NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N7545 **NAFO SCR Doc. 24/039**

SCIENTIFIC COUNCIL MEETING – JUNE 2024

United States survey coverage in NAFO Subareas 4-7 from 2014-2023 with a focus on comparison among surveys.

Katherine Sosebee, Nancy McHugh, W. David McElroy, and Julie Nieland

NEFSC
166 Water Street,
Woods Hole, MA 02536
dave.mcelroy@noaa.gov

Abstract

The Northeast Fisheries Science Center (NEFSC) conducts several fisheries surveys within the region from Nova Scotia, Canada to just south of Cape Hatteras, North Carolina. The three bottom trawl surveys described are the spring, fall and Atlantic States Marine Fisheries Commission summer shrimp surveys. The NEFSC added an additional set of spring and fall surveys in 2014 conducted using bottom longlines conducted on fishing industry vessels. The coverage and timing of each survey is provided from 2014-2023. Information on the biomass of selected species from these surveys is also summarized.

INTRODUCTION

The NEFSC spring and fall Bottom Trawl Surveys (BTS) surveys have a history that extends prior to 1963 (Flescher 1977, Overholtz and Monteiro 1976, Survey Working Group 1988, Smith 2002), but the seasonal bottom trawl surveys did not become standardized until 1963 (Grosslein 1969, Flescher 1976, Figs. 1-2). These surveys provide one of the major components of stock assessments in the northeast United States (NEFSC 2022.). In addition, the Atlantic States Marine Fisheries Commission has supported a summer survey to sample Northern Shrimp since 1983 (NEFSC 2014). The last update of these surveys was described in Johnston and Sosebee 2014.

The NEFSC Gulf of Maine Bottom Longline Survey (BLLS) began in 2014 and has occurred in the spring and fall concurrently with the NEFSC BTS. The BTS gear physically cannot efficiently sample very complex, rough-bottom areas, and so catchability of fish that primarily inhabit these areas may be reduced. The BLLS was designed to increase sampling of several data-poor stocks that are associated specifically with rough-bottom habitat, while also enhancing data collection for some seemingly well-sampled fish stocks (McElroy et al. 2019). The BLLS overlaps spatially and temporally with the BTS, and the BLLS stratified random design was based on the BTS stratification of depth and area. These factors allow comparisons to be made between results of the two surveys and simplify data integration. The BLLS was further sub-stratified by “rough” and “smooth” bottom type by rugosity to account for habitat.

METHODS

Fall and Spring Bottom Trawl Surveys

The NEFSC bottom trawl surveys began in the fall in 1963 (Grosslein 1969, Azarovitz 1981, Azarovitz 1994) and the spring in 1968. A description of the timing, coverage and gear/vessel changes from 1963-2013 is provided in Johnston and Sosebee 2014. For 2014-2023, Any years not discussed below had full coverage, the timing was close to normal (March-mid-May for spring and September-mid-November for fall), and the vessel was the NOAA Ship *Henry B. Bigelow* (HB).

In 2017, the fall survey was delayed until late October (Fig. 3) because the primary vessel was unavailable. The vessel which conducted the survey, the NOAA Ship *Pisces* (PI), was only available for a short time and thus, the survey was shortened and only the Gulf of Maine and Georges Bank were sampled (Strata 01130-01300, 01340-01400, 03560, and 0359-0361; Table 1). Since the vessel was considered a sister ship to the HB, no calibrations were deemed necessary. In 2018, the fall survey did not cover the strata in the Bay of Fundy (01340, 01351) and only one tow was completed in the central Gulf of Maine (01360). In 2020, the survey was not conducted due to the COVID-19 pandemic. The 2022 and 2023 surveys were completely covered with few strata having less than 50% coverage (Fig. 4)

In 2014, there was an issue with the HB and the spring survey was delayed which resulted in stations south of Delaware Bay (strata 01610-01680, 03320, 03350, 03410, 03440 and any 07 or 08 strata) not being completed (Table 2). In 2016, the survey was delayed until April and was extended until June (Fig. 5) so all sampling was completed but the timing may have affected any indices of species that are migrating at that time. This effect is unknown as to the magnitude. In 2020, the survey was shortened due to the COVID-19 pandemic and only the southern strata were covered. In 2021, the very southern stations (01610-01640 and any 07 and 08 strata) were not covered. In 2023, only Georges Bank strata (01130-01250) were covered and only during the daytime (Fig. 6).

Shrimp Survey

The description of the shrimp survey from 1983-2013 was given in Johnston and Sosebee (2014). The survey occurs mainly in the deeper waters of the Gulf of Maine (Fig. 7). Since 2013, the survey has generally maintained sampling of the core strata (04010, 04030, and 04050-04080) except for 2018 when stratum 04070 was not sampled (Table 3). The timing of the survey over the last ten years has been similar to the past although slightly earlier than the 1980s (Fig. 8). In 2023 there was sampling in all strata (Table 3; Fig. 9) except for 04110 and 04120 (which have not been sampled since 2005 (Johnston and Sosebee 2014)). The shrimp survey was suspended after the 2023 survey since the shrimp population has been very low since 2014 and can still be monitored by the NEFSC fall BTS (NEFSC 2014) and the Maine/New Hampshire Inshore BTS.

Spring and Fall Bottom Longline Surveys

The BLLS is conducted from two commercial fishing vessels. Both vessels use tub-trawl longlines, deploying 1,000 #12 semicircle hooks pre-baited with squid on a 1 nm mainline, soaked for 2 hours across the slack tide (McElroy et al. 2019). This mainline length was chosen to be consistent with the mean tow distance of the BTS. The survey focuses on 6 BTS offshore strata in the Gulf of Maine: 26, 27, 28, 29, 36, and 37 (Figure 10: BLLS and BTS strata overlaid). All of strata 26, 27, and 37 were included in the survey area for the BLLS, but only portions of strata 28, 29, and 36 were included. The BLLS followed the same stratified random design as the BTS but with sub-stratification into “rough” and “smooth” bottom types (Figure 11), which were based on rugosity using the 70^{th} percentile of the terrain ruggedness index (Riley et al. 1999; Hare et al. 2012; McElroy et al. 2019). This survey samples 45 stations (divided between both bottom types) in the spring (April – May) and fall (October – November; Table 4; Figure 12). The BLLS occurred during the same period as the BTS. Sampling density was higher in the BLLS than the BTS in the same strata, and BLLS stations were more heavily allocated to rough bottom substrata (Politis et al. 2014; McElroy et al. 2019). Starting in 2017, changes were made to the survey design for station allocation by bottom type. The total number of smooth stations decreased from 12 to 7, and strata were combined for the smooth strata. This decision was based on preliminary results indicating higher incidence of predation of hooked fish on smooth bottom, hooks coming up empty of bait, increased variance of the sampled smooth bottom mean abundance, discussions with the captains, and the assumption that the existing BTS samples smooth bottom areas efficiently (McElroy et al. 2019). Recent research supports lower bait retention on smooth-bottom habitat (Nelson et al. 2024). The 5 additional stations were re-allocated to rough strata, maintaining the 45 stations per season total. After each station was completed, the chief scientist evaluates whether or not the data was representative by applying criteria for the quality and characteristics of the station type, gear performance, environmental conditions, and data acquisition. If a station was determined to be unrepresentative, then the station was repeated on a later date or an alternative station was sampled when feasible. Forty-five stations were sampled in the BLLS in all seasons except the spring of 2020 the BLLS was canceled due to the COVID-19 pandemic. Some stations were excluded from index calculations due to operational or standardization issues: n fall of 2017 (43), , fall 2020 (43), fall 2021 (44), and fall 2023 (44; Table 5: representative stations). The locations of rough- and smooth-bottom stations sampled in spring and fall 2022 and 2023 are shown in Figure 13.

Length and aggregate weight measurements were recorded for each species at each station, and a few species (principally spiny dogfish, *Squalus acanthias*) were further sorted by sex. If catch of an individual species was too large, then total catch weight was taken, but only a subsample of the catch was measured for length. Additional biological samples, including but not limited to sex, age, and maturity samples, were collected for certain species and size groups based upon requests.

Survey Index Calculation

Fall, Spring, and Shrimp Bottom Trawl Surveys

Stratified mean weight/tow indices were calculated for selected species (Cochran, 1979). The data were adjusted for the tow specific swept area for 2009 onwards since the gear mensuration data were available on the HB. Spring and fall BTS strata sets used differed by species/stock (Table 6). Vessel (RV *Albatross IV* (AL)/RV *Delaware II* (DE)), gear and door calibration factors were applied when significant (Sissenwine and Bowman, 1978; Byrne and Forrester 1991a, Byrne and Forrester 1991b, Johnston and Sosebee 2014). Calibrations between the HB and the AL were also applied (Miller et al. 2010) with two species having length-based calibrations (haddock (*Melanogrammus aeglefinus*) and red hake (*Urophycis chuss*); Miller et al. 2013, NEFSC 2011). Indices for spiny dogfish were calculated by sex and then the two sexes were added together to create an overall index. The shrimp survey strata used were generally 04010, 04030, and 04050-04080. The species/stocks were selected if indices had been developed in the spring and fall bottom longline surveys.

Spring and Fall Bottom Longline Surveys

The stratified mean abundance and biomass were estimated by season and bottom type (and also by sex for spiny dogfish) for each BLLS from spring 2014 through spring 2023. The estimation procedure was programmed in SAS (SAS 9.4, SAS Institute Inc., Cary, NC) following stratified random sampling statistics as described by Cochran (1977; McElroy et al. 2019). The indices for both rough- and smooth-bottom types combined were considered appropriate for white hake (*Urophycis tenuis*), red hake (Northern stock), Atlantic halibut (*Hippoglossus hippoglossus*), spiny dogfish, and thorny skate (*Amblyraja radiata*). Abundance and biomass indices for haddock (GOM stock) and Atlantic wolffish (*Anarhichas lupus*) were calculated for rough-bottom stations only. Rough-bottom stations were used for Atlantic wolffish indices because this species was caught almost solely in rough-bottom sets (only 1 wolffish was caught at a smooth-bottom station during the whole time series). For haddock, rough-bottom stations were chosen due to the higher probability of occurrence of haddock in rough strata sets, and smooth strata sets were thought to be more affected by depredation. Data were further restricted by strata; only strata 26, 27, 28, and 37 were used to calculate the indices. Offshore strata 29 and 36 were excluded because fewer haddock were caught in these strata, and there were concerns that the lower abundance from these two strata would dilute the indices. Decisions about strata and bottom-type selection were made during the assessment review process for each stock.

The indices of the 4-5 time series were normalized to the mean of the 2014-2021 or 2014-2022 values to account for changes in biomass over time to compare the shorter time series to the fall BTS. The end year differed if the indices for one of the surveys was different (i.e. the spring BTS survey was only through 2022 due to sampling issues noted above).

RESULTS AND DISCUSSION

For Gulf of Maine haddock, the four surveys are in general agreement (Fig. 14). The fall survey increased more than the spring survey during the late 1970s and early 2000s. However, all four surveys picked up the increase from the 2013 year class flowed by the decrease as the year class aged and no longer is the dominant year class (NEFSC 2022).

White hake indices track fairly well with the spring and fall increasing in the 1970s, stable at a lower level in the 1980s, and then decreasing to low values in the mid-1990s (Fig. 15). The shrimp survey also is consistent with all three surveys increasing to a higher level in the 2000s followed by a decline to a lower level around 2013. The BLLS has a similar trend in biomass even though the length compositions differ between the BTS and BLLS (McElroy et al. 2021).

Biomass indices of all 4 surveys for northern red hake (Fig. 16) are generally in agreement. The spring and fall BTS do not always agree and this could be due to a couple of factors. The spring survey used a different gear from 1973-1981 (Johnston and Sosebee 2014) and there was no significant calibration factor (Sissenwine and Bowman 1978) for the gear, and there was a significant day/night difference. The comparative gear work took place in late August/early September, so if there is a seasonal difference in the efficiency, this would not necessarily have been demonstrated for the spring. In addition, the distributions during the two seasons are somewhat different, with the fall survey having a more dispersed distribution and the spring found more in deeper waters (Sosebee and Cadrin 2006, NEFSC 2011).

The Atlantic halibut indices do not track each other well (Fig. 17). All the indices are very noisy, and all but the spring BLLS have zero values due to very low biomass of the stock in the Gulf of Maine since before the fall BTS started in 1963 (NEFSC 2008). The abundance and biomass of Atlantic halibut seems to be at or below the detection level of the BTS and approaching it for the BLLS.

The indices for Atlantic wolfish are in general agreement with spring and fall BTS surveys declining (Fig. 18) from the late 1990s through the early 2000s and both being very low currently, including some zero years (Fig. 19). The fall BLLS survey was also zero in 2020 and 2021. As with Atlantic halibut, the biomass of Atlantic wolfish is at or near the detection level of all the surveys.

The biomass indices for spiny dogfish (Fig. 20) do not agree, particularly in the early years of the BTS and the shrimp survey. Spiny dogfish migrate between the seasons and some of the population is likely to be unavailable in the fall (Rago et al. 1998). The differences between the shrimp survey and the spring and fall BTS is likely a combination of the smaller area sampled by the shrimp survey and potential changes in the timing and area of the seasonal migration (NEFSC 2003, NEFSC 2006). This is probably true for the BLLS as well.

Thorny skate indices of biomass from the BTS agree fairly well with the indices declining over the time series (Fig. 21) even if the individual years do not always line up. The shrimp survey starts out at a lower level than the spring and fall BTS (Fig. 22) because the abundance in that area was already lower than the areas of the inshore Gulf of Maine and the areas around the edges of Georges Bank (Fig. 23). The BLLS also show the same decline over those time series.

REFERENCES

Azarovitz, T. R. 1981. A brief historical review of the Woods Hole Laboratory trawl survey time series. In Doubleday, W.G. and D. Rivard, (eds.), Bottom trawl surveys. Can. Spec. Publ. Fish. Aquat. Sci. 58:62-67.

Azarovitz, T.R. 1994. Northeast Fisheries Science Center Bottom Trawl Surveys. In: Atlantic States Marine Fisheries Commission. 1994. Proceedings of the Workshop on the Collection and Use of Trawl Survey Data for Fisheries Management. Special Report No. 35.

Byrne, C. J. and Forrester, J. 1991a. Relative fishing power of two types of trawl doors. NEFSC SAW/12/Pl. Northeast Fisheries Science Center, Woods Hole, MA.

Byrne, C. J. and Forrester, J. 1991b. Relative fishing power of NOAA R/Vs Albatross IV and Delaware II. NEFSC SAW/12/Pl. Northeast Fisheries Science Center, Woods Hole, MA.

Cochran W.G. 1977. Sampling techniques, 3rd edition. New York: John Wiley & Sons.

Flescher, D. 1976. Research Vessel Cruises, 1963-1975, National Marine Fisheries Service, Woods Hole, Massachusetts. WH Lab. Ref. Doc. 76-14.

Flescher, D. 1977. Research Vessel Cruises, 1948-1962, National Marine Fisheries Service, Woods Hole, Massachusetts. WH Lab Ref. Doc. 77-09.

Grosslein, M.D. 1969. Groundfish Survey Methods. WH Lab. Ref. Doc. 69-2.

Hare J.A., J.P. Manderson, J.A. Nye, M.A. Alexander, P.J. Auster, D.L. Borggaard, A.M. Capotondi, K.B. Damon-Randall, E. Heupel, I. Mateo, L. O'Brien, D.E. Richardson, C.A. Stock, and S.T Biegel. 2012. Cusk (*Brosme brosme*) and climate change: assessing the threat to a candidate marine fish species under the US Endangered Species Act. ICES J. Mar. Sci. 69(10):1753-1768. DOI: 10.1093/icesjms/fss160.

Johnston, R and K. Sosebee. 2014. History of the United States Bottom Trawl Surveys, NAFO Subareas 4-7. NAFO SCR Doc. 14/024. Ser. No. N6319. 41p.

Keith, Charles (2023). Cruise Results : Gulf of Maine Northern Shrimp Survey, NOAA FRV Gloria Michelle, Cruise No. GM 23-03 (Parts I-III). https://doi.org/10.25923/exnv-6s37

McElroy, W.D., L. O'Brien, J. Blaylock, M.H. Martin, P.J. Rago, J.J. Hoey, and V.A. Sheremet. 2019. Design, implementation, and results of a cooperative research Gulf of Maine longline survey, 2014 – 2017. NOAA Tech. Memo. NMFS-NE-249, 161 p. https://doi.org/10.25923/2sgn-mx62.

McElroy, W.D., J. Blaylock, G.R. Shepherd, C.M. Legault, P.C. Nitschke, and K.A. Sosebee. 2021. Comparison of a bottom longline survey and a bottom trawl survey for 2 groundfish species in the Gulf of Maine to evaluate habitat-related availability of large fish. Fish. Bull. 119:231–242.

Miller T.J., C. Das C, P.J. Politis, A.S. Miller, S.M. Lucey, C.M. Legault, R.W. Brown, and P.J. Rago. 2010. Estimation of Albatross IV to Henry B. Bigelow calibration factors. Northeast Fish Sci Cent Ref Doc. 10-05; 233 p.

Miller. T.J. 2013. A comparison of hierarchical models for relative catch efficiency based on paired-gear data for US Northwest Atlantic fish stocks. Can. J. Fish. Aquat. Sci. 70: 1306–1316 (2013). http://dx.doi.org/10.1139/cjfas-2013-0136.

NEFSC. 2003. Report of the 37th Northeast Regional Stock Assessment Workshop (37th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 03-16; 597 p.

NEFSC. 2006. Report of the 43rd Northeast Regional Stock Assessment Workshop (43rd SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 06-25; 400 p.

NEFSC. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts, August4-8, 2008. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

NEFSC. 2011. 51st Northeast Regional Stock Assessment Workshop (51st SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-02; 856 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at https://repository.library.noaa.gov/view/noaa/3778.

NEFSC. 2014. 58th Northeast Regional Stock Assessment Workshop (58th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 14-04; 784 p.

NEFSC. 2022. Management Track Assessments Fall 2022. US Dept Commer, Northeast Fish Sci Cent Tech Memo. 305; 167p.+xv. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Nelson, L.N., W.D. McElroy, A.W. Jones, G.A. Maynard, C.T. Tholke, and A.J.M. Mercer. 2024. Taking the bait: Environmental factors affecting bait retention and hook disposition in the Gulf of Maine Bottom Longline Survey. Fish. Res. 273:106957. https://doi.org/10.1016/j.fishres.2024.106957.

Overholtz, W.J. and E.S Monteiro. 1976. A Synopsis of Groundfish Survey Cruises (Albatross III, Delaware I) 1948-1962. WH Lab Ref Doc. 76-13.

Politis P.J., J.K. Galbraith, P. Kostovick, and R.W. Brown. 2014. Northeast Fisheries Science Center bottom trawl survey protocols for the NOAA Ship Henry B. Bigelow. Northeast Fish Sci Cent Ref Doc. 14-06. http://doi.org/10.7289/V5C53HVS.

Rago, P.J., K.A. Sosebee, J.K.T. Brodziak, S.A. Murawski, and E.D. Anderson. 1998. Implications of recent increases in catches on the dynamics of Northwest Atlantic spinydogfish (*Squalus acanthias*). Fish Res. 39:165-181.

Riley S.J., S.D. DeGloria, and R. Elliot. 1999. A terrain ruggedness index that quantifies topographic heterogeneity. Intermt. J. Sci. 5:23–27.

Sosebee, K.A. and S.X. Cadrin. 2006. A Historical Perspective on the Abundance and Biomass of Northeast Demersal Complex Stocks from NMFS and Massachusetts Inshore Bottom Trawl Surveys, 1963-2002. U.S. Dep. Commer., Northeast Fish. Sci. Cent. Ref. Doc. 06-05; 200 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Sissenwine, M.P. and E.W. Bowman. 1978. An analysis of some factors affecting the catchability of fish by bottom trawls. ICNAF Res Bull. 13:81-87.

Smith, T, D. 2002. The Woods Hole bottom-trawl resource survey: development of fisheries-independent multispecies monitoring. - ICES Mar. Sci. Symp. 215:474-482.

Survey Working Group, Northeast Fisheries Center. 1988. An Evaluation of the Bottom Trawl Survey Program of the Northeast Fisheries Center. NMFS-F/NEC-52.

Table 1. Number of stations successfully completed by stratum for the fall bottom trawl survey from 2014- 2023. No survey conducted in 2020 due to COVID-19.

	Offshore Stations North of Cape Hatteras															
Stratum	01010	01020	01030	01040	01050	01060	01070	01080	01090	01100	01110	01120	01130	01140	01150	01160
Depth Range (m)	27-55	55-110	110-183	183-366	27-55	55-110	110-183	183-366	27-55	55-110	110-183	183-366	55-110	110-183	183-366	55-110
2014	7	8	4	3	5	8	4	3	5	8	4	3	10	4	3	14
2015	7	8	4	3	5	8	4	3	5	8	4	3	10	4	3	14
2016	7	9	4	3	4	7	4	3	5	9	4	3	10	4	3	14
2017													10	4	3	11
2018	7	8	4	3	5	8	4	3	5	8	4	3	10	4	3	12
2019	7	8	4	3	5	9	4	3	5	9	4	2	10	4	2	14
2020																
2021	7	8	4	3	5	8	4	3	4	9	4	3	10	5	3	14
2022	6	7	3	2	4	7	3	3	4	9	3	2	7	3	3	10
2023	7	8	4	3	4	8	4	3	5	7	4	3	7	3	2	11

	Offshore Stations North of Cape Hatteras															
Year	01170	01180	01190	01200	01210	01220	01230	01240	01250	01260	01270	01280	01290	01300	01340	01351
Depth Range (m)	110-183	183-366	27-55	27-55	55-110	110-183	55-110	110-183	27-55	55-110	110-183	183-366	183-366	183-366	110-183	110-183
2014	4	4	9	5	4	4	6	8	2	6	5	7	9	2	6	3
2015	4	4	9	6	4	4	5	9	2	6	5	7	10	3	7	4
2016	4	4	9	6	5	4	6	8	4	6	5	7	11	3	7	4
2017	4	4	7	5	4	5	4	6	3	7	3	4	11	3	5	3
2018	3	2	8	5	3	3	6	8	3	6	5	7	7			
2019	4	4	8	5	4	5	6	6	2	4	5	6	10	2	6	3
2020																
2021	4	4	9	7	4	4	5	8	2	5	4	6	8	3	7	4
2022	4	4	7	4	3	4	5	5	2	3	3	4	6	2	5	3
2023	3	3	6	8	4	4	6	7	3	5	4	6	9	3	5	2

Table 1. continued.

	Offshore Stations North of Cape Hatteras															
Year	01360	01370	01380	01390	01400	01610	01620	01630	01640	01650	01660	01670	01680	01690	01700	01710
Depth Range (m)	183-366	110-183	110-183	55-110	55-110	27-55	55-110	110-183	183-366	27-55	55-110	110-183	183-366	27-55	55-110	110-183
2014	9	7	8	2	3	5	3	3	3	7	3	3	3	7	5	3
2015	12	7	8	5	3	5	3	3	2	7	3	3	2	7	5	3
2016	12	7	8	4	3	5	3	3	3	7	3	3	3	7	5	3
2017	8	7	6	3	4											
2018	1	5	4	2	2	5	3	3	2	6	3	3	3	5	5	3
2019	10	5	6	2	3	5	3	3	2	7	3	3	3	7	5	3
2020																
2021	10	7	7	2	3	5	3	4	3	7	3	3	3	7	5	3
2022	7	5	4	2	2	5	3	3	2	7	3	3	3	7	5	3
2023	8	6	6	2	3	4	3	3	3	7	3	3	3	7	5	3

Table 1. continued.

	Offshore Stations North of Cape Hatteras					Inshore Stations North of Cape Hatteras										
Year	01720	01730	01740	01750	01760	03020	03050	03080	03110	03140	03170	03200	03230	03260	03290	03320
Depth Range (m)	183-366	27-55	55-110	110-183	183-366	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27
2014	3	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2015	3	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2016	3	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2017																
2018	3	6	5	3	3	3	3	3	3	3	3	5	3	2	2	2
2019	3	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2020																
2021	3	6	5	3	2	2	3	3	3	3	3	4	3	3	3	3
2022	3	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2023	3	6	5	3	3	3	3	2	3	3	3	4	3	3	3	3

Table 1. continued.

	Inshore Stations North of Cape Hatteras												
Year	03350	03380	03410	03440	03450	03460	03560	03590	03600	03610	03640	03650	03660
Depth Range (m)	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	27-41	41-55	18-27	27-41	41-55
2014	3	3	5	4	3	3	2	3	3	3	2	3	3
2015	3	3	5	4	3	3	2	3	3	3	3	4	3
2016	3	3	5	4	3	4	5	3	3	3	3	3	3
2017							1	1	3	3			
2018	2	2	2	4	2	4	3	2	3	3	2	3	3
2019	3	3	5	4	3	4	2	3	4	3	2	2	2
2020													
2021	3	3	5	4	3	4	2	2	2	3	2	2	2
2022	3	3	5	4	3	3	2	3	3	2	2	2	2
2023	3	3	5	3	3	4	2	2	2	3	2	2	2

Table 1. continued.

	Stations South of Cape Hatteras (07 = inshore, 08 = offshore)				
Year	07520	08500	8510	8520	08530
Depth Range (m)	18-27	27-55	55-110	110-183	183-366
2014	2	3	3	3	3
2015	2	3	3	3	3
2016	2	3	3	3	3
2017					
2018	2	3	2	2	2
2019	2	3	3	3	3
2020					
2021	2	3	3	3	3
2022	2	3	3	3	2
2023	2	3	3	3	3

Table 2. Number of stations successfully completed by stratum for the spring bottom trawl survey from 2014-2023.

	Offshore Stations North of Cape Hatteras															
Stratum	01010	01020	01030	01040	01050	01060	01070	01080	01090	01100	01110	01120	01130	01140	01150	01160
Depth Range (m)	27-55	55-110	110-183	183-366	27-55	55-110	110-183	183-366	27-55	55-110	110-182	182-366	55-110	110-182	182-366	55-110
2014	6	8	4	3	5	8	4	3	5	9	4	2	8	3	2	12
2015	7	8	4	3	5	8	4	3	5	8	4	3	10	4	3	16
2016	7	8	4	3	5	7	3	3	5	9	3	2	10	3	2	14
2017	7	8	4	3	6	8	4	4	5	10	4	3	11	4	3	16
2018	6	4	3	3	4	6	3	3	3	5	3	3	5	3	2	11
2019	7	8	4	3	5	8	4	4	5	10	4	3	10	4	3	14
2020	5	3	2	2												
2021	7	7	3	3	5	8	3	3	5	8	3	3	8	3	3	14
2022	7	8	4	3	5	7	4	3	5	9	4	3	10	4	2	14
2023													10	3	3	13

Table 2. Cont.

	Offshore Stations North of Cape Hatteras															
Stratum	01170	01180	01190	01200	01210	01220	01230	01240	01250	01260	01270	01280	01290	01300	01340	01351
Depth Range (m)	110-182	182-366	27-55	27-55	55-110	110-182	55-110	110-182	27-55	55-110	110-182	182-366	182-366	182-366	110-182	110-182
2014	4	3	8	4	4	4	4	6	3	6	5	7	8	2	6	4
2015	4	3	8	6	4	4	6	8	4	6	5	7	10	3	7	4
2016	4	4	9	6	4	4	5	8	4	6	5	7	10	3	7	4
2017	4	4	9	8	4	4	7	7	6	5	5	6	11	3	7	4
2018	4	3	5	2	4	4	3	4	2	3	3	2	4	2	2	2
2019	4	4	8	6	4	4	6	8	2	5	5	7	10	3	6	4
2020																
2021	4	4	8	6	4	4	6	8	2	5	5	7	10	3	6	3
2022	4	4	9	6	4	4	6	8	3	5	5	6	8	2	6	4
2023	4	3	9	5	4	4	5	4	3							

Table 2. Cont.

	Offshore Stations North of Cape Hatteras															
Stratum	01360	01370	01380	01390	01400	01610	01620	01630	01640	01650	01660	01670	01680	01690	01700	01710
Depth Range (m)	182-366	110-182	110-182	55-110	55-110	27-55	55-110	110-182	182-366	27-55	55-110	110-182	182-366	27-55	55-110	110-182
2014	10	7	8	5	3									7	5	3
2015	12	7	8	5	3	5	3	3	2	7	3	3	3	7	5	3
2016	12	7	8	5	3	5	2	1	2	7	3	3	3	7	5	3
2017	9	6	5	3	2	5	3	3	3	8	3	3	3	7	5	3
2018	6	3	3	2	2	5	3	2	3	7	2	3	2	5	5	3
2019	12	7	8	3	2	5	3	3	2	7	3	3	2	7	5	3
2020						5	3	3	3	7	3	3	3	7	6	3
2021	11	7	8	3	3					6	2	2	2	7	3	3
2022	12	7	8	4	2	5	3	3	3	7	3	3	3	7	5	3
2023																

Table 2. Cont.

	Offshore Stations North of Cape Hatteras										Inshore Stations North of Cape Hatteras					
Year	01720	01730	01740	01750	01760	03020	03050	03080	03110	03140	03170	03200	03230	03260	03290	03320
Depth Range (m)	182-366	27-55	55-110	110-182	182-366	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27
2014	3	5	5	3	3	2	3	3	3	2	3	4	3	2	3	
2015	2	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2016	3	6	5	3	3	2	2	2	2	3	3	4	3	3	3	2
2017	3	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2018	3	3	4	3	3	3	3	3	3	3	3	4	3	3	3	3
2019	2	6	5	2	3	3	3	3	3	2	3	4	3	3	3	3
2020	3	6	5	3	3				3	3	3	4	3	3	3	3
2021	3	6	4	3	3	3	3	3	3	3	3	3	3	3	3	3
2022	3	6	5	3	3	3	3	3	3	3	3	4	3	3	3	3
2023																

Table 2. Cont.

	Inshore Stations North of Cape Hatteras												
Year	03350	03380	03410	03440	03450	03460	03560	03590	03600	03610	03640	03650	03660
Depth Range (m)	18-27	18-27	18-27	18-27	18-27	18-27	18-27	18-27	27-41	41-55	18-27	27-41	41-55
2014					3	4	2	3	3	3	3	3	3
2015	3	3	5	3	3	4	3	3	3	3	3	3	3
2016	3	3	4	3	2	3	2	3	3	3	3	3	3
2017	3	3	5	5	4	4	3	4	3	3	3	4	3
2018	3	3	5	4	2	2	2	2	3	2	2	2	2
2019	3	3	5	4	3	4	2	3	3	3	2	3	3
2020	3	3	5	4									
2021	3	3			3	3	3	3	3	3	3	3	3
2022	3	3	5	4	3	3	2	3	3	3	3	3	3
2023													

Table 2. Cont.

	Stations South of Cape Hatteras (07 = inshore, 08 = offshore)				
Year	07520	08500	08510	08520	08530
Depth Range (m)	18-27	27-55	55-110	110-183	183-366
2014					
2015	2	3	3	3	3
2016	2	2	2	2	2
2017	2	3	3	3	3
2018					
2019	2	2	2	2	2
2020	3	3	3	3	3
2021					
2022	2	3	3	3	3
2023					

Table 3. Number of stations successfully completed by stratum for the shrimp survey.

CRUISE	04010	04020	04030	04040	04050	04060	04070	04080	04090	04100	04110	04120
Depth Range (m)	50-191	46-93	54-178	30-180	152-287	69-217	122-267	8-233	154-228	81-237	144-244	94-196
2014	7	1	9		5	14	4	8	3	3		
2015	5		4		4	11	6	2		1		
2016	6	2	9	2	4	12	4	6	2	3		
2017	7		10		6	9	6	7		3		
2018	8		10		3	7		3		2		
2019	6	2	10	2	6	14	6	8	2	4		
2020												
2021	5		8		4	10	4	6		3		
2022	5		8		4	10	4	6		3		
2023	7	2	10	2	6	12	6	8	4	5		

Table 4. Northeast Fisheries Science Center Gulf of Maine bottom longline survey station target numbers by bottom type sub-strata, year, and strata.

Rough Strata	2014 – 2016	2017 – 2023	Smooth Strata	2014 – 2016	New Smooth	2017 – 2023
26	5	5	26	2	2627	2
27	5	5	27	2	2837	3
28	5	7	28	2	2936	2
29	6	7	29	2		
36	6	6	36	2		
37	6	8	37	2		
Total	33	38		12		7

Table 5. Northeast Fisheries Science Center Gulf of Maine bottom longline survey station counts by year, season, and bottom type for representative sets used for indices of abundance and biomass. BLLS sampled 45 stations per season, except for no survey in spring 2020.

	Spring				Fall		
Year	Rough	Smooth	Combined		Rough	Smooth	Combined
2014	33	12	45		33	12	45
2015	33	12	45		33	12	45
2016	33	12	45		33	12	45
2017	38	7	45		36	7	43
2018	38	7	45		38	7	45
2019	38	7	45		38	7	45
2020	0	0	0		36	7	43
2021	38	7	45		37	7	44
2022	38	7	45		38	7	45
2023	38	7	45		37	7	44

Table 6. Bottom trawl survey strata sets and calibration factors used by stock.

Stock	Strata Set	Calibration Factors
Gulf of Maine haddock	0126-01280,01360-01400	Door, Vessel, HBB- Length-based
White hake	01210-01300, 01360-01400	HBB-Constant
Northern red hake	01200-01300, 01360- 01400	Door, Vessel, HBB- Length-based
Atlantic halibut	01130- 01300, 01360-01400	HBB-Constant
Atlantic wolfish	01090-01150, 01190-01200, 01230-01280, 01370-01400	HBB-Constant
Spiny dogfish	01010-01300, 01340, 01360-01400, 01610-01760, 03020, 03050, 03080, 03110, 03140, 03170, 03200, 03230, 03260, 03290, 03320, 03350, 03380, 03410, 03440-03460, 03560, 03590-03610, 03640-03660	Vessel, HBB-Constant
Thorny skate	01010-01300, 01340-01400	HBB-Constant

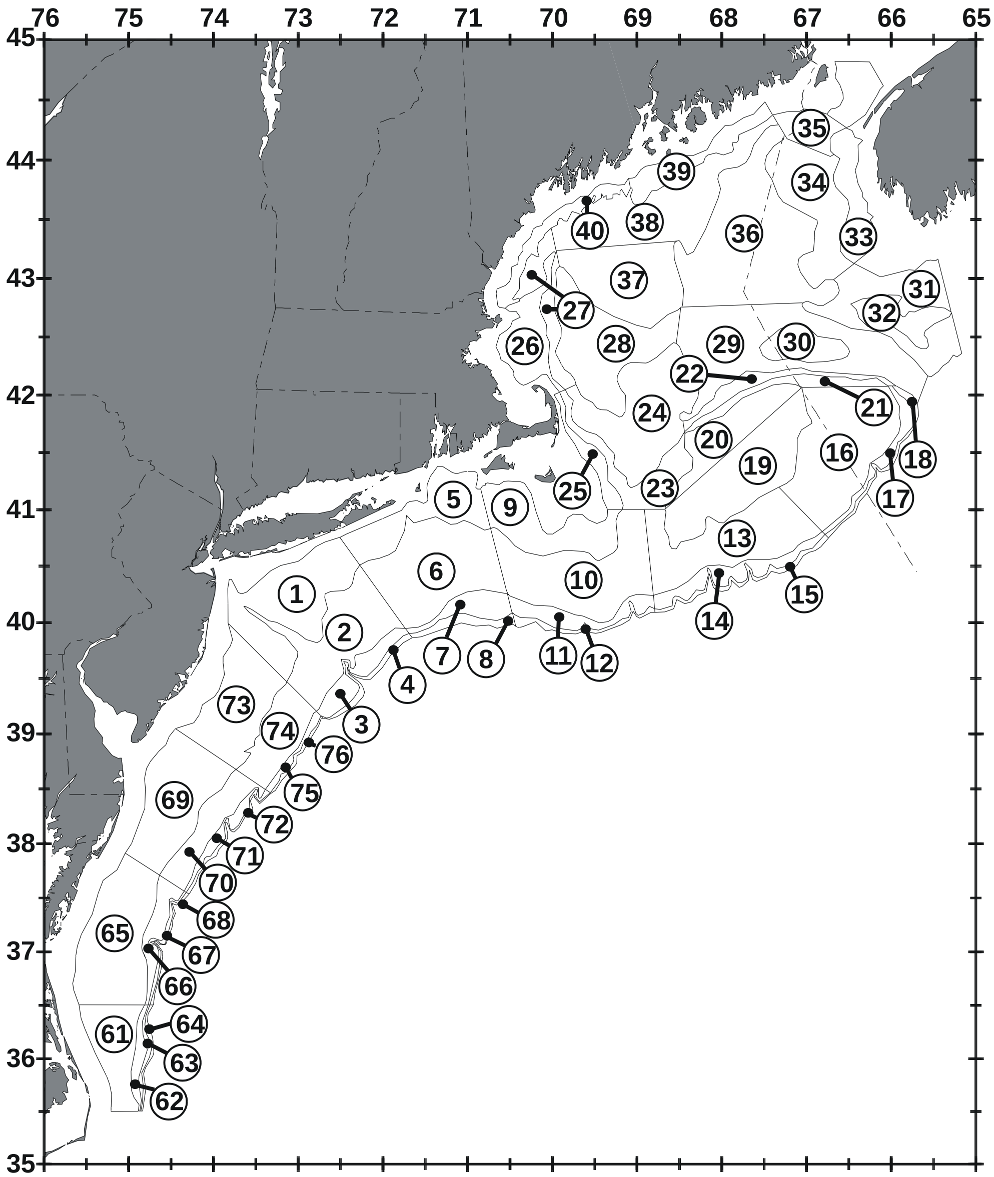

Figure 1. Map of offshore strata (01 code) for the fall and spring bottom trawl surveys.

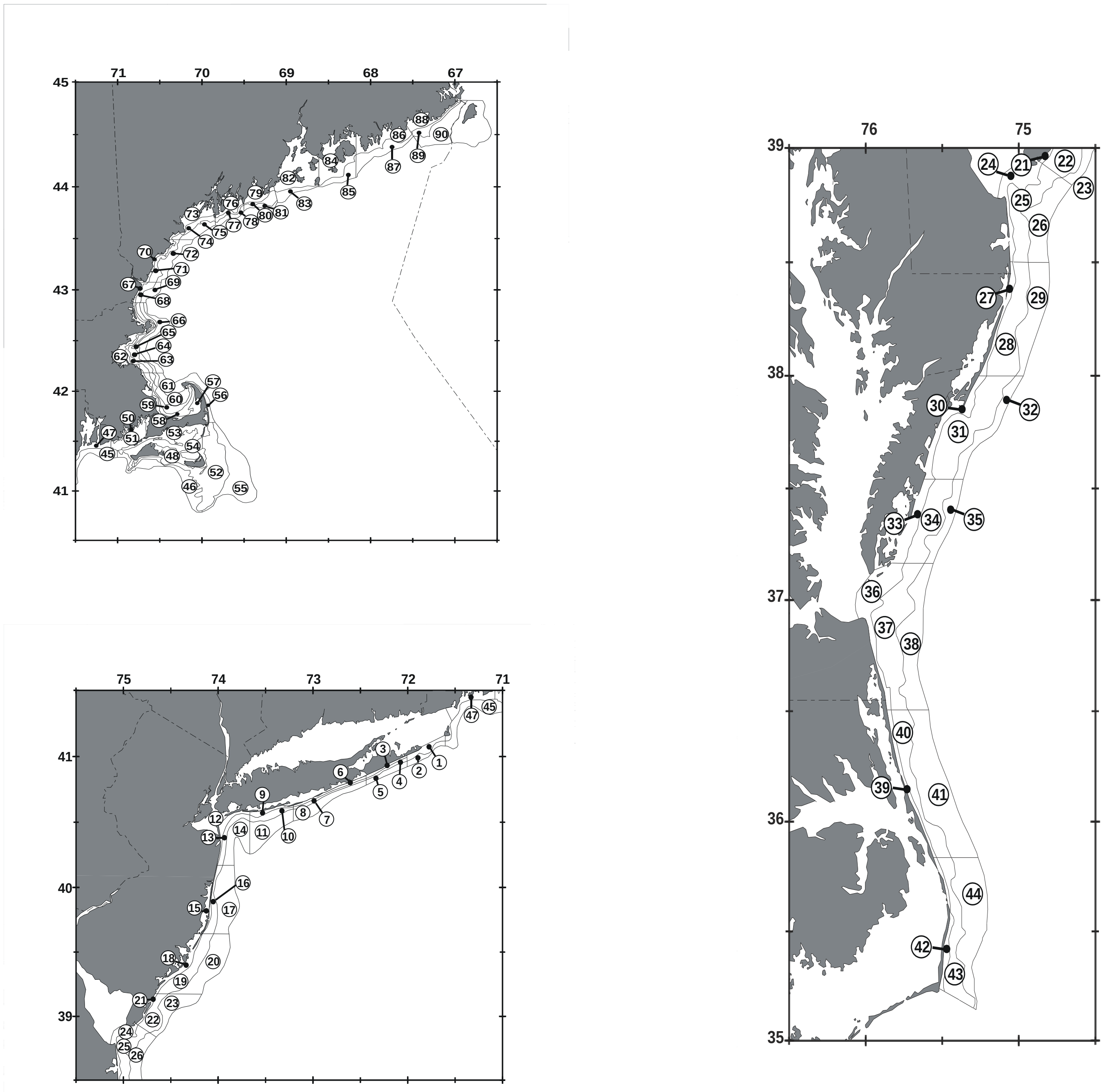

Figure 2. Map of inshore strata (03 code) for the fall and spring bottom trawl surveys.

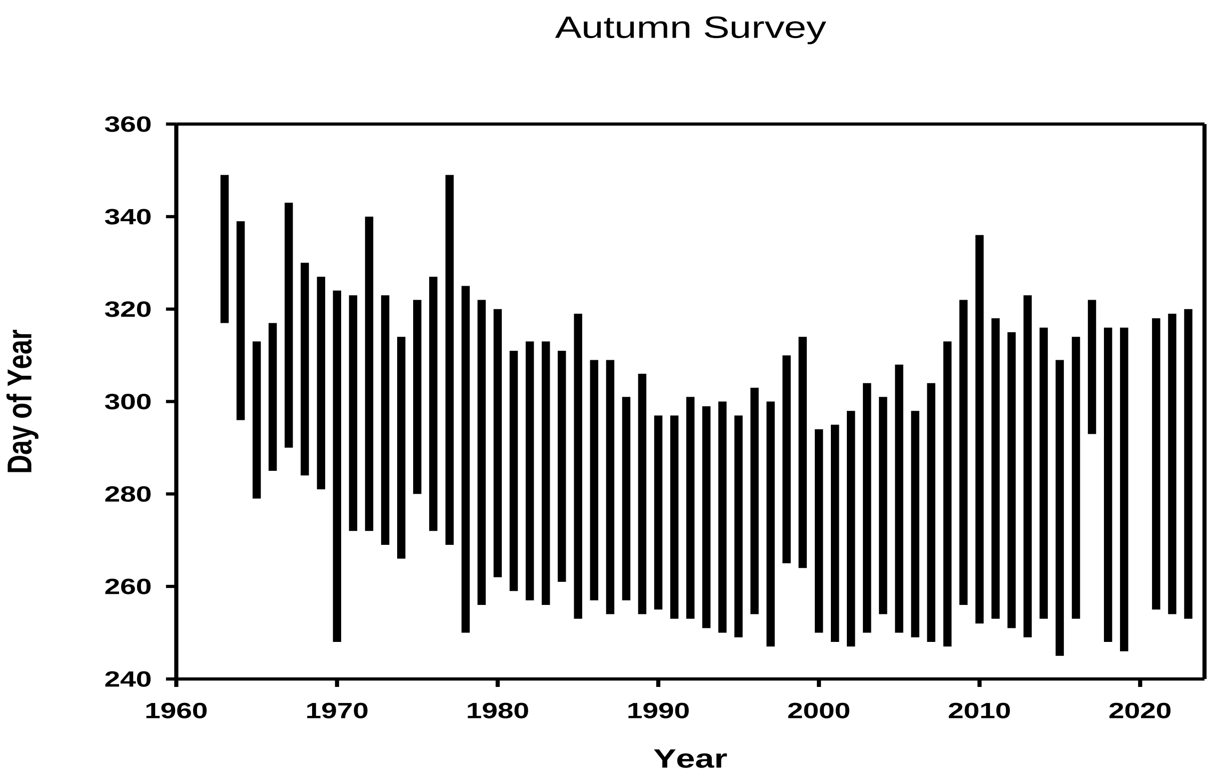

Figure 3. Timing of the fall bottom trawl survey from 1963-2023.

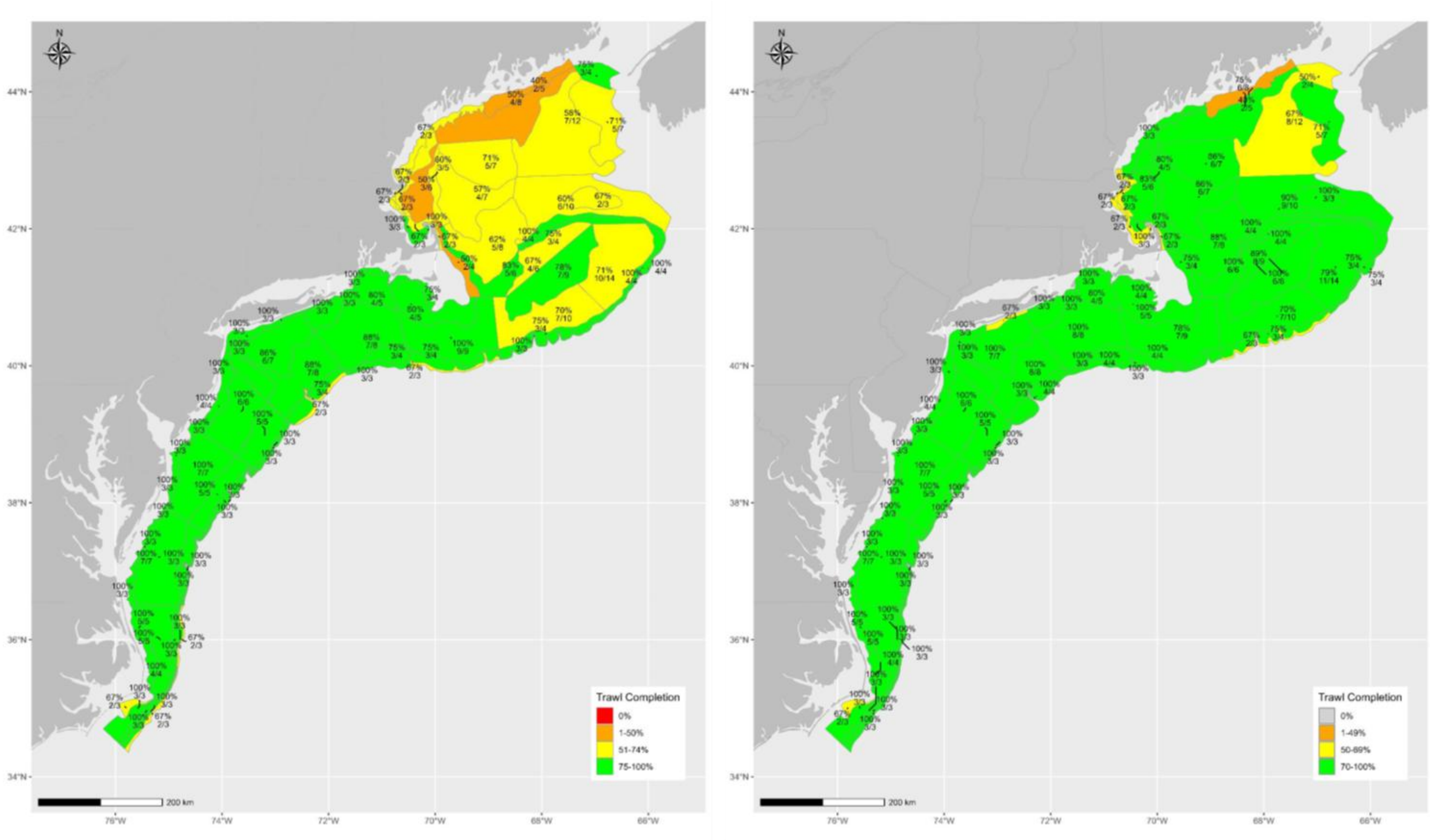

Figure 4. Coverage of the fall bottom trawl survey in 2022 (left panel) and 2023 (right panel).

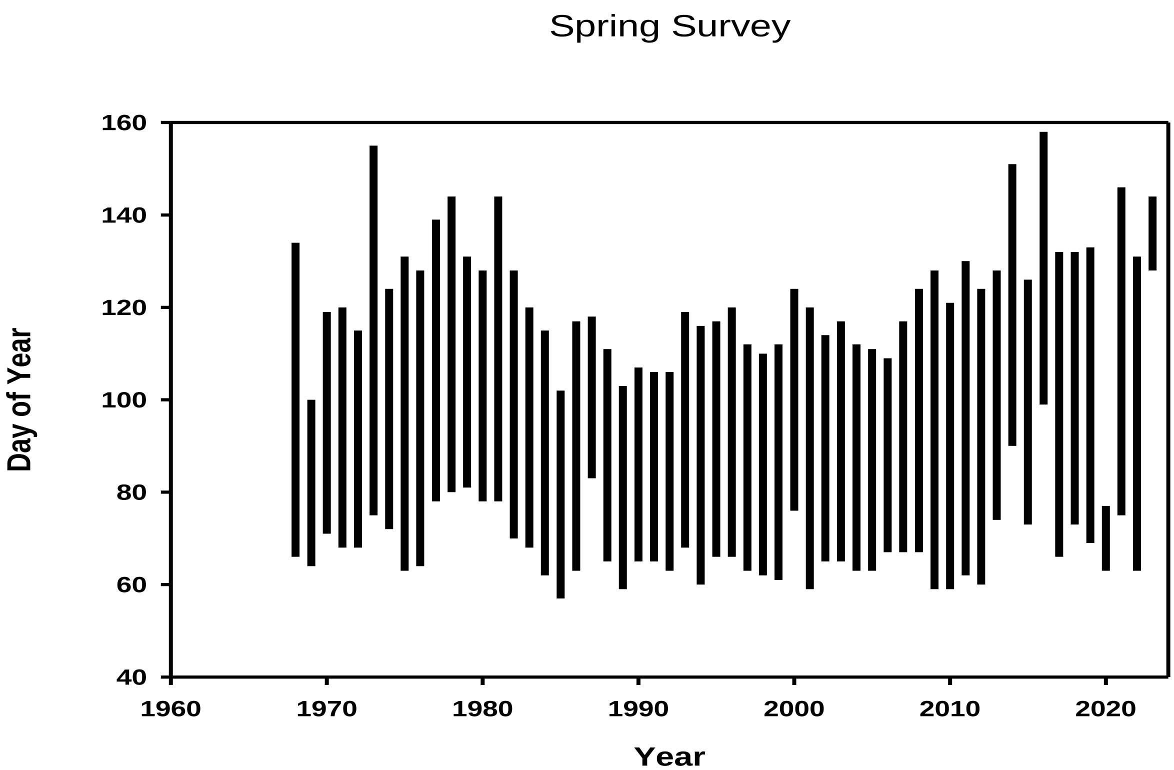

Figure 5. Timing of the spring bottom trawl survey from 1968-2023.

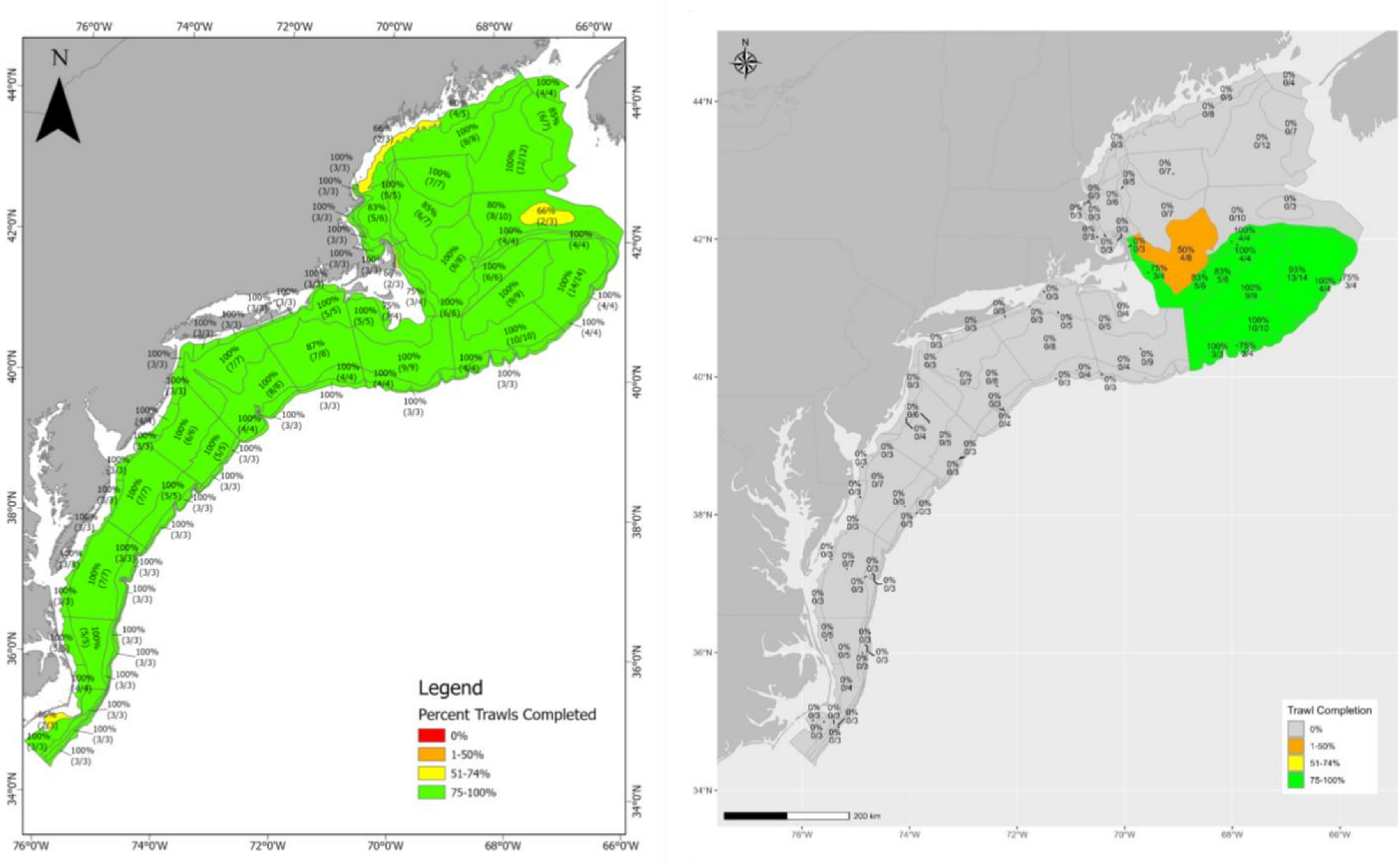

Figure 6. Coverage of the spring bottom trawl survey in 2022 (left panel) and 2023 (right panel).

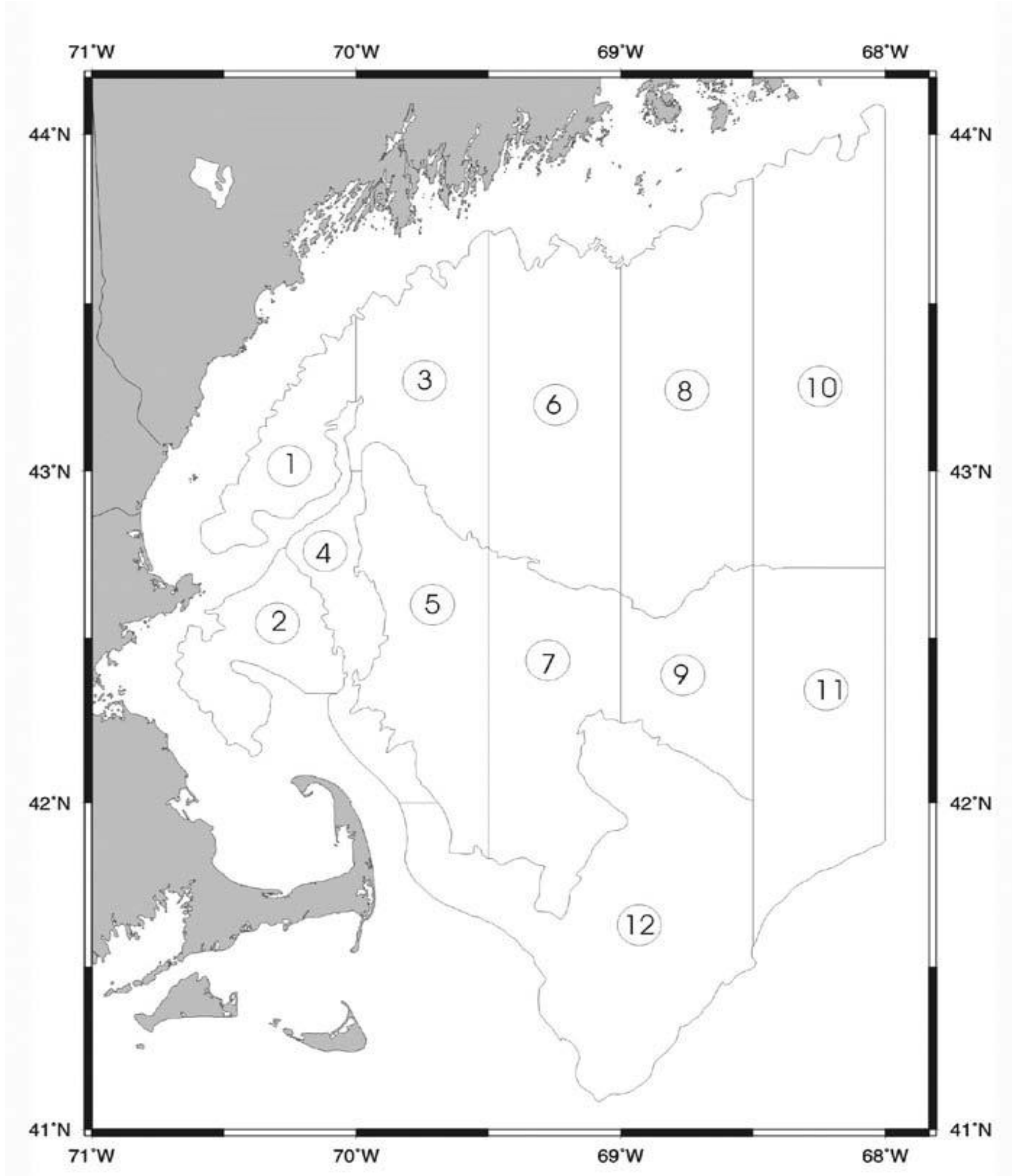

Figure 7. Strata used for the shrimp bottom trawl survey.

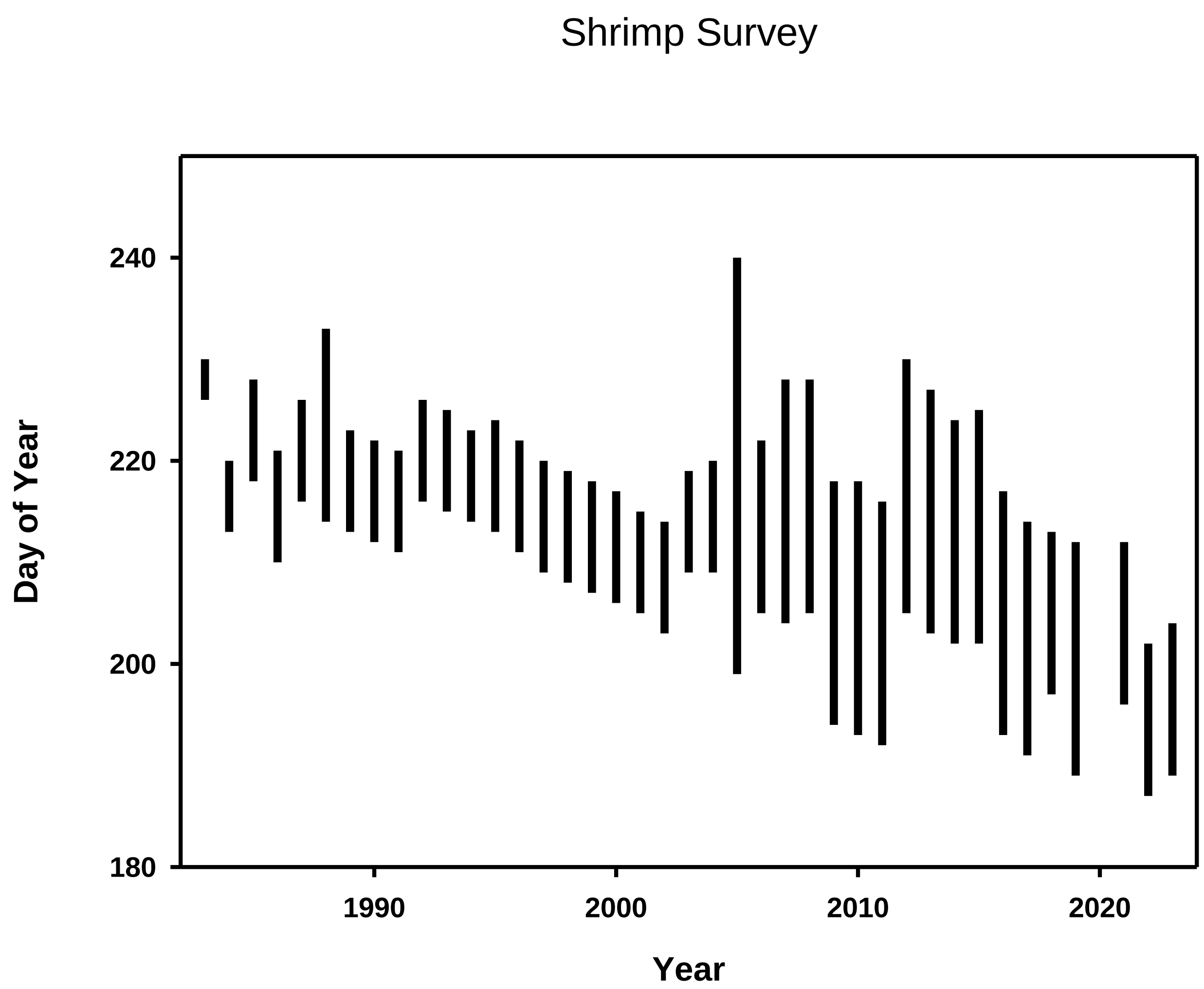

Figure 8. Timing of the shrimp bottom trawl survey from 1983-2023.

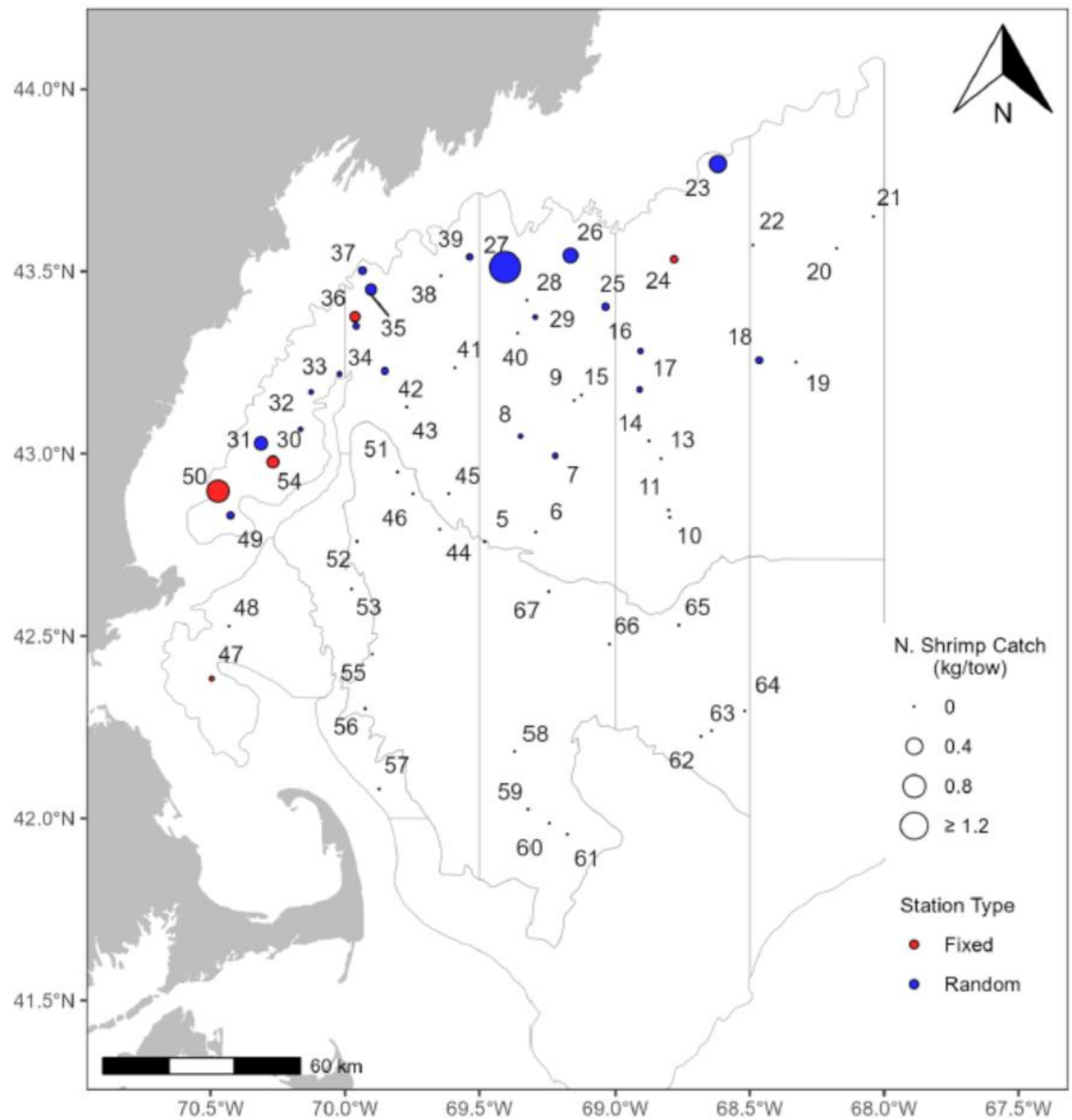

Figure 9. Stations sampled during the shrimp survey in 2023 (left panel) and 2023 (right panel). From Keith 2023.

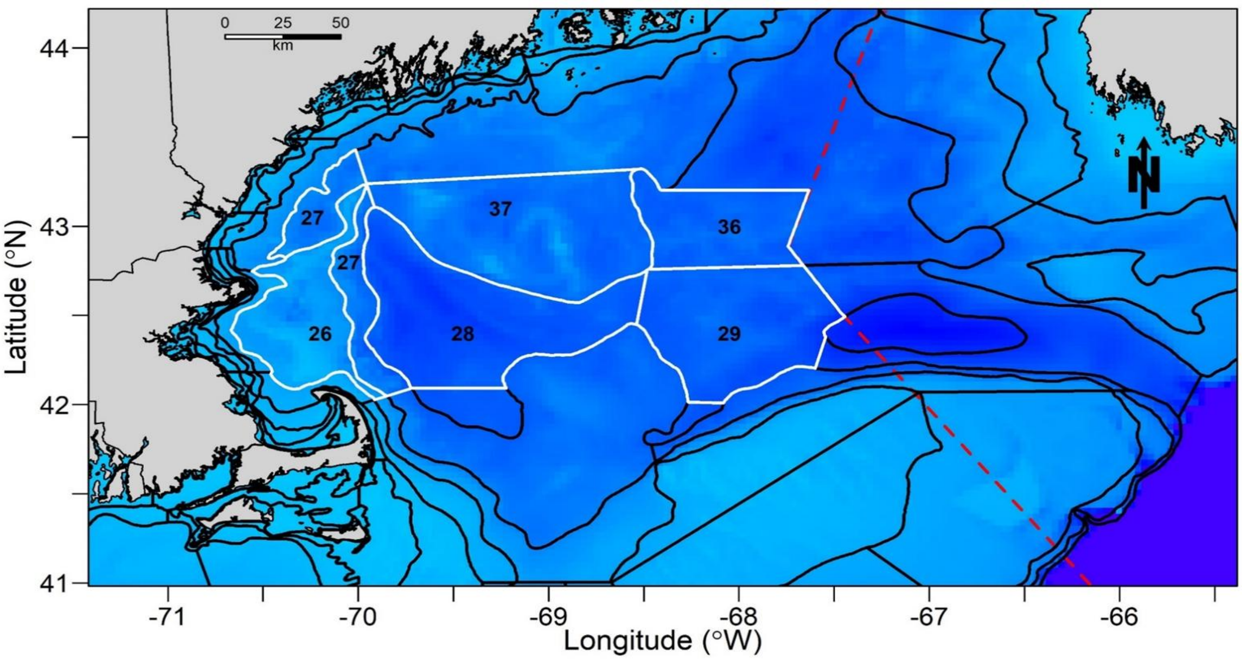

Figure 10. Map of the Northeast Fisheries Science Center (NEFSC) Gulf of Maine Bottom Longline Survey (BLLS) strata (white lines) and the NEFSC Bottom Trawl Survey (BTS) offshore strata (black lines). The BLLS strata included all of BTS strata 26, 27, and 37 and portions of BTS strata 28, 29, and 36. The red dashed line represents the Exclusive Economic Zone boundary.

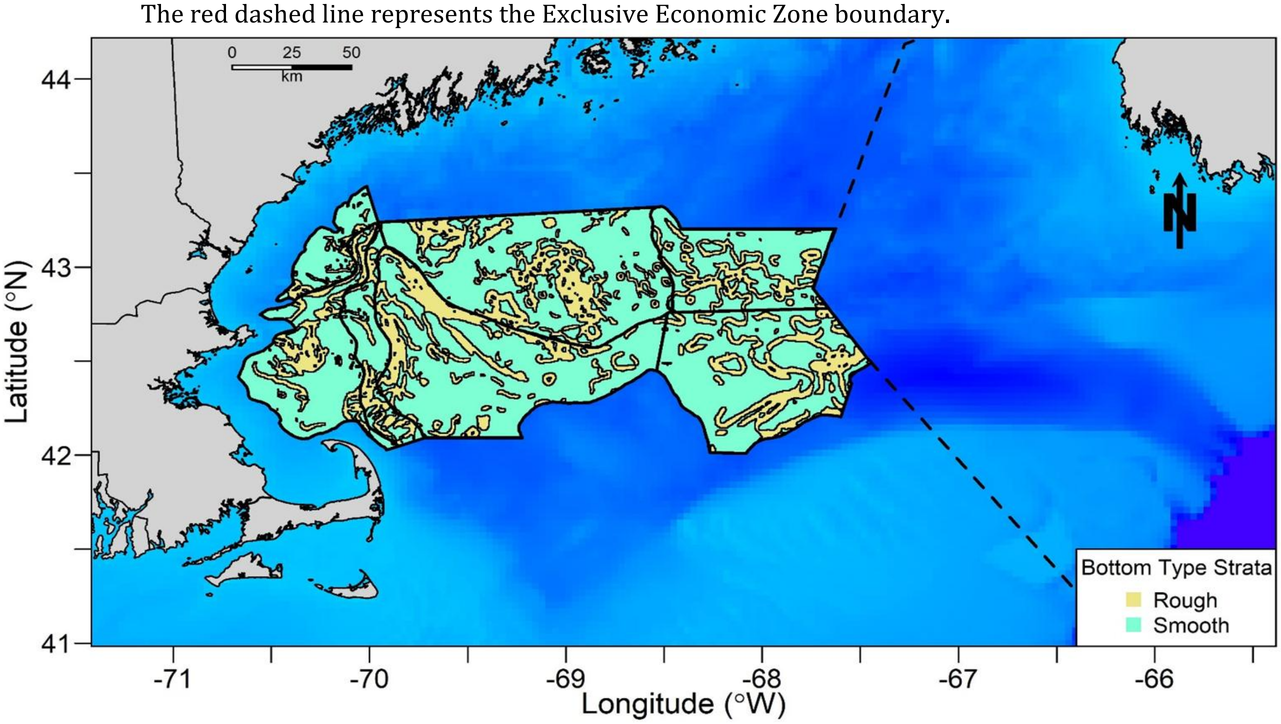

Figure 11. Map of the NEFSC Gulf of Maine Bottom Longline Survey (BLLS) strata (black lines). The BLLS strata were sub-stratified by rough (yellow) and smooth (green) bottom types based on rugosity. The black dashed line represents the Exclusive Economic Zone boundary.

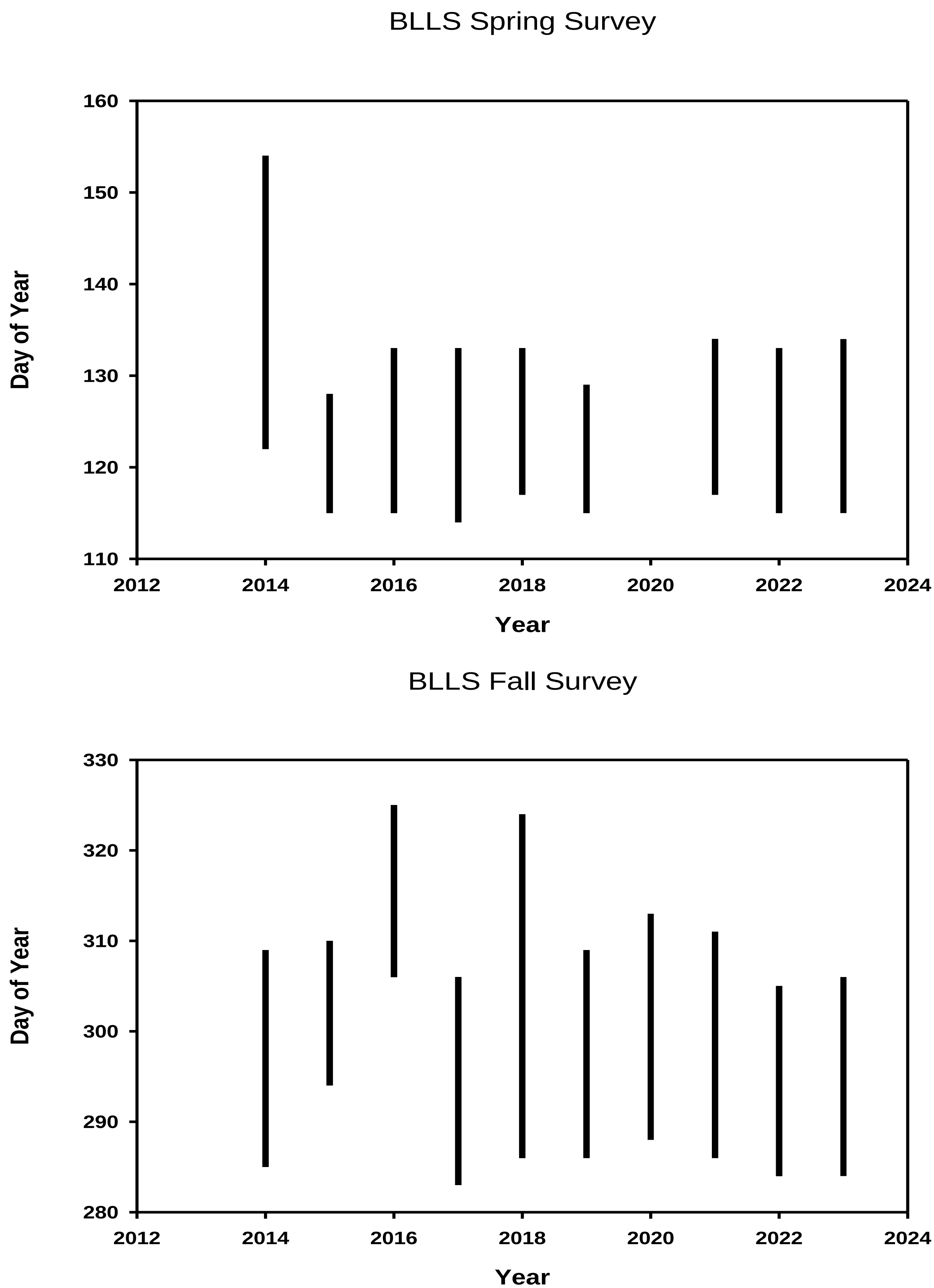

Figure 12. Timing of the BLLS for the spring (top panel) and the fall (bottom panel) from 2014-2023.

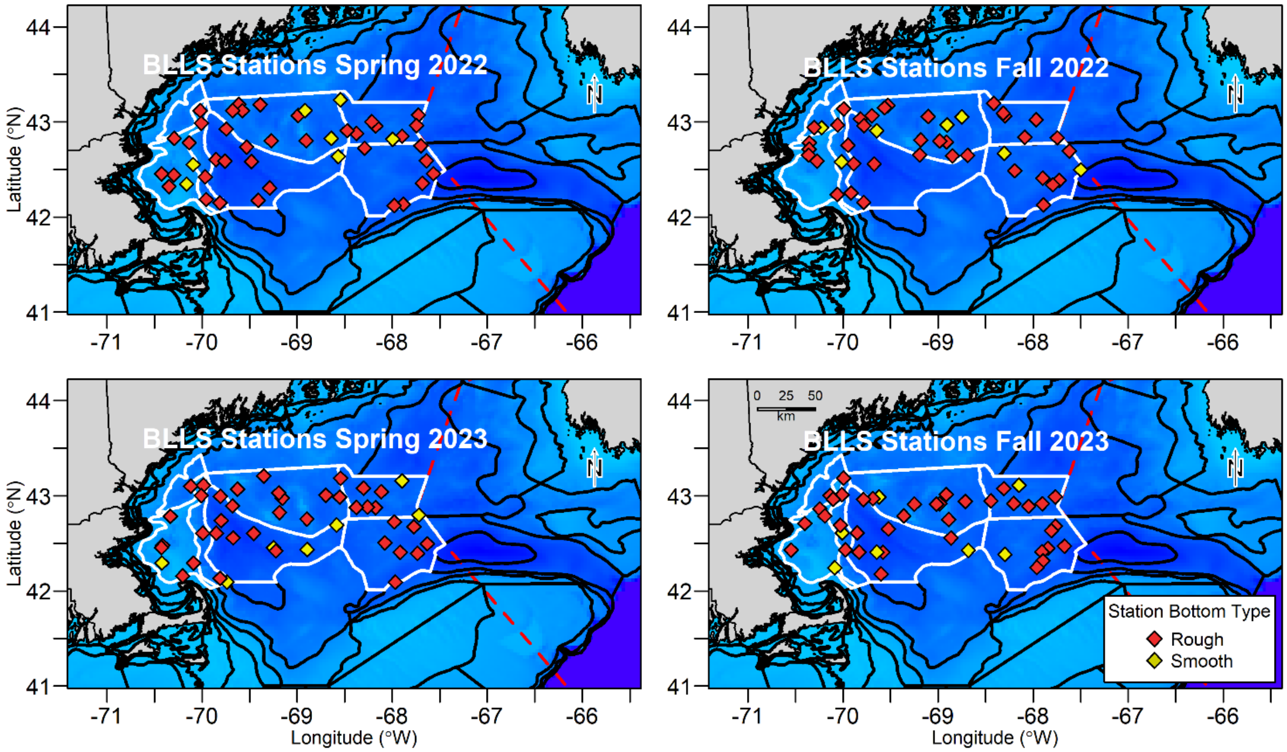

Figure 13. Map of the Northeast Fisheries Science Center (NEFSC) Gulf of Maine Bottom Longline Survey (BLLS) stations sampled (location for the end of each set) in the spring and fall of 2022-2023. The BLLS strata (white lines) and the NEFSC Bottom Trawl Survey (BTS) offshore strata (black lines) are shown with rough (red) and smooth (yellow) bottom types indicated. The red dashed line represents the Exclusive Economic Zone boundary.

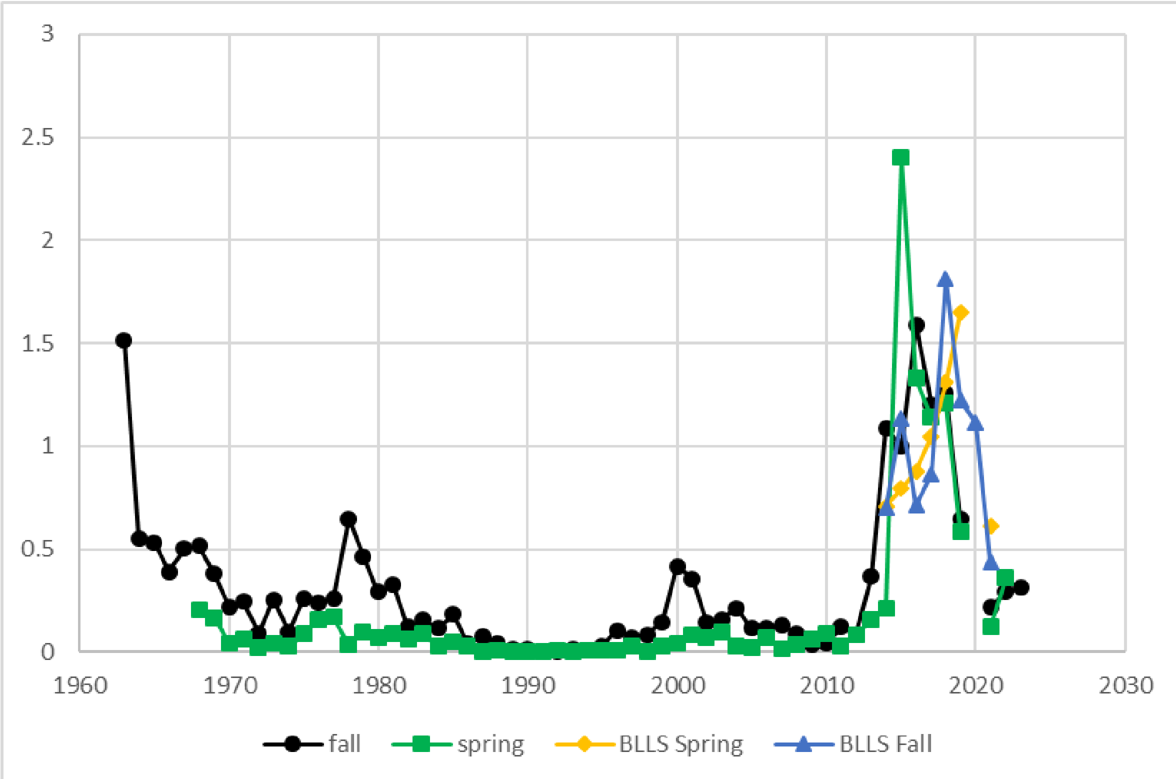

Figure 14. Survey indices from 1963-2023 for Gulf of Maine haddock for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2021 for each series since the bottom longline surveys were only calculated through 2021.

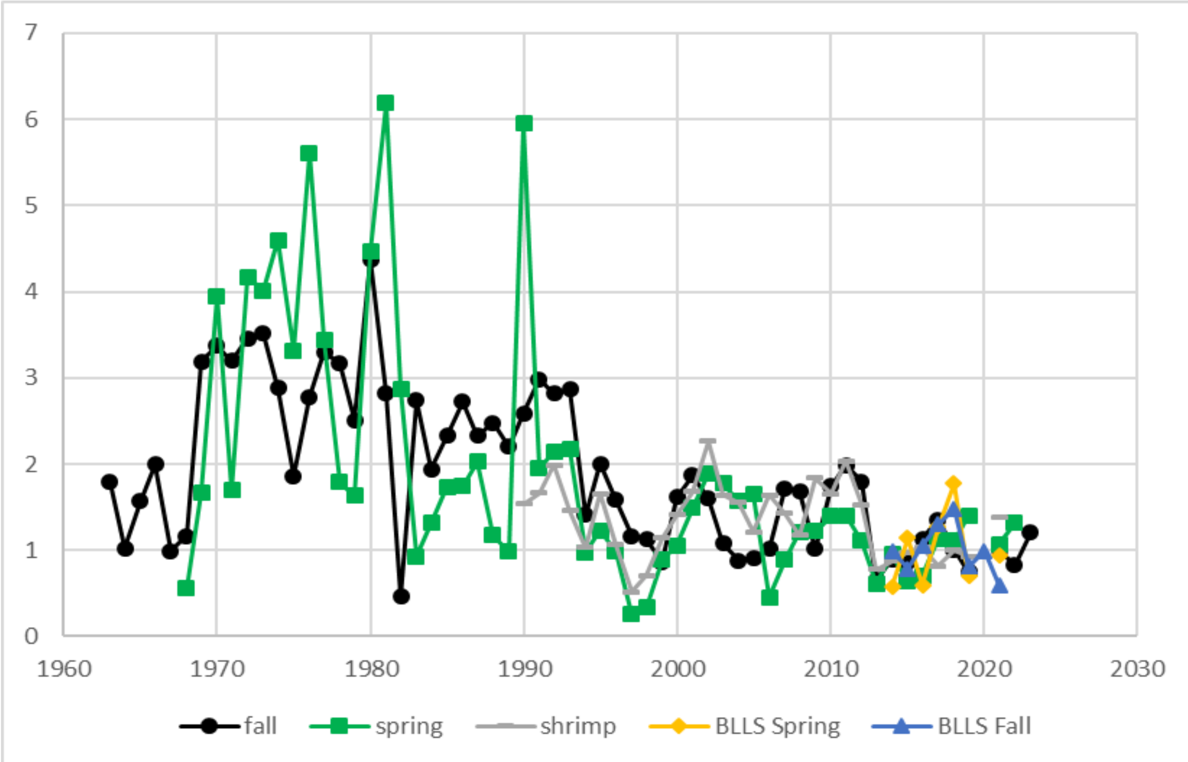

Figure 15. Survey indices from 1963-2023 for white hake for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), shrimp bottom trawl survey (grey dashes), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2021 for each series since the shrimp and the bottom longline surveys were only calculated through 2021.

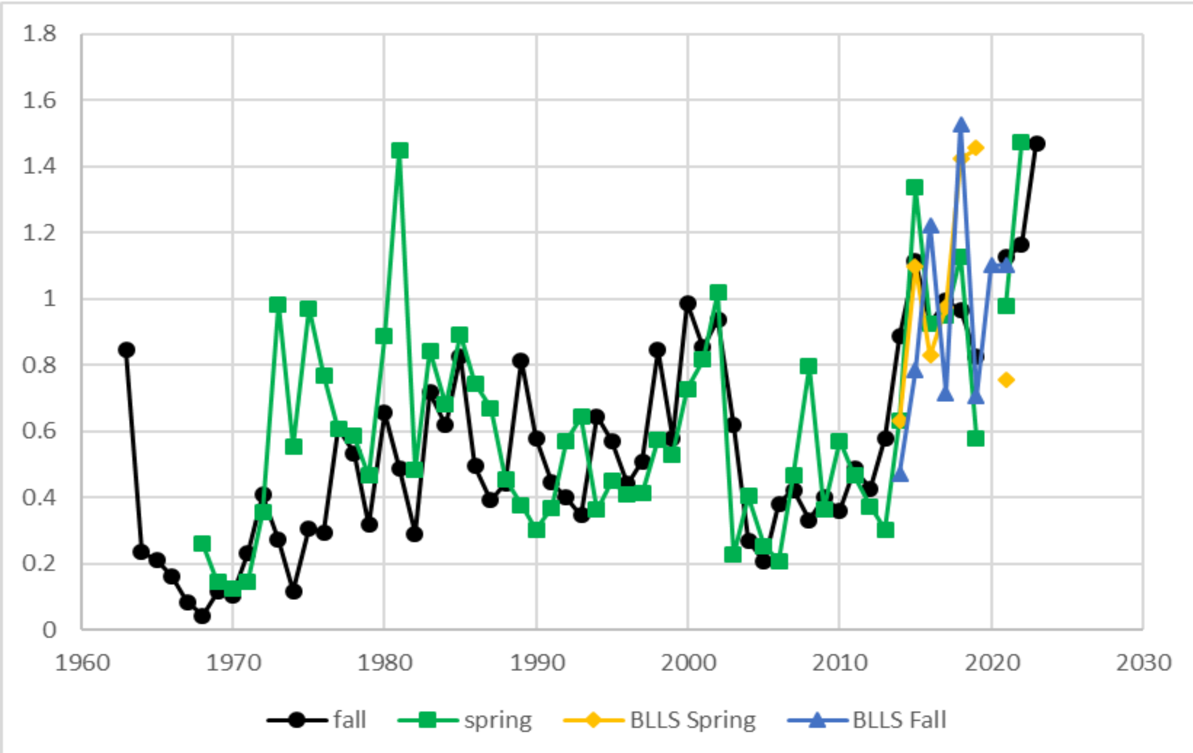

Figure 16. Survey indices from 1963-2023 for northern red hake for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2022 for each series since the spring bottom trawl survey and the bottom longline surveys were only calculated through 2022. Difference in spring 70s may be Yankee 41.

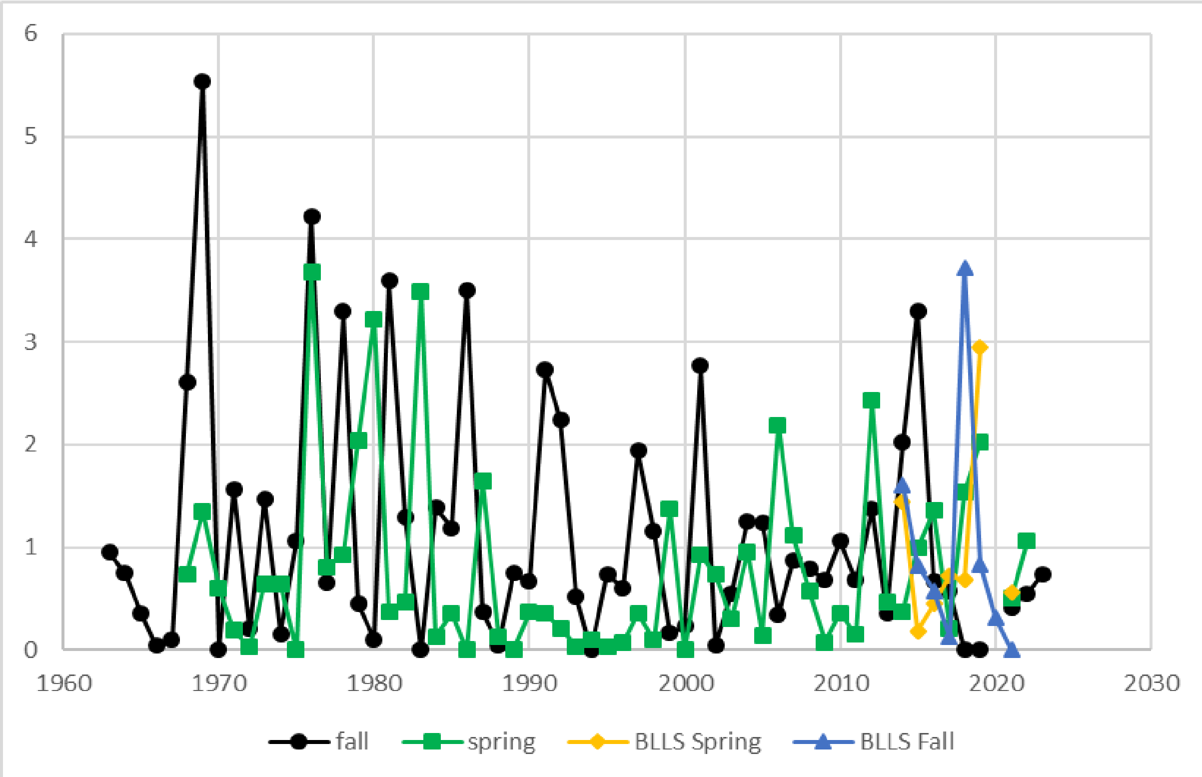

Figure 17. Survey indices from 1963-2023 for Atlantic halibut for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2022 for each series since the bottom longline surveys were only calculated through 2021.

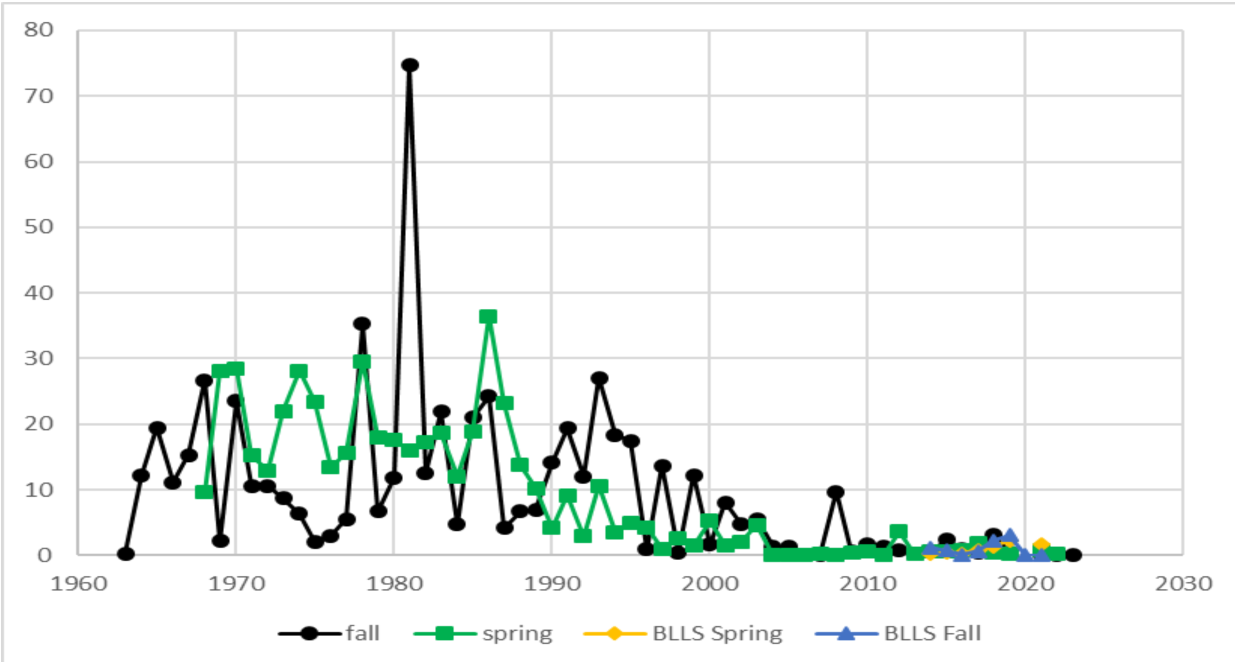

Figure 18. Survey indices from 1963-2023 for Atlantic wolffish for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2022 for each series since the bottom longline surveys were only calculated through 2021.

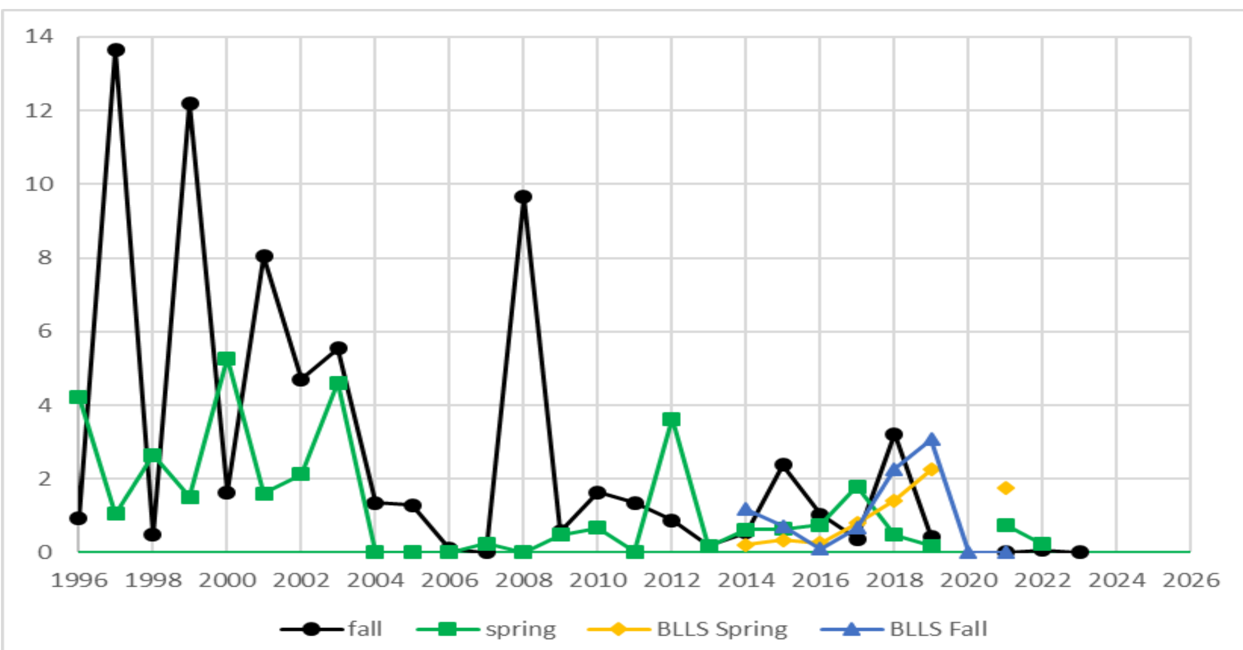

Figure 19. Survey indices from 1996-2023 for Atlantic wolffish for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2022 for each series since the bottom longline surveys were only calculated through 2021.

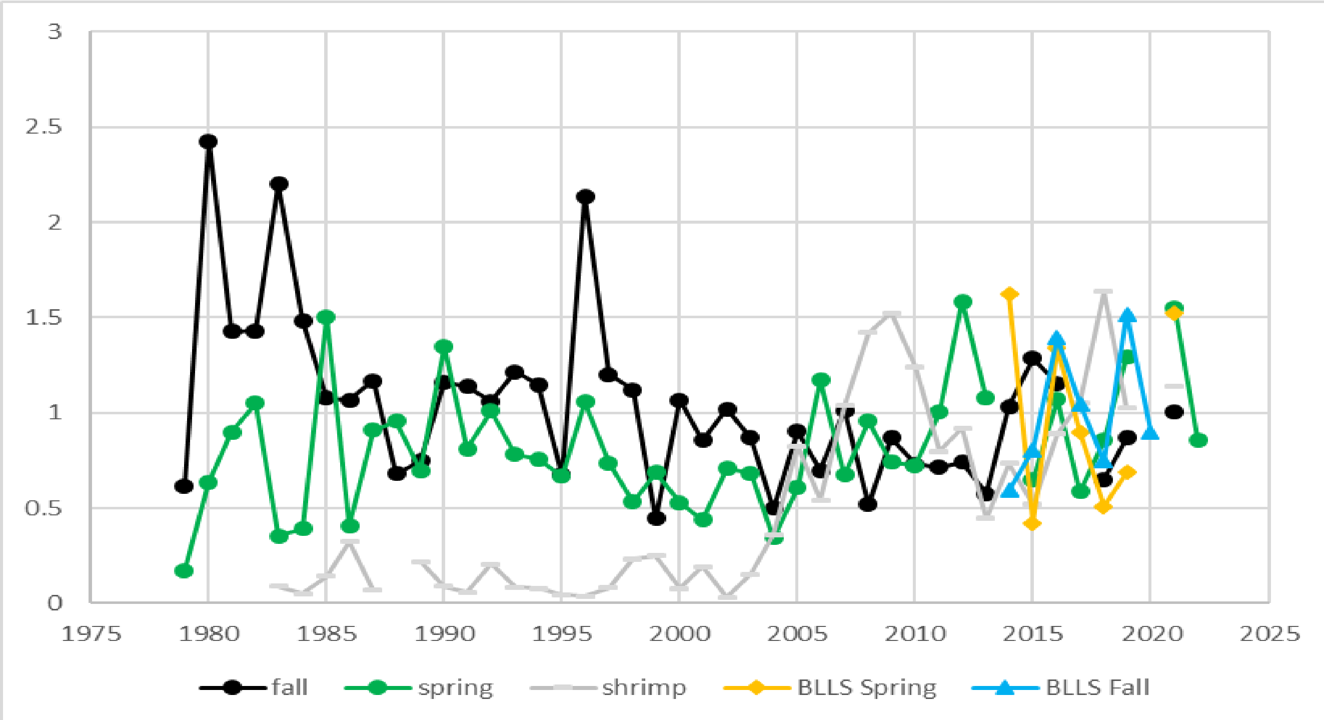

Figure 20. Survey indices from 1979-2023 for spiny dogfish for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), shrimp bottom trawl survey (grey dashes), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2021 for each series since the shrimp and the bottom longline surveys were only calculated through 2021.

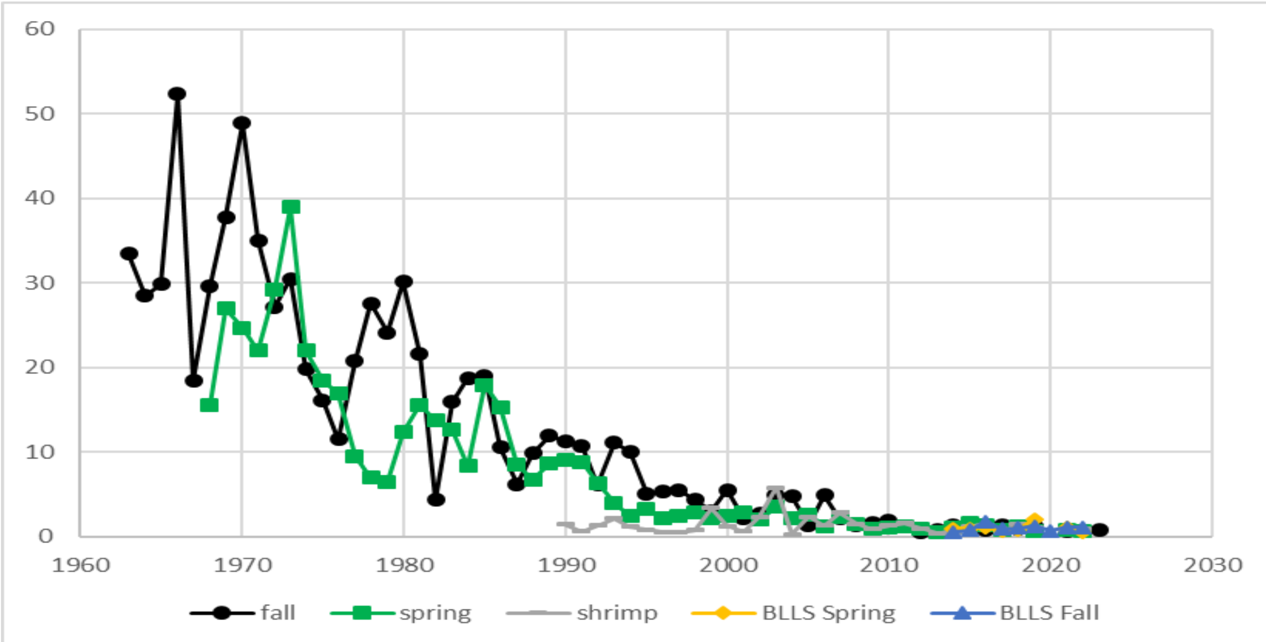

Figure 21. Survey indices from 1963-2023 for thorny skate for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), shrimp bottom trawl survey (grey dashes), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2022 for each series since the spring bottom trawl, the shrimp, and the bottom longline surveys were only calculated through 2022.

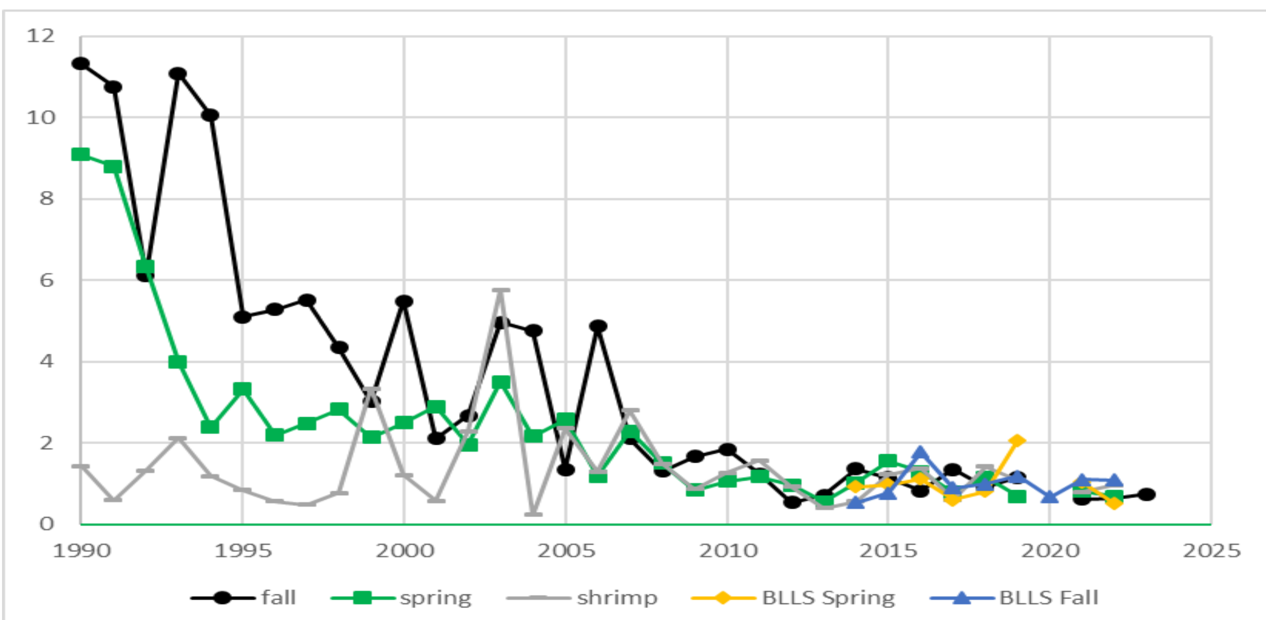

Figure 22. Survey indices from 1990-2023 for thorny skate for the United States fall bottom trawl (black circles), spring bottom trawl (green squares), shrimp bottom trawl survey (grey dashes), spring bottom longline survey (yellow diamonds) and fall bottom longline survey (blue triangles). The indices are normalized to the mean of 2014-2022 for each series since the spring bottom trawl, the shrimp, and the bottom longline surveys were only calculated through 2022.

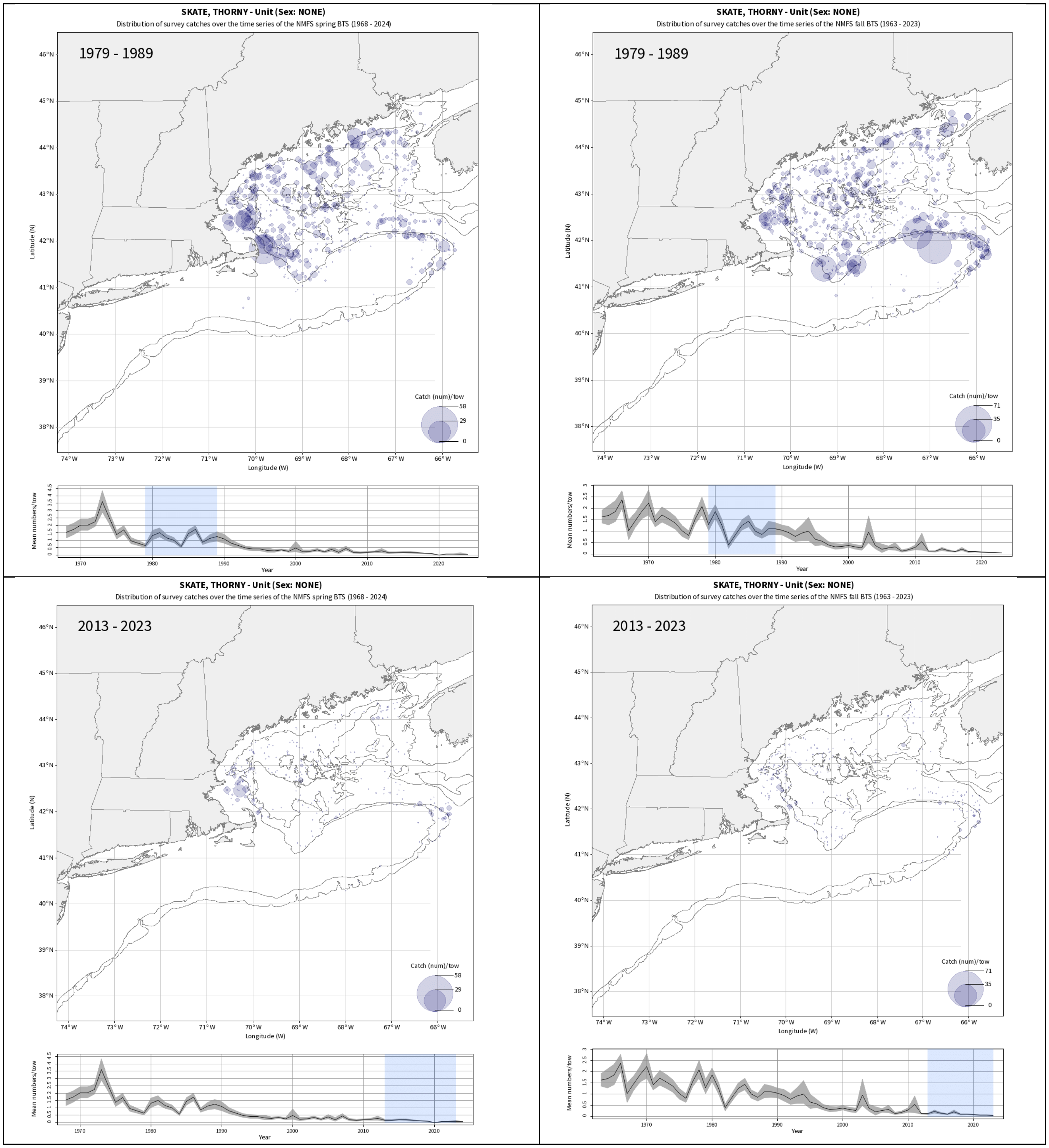

Figure 23. Distribution of thorny skate (*Amblyraja radiata*) from the Northeast Fisheries Science Center spring (left panels) and fall (right panels) bottom trawl surveys from 1979-1989 (top panels) and 2013-2023 (bottom panels).