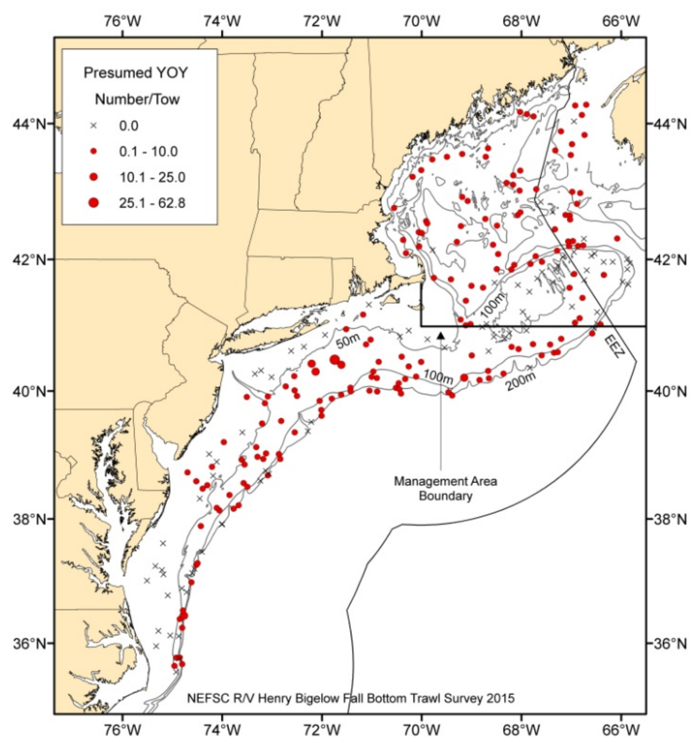


Figure 32. Distribution of presumed young-of-year monkfish in 2015 in (A.) NEFSC and VIMS scallop dredge survey tows (late spring), and (B.) NEFSC fall surveys.

D. Monkfish

North South

A.

B.

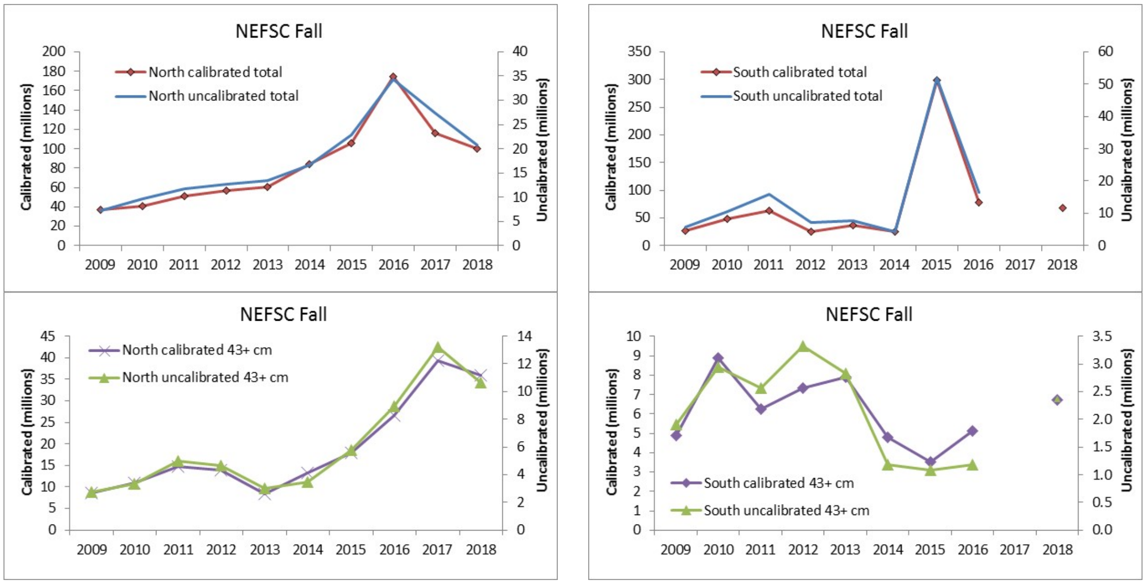


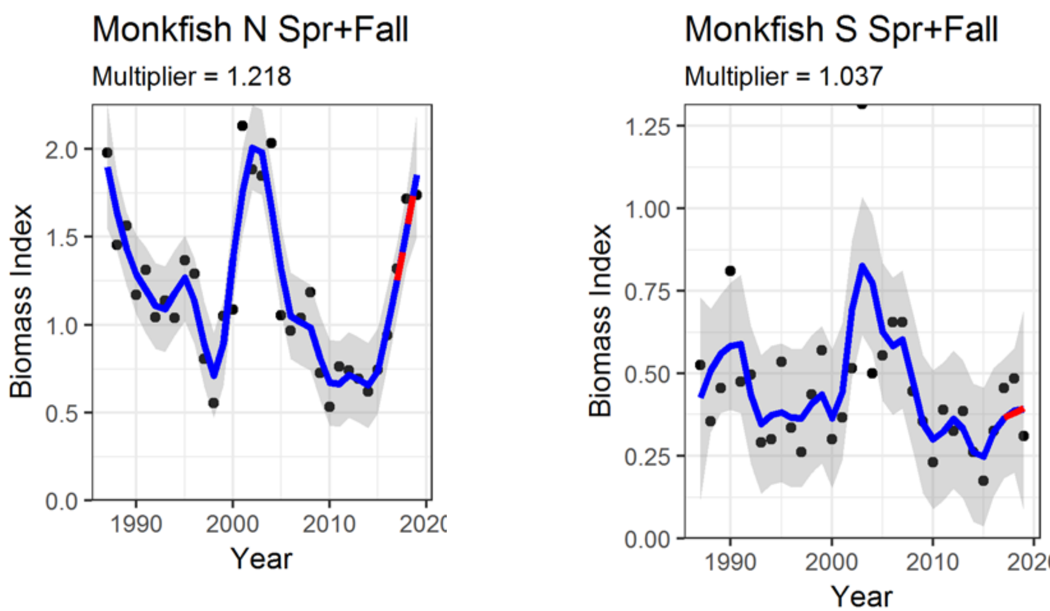
Figure 33. Area-swept abundance estimated from NEFSC fall surveys using adjustments from chain-sweep study compared to unadjusted estimates. A. total abundance, B. exploitable abundance (43+ cm).

D. Monkfish

Figure 34. Estimates of relative exploitation from NEFSC fall surveys using minimum area-swept numbers or biomass adjusted for sweep type (adjusted to chain sweep), assuming that 100% of monkfish encountered by the trawl are captured and not accounting for missed strata in some years.

D. Monkfish

A.



B.

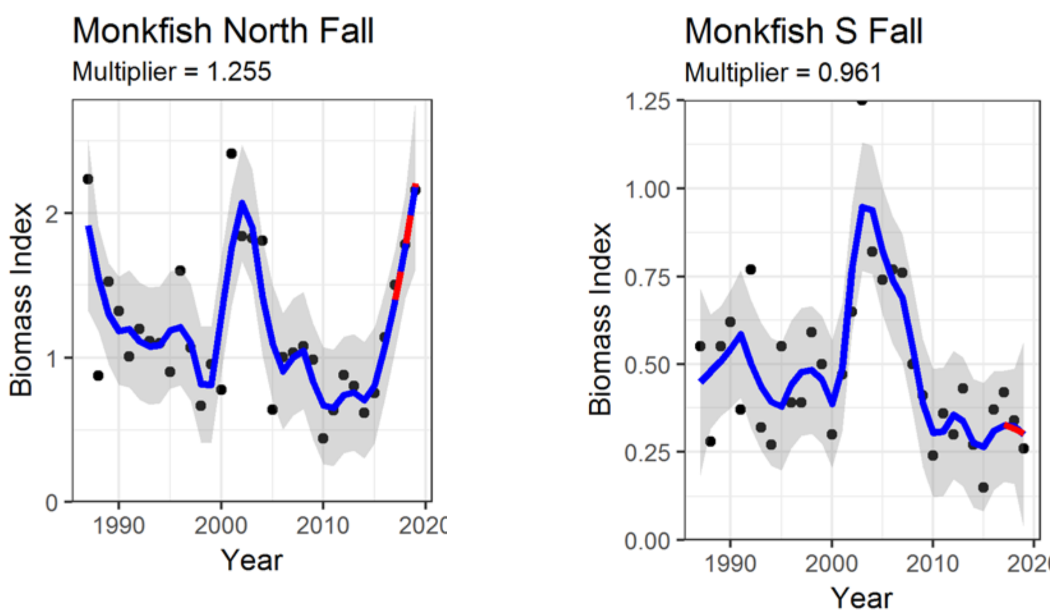


Figure 35. Results of “Plan B” analysis. Points are observed biomass indices, lines are loess-smoothed indices, “multiplier” is slope of log-linear regression through terminal three smoothed points. A. Results using both spring and fall indices, B. Results using fall survey indices only.