NOAA Technical Memorandum NMFS-NE-249

Design, Implementation, and Results of a Cooperative Research Gulf of Maine Longline Survey, 2014-2017

US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts
June 2019

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Design, Implementation, and Results of a Cooperative Research Gulf of Maine Longline Survey, 2014-2017

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Information Quality Act Compliance: In accordance with section 515 of Public Law 106-554, the Northeast Fisheries Science Center completed both technical and policy reviews for this report. These predissemination reviews are on file at the NEFSC Editorial Office.

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ABSTRACT

In 2013, the National Cooperative Research Program accepted and funded the Northeast Fisheries Science Center's (NEFSC) Northeast Cooperative Research Branch to implement a bottom longline survey (LLS) in the western and central Gulf of Maine (GM). The objective of the proposed LLS was to increase sampling of several data-poor and depleted stocks specifically associated with rocky habitat, while also enhancing data collection for some data-rich stocks already seemingly well sampled on the bottom trawl survey (BTS). The LLS stratified random design was based on the NEFSC BTS stratification of depth and area, and this was further stratified by "rough" and "smooth" bottom type within the strata area to account for habitat. The survey area includes 6 BTS offshore strata: part of strata 28, 29, and 36 and all of strata 26, 27, and 37.

During 2014-2017, the survey sampled 45 station locations each spring (April-May) and fall (October-November), during the same seasonal period as the NEFSC research BTS, so that the LLS would overlap with the BTS not only spatially, but temporally as well, for comparability. Two commercial fishing vessels simultaneously conducted the survey. The survey longline gear is a 1 nautical mile/1,852 m groundline baited with frozen squid (*Illex spp*) on each of 1000 #12 semi-circle, easy-baiter hooks. A temperature/depth probe is secured on each anchor, as well as a current meter to measure the near-bottom velocities. The gear is set across slack tide for a minimum 2-hour soak time.

The number of species caught and the preferred bottom type were relatively consistent between seasons and years. A total of 38 unique species were caught, including 23 fish species, 7 invertebrate species, and 8 elasmobranch species (3 shark and 5 skate species). Of the 38 species, 92% were caught on rough bottom and 74% were caught on smooth bottom. Most species of higher abundance were generally distributed throughout the survey area, with similar distribution between seasons, with the exception of white hake and spiny dogfish. Although catch rates were higher on rough bottom, some species still showed a notable presence on smooth bottom, including Atlantic cod, barndoor skate, cusk, haddock, little skate, longhorn sculpin, red hake, spiny dogfish, and white hake.

Although the LLS could not be designed to be synoptic for any given stock, the data acquired are representative and will be informative and potentially improve NEFSC stock assessments for at least 8 stocks in the GM (Atlantic cod, barndoor skate, cusk, haddock, red hake, spiny dogfish, thorny skate, and white hake). The LLS would need to continue beyond about 10 years to determine the full benefit of these additional abundance indices to stock assessments. The LLS will also provide biological and abundance data for status reviews of 4 species of concern (Atlantic halibut, Atlantic wolffish, cusk, and thorny skate) by NOAA under the Endangered Species Act, and has provided oceanographic data for calibration of the finite volume coastal ocean (circulation) model (FVCOM, University of Massachusetts, Dartmouth). Further analyses can compare LLS data to BTS results (e.g., area fished vs. swept area biomass estimates) and other sampling programs to inform management and listing decisions, as well as to support proactive conservation and/or recovery plans.

INTRODUCTION

The catchability of fish that primarily inhabit complex rocky habitat is purportedly reduced in the Northeast Fisheries Science Center (NEFSC) multispecies bottom trawl survey (BTS). Although the BTS gear is equipped with a rockhopper sweep that enables sampling of rough bottom, the trawl physically cannot efficiently sample very complex, hard-bottom areas (i.e., large boulder fields and ledges). Some depleted stocks and data-poor species, e.g. Atlantic halibut (*Hippoglossus hippoglossus*), cusk (*Brosme brosme*) and Atlantic wolffish (*Anarhichas lupus*), appear to have low catchability or density-dependent catches in the BTS. As the abundance declines in some stocks, particularly in recent years, some fish appear to be aggregating into their preferred habitat (i.e., complex, rough bottom). Industry constituents have expressed concern that the lack of sampling on very complex bottom could undermine assessments of several economically important Gulf of Maine (GM) stocks including Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and white hake (*Urophycis tenuis*), although these species have historically been well sampled in the BTS.

To address these concerns, a proposal was submitted to the National Cooperative Research Program (NCRP) to implement a bottom longline survey (LLS) in the western and central GM. The objective of the proposed LLS was to increase sampling of several data-poor and depleted stocks specifically associated with rocky habitat, while also enhancing data collection for some data-rich stocks already seemingly well sampled on the BTS.

In 2013, the NCRP accepted and funded the NEFSC Cooperative Research Branch (CRB) proposal "*Development of a bottom longline survey for stocks associated with complex rocky habitat in the western and central Gulf of Maine, including several data poor stocks that are ESA species of concern*," and in 2014 a second proposal, requesting a continuation, was also granted. This funding resulted in a pilot bottom LLS conducted by the NEFSC CRB during the spring and autumn of 2014 and 2015. Additional non-competitive funds were procured for continuing the survey through to 2017.

This survey is the first NEFSC bottom LLS conducted for groundfish. The NEFSC conducts a LLS for large coastal sharks, initiated in 1986 (http://www.nefsc.noaa.gov/nefsc/Narragansett/sharks/survey.html). The groundfish LLS was designed to build upon previously funded and ongoing cooperative research sampling programs utilizing fixed longline gear for groundfish, specifically the Maine Department of Marine Resources halibut longline survey from 2007-2008 off coastal Maine and the University of Maine Penobscot East Resource Center sentinel longline survey in the eastern GM (inside 50 miles). Although these are important efforts, the surveys are restricted in geographic scope. The NEFSC LLS has a larger geographical sampling area, targets a broader range of data-poor species and some important data-rich species, and can provide critical information to support management efforts in the GM.

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA) mandates annual catch limits (ACLs) for most stocks managed under Fishery Management Plans (FMPs). The inherent uncertainty in setting ACLs and the sometimes constraining of fishing effort on targeted species by non-target ACLs has increased the emphasis on improving and refining assessments for important commercial and recreational stocks, depleted stocks, and "data-poor" stocks (Witherell 2010). The LLS, with enough years of data, can provide abundance indices for use in several stock assessments. In addition to the BTS indices currently used in assessments, particularly for data-poor assessments, adding this survey could improve some stock assessments.

Comparisons of catches between the pilot LLS and the concurrent NEFSC BTS helps address concerns about the catchability of specific groundfish species collected on the BTS. The LLS is also providing data for specific species to inform NOAA Endangered Species Act (ESA) listing evaluations. Atlantic halibut and Atlantic wolffish are NOAA Species of Concern (SOC) and cusk and thorny skate (*Amblyraja radiata*) are (or were) NOAA candidate species under the ESA. The LLS samples all of these species, and some species were captured frequently. Longline survey abundance indices and life history data are informing the cusk and thorny skate listing decisions and providing critical data to assist in their recovery (if listed) or proactive conservation (if not listed).

This document describes the implementation of the GM bottom LLS, including design and methodology; shipboard protocols; data collection, auditing, and access; as well as preliminary catch results and environmental observations. Catch distributions, length frequency distributions, and stratified mean abundance and biomass estimates by year and season are presented, as well as environmental data (depth and temperature) and oceanographic data (current velocity and direction), for the 2014-2017 surveys.

METHODS

Bottom Longline Survey

Survey design

The GM bottom LLS was designed to sample complex, rocky habitat not easily accessible to the NEFSC research BTS. However, to have some comparability to the BTS catches, the LLS stratified random design was based on the NEFSC BTS stratification of depth and area (Azarovitz 1981; Grosslein 1969, 1974) and then further stratified by "rough" and "smooth" bottom type within the strata area as a proxy for distinguishing between potential habitats.

The allocated budget allowed sufficient funds to sample 45 station locations each spring and fall season. The actual survey area was based on a qualitative assessment of the distribution of BTS catches for several key species (Atlantic cod, Atlantic wolffish, cusk, spiny dogfish [*Squalus acanthias*], white hake, barndoor skate [*Dipturus laevis*], thorny skate, and winter skate [*Leucoraja ocellata*]) in the GM area during the spring (1968-2012) and the fall (1963-2011). Cumulative BTS catches for each of these species over these time periods indicated that 6 GM offshore strata (26, 27, 28, 29, 36, and 37; Figure 1) had the highest proportion of catches and the greatest overlapping distribution of these species of interest.

The central GM strata (28, 29, and 36) were too large to complete given the LLS budget, so these strata were truncated, and thus, the excluded parts are not included in the final sampling area. Sections of strata 36 and 29 that are in Canadian waters could not be sampled because the US commercial vessels that conduct the survey did not have permission to operate in Canadian waters, whereas the BTS does (Figure 2).

The habitat stratification of "rough" or "smooth" bottom type was based on rugosity. The rugosity in the GM – Georges Bank (GM-GB) region was quantified as a terrain ruggedness index (TRI), calculated from a 15-arc second (350 m East–West, 430 m North–South) bathymetric grid that merged Canadian and US soundings (Hare et al. 2012; Riley et al. 1999). The TRI was defined as the square root of the sum of the difference of squared elevations between a grid cell and the neighboring 8 cells. The spatial resolution (grain) of the TRI grid was 1.3 km^2 = 0.5 $miles^2$ (Figure 3).

The range and percentile distribution of TRI values were examined within each stratum after the final survey strata area was selected (Table 1; Figure 4) to determine criteria for designating a sampling location as having "rough" or "smooth" bottom type. Within each stratum, any area with a TRI index greater than the 70^{th} percentile was designated to be "rough" and alternatively, any area with a TRI less than that was designated as having a "smooth" bottom type

(Figure 2). The larger percentile was chosen in an attempt to ensure that any rough areas indicated that the survey was truly on rougher bottom than adjacent areas. We then used Geographic Information System (GIS) software (ESRI ArcGIS) to assign bottom type values (rough or smooth) to each potential station location in the study area.

The total number of stations allocated to each LLS stratum was based on both the stratum area and the bottom type, with the number of stations allocated per stratum in the BTS as a guide. The stratum area (nm^2) in the BTS is based on a historically digitized estimate, whereas, the LLS stratum area (km^2) is estimated in ArcGIS, using Geographic Coordinate System, GCS North American 1983. Based on a total of 45 stations within a 28,307 km^2 area, the LLS sampling unit was 1 station per 629 km^2, whereas, the BTS sampling unit was 1 station per 1000 km^2 in these same strata (45,978 km^2). The allocated number of LLS stations was lower for strata 26, 27, and 36, as expected, given the smaller area of these strata relative to the larger areas of strata 28, 29, and 37. However, a minimum of 2 smooth bottom stations per stratum was required to estimate the variability in the catch estimates and establish any significant differences in catch by bottom type. Based on this requirement and the 45 budgeted stations, the number of stations was re-assigned to each stratum resulting in 30% of the stations allocated to smooth and 70% to rough bottom in each of the strata (Table 2). This change resulted in the total number of LLS stations being either over-allocated or under-allocated in some strata, but overall still averaging a higher sampling density than the BTS sampling density of 1 per 1000 km^2.

Stations were allocated as described above for the LLS during 2014-2016. For the 2017 LLS, however, several changes were made to the survey design including combining strata and modifying the station allocation methodology. The total number of smooth stations decreased from 12 in 2016 to 7 in 2017. This decision was based on several factors: preliminary results indicating higher incidence of predation of hooked fish on smooth bottom, hooks coming up "shiny" (i.e., empty of bait – where bait was eaten by benthic organisms), 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.

Strata were combined to create 3 strata to be used for smooth station allocation, while keeping the original 6 strata for rough station allocations. The 3 smooth strata are: 26+27, 28+37, and 29+36, designated as strata 2627, 2837, and 2936. Two smooth stations were allocated to strata 2627 and 2936, and 3 stations were allocated to stratum 2837 (the largest of the 3), allowing for estimation of variance of the catch in these strata (Table 2).

The remaining 38 stations were allocated as rough stations in the original 6 strata. The number of stations was determined based on the total area of rough bottom in each stratum, rather than on the total area (rough + smooth) of the stratum, as described above for the 2014-2016 surveys. This change resulted in a total rough area of 8,558 km^2, with a sampling unit of 1 station per 225 km^2, lower than the 629 km^2 applied in the previous 3 surveys. The number of rough stations per stratum was allocated as listed in Table 2. These allocations were further adjusted taking into consideration that 2 of the largest strata (28 and 29) both have the lowest TRI relative to the other strata (Table 1 and Figure 4).

The locations of the allocated number of stations were randomly selected within each stratum by using a randomization procedure within ArcGIS (Create Random Points, http://desktop.arcgis.com/en/arcmap/10.4/tools/data-management-toolbox/create-random-points.htm; D. Chevrier pers. comm). With this point-in-polygon (i.e., stratum) method, any individual latitude/longitude point was eligible as a station location. As a rule, no station location could be within 3 nm of another station, unless it was in an adjacent stratum. For each survey, a second set of 45 “alternative” stations were randomly selected to be available if needed (e.g., if a station needed to be moved more than 3 nm from the original station location because of gear conflicts or incorrect bottom designation, or if sufficient funds were available at the end of a survey to conduct additional stations). Computationally, because of the smaller and narrower areas in the rough strata, the ArcGIS procedure for selecting random station locations needed to be run with a cut-point of 0.5 nm rather than the required 3 nm. As follow-up, for stations that were selected within 3 nm of each other, the nearest alternative stations was chosen to replace the “too near” stations.

The survey was conducted in the spring (April-May) and fall (October-November) during the same period as the NEFSC research BTS so that the LLS, weather permitting, would overlap with the BTS not only spatially, but temporally as well, for comparability. LLS station locations for spring and fall are presented in Figure 5 (2014), Figure 6 (2015), Figure 7 (2016), and Figure 8 (2017).

Survey vessels

Two commercial fishing vessels (Figure 9), simultaneously conducted the survey. Captain Phil Lynch operates the 350 HP F/V *Mary Elizabeth* (55’) from Scituate, MA, and Captain Eric Hess operates the 400 HP F/V *Tenacious II* (40’) from East Dennis, MA, along with their crew members. Although the captains engage in other fisheries during the year, including the hook fishery, both vessels are equipped to run longline gear during the survey.

Survey gear

The survey bottom longline gear was a 1 nautical mile/1,852 m groundline baited with 1000 #12 semi-circle, easy-baiter hooks. One nm of groundline was chosen to closely match the distance fished by the otter trawl in the BTS. Each hook was baited with frozen squid *Illex* (usually *I. argentinus*), recommended by the survey vessel captains as the preferable bait given the high oil content. The gear was baited by 2 different baiters, in Chatham, MA, and Yarmouth, MA. The gear was baited prior to each trip and kept frozen until deployment. The baited hooks were carefully laid in layers with sheets of newspaper separating them to allow the gear to be pulled over the rail without tangles. On average, each piece of bait weighed 13.0 (n = 559 pieces) grams and measured 37.9 mm x 25.5 mm x 15.5 mm (n = 639 pieces).

Typically, each vessel carried 6 or 7 sets of gear, baited and kept frozen, on each leg of the survey. The gear for 1 station consisted of 4 totes, each with 1500’ of #7 braided groundline with 250 hooks, 6’ between hooks, and 15 inch #550 green gangions spliced into the groundline. Twenty-five feet of buoy line were attached on each end for a total of 1,550’ per tote. The groundline was secured to the bottom by a 20 or 22 lb anchor at the terminal ends of the gear (Figure 10), although the anchor style differed slightly between the vessels. On each anchor a Star Oddi temperature/depth probe was secured. Data were captured every 20 seconds with temperature recorded in °C and depth (m) determined from the pressure.

The near-bottom velocities were measured by a SeaHorse Tilt Current Meter (Model SH1M50) specifically designed for this project (Figure 11). The current meter consists of a tilt and magnetometer data logger mounted inside a 50 cm long 1 inch PVC pipe tethered to a 12 oz weight. The principle of operation is based on a balance between the hydrodynamic drag and buoyancy of the pipe. The stronger the current, the more it tilts downstream in the ambient flow. The relationship between the flow speed and the tilt angle is obtained from empirical calibrations. The direction of the current is estimated relative to the earth magnetic field. The instrument has an accuracy of about 2 cm/s in speed and 4 degrees in direction. The logger also has an integrated temperature sensor. A current meter, with a 12 oz mooring weight, is attached to the main line at about 10 ft from each of the anchors. The current meter is positively buoyant and can withstand pressure at depths in excess of 160 fathoms (960'/293 m). The meter records the current velocity relative to the direction of longline gear for the duration of the set, as well as recording both depth and temperature.

Station protocols

The gear was set across the slack tide for a 2-hour soak time, and each gear operation event was recorded in the Global Positioning System (GPS) polling file. The start time of the set corresponded to the moment the first anchor was released and the end time of the set corresponded to the time the second anchor was released. Two hours after the release of the second anchor, the gear was hauled back starting at the end that was last deployed (i.e., second anchor). The haul back start time represented the start of the hauling of the buoy line, and the haul back end time was when the second anchor was pulled aboard the vessel. The catch was sorted and weighed (± 0.1 kg) by species. All fish species and macroinvertebrates were measured, and catches of other invertebrates (e.g., star fish, anemones, corals, tunicates) were noted. Length measurements (± 0.5 cm) were taken with electronic measuring boards, and further biological samples were taken for designated species and sizes.

While the longline was soaking and if conditions permitted, a Go-Pro HERO 4 camera (some videos the first year were taken with earlier models) recording in 1080 pixels and 30 frames per second secured on a frame (Figure 12) that was lowered for 5-10 minutes to observe the bottom type at each station. Two 1,200 lumen LED lights with a 60º spread were attached to the frame below the camera. The image quality (IQ) subhousing for the camera and lights were rated to a depth of 300 m.

More details and specific bottom longline operation protocols are provided in Appendix A.

Data collection

The FSCS (Fisheries Scientific Computing System) data collection system used on the BTS is not yet available for the LLS, so for these initial years, handwritten logs were used for recording catch weight data, which were then transferred to laptops at the end of each station workup. At each station, the total catch weight and the length measurements were recorded for each species from electronic Marel Marine motion compensating scales and electronic measuring boards (Initially the Lat. 37 wireless fish measuring board [950wFMB] and the Ichthystick II since 2016), respectively. The individual size measurements taken (fork length, total length, carapace width, etc.) varied by species, and these were consistent with protocols for the BTS. Lengths were recorded directly into handheld computers. If lengths of depredated fish could not be obtained, the otoliths were collected (starting in 2015) and measured later in the laboratory with digital calipers to derive the fish's length. The individual weight of depredated fish was then estimated when the survey data were audited. If an individual species catch was too large (e.g., spiny dogfish) total catch weight was taken, but only a subsample of the catch was measured for length. Spiny dogfish, large sharks, crabs (Cancridae, Lithodidae, Geryonidae), and American lobster (*Homarus americanus*) were sorted and recorded by sex. For select species and size groups, additional individual biological samples were taken, including sex, macroscopic maturity stage (following Burnett et al. 1989), individual weight, gonad histology, gonad and liver weight, and age structures (Table 3). These data samples were taken at the requests of specific researchers interested in each species. Any large sharks caught were tagged and released, as well as a small subset of spiny dogfish in the eastern strata in support of the NEFSC's Apex Predators Program. The length and weight of large sharks were estimated as they were released at the side of the vessel and not brought on board.

The vessel GPS and depth sounder data were collected continuously, recording latitude and longitude, depth, speed, and course direction for the duration of the set and the haul back.

Data evaluation

Representativeness of the data was determined by the chief scientist after each station was completed by applying criteria that evaluated the quality and characteristics of the station type, gear performance, environmental conditions, and data acquisition (Table 4). When the variables of station_type, gear_interaction, environmental_conditions, data_acquisition, gear_evaluation, and gear_damage are concatenated, only those records with a value ≤ 133334 would be considered to have been collected from a representative station, and thus, acceptable for inclusion in an analysis. At sea, if a station was determined to be unrepresentative by the chief scientist, the station was repeated, if feasible, and was recorded as such in the database. This procedure occurred only once, so far.

Data auditing

After the cruises were completed, the data were audited manually for transcription errors and with programs written in the R programming language (R_Core_Team, 2015) and then loaded into the NEFSC Oracle Database. In the audit, any missing fields and any outliers were addressed if possible, or they were flagged in the database. Length-weight and other arithmetic relationships were used in standardized routines to validate values or flag unusual ones.

A few stations (9 total, including 7 in 2014) had sets that either overlapped a stratum boundary (6) or were located completely outside the original assigned stratum (3). In the overlapping cases, the stations were assigned to the stratum where the set originated. These stations ranged from 0.8-77.9% of the length of the set occurring in another stratum, and only 2 of these exceeded 50%. The 3 stations that fully crossed a boundary were assigned to the stratum where they occurred, which was a different stratum than originally planned using the station allocation protocol described above.

Discrepancies in the catch data, mainly from depredation, were addressed in the following manner. When weight was missing but length was available, we used length-weight equations to provide estimates of catch weight for depredated catch. Depredated red hake, (*Urophycis chuss*) and haddock lengths were back-calculated based on a generalized additive model (GAM) of otolith length or width (both were used when available) and fish length (starting in 2015). These regressions were developed from otolith measurements (using digital calipers) of age samples from the BTS and LLS from overlapping geographic regions and years. Depredated catch of other species will be adjusted in the future when the otolith analyses have been completed. When depredated catch lacked a measured length or a back-calculated length estimate, the weight was estimated based on the mean weight for that species at that station. If fewer than 10 individuals were captured then a mean weight from all stations in the given season was used. Finally, if the number of fish caught for a given species was missing, we used the recorded weight for that species divided by the stratum mean weight to impute the missing number. If fewer than 10 individuals were caught in the stratum, we used the mean weight for that species from all strata in the given season and year, or all strata and all years in the given season if necessary. There were only 14 instances where the catch number was estimated.

Data access

All audited longline data are available in the NEFSC Oracle COOPLL schema, which currently includes about 13 Oracle tables and materialized views for station, operational, catch, biological, and environmental data (Table 5). Data tables are in various stages of development, and we expect to add other data (e.g., the video data) at a later date. Currently, a unique station is obtained by linking the cruise and station variables. Further details of the database and descriptions of data fields can be obtained from https://inport.nmfs.noaa.gov/inport/item/27731.

Data Analyses

Data selection

The analyses and summaries presented in this document used data from representative stations only. One station in fall 2014 was not included as it had a gear problem resulting in it being unrepresentative, but the site was repeated later in the same survey with a valid station that was included. One station in fall 2017 was considered unrepresentative, and this resulted in there only being 44 valid stations for that survey. Station sites taken from the alternate random draw list were used in 2 instances when stations could not be conducted in a representative manner at the site of the original base station draw.

Stratified means

The stratified mean abundance and biomass for each species was estimated by bottom type for each LLS during 2014-2017. The estimation procedure was programmed in R computing language (R_Core_Team 2015) and in SAS (SAS 9.4, SAS Institute Inc., Cary, NC) following stratified random sampling statistics as described by Cochran (1977). The finite correction factor was not estimated since the sample sizes (n) are assumed to be small relative to the population (Cochran 1977).

The mean abundance or biomass, by bottom type, within a stratum area, $\bar{U}_{kb}$, was estimated as:

$$\bar{U}_{kb} = \frac{1}{n_{kb}} \sum_{t=1}^{n_{kb}} U_{kbt} \quad (1),$$

where U = number or weight (kg) of fish,
k = stratum (26, 26, 28, 29, 36, 37),
b = bottom type (rough, smooth),
n = number of stations (t).

The variance of the bottom stratum mean, $(\bar{U}_{kb})$, was estimated as

$$v\,(\bar{U}_{kb}) = \frac{1}{n_{kb}}\, s_{kb}^2(U) \quad (2),$$

where the bottom stratum sample variance, $s_{kb}^2(U)$, was estimated as :

$$s_{kb}^2(U) = \frac{\sum_{t=1}^{n_{kb}}(U_{kbt} - \bar{U}_{kb})^2}{n_{kb} - 1} \qquad (3).$$

The stratified mean abundance or biomass across the entire survey area, by bottom type, was then estimated as:

$$\bar{U}_b = \frac{1}{A_b} \sum_k A_{kb} \bar{U}_{kb} \qquad (4),$$

where A_{kb} = area of bottom type b in stratum k (km^2), and A_b = total area (km^2) of either rough bottom or smooth bottom.

The variance of the stratified mean by bottom type for abundance and biomass was estimated as:

$$v(\bar{U}_b) = \frac{1}{A_b^2} \sum_k A_{kb}^2 \, v(\bar{U}_{kb}) \qquad (5).$$

The stratified mean for the entire survey area, with bottom types combined (R = rough, S = smooth), was estimated as:

$$\bar{U} = \frac{1}{(A_S + A_R)} \left(A_S \bar{U}_S + A_R \bar{U}_R \right) \qquad (6).$$

The variance of the stratified mean for the entire survey area, with bottom types combined was estimated as:

$$v(\bar{U}) = \frac{1}{(A_S + A_R)^2} \sum_b A_b^2 \, v(\bar{U}_b) \qquad (7).$$

The coefficient of variation (CV) was estimated for each abundance and biomass mean as the ratio of the standard deviation/mean.

Current velocity

During the survey, the current meters were programmed to collect samples every second, which were then averaged into 1-minute velocity estimates denoted as the near-bottom eastward and northward velocity components, $V_E(t)$ and $V_N(t)$.

For estimation of current velocity, a time period ($T_1 < t < T_2$) was selected between the moment T_1 when the deployment ended (the second anchor dropped plus 5 minutes) and the moment T_2, when recovery started (beginning of the haulback minus 5 minutes). The 5-minute margins were introduced to account for inaccuracies in time synchronization with note keeping.

From the near-bottom eastward and northward velocity components, $V_E(t)$ and $V_N(t)$, progressive vector diagrams (PVD), $D_E(t)$ and $D_N(t)$, were calculated by integrating in time from moment T_1,

$$D_E(t) = \int_{T1}^{t} V_E(t')\, dt' \qquad (8),$$

$D_N(t) = \int_{T1}^{t} V_N(t')\,dt'$, (9)

where $D_E(t)$ and $D_N(t)$ were the eastward and northward displacement as a result of the velocity field. They approximately correspond to the track a "particle" released at the instrument location would follow as it is driven by the currents. We specify "approximately" because the flow is assumed to be spatially uniform.

RESULTS

Survey Logistics

The pilot LLS was conducted using 2 vessels with the intention to occupy 45 stations each season, and to overlap temporally with the NEFSC BTS in the central GM offshore strata. Retrieval of the gear began at the second anchor after a minimum 2-hour soak time. The average total haul back time was 59 minutes but varied between 45-75 minutes on typical stations.

Typical of any new survey, we encountered some problems, but none that were insurmountable. During the first survey, one of the LLS vessels had engine problems, leaving only the one other vessel to complete the LLS. Thus, the LLS survey was extended temporally beyond that of the BTS by about 3 days in spring 2014. The remaining surveys were completed in a timely manner with no significant issues, while overlapping with the sampling of the BTS in the area; however, the fall 2016 survey experienced heavy weather, extending the survey longer than expected.

Stations

Each survey had 45 representative stations, except fall 2017, which had only 44 stations that could be included in analyses. From 2014-2016, there were 33 stations located on rough bottom and 12 stations on smooth bottom in each season. In 2017 there were 38 rough bottom stations in the spring, 37 stations in the fall, and 7 stations on smooth bottom in both seasons.

Biological Data

The number of species caught and the preferred bottom type were fairly consistent between seasons and years (Table 6). During the 8 surveys, a total of 38 unique species were caught, including 23 fish species, 7 invertebrate species, and 8 elasmobranch species (3 shark and 5 skate species). Of the 23 fish species, 21 were groundfish (including 4 flounders) and 2 were semi-pelagics (pollock [*Pollachius virens*] and silver hake [*Merluccius bilinearis*]).

Eight species were caught at low occurrence (i.e., 1-3 individuals across all 2014-2017 surveys): American plaice (*Hippoglossoides platessoides*), red deepsea crab (*Chaceon quinquedens*), fourbeard rockling (*Enchelyopus cimbrius*), ocean quahog (*Arctica islandica*), porbeagle shark (*Lamna nasus*), spotted hake *(Urophycis regia*), winter flounder (*Pseudopleuronectes americanus*), and yellowtail flounder (*Limanda ferruginea*). These species were included in Table 6 but were omitted from subsequent analyses and plots.

Atlantic hagfish (*Myxine glutinosa*) were caught on several surveys but were erroneously not recorded until fall 2015. The veracity of the Atlantic hagfish abundance may be uncertain since some of the samples were attached to hooked fish, rather than being hooked. The abundance of this species may only be useful as a presence/absence metric.

Of the 38 species, 35 (92%) were caught on rough bottom while 28 species (74%) were caught on smooth bottom (Table 6). There were 25 species captured on both habitat types in total, but only nine species (24%) were caught on both bottom types consistently; these were Atlantic cod, barndoor skate, cusk, haddock, red hake, smooth skate (*Malacoraja senta*), spiny dogfish, thorny skate, and white hake.

The total biological samples taken, per species, during 2014-2017, are presented in Table 7. The type and number of samples collected were based on requests specified by biologists working on each species. Sampling effort was focused on less common sizes (e.g., larger fish) and species that are data poor in general (e.g., cusk, Atlantic halibut, Atlantic wolffish).

Distribution and length frequencies

Species distribution plots by weight and number (Appendix B Figures 1- 40) indicated that most species of higher abundance (e.g., red hake and haddock) were distributed throughout the survey area, while species of lower abundance (e.g., Atlantic wolffish, Atlantic halibut) were generally in localized areas of the survey during 2014-2017. The distribution was generally similar between seasons, except for a few species, including white hake and barndoor skate, which were distributed more to the east in the spring than in the fall.

The proportion of species caught by bottom type is most easily seen by examination of the length frequency plots (Appendix C Figures 1 - 40). Most species appeared to have higher proportions of each fish length captured on rough bottom than smooth bottom stations; although, more stations were surveyed on rough bottom than on smooth bottom. Ten species were caught solely on rough bottom: American lobster, Atlantic wolffish, fourbeard rockling, northern stone crab (*Lithodes maja*), porbeagle shark, sea raven (*Hemitripterus americanus*), spotted hake, tilefish (*Lopholatilus chamaeleonticeps*), winter flounder, and yellowtail flounder, albeit very few in number. Spiny dogfish and red hake had higher proportions of catch on rough bottom than on smooth bottom, but they were the most frequently caught species on smooth bottom, along with white hake.

Abundance and biomass indices

Indices of abundance and biomass (stratified means) were generally higher on rough bottom (Table 8; Figures 13-16) for the majority of species in all surveys, suggesting a general preference for rough bottom for most species. The coefficient of variation (CV) of abundance ranged between 0.11-0.46 for the primary species of interest (cod, cusk, haddock, red hake, smooth skate, spiny dogfish, thorny skate, and white hake). Some species had either higher catches (i.e., barndoor skate, cusk, pollock, and white hake) or lower catches (i.e., Atlantic cod, Atlantic wolffish, and smooth skate [*Malacoraja senta*]) in the fall compared to the spring, suggesting seasonal movements of these species on/off rough bottom or in/out of the survey area overall.

Although catch rates were higher on rough bottom, some species still showed a significant presence on smooth bottom (Table 9; Figures 17-20) including Atlantic cod, barndoor skate, cusk, haddock, little skate (*Leucoraja erinacea*), longhorn sculpin (*Myoxocephalus octodecemspinosus*), red hake, spiny dogfish, thorny skate, and white hake. The CVs for indices of abundance for these species were higher on smooth bottom, ranging between 0.07-0.97 (excluding 0.00 and 1.00).

Stratified means estimated by combining rough and smooth bottom means were dominated by the rough bottom results (Table 10; Figures 21-24) with similarly higher catches for Atlantic cod, cusk, haddock, longhorn sculpin, red hake, spiny dogfish, thorny skate, and white hake. The abundance index CVs ranged between 0.07-0.97 for these species.

Environmental Data

Current velocity

Current velocity components, $V_E(t)$ and $V_N(t)$, were estimated for each station where data were available. A typical record of velocity estimates is shown in Figure 25. One can see that the velocity components from the 2 instruments, separated by approximately 1 nautical mile, are similar, which indicates that the instruments worked consistently. The parts of the curves shown in yellow correspond to the whole raw record.

The exact moments of the disturbances in deployment and recovery of the gear can also be seen as spikes in the velocity records. We eliminated these disturbances from the analysis by using the time period, $T_1 < t < T_2$, as described above. One can also see the asymptotic temperature adjustment following the instrument submergence and recovery in the same plot.

The PVD curves, $D_E(t)$ and $D_N(t)$, are shown in red for the first instrument and in green for the second in Figure 26. The similarity of the 2 PVDs from the 2 instruments suggests not only that the instruments worked consistently, but also that the flow was spatially uniform, which we can expect in the areas of smooth bottom. For a spatially uniform flow the PVD can be interpreted as the trajectory of a particle released at time $t = T_1$. In the areas of rough bottom, or if the anchors landed at vastly different depths, the PVDs could differ.

During this particular deployment one can see that the flow was initially southward, and then it veered more to the southeast, while the long line was oriented from southeast to northwest (from the first to second anchor).

Only 1 SeaHorse Tilt Current Meter was deployed on each longline throughout the spring 2014 survey. Starting with the autumn 2014 survey, 2 current meters were deployed, 1 on each end of the longline, throughout the survey. With the exception of the spring 2015 survey, when the current meters were not functioning on either vessel because of battery failures, 2 instruments have been deployed per longline for each survey.

Depth and temperature

Summary statistics for temperature and depth were calculated 10 - 103 minutes after the moment the first anchor reached bottom. This procedure eliminated the time during which the gear settled at the bottom and avoided any influence from the vessel pulling on the mainline during gear deployment or haul back. Mean depth (m) observed at each station, summarized by stratum (Figure 27), indicates relatively shallower depths in the western (26, 27) and northern strata (37), compared to that of the deeper waters of the southern (28) and eastern strata (29, 36). Mean temperature (°C) by depth (m) within season does not show any pattern by bottom type (Figure 28). The nearshore, shallower strata (26, 27), however, show the expected cooler temperatures in the spring and warmer temperatures in the fall, compared to the less variable temperatures in the deeper offshore strata. Mean temperature estimates indicate seasonal variability as expected, with more seasonal variability in the nearer shore strata (26, 27; Figure 29).

DISCUSSION

The LLS was successfully completed during the pilot years, 2014-2015, and with additional funding, successful surveys were also completed during 2016-2017. In addition, the 2018 surveys were completed successfully, but data auditing was not completed in time for this document. The 2019 spring and fall surveys are currently funded and we anticipate them to be completed. The surveys thus far were completed in a timely manner, overlapping with the BTS survey coverage of the area in spite of engine problems (spring 2014) and windy weather conditions (fall 2016) during the first 4 years.

Given the likelihood of rougher weather in the fall and the longer survey season experienced during the fall 2016 survey and after discussions with the captains and considering the statistical implications, we decided to move the fall survey to start about 2 weeks earlier, in 2017. This timing still allows for overlap with the BTS, but it also provides more leeway for bad weather.

In 2017 there were limited changes to data collection and sampling protocols, and incremental improvements to data handling and auditing routines were added. The most significant improvement was the building and use of Ichthystick II electronic fish measuring boards. These digital boards were faster and have a greater capacity to integrate with more advance electronic data capture hardware and software that will be employed in 2018 and beyond.

Acknowledging the imperfections and limitations of using only rugosity to infer bottom type, we chose to use the TRI primarily because it was a synoptic metric for the survey area of interest. Derived from bathymetry data in a nearest neighbor cell approach, the TRI provides a good indicator of steepness but cannot provide information on the sediment type, surface texture, or relative hardness. The TRI was used to stratify for bottom type in each area stratum and appears to be generally accurate. The species composition and large catches of species that prefer hard bottom (e.g., cusk) support the general applicability of TRI. Preliminary analyses comparing the Go-Pro video bottom observations indicate about 80% agreement with the designated bottom type of rough or smooth (G. Gianesin, pers. comm.). Other databases, such as the United States Geological Survey (USGS) surficial sediment data in the GM area (McMullen et al. 2014; Valentine and Gallea 2015) do not have sufficient areal coverage to designate bottom type on the finer scale needed for the LLS. Also, although sediment type is identified in these USGS databases, the bottom topography is lacking and this is an important component for determining rough complex bottom type vs. smooth bottom type for the LLS.

We have started investigating the use of the single beam, multi-frequency sonar data from both the NOAA ship R/V *Henry B. Bigelow* and former NOAA R/V *Albatross IV*. These data would reliably provide an inference of hardness and roughness of the bottom and a measure of slope, but not truly provide information about sediment bottom type (e.g., sand, gravel, clay, cobble). Initial results are promising, but it will take several more years to amass sufficient spatial coverage to analyze differences relative to the TRI. In the interim, the single beam sonar data could potentially be used in conjunction with the TRI data to refine our current "bottom type" designations.

The total number of survey stations (45) and the extent of the survey area was originally determined by species distributions, vessel capabilities, and survey logistics (e.g., time on a station, steaming time to the most eastern stations) as well as the degree of precision required and budget constraints, as is common in survey design (Cochran 1977).

Although the LLS could not be designed to be synoptic for any given stock, the results indicate that the survey covers a large enough area to provide representative length frequencies and robust stratified mean abundance indices for several species, similar to those indices derived from state surveys of nearshore waters. The majority of species captured exhibited higher abundance on rough bottom and purportedly has a preference for complex rocky-bottom habitats. Some catch differences between bottom types could be attributed to lower catchability of fish by the longline gear on certain bottom types (e.g., mud) where the baits are consumed rapidly by invertebrates (e.g., isopods, polychaetes), as well as to habitat preferences. Of the 38 species captured, 8 species (Atlantic cod, barndoor skate, cusk, haddock, red hake, spiny dogfish, thorny skate, and white hake) were captured in sufficient numbers to potentially provide primary (e.g., cusk) or ancillary (e.g., Atlantic cod, haddock, spiny dogfish, white hake) abundance indices for use in the assessment models. This applicability would need to be verified within a model framework, and the LLS would need to continue for at least 8-10 years to determine the full benefit of these indices to an assessment.

The LLS survey has also been able to provide a platform for other research. During the fall 2016 survey, thorny skate were tagged as part of a study for the Anderson Cabot Center for Ocean Life at the New England Aquarium, and data on barotrauma of cusk were collected for 2 graduate students. In addition, during the autumn 2014 survey season, 8 stations were set to conduct a bait experiment with the LLS gear after the regular survey, using alternating totes of clam and squid as bait. Comparison analyses of these catches will provide data on which bait has higher catchability for various species.

The LLS has been beneficial for the collection of biological data (e.g., sex, maturity, gonad histology, age) for both data-rich and data-poor species. These samples for several data-poor species are included in several ongoing maturity studies. Age structures collected from the larger fish of several species will supplement samples from the BTS for application in stock assessments. Biological data for data-poor species, as well as abundance data, will be available for use in ESA status reviews by Protected Resources (PR) at the Greater Atlantic Region Fisheries Office (GARFO) for NOAA Species of Concern (SOC) and candidate species. Currently, NOAA SOC captured on the LLS include Atlantic halibut, Atlantic wolffish, cusk, thorny skate, and porbeagle, the latter 3 also being candidate species. The LLS thorny skate data have already been included in the status review conducted by the PR office at GARFO (Sosebee et al. 2016; https://www.greateratlantic.fisheries.noaa.gov/protected/pcp/soc/thorny_skate.html). Also, the biological data collected will be used in ongoing life history studies of several of these data poor species.

Gear saturation and depredation are not unusual issues for longline gear, and both could potentially affect the quality and quantity of our LLS data. On some LLS sets, large quantities of spiny dogfish have been captured, potentially saturating the gear. Further analyses will establish criteria to designate a set as not being representative because of gear saturation or to account for it statistically, e.g. using hook availability. Depredation of the catch, usually red hake and haddock, by spiny dogfish, Atlantic hagfish, and invertebrates, has been partially addressed. Several student interns collected data for developing the relationship between otolith length and fish length for red hake and haddock, which enables the estimation of length frequencies and catch weights for the retained depredated catch. A similar relationship has been initiated for white hake, and relationships for other species will be established in the future.

Occasionally, “extra fish,” including large sharks, Atlantic halibut, barndoor skate, Atlantic cod, white hake, and Atlantic hagfish, have also been caught by the longline when these species prey on smaller hooked fish (i.e., red hake and haddock). If this secondary catch were a prevalent problem, the selectivity of the longline could potentially be affected, but most of these species are also regularly captured on the baited hooks. Atlantic hagfish were not consistently recorded on the first 3 surveys, but they have been since fall 2015. The hagfish thus captured would likely only be used as presence/absence data since they do not always get hooked in the mouth, but they are sometimes found on captured fish or wrapped around the gangion.

The environmental and oceanographic data collected (e.g., depth, bottom temperature, and current velocity) will potentially be important covariates in the future estimation of catch per unit effort (CPUE) of select species in the LLS. Current velocity will also potentially allow for estimation of the area fished and total biomass of species in the survey area. The 2-hour velocity estimates collected at each longline set have already been provided to colleagues for calibration of the Finite Volume Coastal Ocean (circulation) Model (FVCOM) developed by the University of Massachusetts, Dartmouth (UMASSD) and the Woods Hole Oceanographic Institute and maintained at the School for Marine Science and Technology, UMASSD. This type of localized velocity data from the central GM has not previously been available to the FVCOM modelers.

Although the LLS data have yet to be thoroughly analyzed, some notable observations have been made. One significant and relevant finding thus far is that the length frequency of Atlantic cod on the rough bottom is similar to that captured by the BTS, which is not consistent with the often mentioned belief that the GM cod assessment is negatively biased because of inadequate sampling of large cod by the BTS (i.e., the hypothesis that large cod are "hiding" in the rocks). Another unexpected result was the capture of several tilefish in the southeastern LLS area during spring 2015. These samples validate previous reports of tilefish in that area reported in the landings data and in observer records.

If the LLS were continued for the long term, the data acquired would inform and potentially improve at least 8 NEFSC stock assessments, provide biological data and abundance for status reviews of 4 SOC, and provide oceanographic data for calibration of the ocean circulation model (FVCOM). Further analyses can compare LLS data to bottom trawl surveys results (e.g., area fished vs. swept area biomass estimates) and other sampling programs to inform management and listing decisions, as well as to support proactive conservation and/or recovery plans.

ACKNOWLEDGEMENTS

We thank Captain Eric Hesse of the F/V *Tenacious II* and Captain Phil Lynch of the F/V *Mary Elizabeth* for their expertise and knowledgeable advice, and for the cooperation and skill of their crew, and longline baiting crews. We appreciate all the support from Diane Borggaard, David Chevrier, Toni Chute, Larry Brady, Josh Moser, Emilee Tholke, Jonathan Duquette, Ryan Silva, and James Manning and especially Carolyn Woodhead for logistical support that kept us afloat. Special thanks to the Northeast Cooperative Research Branch staff for their hard work at sea and dedication: Calvin Alexander, Dominique St. Amand, Brian Gervelis, Giovanni Gianesin, Kevin Jackson, Elizabeth Marchetti, Christopher Sarro. We thank Gregory Hinks, NJDEP, for the "Data trawler" software for recording length data, and thanks to summer interns Antony Papadia and Merril Nadeau for measuring hundreds of otoliths.

The LLS has been funded through the National Cooperative Research Program, the NEFSC Cooperative Research Branch, and the Greater Atlantic Regional Fisheries Office.

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Table 1. Percentiles of the terrain ruggedness index (TRI) for strata 26-29 and 36-37 in the Gulf of Maine. The interquartile value (IQR) and the minimum TRI value estimated as an outlier (Q3+1.5 [IQR]). A TRI index value greater than the 70th percentile (in bold) was designated to be "rough."

Stratum	10% of TRI	20% of TRI	25% of TRI	30% of TRI	40% of TRI	50% of TRI	60% of TRI	**70% of TRI**	75% of TRI	80% of TRI	90% of TRI	100% of TRI	IQR	Min TRI
26	1.23	2.25	2.77	3.35	4.42	5.63	7.61	**10.55**	12.43	14.71	21.10	49.57	9.66	26.91
27	2.01	3.83	4.65	5.45	7.08	8.80	10.65	**12.95**	14.29	15.92	21.21	49.61	9.63	28.74
28	0.50	1.22	1.54	1.82	2.39	3.19	4.27	**5.63**	6.46	7.44	10.27	29.23	4.91	13.82
29	0.50	0.90	1.12	1.35	1.96	2.66	3.46	**4.34**	4.82	5.42	7.30	28.01	3.70	10.36
36	0.65	1.20	1.52	1.84	2.60	3.52	4.67	**6.05**	6.97	8.11	10.92	25.93	5.46	15.16
37	0.69	1.40	1.81	2.30	3.37	4.65	6.26	**8.23**	9.41	10.99	15.43	57.98	7.60	20.81
All	0.67	1.33	1.69	2.06	2.93	3.99	5.22	**6.90**	8.03	9.38	13.75	57.98	6.34	17.53

Table 2. Worksheet for estimating the allocation of stations to strata based on area and habitat for the longline survey (LLS) based on the bottom trawl survey (BTS) in 2014-2016 (Panel A) and in 2017 for the further adjustment to the LLS rough and smooth strata (Panel B). Estimated number (n) of stations for each stratum determined by applying the new area unit per station to each stratum (total new strata area / station = 629 km^2 / station in A; Rough strata area = 225 km^2 / station and smooth strata area = 2821 km^2 / station in B). Number of stations was then adjusted to account for coverage of both bottom types and logistical considerations.

2A.

BTS strata	BTS area (nm^2)	BTS area (km^2)	BTS station n	BTS area per station (km^2)	LLS strata	LLS strata area (km^2)	Strata area difference (km^2)	LLS Estimated station n	LLS Reassigned station n	LLS n smooth (0.3 * total)	LLS n rough (0.7 * total)
01260	1014	3478	9	386	26	3375	103	5	7	2	5
01270	720	2470	5	494	27	2470	0	3	7	2	5
01280	2249	7714	7	1102	28	6795	919	10	7	2	5
01290	3245	11130	9	1237	29	5450	5680	8	8	2	6
01360	4069	13956	9	1551	36	3276	10680	5	8	2	6
01370	2108	7230	7	1033	37	6941	289	11	8	2	6
Total	13405	45978	46	1000		28307	17671	42	45	12	33

2B.

Rough strata	Rough strata area (km^2)	Number of stations	Estimated station n	Reassigned station n	Smooth strata	Smooth strata area (km^2)	Estimated station n	Reassigned station n
26	1021	5	5	5	2627	4068	1	2
27	756	3	3	5	2837	9597	3	3
28	2044	9	9	7	2936	6083	2	2
29	1642	7	7	7				
36	1001	4	4	6				
37	2094	9	9	8				
Total	8558		38	38		19749	6	7

Table 3. Example deck sheet used by field staff for biological sampling requests (sex, maturity, individual weight, histology, age structures) to be collected at each station by species and length group. Some requests have been added or changed among years based on requesting biologists' needs (these were the requests in 2016). Species were assigned a research priority level (1 being highest) to give the chief scientist criteria when time was limited. Additional requests (not listed here) for work such as tagging or genetic samples were opportunistically conducted at the chief scientists' discretion.

Species	Scientific Name	Priority	Minimum Length	Number of Samples	Sex	Macroscopic Maturity	Individual Weight	Gonad Histology	Stomach Sample	Age Structure
Acadian redfish	*Sebastes fasciatus*	4	44	ALL	X	X	X			Otolith
American plaice	*Hippoglossoides platessoides*	4	52	ALL	X	X	X			Otolith
Atlantic halibut	*Hippoglossus hippoglossus*	1	ALL	ALL	X	X	X	X		Otolith
Atlantic wolffish	*Anarhichas lupus*	1	ALL	ALL	X	X	X	X		Head
barndoor skate	*Dipturus laevis*	3	41	ALL	X	X	X			
Atlantic cod	*Gadus morhua*	2	70	ALL	X	X	X			Otolith
cusk	*Brosme brosme*	1	ALL	ALL	X	X	X	X		Otolith
haddock	*Melanogrammus aeglefinus*	4	60	2 per 1	X	X	X			Otolith
goosefish	*Lophius americanus*	4	90	ALL	X	X	X			Illicium
ocean pout	*Zoarces americanus*	2	41	1 per 5	X	X	X			Head
pollock	*Pollachius virens*	2	81	ALL	X	X	X			Otolith
red hake	*Urophycis chuss*	3	45	ALL	X	X	X			Otolith
silver hake	*Merluccius bilinearis*	4	45	ALL	X	X	X			Otolith
smooth skate	*Malacoraja senta*	2	31	ALL	X	X	X			
thorny skate	*Amblyraja radiata*	2	31	ALL	X	X	X			
tilefish	*Lopholatilus chamaeleonticeps*	3	ALL	ALL	X	X	X	X	X	Otolith
white hake	*Urophycis tenuis*	2	60	ALL	X	X	X			Otolith
witch flounder	*Glyptocephalus cynoglossus*	4	50	ALL	X	X	X			Otolith

Table 4. Station evaluation criteria: codes, description, and the maximum values for a representative station for analysis (values above this cutoff considered unrepresentative). These are evaluations made by the scientists during each gear deployment and haul back. The stations were evaluated in 6 broad categories (A), which are listed by the database column names, with 3 to 8 potential criteria codes (with the displayed description in the software). More detailed descriptions for each category (B) and a display value are also provided. A standard random survey station will have a station type of 1 and assignment of 1.

A.

CATEGORY	MIN	MAX	CUTOFF	DESCRIPTION
STATION_TYPE	1	4	1	TYPE OF SURVEY STATION
STATION_ASSIGNMENT	1	3	NA	STATION LOCATION ASSIGNMENT
GEAR_EVALUATION	1	6	3	GEAR TANGLES AND RELATIVE SCALE WITH IMPLICATION FOR REPRESENTATIVENESS
GEAR_DAMAGE	1	5	4	PARTING OF MAINLINE AND ANY ASSOCIATED GEAR LOSS
GEAR_INTERACTION	1	4	3	INTERACTIONS WITH OTHER FISHING GEAR AND SEVERITY
INTERACTION_TYPE	1	8	NA	TYPE OF GEAR INTERACTION
ENVIRONMENTAL_CONDITIONS	1	4	3	EFFECT OF CONDITIONS ON CATCH AND CATCH RETENTION (WIND; SEA STATE; BIRDS; CURRENT)
DATA_ACQUISITION	1	4	3	DATA ACQUISITION QUALITY

B.

CATEGORY	VALUE	DISPLAY_VALUE	VALUE_DESCRIPTION
STATION_TYPE	1	RANDOM	RANDOM STANDARD SURVEY SET
STATION_TYPE	2	NON-RANDOM	NON STANDARD RANDOM SET
STATION_TYPE	3	EXPERIMENTAL	EXPERIMENTAL SET
STATION_TYPE	4	OTHER	OTHER NON SURVEY SET
STATION_ASSIGNMENT	1	BASE	LOCATION FROM ORIGINAL BASE LIST OF RANDOM STATIONS
STATION_ASSIGNMENT	2	ALTERNATE	LOCATION FROM ALTERNATE LIST OF RANDOM STATIONS
STATION_ASSIGNMENT	3	REPEAT	REPEATED STATION OF AN ORIGINAL BASE RANDOM STATION
GEAR_EVALUATION	1	NONE	NO TANGLES
GEAR_EVALUATION	2	<50	REPRESENTATIVE. FEW SMALL TANGLES. LESS THAN 50 HOOKS
GEAR_EVALUATION	3	50-150	REPRESENTATIVE. SOME TANGLES. APPROXIMATELY 50 TO 150 HOOKS
GEAR_EVALUATION	4	150+	NOT REPRESENTATIVE. LARGE OR MULTIPLE TANGLES >150 HOOKS(~HALF BOX) ON HAUL BACK
GEAR_EVALUATION	5	WHOLE BOX	NOT REPRESENTATIVE. MASSIVE TANGLES EFFECTING AN ENTIRE BOX OR MORE OF GEAR
GEAR_EVALUATION	6	ABORT	ABORTED SET
GEAR_DAMAGE	1	NONE	NO PARTING OF MAINLINE
GEAR_DAMAGE	2	PART RETIED	GEAR PARTED BUT RETIED AT VESSEL
GEAR_DAMAGE	3	SNGL. PART-COMPLETE	GEAR PARTED BUT HAUL COMPLETED FROM OTHER END AND CONSIDERED REPRESENTATIVE
GEAR_DAMAGE	4	MULT. PARTS-COMPLETE	GEAR PARTED MULTIPLE TIMES WITH LITTLE GEAR LOSS. CONSIDERED REPRESENTATIVE
GEAR_DAMAGE	5	NOT-REPRESENTATIVE	MULTIPLE GEAR PARTS WITH SIGNIFICANT GEAR LOSS. ENOUGH TO BE NON REPRESENTATIVE
GEAR_INTERACTION	1	NONE	NO INTERACTIONS
GEAR_INTERACTION	2	FEW	SOME INTERACTION BUT NO DAMAGE. REPRESENTATIVE
GEAR_INTERACTION	3	SOME	SOME DAMAGE TO LONGLINE BUT STILL REPRESENTATIVE
GEAR_INTERACTION	4	MAJOR	CATASTROPHIC INTERACTION. UNREPRESENTATIVE
INTERACTION_TYPE	1	NONE	NO GEAR INTERACTION
INTERACTION_TYPE	2	LOBSTER POT -SINGLE	SINGLE LOBSTER POT
INTERACTION_TYPE	3	LOBSTER POT-MULTIPLE	MULTIPLE LOBSTER POTS
INTERACTION_TYPE	4	LOBSTER POT -GHOST	GHOST LOBSTER POT
INTERACTION_TYPE	5	GILLNET-ACTIVE	ACTIVE GILLNET
INTERACTION_TYPE	6	GILLNET-GHOST	GHOST GILLNET
INTERACTION_TYPE	7	OTTER TRAWL	OTTER TRAWL
INTERACTION_TYPE	8	ROD AND REEL	ROD AND REEL
INTERACTION_TYPE	9	OTHER	OTHER
ENVIRONMENTAL_CONDITIONS	1	NONE	NO ENVIRONMENTAL CONDITION ISSUES
ENVIRONMENTAL_CONDITIONS	2	FEW	FEW FISH LOST DUE TO SEA STATE OR BAITS LOST TO BIRDS (< 50 HOOKS)
ENVIRONMENTAL_CONDITIONS	3	SOME	SOME FISH LOST DUE TO SEA STATE OR BAITS LOST TO BIRDS (50 TO 100 HOOKS)
ENVIRONMENTAL_CONDITIONS	4	MANY	MANY FISH LOST DUE TO SEA STATE OR BAITS LOST TO BIRDS (100+ HOOKS)
DATA_ACQUISITION	1	NONE	NO DATA COLLECTION ISSUES
DATA_ACQUISITION	2	FEW	A FEW DATA QUALITY ISSUES OR DATA LOSS (<5% OF DATA)
DATA_ACQUISITION	3	SOME	SOME DATA QUALITY ISSUES OR LOSS (5 TO 15% OF DATA)-POSSIBLY UNREPRESENTATIVE
DATA_ACQUISITION	4	MAJOR	MAJOR ISSUES, POOR QUALITY OR LOST DATA (>15% OF DATA), UNREPRESENTATIVE

Table 5. Initial Oracle database table structure for station, catch, length, biosampling, damaged fish otolith, raw current, and global positioning system (GPS) raw polling and depth sounder data tables. Data are updated each season, and the structure is adjusted as the survey data collection is improved. Column and table descriptions provided in the Oracle database metadata (https://inport.nmfs.noaa.gov/inport/item/27731).

Table	Column Name	Format	Table	Column Name	Format
STATION	CRUISE	NUMBER(10,0)	LENGTH	CRUISE	NUMBER(10,0)
STATION	STATION	NUMBER(5,0)	LENGTH	STATION	NUMBER(5,0)
STATION	STATION_ID	VARCHAR2(10 BYTE)	LENGTH	SVSPP	NUMBER(5,0)
STATION	TRIP_ID	NUMBER(20,0)	LENGTH	COMMON_NAME	VARCHAR2(50 BYTE)
STATION	EFFORT_NUM	NUMBER(5,0)	LENGTH	SEX	NUMBER(2,0)
STATION	STRATUM	NUMBER(5,0)	LENGTH	LENGTH	NUMBER(4,0)
STATION	ASSIGNED_STRATUM	NUMBER(5,0)	LENGTH	ENTRY_ORDER	NUMBER(4,0)
STATION	BOTTOM_TYPE	VARCHAR2(10 BYTE)	LENGTH	NOTES	VARCHAR2(255 BYTE)
STATION	AREA	NUMBER(5,0)	LENGTH	VESSEL	NUMBER
STATION	BEGIN_SET_TIME	DATE	LENGTH	EST_LENGTH	VARCHAR2(1 BYTE)
STATION	END_SET_TIME	DATE	LENGTH	AUDIT_FLAG	VARCHAR2(3 BYTE)
STATION	BEGIN_HAUL_TIME	DATE	BIOSAMPLING	CRUISE	NUMBER(10,0)
STATION	END_HAUL_TIME	DATE	BIOSAMPLING	STATION	NUMBER(5,0)
STATION	SOAK_DURATION_DH	NUMBER(7,4)	BIOSAMPLING	COMMON_NAME	VARCHAR2(50 BYTE)
STATION	DECDEG_BEGLAT_SET	NUMBER(8,5)	BIOSAMPLING	SVSPP	NUMBER(5,0)
STATION	DECDEG_BEGLON_SET	NUMBER(8,5)	BIOSAMPLING	LENGTH	NUMBER(4,0)
STATION	DECDEG_ENDLAT_SET	NUMBER(8,5)	BIOSAMPLING	WEIGHT	NUMBER(6,3)
STATION	DECDEG_ENDLON_SET	NUMBER(8,5)	BIOSAMPLING	SEX	NUMBER
STATION	DECDEG_BEGLAT_HAUL	NUMBER(8,5)	BIOSAMPLING	MATURITY	VARCHAR2(2 BYTE)
STATION	DECDEG_BEGLON_HAUL	NUMBER(8,5)	BIOSAMPLING	FISH_ID	NUMBER(8,0)
STATION	DECDEG_ENDLAT_HAUL	NUMBER(8,5)	BIOSAMPLING	GONAD_WT	NUMBER(6,1)
STATION	DECDEG_ENDLON_HAUL	NUMBER(8,5)	BIOSAMPLING	LIVER_WT	NUMBER(6,1)
STATION	STATION_TYPE	NUMBER(1,0)	BIOSAMPLING	GUTTED_WT	NUMBER(6,1)
STATION	STATION_ASSIGNMENT	NUMBER(1,0)	BIOSAMPLING	COMMENTS	VARCHAR2(255 BYTE)
STATION	GEAR_EVALUATION	NUMBER(1,0)	BIOSAMPLING	AGE	NUMBER(3,0)
STATION	GEAR_DAMAGE	NUMBER(1,0)	BIOSAMPLING	EST_LENGTH	VARCHAR2(1 BYTE)
STATION	GEAR_INTERACTION	NUMBER(1,0)	BIOSAMPLING	AUDIT_FLAG	VARCHAR2(3 BYTE)
STATION	INTERACTION_TYPE	NUMBER(1,0)	CURRENT	CRUISE	NUMBER(10)
STATION	ENVIRONMENTAL_CONDITIONS	NUMBER(1,0)	CURRENT	DATE_TIME	DATE
STATION	DATA_ACQUISITION	NUMBER(1,0)	CURRENT	TILT	NUMBER(6,2)
STATION	SET_NOTES	VARCHAR2(300 BYTE)	CURRENT	VELOCITY_X	NUMBER(8,2)
STATION	HAUL_NOTES	VARCHAR2(255 BYTE)	CURRENT	VELOCITY_Y	NUMBER(8,2)
STATION	CATCH_NOTES	VARCHAR2(300 BYTE)	CURRENT	TOTAL_VELOCITY	NUMBER(8,2)
STATION	BOTTOM_VIDEO	NUMBER(1,0)	CURRENT	DEGREES_TRUE	NUMBER(8,2)
STATION	WINDDIR	VARCHAR2(3 BYTE)	CURRENT	VELOCITY_EASTING	NUMBER(8,2)
STATION	WINDSP	NUMBER(3,0)	CURRENT	VELOCITY_NORTHING	NUMBER(8,2)
STATION	WAVEHGT	NUMBER(3,0)	CURRENT	SERIAL_NUM	NUMBER(10)
STATION	SWELLHGT	NUMBER(3,0)	DAMAGED_FISH_OTOLITHS	CRUISE	NUMBER(10,0)
STATION	VESSEL_NAME	VARCHAR2(50 BYTE)	DAMAGED_FISH_OTOLITHS	STATION	NUMBER(5,0)
STATION	CURRENT_INSTR_ID1	VARCHAR2(14 BYTE)	DAMAGED_FISH_OTOLITHS	SVSPP	NUMBER(5,0)
STATION	CURRENT_INSTR_ID2	VARCHAR2(14 BYTE)	DAMAGED_FISH_OTOLITHS	FISH_ID	NUMBER(3,0)
CATCH	CRUISE	NUMBER(10,0)	DAMAGED_FISH_OTOLITHS	OL	NUMBER(6,4)
CATCH	STATION	NUMBER(5,0)	GPS_DEPTH	CRUISE	NUMBER(10)
CATCH	COMMON_NAME	VARCHAR2(50 BYTE)	GPS_DEPTH	DATE_TIME	DATE
CATCH	SVSPP	NUMBER(5,0)	GPS_DEPTH	LATITUDE	NUMBER(10,5)
CATCH	SEX	NUMBER(2,0)	GPS_DEPTH	LONGITUDE	NUMBER(10,5)
CATCH	LENWT	NUMBER(9,3)	GPS_DEPTH	DEPTH	NUMBER(7,2)
CATCH	LENNUM	NUMBER(6,0)	GPS_DEPTH	SPEED	NUMBER(5,2)
CATCH	CATCHWT	NUMBER(9,3)	GPS_DEPTH	COURSE	NUMBER(6,2)
CATCH	CATCHNUM	NUMBER(6,0)	GPS_DEPTH	FIX	NUMBER(3)
CATCH	COMMENTS	VARCHAR2(255 BYTE)	GPS_DEPTH	NUM_SATELLITES	NUMBER(38)
CATCH	AUDIT_FLAG	VARCHAR2(3 BYTE)	GPS_DEPTH	EFFORT_BUTTON_ACTIVITY	VARCHAR2(100)

Table 6. Percent of longline stations with positive catches for a species by survey season, year, and bottom type (rough [A], smooth [B], and both bottom types combined [C]) during spring and fall, 2014-2017.

A.

Species	Scientific Name	Rough 2014 Spring	Rough 2014 Fall	Rough 2015 Spring	Rough 2015 Fall	Rough 2016 Spring	Rough 2016 Fall	Rough 2017 Spring	Rough 2017 Fall
ACADIAN REDFISH	*Sebastes fasciatus*	45.5	24.2	42.4	36.4	24.2	27.3	36.8	27.0
AMERICAN LOBSTER	*Homarus americanus*				6.1	6.1	6.1	2.6	
AMERICAN PLAICE	*Hippoglossoides platessoides*								
ATLANTIC COD	*Gadus morhua*	81.8	69.7	78.8	78.8	72.7	84.8	86.8	73.0
ATLANTIC HAGFISH	*Myxine glutinosa*				12.1	12.1	15.2	10.5	18.9
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	12.1	9.1	6.1	6.1	9.1	3.0	15.8	5.4
ATLANTIC ROCK CRAB	*Cancer irroratus*					3.0			
ATLANTIC WOLFFISH	*Anarhichas lupus*	6.1	9.1	12.1	6.1	6.1	3.0	18.4	2.7
BARNDOOR SKATE	*Dipturus laevis*	15.2	36.4	3.0	42.4	12.1	39.4	18.4	43.2
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	6.1	12.1	9.1	18.2	9.1	12.1	15.8	18.9
BLUE SHARK	*Prionace glauca*		9.1						5.4
CUSK	*Brosme brosme*	57.6	69.7	66.7	78.8	69.7	69.7	68.4	70.3
RED DEEPSEA CRAB	*Chaceon quinquedens*								
FOURBEARD ROCKLING	*Enchelyopus cimbrius*					3.0			
HADDOCK	*Melanogrammus aeglefinus*	75.8	75.8	93.9	90.9	97.0	93.9	94.7	100.0
JONAH CRAB	*Cancer borealis*	6.1	12.1	18.2	18.2	15.2	21.2	21.1	35.1
LITTLE SKATE	*Leucoraja erinacea*				3.0	3.0		5.3	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	9.1	12.1	15.2	12.1	18.2	9.1	18.4	2.7
MONKFISH	*Lophius americanus*	3.0	6.1	6.1	9.1	3.0	6.1	21.1	21.6
NORTHERN STONE CRAB	*Lithodes maja*	3.0	6.1		3.0		3.0	5.3	5.4
OCEAN POUT	*Zoarces americanus*		3.0	3.0		9.1		5.3	2.7
OCEAN QUAHOG	*Arctica islandica*								
POLLOCK	*Pollachius virens*	21.2	36.4	15.2	21.2	18.2	24.2	34.2	40.5
PORBEAGLE SHARK	*Lamna nasus*					3.0		2.6	
RED HAKE	*Urophycis chuss*	72.7	90.9	93.9	97.0	93.9	93.9	84.2	81.1
SEA RAVEN	*Hemitripterus americanus*	6.1		6.1	3.0	6.1		2.6	2.7
SEA SCALLOP	*Placopecten magellanicus*		3.0		3.0	6.1		2.6	
SILVER HAKE	*Merluccius bilinearis*		3.0	21.2	9.1	12.1	9.1	26.3	5.4
SMOOTH SKATE	*Malacoraja senta*	27.3	21.2	66.7	27.3	42.4	30.3	65.8	37.8
SPINY DOGFISH	*Squalus acanthias*	84.8	100.0	78.8	100.0	93.9	100.0	89.5	97.3
SPOTTED HAKE	*Urophycis regia*								2.7
THORNY SKATE	*Amblyraja radiata*	66.7	66.7	69.7	60.6	63.6	45.5	71.1	59.5
TILEFISH	*Lopholatilus chamaeleonticeps*			6.1				2.6	5.4
WHITE HAKE	*Urophycis tenuis*	36.4	66.7	42.4	72.7	57.6	87.9	65.8	86.5
WINTER FLOUNDER	*Pseudopleuronectes americanus*	3.0			6.1				
WINTER SKATE	*Leucoraja ocellata*		6.1	6.1	3.0	9.1	3.0	13.2	8.1
WRYMOUTH	*Cryptacanthodes maculatus*	3.0				9.1		2.6	2.7
YELLOWTAIL FLOUNDER	*Limanda ferruginea*			3.0					

B.

Species	Scientific Name	Smooth 2014 Spring	Smooth 2014 Fall	Smooth 2015 Spring	Smooth 2015 Fall	Smooth 2016 Spring	Smooth 2016 Fall	Smooth 2017 Spring	Smooth 2017 Fall
ACADIAN REDFISH	*Sebastes fasciatus*			8.3	8.3	8.3	16.7		
AMERICAN LOBSTER	*Homarus americanus*								
AMERICAN PLAICE	*Hippoglossoides platessoides*		8.3						
ATLANTIC COD	*Gadus morhua*	50.0	41.7	75.0	25.0	33.3	41.7	14.3	42.9
ATLANTIC HAGFISH	*Myxine glutinosa*				33.3	25.0	25.0		42.9
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	8.3				8.3	8.3		
ATLANTIC ROCK CRAB	*Cancer irroratus*	8.3							
ATLANTIC WOLFFISH	*Anarhichas lupus*								
BARNDOOR SKATE	*Dipturus laevis*	25.0	58.3	16.7	66.7	16.7	75.0		85.7
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*		16.7				8.3	14.3	
BLUE SHARK	*Prionace glauca*								14.3
CUSK	*Brosme brosme*	33.3	8.3	16.7	16.7	16.7	50.0		42.9
RED DEEPSEA CRAB	*Chaceon quinquedens*		8.3						
FOURBEARD ROCKLING	*Enchelyopus cimbrius*								
HADDOCK	*Melanogrammus aeglefinus*	50.0	33.3	91.7	50.0	83.3	58.3	57.1	100.0
JONAH CRAB	*Cancer borealis*			8.3	41.7	8.3	33.3	28.6	14.3
LITTLE SKATE	*Leucoraja erinacea*	16.7		16.7			8.3	28.6	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	16.7	8.3	8.3		8.3		28.6	
MONKFISH	*Lophius americanus*	8.3			25.0		8.3		
NORTHERN STONE CRAB	*Lithodes maja*								
OCEAN POUT	*Zoarces americanus*			8.3		16.7			
OCEAN QUAHOG	*Arctica islandica*	8.3							
POLLOCK	*Pollachius virens*	8.3					8.3		
PORBEAGLE SHARK	*Lamna nasus*								
RED HAKE	*Urophycis chuss*	83.3	91.7	100.0	100.0	91.7	83.3	85.7	85.7
SEA RAVEN	*Hemitripterus americanus*								
SEA SCALLOP	*Placopecten magellanicus*					8.3		14.3	
SILVER HAKE	*Merluccius bilinearis*	8.3		16.7				14.3	
SMOOTH SKATE	*Malacoraja senta*	33.3	16.7	33.3	8.3	33.3	50.0	28.6	28.6
SPINY DOGFISH	*Squalus acanthias*	91.7	100.0	83.3	100.0	100.0	100.0	71.4	100.0
SPOTTED HAKE	*Urophycis regia*								
THORNY SKATE	*Amblyraja radiata*	50.0	25.0	41.7	33.3	50.0	50.0	28.6	42.9
TILEFISH	*Lopholatilus chamaeleonticeps*								
WHITE HAKE	*Urophycis tenuis*	58.3	75.0	58.3	91.7	91.7	66.7	85.7	100.0
WINTER FLOUNDER	*Pseudopleuronectes americanus*								
WINTER SKATE	*Leucoraja ocellata*	16.7	8.3	16.7		25.0	8.3	28.6	
WRYMOUTH	*Cryptacanthodes maculatus*	8.3	16.7	16.7	8.3	16.7		14.3	
YELLOWTAIL FLOUNDER	*Limanda ferruginea*								

C.

Species	Scientific Name	Both 2014 Spring	Both 2014 Fall	Both 2015 Spring	Both 2015 Fall	Both 2016 Spring	Both 2016 Fall	Both 2016 Spring	Both 2016 Fall
ACADIAN REDFISH	Sebastes fasciatus	33.3	17.8	33.3	28.9	20.0	24.4	31.1	22.7
AMERICAN LOBSTER	Homarus americanus				4.4	4.4	4.4	2.2	
AMERICAN PLAICE	Hippoglossoides platessoides		2.2						
ATLANTIC COD	Gadus morhua	73.3	62.2	77.8	64.4	62.2	73.3	75.6	68.2
ATLANTIC HAGFISH	Myxine glutinosa				17.8	15.6	17.8	8.9	22.7
ATLANTIC HALIBUT	Hippoglossus hippoglossus	11.1	6.7	4.4	4.4	8.9	4.4	13.3	4.5
ATLANTIC ROCK CRAB	Cancer irroratus	2.2				2.2			
ATLANTIC WOLFFISH	Anarhichas lupus	4.4	6.7	8.9	4.4	4.4	2.2	15.6	2.3
BARNDOOR SKATE	Dipturus laevis	17.8	42.2	6.7	48.9	13.3	48.9	15.6	50.0
BLACKBELLY ROSEFISH	Helicolenus dactylopterus	4.4	13.3	6.7	13.3	6.7	11.1	15.6	15.9
BLUE SHARK	Prionace glauca		6.7						6.8
CUSK	Brosme brosme	51.1	53.3	53.3	62.2	55.6	64.4	57.8	65.9
RED DEEPSEA CRAB	*Chaceon quinquedens*		2.2						
FOURBEARD ROCKLING	Enchelyopus cimbrius					2.2			
HADDOCK	Melanogrammus aeglefinus	68.9	64.4	93.3	80.0	93.3	84.4	88.9	100.0
JONAH CRAB	Cancer borealis	4.4	8.9	15.6	24.4	13.3	24.4	22.2	31.8
LITTLE SKATE	Leucoraja erinacea	4.4		4.4	2.2	2.2	2.2	8.9	
LONGHORN SCULPIN	Myoxocephalus octodecemspinosus	11.1	11.1	13.3	8.9	15.6	6.7	20.0	2.3
MONKFISH	Lophius americanus	4.4	4.4	4.4	13.3	2.2	6.7	17.8	18.2
NORTHERN STONE CRAB	Lithodes maja	2.2	4.4		2.2		2.2	4.4	4.5
OCEAN POUT	Zoarces americanus		2.2	4.4		11.1		4.4	2.3
OCEAN QUAHOG	Arctica islandica	2.2							
POLLOCK	Pollachius virens	17.8	26.7	11.1	15.6	13.3	20.0	28.9	34.1
PORBEAGLE SHARK	Lamna nasus					2.2		2.2	
RED HAKE	Urophycis chuss	75.6	91.1	95.6	97.8	93.3	91.1	84.4	81.8
SEA RAVEN	Hemitripterus americanus	4.4		4.4	2.2	4.4		2.2	2.3
SEA SCALLOP	Placopecten magellanicus		2.2		2.2	6.7		4.4	
SILVER HAKE	Merluccius bilinearis	2.2	2.2	20.0	6.7	8.9	6.7	24.4	4.5
SMOOTH SKATE	Malacoraja senta	28.9	20.0	57.8	22.2	40.0	35.6	60.0	36.4
SPINY DOGFISH	Squalus acanthias	86.7	100.0	80.0	100.0	95.6	100.0	86.7	97.7
SPOTTED HAKE	Urophycis regia								2.3
THORNY SKATE	Amblyraja radiata	62.2	55.6	62.2	53.3	60.0	46.7	64.4	56.8
TILEFISH	Lopholatilus chamaeleonticeps			4.4				2.2	4.5
WHITE HAKE	Urophycis tenuis	42.2	68.9	46.7	77.8	66.7	82.2	68.9	88.6
WINTER FLOUNDER	Pseudopleuronectes americanus	2.2			4.4				
WINTER SKATE	Leucoraja ocellata	4.4	6.7	8.9	2.2	13.3	4.4	15.6	6.8
WRYMOUTH	Cryptacanthodes maculatus	4.4	4.4	4.4	2.2	11.1		4.4	2.3
YELLOWTAIL FLOUNDER	Limanda ferruginea			2.2					

Table 7. Total number of fish sampled overall and for each type of biological data by species on the bottom longline survey, 2014-2017, with the spring and fall seasons combined.

SPECIES	SCIENTIFIC NAME	YEAR	SAMPLED	TOTAL WEIGHT	MATURITY	AGE TAKEN	GONAD HISTOLOGY	ORGAN WEIGHTS
ATLANTIC COD	*Gadus morhua*	2014	27	27	26	27	1	0
		2015	72	72	72	67	6	6
		2016	36	36	36	36	0	0
		2017	53	53	53	53	0	0
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	2014	9	9	9	9	8	7
		2015	4	4	4	4	4	3
		2016	6	5	6	6	6	6
		2017	12	12	12	12	12	12
ATLANTIC WOLFFISH	*Anarhichas lupus*	2014	8	8	8	8	8	6
		2015	10	10	10	10	10	9
		2016	3	3	3	3	3	3
		2017	17	17	17	17	16	17
BARNDOOR SKATE	*Dipturus laevis*	2014	94	94	94	0	0	0
		2015	74	74	74	0	0	0
		2016	94	94	92	0	0	0
		2017	103	103	101	0	0	0
CUSK	*Brosme brosme*	2014	624	622	621	623	522	470
		2015	385	382	385	385	291	259
		2016	435	435	432	414	291	252
		2017	630	630	629	629	54	66
HADDOCK	*Melanogrammus aeglefinus*	2014	36	36	34	36	1	0
		2015	46	46	46	46	0	0
		2016	45	45	45	44	0	0
		2017	53	53	53	53	0	0
OCEAN POUT	*Zoarces americanus*	2015	3	3	3	3	0	0
		2016	6	6	6	6	0	0
		2017	4	4	4	4	1	1
POLLOCK	*Pollachius virens*	2014	1	1	1	1	0	0
RED HAKE	*Urophycis chuss*	2015	85	80	84	85	0	0
		2016	66	66	66	65	0	0
		2017	64	63	64	64	0	0
SMOOTH SKATE	*Malacoraja senta*	2014	32	27	32	0	0	0
		2015	112	111	112	0	0	0
		2016	80	79	80	0	0	0
		2017	145	145	145	0	0	0
THORNY SKATE	*Amblyraja radiata*	2014	443	355	443	0	0	0
		2015	568	568	567	0	0	0
		2016	623	623	501	0	0	0
		2017	477	474	400	0	0	0
TILEFISH	*Lopholatilus chamaeleonticeps*	2015	8	8	8	8	0	0
		2017	5	5	5	5	5	5
WHITE HAKE	*Urophycis tenuis*	2014	270	269	266	266	28	21
		2015	247	247	247	247	0	0
		2016	263	262	263	263	0	0
		2017	399	399	398	399	0	0

Table 8. Bottom longline stratified mean number (NUM; A) and weight (WT; C) per set with coefficients of variation (CV; B, D) for all species caught on rough bottom in spring and fall, 2014-2017.

A.

SPECIES	SCIENTIFIC NAME	NUM 2014 SPRING	NUM 2014 FALL	NUM 2015 SPRING	NUM 2015 FALL	NUM 2016 SPRING	NUM 2016 FALL	NUM 2017 SPRING	NUM 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	3.10	3.08	1.47	0.90	0.64	1.48	1.66	1.67
AMERICAN LOBSTER FEMALE	*Homarus americanus*	0.00	0.00	0.00	0.02	0.06	0.03	0.00	0.00
AMERICAN LOBSTER MALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00
AMERICAN LOBSTER UNSEXED	*Homarus americanus*	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
ATLANTIC COD	*Gadus morhua*	8.76	5.40	8.60	9.72	11.88	8.02	6.88	6.12
ATLANTIC HAGFISH	*Myxine glutinosa*	0.00	0.00	0.00	0.14	0.14	0.24	0.17	0.25
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	0.12	0.15	0.06	0.08	0.13	0.02	0.23	0.05
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.14	0.12	0.17	0.06	0.09	0.04	0.37	0.09
BARNDOOR SKATE	*Dipturus laevis*	0.63	1.71	0.06	1.28	0.48	1.97	0.69	1.49
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.16	0.67	0.74	1.12	0.54	0.85	1.30	0.86
BLUE SHARK FEMALE	*Prionace glauca*	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
BLUE SHARK MALE	*Prionace glauca*	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.05
BLUE SHARK UNSEXED	*Prionace glauca*	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
CUSK	*Brosme brosme*	12.77	17.69	4.90	8.24	4.37	12.84	10.05	12.68
HADDOCK	*Melanogrammus aeglefinus*	28.29	18.24	34.34	37.58	36.79	25.76	46.63	33.52
JONAH CRAB FEMALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08
JONAH CRAB MALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.11	0.10	0.18	0.41
JONAH CRAB UNSEXED	*Cancer borealis*	0.05	0.22	0.31	0.19	0.05	0.10	0.03	0.00
LITTLE SKATE	*Leucoraja erinacea*	0.00	0.00	0.00	0.17	0.26	0.00	0.81	0.00
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.08	0.70	0.91	0.54	0.67	0.24	5.89	0.07
MONKFISH	*Lophius americanus*	0.03	0.09	0.06	0.25	0.06	0.07	0.29	0.19
NORTHERN STONE CRAB FEMALE	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	0.03	0.04	0.00	0.02	0.00	0.04	0.03	0.02
OCEAN POUT	*Zoarces americanus*	0.00	0.02	0.05	0.00	0.10	0.00	0.07	0.02
POLLOCK	*Pollachius virens*	0.71	1.11	0.26	1.43	0.21	1.30	0.85	1.60
RED HAKE	*Urophycis chuss*	6.70	8.83	23.03	17.43	27.02	18.93	33.39	12.38
SEA RAVEN	*Hemitripterus americanus*	0.09	0.00	0.04	0.02	0.06	0.00	0.02	0.03
SEA SCALLOP	*Placopecten magellanicus*	0.00	0.04	0.00	0.02	0.15	0.00	0.05	0.00
SILVER HAKE	*Merluccius bilinearis*	0.00	0.02	0.53	0.14	0.21	0.08	0.65	0.06
SMOOTH SKATE	*Malacoraja senta*	0.46	0.25	2.33	0.41	1.35	0.54	2.19	1.03
SPINY DOGFISH FEMALE	*Squalus acanthias*	42.22	21.47	28.67	30.65	39.82	41.09	17.85	35.31
SPINY DOGFISH MALE	*Squalus acanthias*	82.78	82.00	43.25	67.23	86.69	124.41	19.99	107.40
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.04	1.39	0.63	12.04	0.03	0.42	12.02	17.84
THORNY SKATE	*Amblyraja radiata*	4.93	5.59	6.64	6.44	11.18	2.58	6.66	3.97
TILEFISH	*Lopholatilus chamaeleonticeps*	0.00	0.00	0.26	0.00	0.00	0.00	0.14	0.14
WHITE HAKE	*Urophycis tenuis*	1.96	7.56	4.00	8.43	5.11	8.67	8.64	9.59
WINTER SKATE	*Leucoraja ocellata*	0.00	0.11	0.07	1.96	0.33	0.02	0.29	0.11
WRYMOUTH	*Cryptacanthodes maculatus*	0.06	0.00	0.00	0.00	0.16	0.00	0.03	0.08

B.

SPECIES	SCIENTIFIC NAME	CV NUM 2014 SPRING	CV NUM 2014 FALL	CV NUM 2015 SPRING	CV NUM 2015 FALL	CV NUM 2016 SPRING	CV NUM 2016 FALL	CV NUM 2017 SPRING	CV NUM 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.38	0.72	0.36	0.47	0.50	0.60	0.37	0.51
AMERICAN LOBSTER FEMALE	*Homarus americanus*				1.00	0.75	1.00		
AMERICAN LOBSTER MALE	*Homarus americanus*						1.00	1.00	
AMERICAN LOBSTER UNSEXED	*Homarus americanus*				1.00				
ATLANTIC COD	*Gadus morhua*	0.30	0.25	0.20	0.18	0.28	0.31	0.24	0.23
ATLANTIC HAGFISH	*Myxine glutinosa*				0.52	0.52	0.48	0.61	0.36
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	0.48	0.58	0.63	0.63	0.58	1.00	0.42	0.72
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*					1.00			
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*								
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.65	0.70	0.29	0.72	0.71	1.00	0.40	1.00
BARNDOOR SKATE	*Dipturus laevis*	0.58	0.41	1.00	0.28	0.56	0.53	0.42	0.23
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.65	0.57	0.57	0.47	0.86	0.65	0.55	0.46
BLUE SHARK FEMALE	*Prionace glauca*		1.00						
BLUE SHARK MALE	*Prionace glauca*		1.00						0.72
BLUE SHARK UNSEXED	*Prionace glauca*		1.00						
CUSK	*Brosme brosme*	0.33	0.29	0.30	0.34	0.28	0.46	0.26	0.26
HADDOCK	*Melanogrammus aeglefinus*	0.26	0.16	0.13	0.21	0.23	0.26	0.12	0.18
JONAH CRAB FEMALE	*Cancer borealis*							1.00	0.61
JONAH CRAB MALE	*Cancer borealis*					0.61	0.62	0.42	0.27
JONAH CRAB UNSEXED	*Cancer borealis*	0.73	0.49	0.41	0.41	0.74	0.49	1.00	
LITTLE SKATE	*Leucoraja erinacea*				1.00	1.00		0.77	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.50	0.66	0.74	0.42	0.41	0.65	0.83	1.00
MONKFISH	*Lophius americanus*	1.00	0.79	0.63	0.66	1.00	0.77	0.26	0.32
NORTHERN STONE CRAB FEMALE	*Lithodes maja*							1.00	1.00
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	1.00	0.58		1.00		1.00	1.00	1.00
OCEAN POUT	*Zoarces americanus*		1.00	1.00		0.47		0.67	1.00
POLLOCK	*Pollachius virens*	0.38	0.54	0.54	0.44	0.39	0.75	0.29	0.33
RED HAKE	*Urophycis chuss*	0.24	0.16	0.11	0.18	0.23	0.19	0.11	0.19
SEA RAVEN	*Hemitripterus americanus*	0.81		0.71	1.00	0.73		1.00	1.00
SEA SCALLOP	*Placopecten magellanicus*		1.00		1.00	0.85		1.00	
SILVER HAKE	*Merluccius bilinearis*		1.00	0.36	0.58	0.43	0.61	0.35	0.73
SMOOTH SKATE	*Malacoraja senta*	0.39	0.40	0.18	0.38	0.24	0.27	0.18	0.24
SPINY DOGFISH FEMALE	*Squalus acanthias*	0.21	0.32	0.42	0.21	0.18	0.16	0.35	0.21
SPINY DOGFISH MALE	*Squalus acanthias*	0.17	0.18	0.39	0.14	0.22	0.18	0.25	0.14
SPINY DOGFISH UNSEXED	*Squalus acanthias*	1.00	0.94	0.97	0.99	1.00	1.00	1.00	0.71
THORNY SKATE	*Amblyraja radiata*	0.16	0.22	0.25	0.26	0.25	0.22	0.20	0.28
TILEFISH	*Lopholatilus chamaeleonticeps*			0.74				1.00	0.79
WHITE HAKE	*Urophycis tenuis*	0.32	0.16	0.22	0.16	0.38	0.20	0.24	0.28
WINTER SKATE	*Leucoraja ocellata*		0.77	0.67	1.00	0.71	1.00	0.45	0.60
WRYMOUTH	*Cryptacanthodes maculatus*	1.00				0.67		1.00	1.00

C.

SPECIES	SCIENTIFIC NAME	WT 2014 SPRING	WT 2014 FALL	WT 2015 SPRING	WT 2015 FALL	WT 2016 SPRING	WT 2016 FALL	WT 2017 SPRING	WT 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	1.40	1.42	0.58	0.49	0.27	0.71	0.73	0.77
AMERICAN LOBSTER FEMALE	*Homarus americanus*	0.00	0.00	0.00	0.01	0.05	0.11	0.00	0.00
AMERICAN LOBSTER MALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.01	0.16	0.00
AMERICAN LOBSTER UNSEXED	*Homarus americanus*	0.00	0.00	0.00	<0.005	0.00	0.00	0.00	0.00
ATLANTIC COD	*Gadus morhua*	11.85	11.76	9.12	21.23	14.21	16.22	10.71	13.77
ATLANTIC HAGFISH	*Myxine glutinosa*	0.00	0.00	0.00	0.02	0.05	0.02	0.02	0.03
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	1.71	1.32	0.97	0.68	1.16	0.34	3.87	0.29
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*	0.00	0.00	0.00	0.00	<0.005	0.00	0.00	0.00
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.17	0.18	0.28	0.11	0.21	0.02	0.66	0.10
BARNDOOR SKATE	*Dipturus laevis*	4.69	15.63	0.40	10.03	2.71	16.85	5.52	13.96
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.07	0.31	0.33	0.51	0.26	0.44	0.54	0.45
BLUE SHARK FEMALE	*Prionace glauca*	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00
BLUE SHARK MALE	*Prionace glauca*	0.00	2.52	0.00	0.00	0.00	0.00	0.00	3.94
BLUE SHARK UNSEXED	*Prionace glauca*	0.00	1.77	0.00	0.00	0.00	0.00	0.00	0.00
CUSK	*Brosme brosme*	21.92	40.48	9.41	19.97	8.87	27.17	19.55	29.57
HADDOCK	*Melanogrammus aeglefinus*	26.89	21.62	31.18	32.34	36.93	23.71	41.15	29.47
JONAH CRAB FEMALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02
JONAH CRAB MALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.02	0.06	0.06	0.17
JONAH CRAB UNSEXED	*Cancer borealis*	0.01	0.05	0.08	0.08	0.03	0.04	0.01	0.00
LITTLE SKATE	*Leucoraja erinacea*	0.00	0.00	0.00	0.11	0.15	0.00	0.68	0.00
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.02	0.10	0.18	0.11	0.13	0.09	1.26	0.02
MONKFISH	*Lophius americanus*	0.13	0.88	0.22	1.30	0.21	0.22	1.79	1.28
NORTHERN STONE CRAB FEMALE	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	0.02	0.02	0.00	0.01	0.00	0.02	0.02	0.02
OCEAN POUT	*Zoarces americanus*	0.00	0.02	0.04	0.00	0.04	0.00	0.09	0.01
POLLOCK	*Pollachius virens*	0.87	1.85	0.34	1.73	0.16	1.33	1.17	3.08
RED HAKE	*Urophycis chuss*	2.42	3.71	7.44	7.05	10.19	8.19	12.21	5.04
SEA RAVEN	*Hemitripterus americanus*	0.08	0.00	0.05	0.04	0.10	0.00	0.04	0.06
SEA SCALLOP	*Placopecten magellanicus*	0.00	0.01	0.00	0.01	0.03	0.00	0.01	0.00
SILVER HAKE	*Merluccius bilinearis*	0.00	<0.005	0.17	0.05	0.08	0.04	0.36	0.02
SMOOTH SKATE	*Malacoraja senta*	0.33	0.18	1.40	0.29	0.79	0.32	1.54	0.65
SPINY DOGFISH FEMALE	*Squalus acanthias*	74.98	26.01	40.24	39.23	46.38	39.88	24.55	30.80
SPINY DOGFISH MALE	*Squalus acanthias*	123.00	118.63	51.58	97.94	106.13	164.39	25.53	138.49
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.12	2.05	0.75	15.22	0.06	0.26	11.16	25.01
THORNY SKATE	*Amblyraja radiata*	6.48	7.93	7.36	10.99	13.72	5.93	8.17	5.25
TILEFISH	*Lopholatilus chamaeleonticeps*	0.00	0.00	1.54	0.00	0.00	0.00	0.87	0.95
WHITE HAKE	*Urophycis tenuis*	4.69	22.24	6.13	18.14	6.57	18.98	14.83	40.92
WINTER SKATE	*Leucoraja ocellata*	0.00	0.28	0.11	3.32	0.62	0.05	0.71	0.25
WRYMOUTH	*Cryptacanthodes maculatus*	0.06	0.00	0.00	0.00	0.12	0.00	0.04	0.04

D.

SPECIES	SCIENTIFIC NAME	CV WT 2014 SPRING	CV WT 2014 FALL	CV WT 2015 SPRING	CV WT 2015 FALL	CV WT 2016 SPRING	CV WT 2016 FALL	CV WT 2017 SPRING	CV WT 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.42	0.70	0.41	0.51	0.51	0.65	0.44	0.54
AMERICAN LOBSTER FEMALE	*Homarus americanus*				1.00	0.76	1.00		
AMERICAN LOBSTER MALE	*Homarus americanus*						1.00	1.00	
AMERICAN LOBSTER UNSEXED	*Homarus americanus*				1.00				
ATLANTIC COD	*Gadus morhua*	0.27	0.22	0.22	0.18	0.28	0.30	0.25	0.26
ATLANTIC HAGFISH	*Myxine glutinosa*				0.59	0.83	0.49	0.48	0.41
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	0.59	0.65	0.63	0.94	0.58	1.00	0.49	0.74
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*					1.00			
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*								
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.65	0.76	0.45	0.71	0.96	1.00	0.48	1.00
BARNDOOR SKATE	*Dipturus laevis*	0.62	0.41	1.00	0.29	0.65	0.53	0.44	0.25
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.70	0.60	0.58	0.47	0.85	0.70	0.54	0.43
BLUE SHARK FEMALE	*Prionace glauca*		1.00						
BLUE SHARK MALE	*Prionace glauca*		1.00						0.81
BLUE SHARK UNSEXED	*Prionace glauca*		1.00						
CUSK	*Brosme brosme*	0.31	0.28	0.27	0.35	0.25	0.45	0.30	0.32
HADDOCK	*Melanogrammus aeglefinus*	0.27	0.16	0.14	0.24	0.28	0.24	0.13	0.17
JONAH CRAB FEMALE	*Cancer borealis*							1.00	0.58
JONAH CRAB MALE	*Cancer borealis*					0.59	0.62	0.45	0.26
JONAH CRAB UNSEXED	*Cancer borealis*	0.73	0.51	0.40	0.43	0.76	0.47	1.00	
LITTLE SKATE	*Leucoraja erinacea*				1.00	1.00		0.80	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.56	0.64	0.75	0.48	0.46	0.56	0.84	1.00
MONKFISH	*Lophius americanus*	1.00	0.82	0.74	0.88	1.00	0.80	0.31	0.39
NORTHERN STONE CRAB FEMALE	*Lithodes maja*							1.00	1.00
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	1.00	0.59		1.00		1.00	1.00	1.00
OCEAN POUT	*Zoarces americanus*		1.00	1.00		0.47		0.72	1.00
POLLOCK	*Pollachius virens*	0.48	0.46	0.60	0.51	0.40	0.61	0.30	0.34
RED HAKE	*Urophycis chuss*	0.27	0.17	0.10	0.18	0.23	0.20	0.11	0.17
SEA RAVEN	*Hemitripterus americanus*	0.71		0.71	1.00	0.93		1.00	1.00
SEA SCALLOP	*Placopecten magellanicus*		1.00		1.00	0.78		1.00	
SILVER HAKE	*Merluccius bilinearis*		1.00	0.39	0.58	0.43	0.60	0.41	0.73
SMOOTH SKATE	*Malacoraja senta*	0.37	0.34	0.17	0.45	0.24	0.28	0.18	0.23
SPINY DOGFISH FEMALE	*Squalus acanthias*	0.32	0.23	0.47	0.16	0.16	0.16	0.37	0.19
SPINY DOGFISH MALE	*Squalus acanthias*	0.19	0.16	0.40	0.15	0.23	0.18	0.29	0.16
SPINY DOGFISH UNSEXED	*Squalus acanthias*	1.00	0.98	0.97	1.00	1.00	1.00	1.00	0.71
THORNY SKATE	*Amblyraja radiata*	0.20	0.23	0.21	0.23	0.18	0.29	0.17	0.25
TILEFISH	*Lopholatilus chamaeleonticeps*			0.73				1.00	0.87
WHITE HAKE	*Urophycis tenuis*	0.39	0.17	0.25	0.14	0.42	0.23	0.27	0.50
WINTER SKATE	*Leucoraja ocellata*		0.73	0.69	1.00	0.67	1.00	0.47	0.58
WRYMOUTH	*Cryptacanthodes maculatus*	1.00				0.84		1.00	1.00

Table 9. Bottom longline stratified mean number (NUM; A) and weight (WT; C) per set with coefficients of variation (CV; B, D) for all species caught on smooth bottom in spring and fall, 2014-2017.

A.

SPECIES	SCIENTIFIC NAME	NUM 2014 SPRING	NUM 2014 FALL	NUM 2015 SPRING	NUM 2015 FALL	NUM 2016 SPRING	NUM 2016 FALL	NUM 2017 SPRING	NUM 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.00	0.00	0.18	0.06	0.06	0.17	0.00	0.00
AMERICAN LOBSTER FEMALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMERICAN LOBSTER MALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMERICAN LOBSTER UNSEXED	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC COD	*Gadus morhua*	4.21	1.22	3.03	0.49	0.40	2.24	0.10	1.90
ATLANTIC HAGFISH	*Myxine glutinosa*	0.00	0.00	0.00	0.28	0.24	0.42	0.00	0.75
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	0.10	0.00	0.00	0.00	0.06	0.06	0.00	0.00
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BARNDOOR SKATE	*Dipturus laevis*	0.27	1.89	0.87	2.39	0.19	1.53	0.00	2.90
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.00	0.19	0.00	0.00	0.00	0.48	2.93	0.00
BLUE SHARK FEMALE	*Prionace glauca*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BLUE SHARK MALE	*Prionace glauca*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
BLUE SHARK UNSEXED	*Prionace glauca*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CUSK	*Brosme brosme*	2.09	0.39	0.48	0.56	0.16	2.99	0.00	1.70
HADDOCK	*Melanogrammus aeglefinus*	5.64	0.56	9.88	1.93	6.57	12.15	13.40	7.80
JONAH CRAB FEMALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JONAH CRAB MALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.46	0.16	0.15
JONAH CRAB UNSEXED	*Cancer borealis*	0.00	0.00	0.12	0.60	0.06	0.00	0.15	0.00
LITTLE SKATE	*Leucoraja erinacea*	2.98	0.00	1.97	0.00	0.00	0.30	7.42	0.00
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	7.45	0.06	0.12	0.00	0.06	0.00	23.90	0.00
MONKFISH	*Lophius americanus*	0.06	0.00	0.00	0.16	0.00	0.12	0.00	0.00
NORTHERN STONE CRAB FEMALE	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OCEAN POUT	*Zoarces americanus*	0.00	0.00	0.06	0.00	0.12	0.00	0.00	0.00
POLLOCK	*Pollachius virens*	0.04	0.00	0.00	0.00	0.00	0.06	0.00	0.00
RED HAKE	*Urophycis chuss*	15.81	7.03	30.85	9.18	14.32	15.77	16.52	8.84
SEA RAVEN	*Hemitripterus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEA SCALLOP	*Placopecten magellanicus*	0.00	0.00	0.00	0.00	0.06	0.00	0.52	0.00
SILVER HAKE	*Merluccius bilinearis*	0.04	0.00	0.45	0.00	0.00	0.00	0.16	0.00
SMOOTH SKATE	*Malacoraja senta*	0.66	0.32	0.88	0.10	0.31	1.28	0.26	0.62
SPINY DOGFISH FEMALE	*Squalus acanthias*	32.88	7.16	12.25	19.43	40.32	36.36	46.07	29.91
SPINY DOGFISH MALE	*Squalus acanthias*	78.02	38.13	17.19	42.49	96.36	127.36	58.60	100.30
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.53	0.25	0.00	17.56	0.00	0.00	0.00	0.15
THORNY SKATE	*Amblyraja radiata*	4.39	0.35	1.69	0.51	1.78	7.88	0.88	1.50
TILEFISH	*Lopholatilus chamaeleonticeps*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHITE HAKE	*Urophycis tenuis*	3.79	8.45	9.27	6.98	5.29	10.43	7.53	10.38
WINTER SKATE	*Leucoraja ocellata*	1.55	0.06	0.28	0.00	0.28	0.06	0.31	0.00
WRYMOUTH	*Cryptacanthodes maculatus*	0.04	0.36	0.34	0.04	2.41	0.00	0.62	0.00

B.

SPECIES	SCIENTIFIC NAME	CV NUM 2014 SPRING	CV NUM 2014 FALL	CV NUM 2015 SPRING	CV NUM 2015 FALL	CV NUM 2016 SPRING	CV NUM 2016 FALL	CV NUM 2017 SPRING	CV NUM 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*			1.00	1.00	1.00	0.78		
AMERICAN LOBSTER FEMALE	*Homarus americanus*								
AMERICAN LOBSTER MALE	*Homarus americanus*								
AMERICAN LOBSTER UNSEXED	*Homarus americanus*								
ATLANTIC COD	*Gadus morhua*	0.46	0.71	0.15	0.80	0.23	0.21	1.00	0.63
ATLANTIC HAGFISH	*Myxine glutinosa*				0.46	0.18	0.66		0.59
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	1.00				1.00	1.00		
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*								
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	1.00							
ATLANTIC WOLFFISH	*Anarhichas lupus*								
BARNDOOR SKATE	*Dipturus laevis*	0.60	0.28	0.33	0.46	0.00	0.28		0.46
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*		0.00				1.00	1.00	
BLUE SHARK FEMALE	*Prionace glauca*								
BLUE SHARK MALE	*Prionace glauca*								1.00
BLUE SHARK UNSEXED	*Prionace glauca*								
CUSK	*Brosme brosme*	0.31	1.00	0.20	0.74	0.78	0.42		0.68
HADDOCK	*Melanogrammus aeglefinus*	0.55	0.70	0.28	0.45	0.22	0.49	0.85	0.39
JONAH CRAB FEMALE	*Cancer borealis*								
JONAH CRAB MALE	*Cancer borealis*						0.34	1.00	1.00
JONAH CRAB UNSEXED	*Cancer borealis*			1.00	0.32	1.00		1.00	
LITTLE SKATE	*Leucoraja erinacea*	0.48		0.76			1.00	0.47	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.39	1.00	1.00		1.00		0.97	
MONKFISH	*Lophius americanus*	1.00			0.27		1.00		
NORTHERN STONE CRAB FEMALE	*Lithodes maja*								
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*								
OCEAN POUT	*Zoarces americanus*			1.00		0.00			
POLLOCK	*Pollachius virens*	1.00					1.00		
RED HAKE	*Urophycis chuss*	0.52	0.25	0.26	0.36	0.31	0.22	0.59	0.41
SEA RAVEN	*Hemitripterus americanus*								
SEA SCALLOP	*Placopecten magellanicus*					1.00		1.00	
SILVER HAKE	*Merluccius bilinearis*	1.00		0.88				1.00	
SMOOTH SKATE	*Malacoraja senta*	0.37	0.72	0.44	1.00	0.45	0.39	0.72	0.78
SPINY DOGFISH FEMALE	*Squalus acanthias*	0.31	0.38	0.37	0.40	0.17	0.07	0.43	0.67
SPINY DOGFISH MALE	*Squalus acanthias*	0.15	0.32	0.43	0.25	0.39	0.22	0.43	0.32
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.75	1.00		1.00				1.00
THORNY SKATE	*Amblyraja radiata*	0.72	0.74	0.20	0.53	0.49	0.34	0.84	0.86
TILEFISH	*Lopholatilus chamaeleonticeps*								
WHITE HAKE	*Urophycis tenuis*	0.33	0.61	0.47	0.48	0.40	0.19	0.34	0.27
WINTER SKATE	*Leucoraja ocellata*	0.23	1.00	0.86		0.15	1.00	0.33	
WRYMOUTH	*Cryptacanthodes maculatus*	1.00	0.33	0.88	1.00	0.90		1.00	

C.

SPECIES	SCIENTIFIC NAME	WT 2014 SPRING	WT 2014 FALL	WT 2015 SPRING	WT 2015 FALL	WT 2016 SPRING	WT 2016 FALL	WT 2017 SPRING	WT 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.00	0.00	0.06	0.03	0.02	0.13	0.00	0.00
AMERICAN LOBSTER FEMALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMERICAN LOBSTER MALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMERICAN LOBSTER UNSEXED	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC COD	*Gadus morhua*	5.85	3.64	6.42	2.24	1.59	4.96	0.20	7.21
ATLANTIC HAGFISH	*Myxine glutinosa*	0.00	0.00	0.00	0.04	0.04	0.07	0.00	0.06
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	2.10	0.00	0.00	0.00	0.53	0.06	0.00	0.00
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BARNDOOR SKATE	*Dipturus laevis*	1.47	17.33	7.32	18.26	0.34	15.92	0.00	26.90
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.00	0.08	0.00	0.00	0.00	0.18	1.43	0.00
BLUE SHARK FEMALE	*Prionace glauca*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BLUE SHARK MALE	*Prionace glauca*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.52
BLUE SHARK UNSEXED	*Prionace glauca*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CUSK	*Brosme brosme*	4.55	0.63	1.76	1.94	0.57	7.11	0.00	2.97
HADDOCK	*Melanogrammus aeglefinus*	4.69	0.70	11.36	2.42	5.72	11.05	11.86	7.51
JONAH CRAB FEMALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JONAH CRAB MALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.16	0.05	0.09
JONAH CRAB UNSEXED	*Cancer borealis*	0.00	0.00	0.06	0.23	0.02	0.00	0.09	0.00
LITTLE SKATE	*Leucoraja erinacea*	1.78	0.00	1.39	0.00	0.00	0.19	5.19	0.00
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	1.58	0.01	0.03	0.00	0.01	0.00	6.10	0.00
MONKFISH	*Lophius americanus*	0.05	0.00	0.00	0.64	0.00	0.58	0.00	0.00
NORTHERN STONE CRAB FEMALE	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OCEAN POUT	*Zoarces americanus*	0.00	0.00	0.04	0.00	0.10	0.00	0.00	0.00
POLLOCK	*Pollachius virens*	0.03	0.00	0.00	0.00	0.00	0.16	0.00	0.00
RED HAKE	*Urophycis chuss*	6.37	2.31	9.71	3.46	5.35	6.59	6.19	3.91
SEA RAVEN	*Hemitripterus americanus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEA SCALLOP	*Placopecten magellanicus*	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00
SILVER HAKE	*Merluccius bilinearis*	0.02	0.00	0.11	0.00	0.00	0.00	0.08	0.00
SMOOTH SKATE	*Malacoraja senta*	0.51	0.19	0.60	0.06	0.16	0.96	0.17	0.39
SPINY DOGFISH FEMALE	*Squalus acanthias*	58.84	11.24	14.93	22.77	50.02	34.59	65.85	24.73
SPINY DOGFISH MALE	*Squalus acanthias*	140.56	55.86	19.76	60.36	120.59	184.33	66.72	123.51
SPINY DOGFISH UNSEXED	*Squalus acanthias*	1.41	0.31	0.00	28.93	0.00	0.00	0.00	0.06
THORNY SKATE	*Amblyraja radiata*	4.36	0.59	4.39	0.94	2.71	10.71	1.13	4.42
TILEFISH	*Lopholatilus chamaeleonticeps*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHITE HAKE	*Urophycis tenuis*	6.80	21.19	14.75	16.71	6.18	24.63	12.94	23.13
WINTER SKATE	*Leucoraja ocellata*	1.85	0.08	0.40	0.00	0.41	0.13	0.45	0.00
WRYMOUTH	*Cryptacanthodes maculatus*	0.01	0.14	0.23	0.02	2.43	0.00	0.14	0.00

D.

SPECIES	SCIENTIFIC NAME	CV WT 2014 SPRING	CV WT 2014 FALL	CV WT 2015 SPRING	CV WT 2015 FALL	CV WT 2016 SPRING	CV WT 2016 FALL	CV WT 2017 SPRING	CV WT 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*			1.00	1.00	1.00	0.80		
AMERICAN LOBSTER FEMALE	*Homarus americanus*								
AMERICAN LOBSTER MALE	*Homarus americanus*								
AMERICAN LOBSTER UNSEXED	*Homarus americanus*								
ATLANTIC COD	*Gadus morhua*	0.49	0.57	0.17	0.75	0.51	0.15	1.00	0.65
ATLANTIC HAGFISH	*Myxine glutinosa*				0.62	0.10	0.64		0.51
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	1.00				1.00	1.00		
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*								
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	1.00							
ATLANTIC WOLFFISH	*Anarhichas lupus*								
BARNDOOR SKATE	*Dipturus laevis*	0.61	0.38	0.33	0.41	0.09	0.23		0.55
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*		0.00				1.00	1.00	
BLUE SHARK FEMALE	*Prionace glauca*								
BLUE SHARK MALE	*Prionace glauca*								1.00
BLUE SHARK UNSEXED	*Prionace glauca*								
CUSK	*Brosme brosme*	0.36	1.00	0.17	0.85	0.71	0.34		0.63
HADDOCK	*Melanogrammus aeglefinus*	0.51	0.82	0.30	0.49	0.19	0.44	0.89	0.37
JONAH CRAB FEMALE	*Cancer borealis*								
JONAH CRAB MALE	*Cancer borealis*						0.32	1.00	1.00
JONAH CRAB UNSEXED	*Cancer borealis*			1.00	0.42	1.00		1.00	
LITTLE SKATE	*Leucoraja erinacea*	0.36		0.74			1.00	0.48	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.46	1.00	1.00		1.00		0.98	
MONKFISH	*Lophius americanus*	1.00			0.59		1.00		
NORTHERN STONE CRAB FEMALE	*Lithodes maja*								
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*								
OCEAN POUT	*Zoarces americanus*			1.00		0.29			
POLLOCK	*Pollachius virens*	1.00					1.00		
RED HAKE	*Urophycis chuss*	0.60	0.28	0.28	0.36	0.30	0.22	0.64	0.43
SEA RAVEN	*Hemitripterus americanus*								
SEA SCALLOP	*Placopecten magellanicus*					1.00		1.00	
SILVER HAKE	*Merluccius bilinearis*	1.00		0.86				1.00	
SMOOTH SKATE	*Malacoraja senta*	0.32	0.71	0.47	1.00	0.40	0.35	0.71	0.82
SPINY DOGFISH FEMALE	*Squalus acanthias*	0.23	0.44	0.33	0.37	0.19	0.06	0.48	0.62
SPINY DOGFISH MALE	*Squalus acanthias*	0.29	0.34	0.42	0.25	0.44	0.23	0.38	0.25
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.75	1.00		1.00				1.00
THORNY SKATE	*Amblyraja radiata*	0.59	0.68	0.40	0.61	0.43	0.34	0.78	0.97
TILEFISH	*Lopholatilus chamaeleonticeps*								
WHITE HAKE	*Urophycis tenuis*	0.31	0.67	0.55	0.58	0.44	0.34	0.26	0.42
WINTER SKATE	*Leucoraja ocellata*	0.54	1.00	0.71		0.28	1.00	0.64	
WRYMOUTH	*Cryptacanthodes maculatus*	1.00	0.67	0.83	1.00	0.93		1.00	

Table 10. Bottom longline stratified mean number (NUM; A) and weight (WT; C) per set with coefficients of variation (CV; B, D) for all species caught on rough and smooth bottom combined in spring and fall, 2014-2017.

A.

SPECIES	SCIENTIFIC NAME	NUM 2014 SPRING	NUM 2014 FALL	NUM 2015 SPRING	NUM 2015 FALL	NUM 2016 SPRING	NUM 2016 FALL	NUM 2017 SPRING	NUM 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.94	0.93	0.57	0.31	0.23	0.56	0.50	0.50
AMERICAN LOBSTER FEMALE	*Homarus americanus*	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00
AMERICAN LOBSTER MALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
AMERICAN LOBSTER UNSEXED	*Homarus americanus*	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
ATLANTIC COD	*Gadus morhua*	5.59	2.48	4.71	3.28	3.87	3.99	2.15	3.18
ATLANTIC HAGFISH	*Myxine glutinosa*	0.00	0.00	0.00	0.24	0.21	0.37	0.05	0.60
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	0.10	0.05	0.02	0.02	0.08	0.05	0.07	0.01
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.04	0.04	0.05	0.02	0.03	0.01	0.11	0.03
BARNDOOR SKATE	*Dipturus laevis*	0.38	1.84	0.62	2.05	0.28	1.66	0.21	2.47
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.05	0.34	0.22	0.34	0.16	0.59	2.43	0.26
BLUE SHARK FEMALE	*Prionace glauca*	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
BLUE SHARK MALE	*Prionace glauca*	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.13
BLUE SHARK UNSEXED	*Prionace glauca*	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
CUSK	*Brosme brosme*	5.32	5.62	1.82	2.88	1.43	5.96	3.04	5.02
HADDOCK	*Melanogrammus aeglefinus*	12.48	5.90	17.28	12.71	15.71	16.27	23.44	15.57
JONAH CRAB FEMALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
JONAH CRAB MALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.03	0.35	0.17	0.23
JONAH CRAB UNSEXED	*Cancer borealis*	0.02	0.07	0.18	0.48	0.06	0.03	0.12	0.00
LITTLE SKATE	*Leucoraja erinacea*	2.08	0.00	1.37	0.05	0.08	0.21	5.42	0.00
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	5.22	0.25	0.36	0.16	0.24	0.07	18.45	0.02
MONKFISH	*Lophius americanus*	0.05	0.03	0.02	0.19	0.02	0.11	0.09	0.06
NORTHERN STONE CRAB FEMALE	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01
OCEAN POUT	*Zoarces americanus*	0.00	0.01	0.06	0.00	0.11	0.00	0.02	0.01
POLLOCK	*Pollachius virens*	0.25	0.34	0.08	0.43	0.06	0.44	0.26	0.48
RED HAKE	*Urophycis chuss*	13.05	7.57	28.48	11.67	18.16	16.72	21.62	9.91
SEA RAVEN	*Hemitripterus americanus*	0.03	0.00	0.01	0.01	0.02	0.00	0.01	0.01
SEA SCALLOP	*Placopecten magellanicus*	0.00	0.01	0.00	0.01	0.09	0.00	0.37	0.00
SILVER HAKE	*Merluccius bilinearis*	0.03	0.01	0.47	0.04	0.06	0.03	0.31	0.02
SMOOTH SKATE	*Malacoraja senta*	0.60	0.30	1.32	0.19	0.62	1.05	0.85	0.75
SPINY DOGFISH FEMALE	*Squalus acanthias*	35.70	11.49	17.21	22.82	40.17	37.79	37.54	31.54
SPINY DOGFISH MALE	*Squalus acanthias*	79.46	51.39	25.07	49.97	93.43	126.46	46.92	102.45
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.38	0.59	0.19	15.89	0.01	0.13	3.63	5.50
THORNY SKATE	*Amblyraja radiata*	4.56	1.93	3.19	2.30	4.62	6.28	2.63	2.25
TILEFISH	*Lopholatilus chamaeleonticeps*	0.00	0.00	0.08	0.00	0.00	0.00	0.04	0.04
WHITE HAKE	*Urophycis tenuis*	3.24	8.18	7.68	7.42	5.24	9.89	7.86	10.14
WINTER SKATE	*Leucoraja ocellata*	1.08	0.08	0.22	0.59	0.30	0.05	0.30	0.03
WRYMOUTH	*Cryptacanthodes maculatus*	0.05	0.25	0.24	0.03	1.73	0.00	0.44	0.02

B.

SPECIES	SCIENTIFIC NAME	CV NUM 2014 SPRING	CV NUM 2014 FALL	CV NUM 2015 SPRING	CV NUM 2015 FALL	CV NUM 2016 SPRING	CV NUM 2016 FALL	CV NUM 2017 SPRING	CV NUM 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.38	0.72	0.36	0.43	0.45	0.50	0.37	0.51
AMERICAN LOBSTER FEMALE	*Homarus americanus*				1.00	0.75	1.00		
AMERICAN LOBSTER MALE	*Homarus americanus*						1.00	1.00	
AMERICAN LOBSTER UNSEXED	*Homarus americanus*				1.00				
ATLANTIC COD	*Gadus morhua*	0.28	0.29	0.13	0.18	0.26	0.20	0.23	0.30
ATLANTIC HAGFISH	*Myxine glutinosa*				0.39	0.18	0.53	0.61	0.51
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	0.67	0.58	0.63	0.63	0.58	0.88	0.42	0.72
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*					1.00			
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	1.00							
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.65	0.70	0.29	0.72	0.71	1.00	0.40	1.00
BARNDOOR SKATE	*Dipturus laevis*	0.42	0.23	0.32	0.38	0.29	0.26	0.42	0.38
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.65	0.35	0.57	0.47	0.86	0.63	0.84	0.46
BLUE SHARK FEMALE	*Prionace glauca*		1.00						
BLUE SHARK MALE	*Prionace glauca*		1.00						0.89
BLUE SHARK UNSEXED	*Prionace glauca*		1.00						
CUSK	*Brosme brosme*	0.25	0.28	0.25	0.31	0.27	0.33	0.26	0.25
HADDOCK	*Melanogrammus aeglefinus*	0.25	0.15	0.14	0.19	0.17	0.28	0.35	0.18
JONAH CRAB FEMALE	*Cancer borealis*							1.00	0.61
JONAH CRAB MALE	*Cancer borealis*					0.61	0.32	0.69	0.49
JONAH CRAB UNSEXED	*Cancer borealis*	0.73	0.49	0.52	0.28	0.75	0.49	0.93	
LITTLE SKATE	*Leucoraja erinacea*	0.48		0.76	1.00	1.00	1.00	0.45	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.39	0.58	0.61	0.42	0.38	0.65	0.88	1.00
MONKFISH	*Lophius americanus*	0.83	0.79	0.63	0.31	1.00	0.82	0.26	0.32
NORTHERN STONE CRAB FEMALE	*Lithodes maja*							1.00	1.00
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	1.00	0.58		1.00		1.00	1.00	1.00
OCEAN POUT	*Zoarces americanus*		1.00	0.79		0.12		0.67	1.00
POLLOCK	*Pollachius virens*	0.36	0.54	0.54	0.44	0.39	0.69	0.29	0.33
RED HAKE	*Urophycis chuss*	0.44	0.17	0.20	0.21	0.20	0.16	0.32	0.26
SEA RAVEN	*Hemitripterus americanus*	0.81		0.71	1.00	0.73		1.00	1.00
SEA SCALLOP	*Placopecten magellanicus*		1.00		1.00	0.65		0.96	
SILVER HAKE	*Merluccius bilinearis*	1.00	1.00	0.59	0.58	0.43	0.61	0.43	0.73
SMOOTH SKATE	*Malacoraja senta*	0.30	0.55	0.23	0.43	0.22	0.33	0.21	0.47
SPINY DOGFISH FEMALE	*Squalus acanthias*	0.21	0.24	0.28	0.25	0.13	0.07	0.37	0.45
SPINY DOGFISH MALE	*Squalus acanthias*	0.12	0.19	0.29	0.16	0.29	0.16	0.38	0.23
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.73	0.73	0.97	0.80	1.00	1.00	1.00	0.69
THORNY SKATE	*Amblyraja radiata*	0.49	0.21	0.18	0.23	0.22	0.30	0.25	0.43
TILEFISH	*Lopholatilus chamaeleonticeps*			0.74				1.00	0.79
WHITE HAKE	*Urophycis tenuis*	0.27	0.44	0.40	0.32	0.30	0.15	0.24	0.21
WINTER SKATE	*Leucoraja ocellata*	0.23	0.65	0.78	1.00	0.26	0.86	0.27	0.60
WRYMOUTH	*Cryptacanthodes maculatus*	0.73	0.33	0.88	1.00	0.87		0.98	1.00

C.

SPECIES	SCIENTIFIC NAME	WT 2014 SPRING	WT 2014 FALL	WT 2015 SPRING	WT 2015 FALL	WT 2016 SPRING	WT 2016 FALL	WT 2017 SPRING	WT 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.42	0.43	0.22	0.17	0.10	0.30	0.22	0.23
AMERICAN LOBSTER FEMALE	*Homarus americanus*	0.00	0.00	0.00	<0.005	0.02	0.03	0.00	0.00
AMERICAN LOBSTER MALE	*Homarus americanus*	0.00	0.00	0.00	0.00	0.00	<0.005	0.05	0.00
AMERICAN LOBSTER UNSEXED	*Homarus americanus*	0.00	0.00	0.00	<0.005	0.00	0.00	0.00	0.00
ATLANTIC COD	*Gadus morhua*	7.66	6.10	7.23	7.98	5.40	8.36	3.37	9.19
ATLANTIC HAGFISH	*Myxine glutinosa*	0.00	0.00	0.00	0.03	0.05	0.05	0.01	0.05
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	1.98	0.40	0.29	0.20	0.72	0.14	1.17	0.09
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*	0.00	0.00	0.00	0.00	<0.005	0.00	0.00	0.00
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.05	0.06	0.09	0.03	0.06	<0.005	0.20	0.03
BARNDOOR SKATE	*Dipturus laevis*	2.44	16.82	5.23	15.77	1.05	16.20	1.67	22.99
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.02	0.15	0.10	0.15	0.08	0.26	1.16	0.13
BLUE SHARK FEMALE	*Prionace glauca*	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00
BLUE SHARK MALE	*Prionace glauca*	0.00	0.76	0.00	0.00	0.00	0.00	0.00	5.04
BLUE SHARK UNSEXED	*Prionace glauca*	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00
CUSK	*Brosme brosme*	9.80	12.68	4.08	7.39	3.08	13.18	5.91	11.01
HADDOCK	*Melanogrammus aeglefinus*	11.40	7.02	17.35	11.47	15.15	14.88	20.71	14.15
JONAH CRAB FEMALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
JONAH CRAB MALE	*Cancer borealis*	0.00	0.00	0.00	0.00	0.01	0.13	0.05	0.12
JONAH CRAB UNSEXED	*Cancer borealis*	<0.005	0.02	0.07	0.19	0.02	0.01	0.07	0.00
LITTLE SKATE	*Leucoraja erinacea*	1.24	0.00	0.97	0.03	0.05	0.13	3.83	0.00
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	1.11	0.04	0.07	0.03	0.04	0.03	4.64	0.01
MONKFISH	*Lophius americanus*	0.08	0.27	0.07	0.84	0.06	0.47	0.54	0.39
NORTHERN STONE CRAB FEMALE	*Lithodes maja*	0.00	0.00	0.00	0.00	0.00	0.00	<0.005	<0.005
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	0.01	<0.005	0.00	<0.005	0.00	0.01	0.01	<0.005
OCEAN POUT	*Zoarces americanus*	0.00	<0.005	0.04	0.00	0.08	0.00	0.03	<0.005
POLLOCK	*Pollachius virens*	0.29	0.56	0.10	0.52	0.05	0.52	0.36	0.93
RED HAKE	*Urophycis chuss*	5.18	2.73	9.03	4.54	6.81	7.07	8.01	4.25
SEA RAVEN	*Hemitripterus americanus*	0.02	0.00	0.02	0.01	0.03	0.00	0.01	0.02
SEA SCALLOP	*Placopecten magellanicus*	0.00	<0.005	0.00	<0.005	0.02	0.00	0.03	0.00
SILVER HAKE	*Merluccius bilinearis*	0.01	<0.005	0.13	0.02	0.02	0.01	0.17	0.01
SMOOTH SKATE	*Malacoraja senta*	0.46	0.19	0.84	0.13	0.35	0.77	0.58	0.47
SPINY DOGFISH FEMALE	*Squalus acanthias*	63.72	15.70	22.58	27.74	48.92	36.19	53.36	26.57
SPINY DOGFISH MALE	*Squalus acanthias*	135.25	74.84	29.38	71.72	116.22	178.30	54.27	128.04
SPINY DOGFISH UNSEXED	*Squalus acanthias*	1.02	0.83	0.23	24.78	0.02	0.08	3.37	7.60
THORNY SKATE	*Amblyraja radiata*	5.00	2.81	5.29	3.98	6.04	9.27	3.26	4.67
TILEFISH	*Lopholatilus chamaeleonticeps*	0.00	0.00	0.47	0.00	0.00	0.00	0.26	0.29
WHITE HAKE	*Urophycis tenuis*	6.16	21.51	12.14	17.15	6.30	22.92	13.51	28.51
WINTER SKATE	*Leucoraja ocellata*	1.29	0.14	0.31	1.00	0.47	0.11	0.53	0.08
WRYMOUTH	*Cryptacanthodes maculatus*	0.02	0.10	0.16	0.01	1.73	0.00	0.11	0.01

D.

SPECIES	SCIENTIFIC NAME	CV WT 2014 SPRING	CV WT 2014 FALL	CV WT 2015 SPRING	CV WT 2015 FALL	CV WT 2016 SPRING	CV WT 2016 FALL	CV WT 2017 SPRING	CV WT 2017 FALL
ACADIAN REDFISH	*Sebastes fasciatus*	0.42	0.70	0.38	0.46	0.46	0.51	0.44	0.54
AMERICAN LOBSTER FEMALE	*Homarus americanus*				1.00	0.76	1.00		
AMERICAN LOBSTER MALE	*Homarus americanus*						1.00	1.00	
AMERICAN LOBSTER UNSEXED	*Homarus americanus*				1.00				
ATLANTIC COD	*Gadus morhua*	0.29	0.27	0.13	0.21	0.25	0.19	0.24	0.38
ATLANTIC HAGFISH	*Myxine glutinosa*				0.52	0.29	0.56	0.48	0.42
ATLANTIC HALIBUT	*Hippoglossus hippoglossus*	0.75	0.65	0.63	0.94	0.59	0.77	0.49	0.74
ATLANTIC ROCK CRAB MALE	*Cancer irroratus*					1.00			
ATLANTIC ROCK CRAB UNSEXED	*Cancer irroratus*	1.00							
ATLANTIC WOLFFISH	*Anarhichas lupus*	0.65	0.76	0.45	0.71	0.96	1.00	0.48	1.00
BARNDOOR SKATE	*Dipturus laevis*	0.44	0.29	0.32	0.34	0.50	0.23	0.44	0.45
BLACKBELLY ROSEFISH	*Helicolenus dactylopterus*	0.70	0.38	0.58	0.47	0.85	0.61	0.86	0.43
BLUE SHARK FEMALE	*Prionace glauca*		1.00						
BLUE SHARK MALE	*Prionace glauca*		1.00						0.79
BLUE SHARK UNSEXED	*Prionace glauca*		1.00						
CUSK	*Brosme brosme*	0.24	0.28	0.19	0.32	0.24	0.31	0.30	0.28
HADDOCK	*Melanogrammus aeglefinus*	0.24	0.16	0.16	0.22	0.21	0.25	0.37	0.17
JONAH CRAB FEMALE	*Cancer borealis*							1.00	0.58
JONAH CRAB MALE	*Cancer borealis*					0.59	0.29	0.67	0.56
JONAH CRAB UNSEXED	*Cancer borealis*	0.73	0.51	0.65	0.37	0.65	0.47	0.98	
LITTLE SKATE	*Leucoraja erinacea*	0.36		0.74	1.00	1.00	1.00	0.46	
LONGHORN SCULPIN	*Myoxocephalus octodecemspinosus*	0.46	0.57	0.61	0.48	0.42	0.56	0.90	1.00
MONKFISH	*Lophius americanus*	0.71	0.82	0.74	0.52	1.00	0.86	0.31	0.39
NORTHERN STONE CRAB FEMALE	*Lithodes maja*							1.00	1.00
NORTHERN STONE CRAB UNSEXED	*Lithodes maja*	1.00	0.59		1.00		1.00	1.00	1.00
OCEAN POUT	*Zoarces americanus*		1.00	0.75		0.26		0.72	1.00
POLLOCK	*Pollachius virens*	0.45	0.46	0.60	0.51	0.40	0.53	0.30	0.34
RED HAKE	*Urophycis chuss*	0.52	0.18	0.21	0.21	0.20	0.16	0.35	0.28
SEA RAVEN	*Hemitripterus americanus*	0.71		0.71	1.00	0.93		1.00	1.00
SEA SCALLOP	*Placopecten magellanicus*		1.00		1.00	0.64		0.93	
SILVER HAKE	*Merluccius bilinearis*	1.00	1.00	0.54	0.58	0.43	0.60	0.43	0.73
SMOOTH SKATE	*Malacoraja senta*	0.26	0.51	0.25	0.44	0.21	0.31	0.21	0.48
SPINY DOGFISH FEMALE	*Squalus acanthias*	0.19	0.25	0.30	0.22	0.14	0.06	0.42	0.41
SPINY DOGFISH MALE	*Squalus acanthias*	0.22	0.19	0.29	0.16	0.32	0.17	0.33	0.18
SPINY DOGFISH UNSEXED	*Squalus acanthias*	0.73	0.77	0.97	0.84	1.00	1.00	1.00	0.70
THORNY SKATE	*Amblyraja radiata*	0.37	0.22	0.25	0.21	0.18	0.28	0.23	0.64
TILEFISH	*Lopholatilus chamaeleonticeps*			0.73				1.00	0.87
WHITE HAKE	*Urophycis tenuis*	0.25	0.46	0.47	0.40	0.33	0.26	0.19	0.33
WINTER SKATE	*Leucoraja ocellata*	0.54	0.59	0.64	1.00	0.32	0.86	0.42	0.58
WRYMOUTH	*Cryptacanthodes maculatus*	0.79	0.67	0.83	1.00	0.91		0.89	1.00

FIGURES

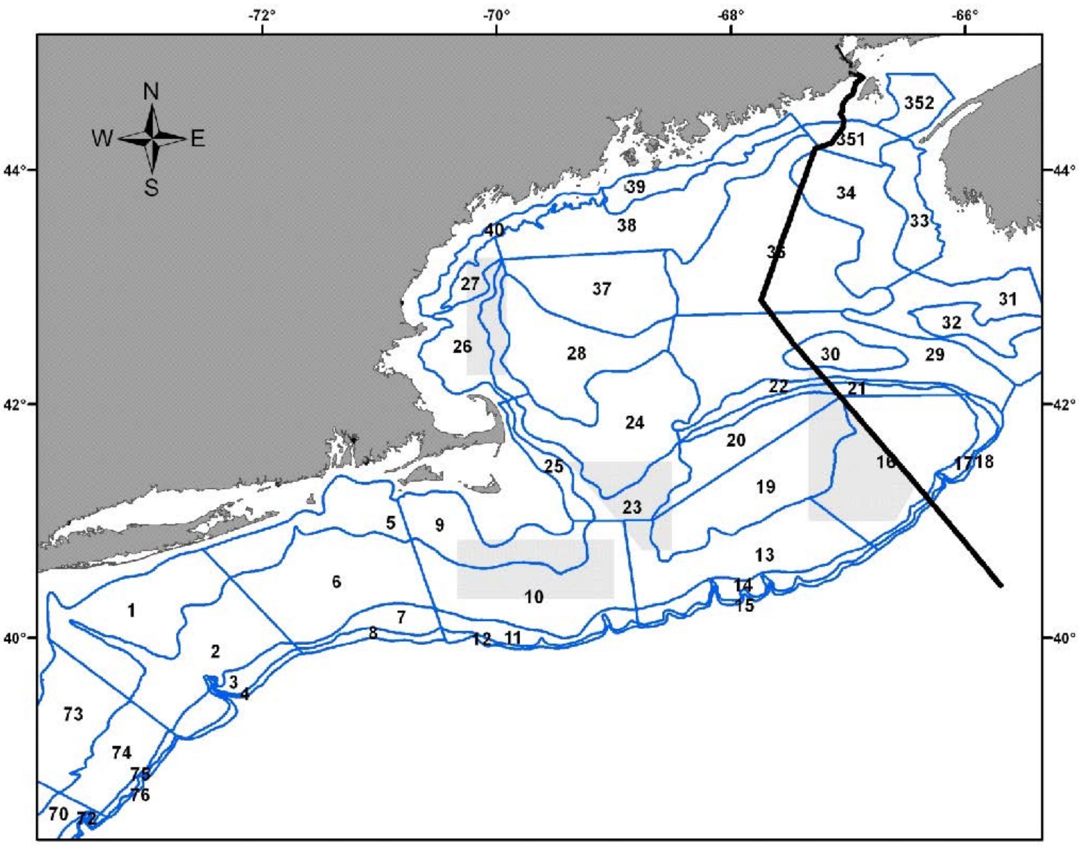


Figure 1. Northeast Fisheries Science Center research bottom trawl survey offshore strata (in blue) in the Gulf of Maine and southern New England area. Gray shaded regions indicate closed areas and the solid black line the Exclusive Economic Zone boundary.

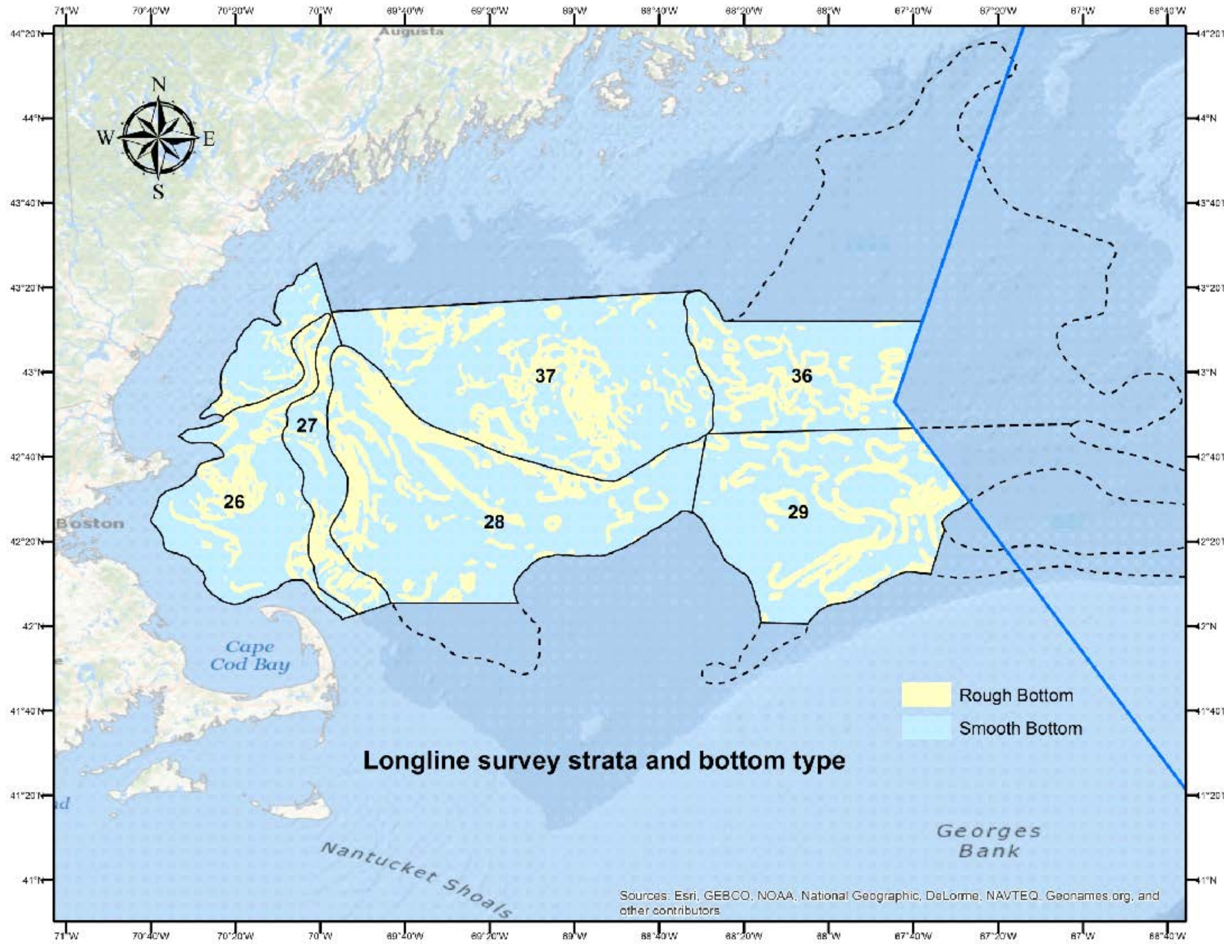


Figure 2. Bottom longline survey strata (26-29, and 36-37, indicated in black solid lines) based on Northeast Fisheries Science Center research bottom trawl survey offshore strata, post-stratified for bottom type (rough or smooth). Dotted line indicates parts of a stratum not included in the longline survey area. Solid blue line is the Exclusive Economic Zone boundary between the United States and Canada.

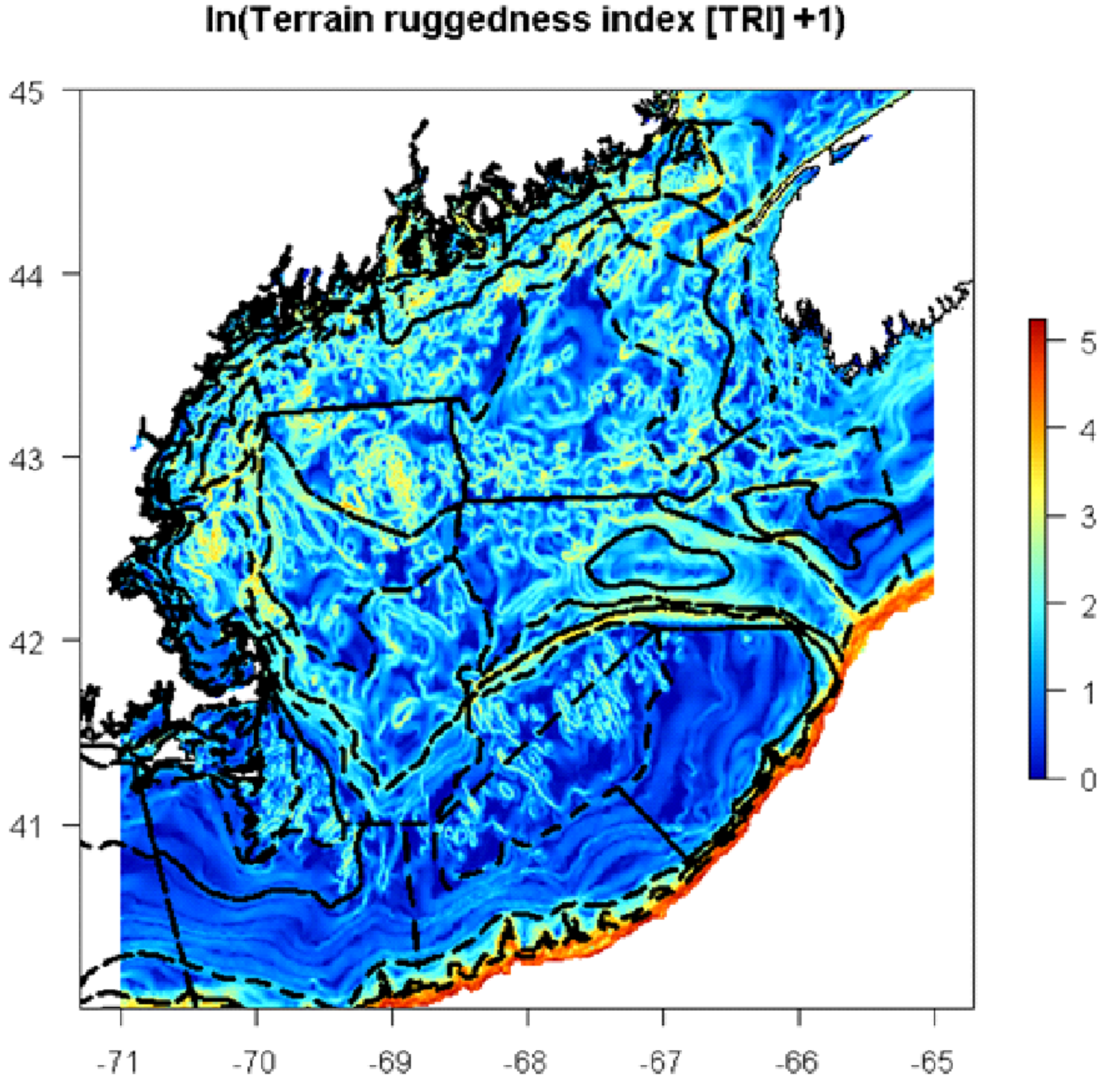


Figure 3. Terrain ruggedness index (TRI) for Gulf of Maine and Georges Bank region.

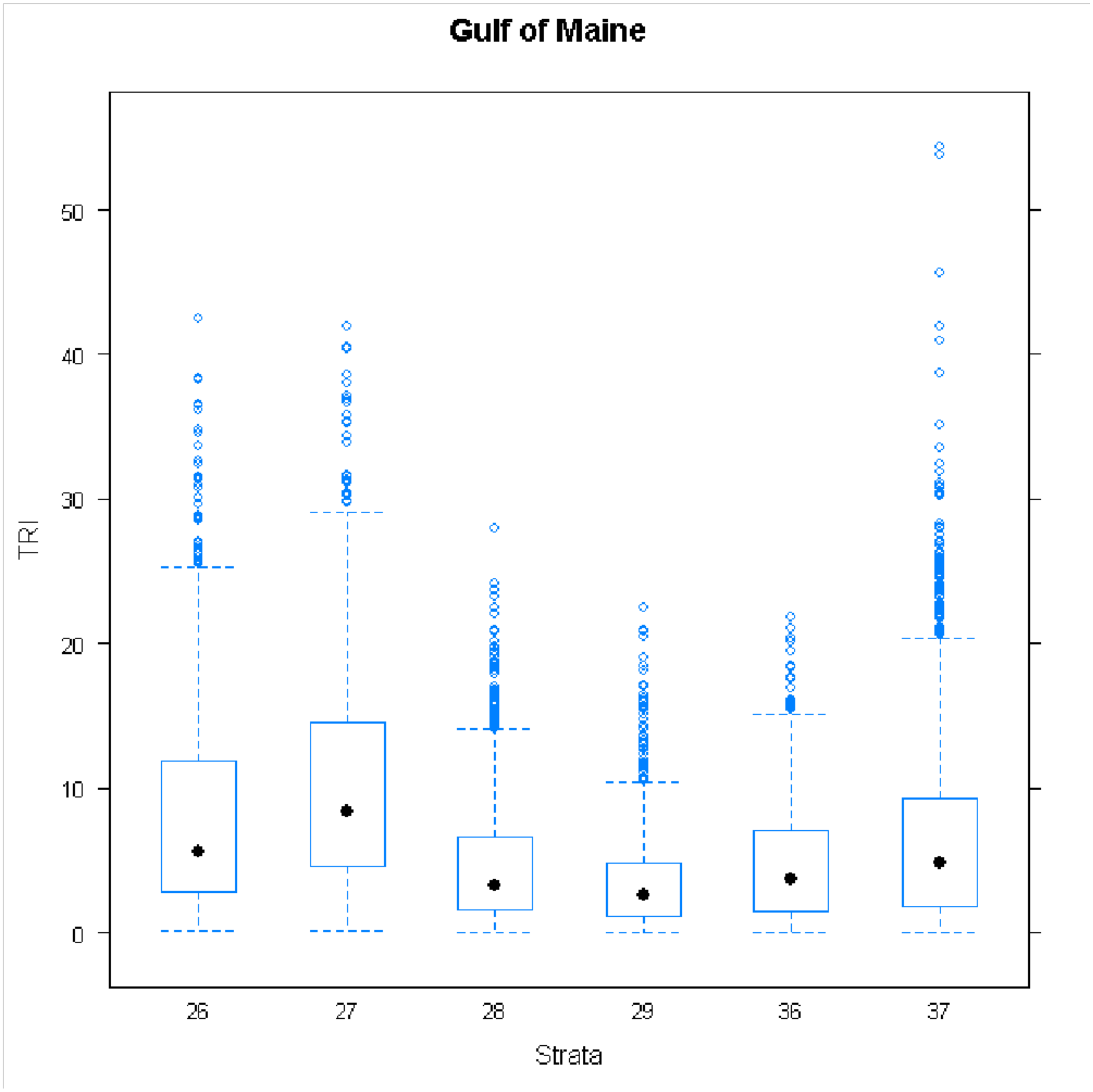


Figure 4. Box and whisker plot of the terrain ruggedness index (TRI) in each grid cell location (1.3 km^2 = 0.5 miles^2) in the Gulf of Maine research bottom trawl survey offshore strata (26, 27, 28, 29, 36, 37).

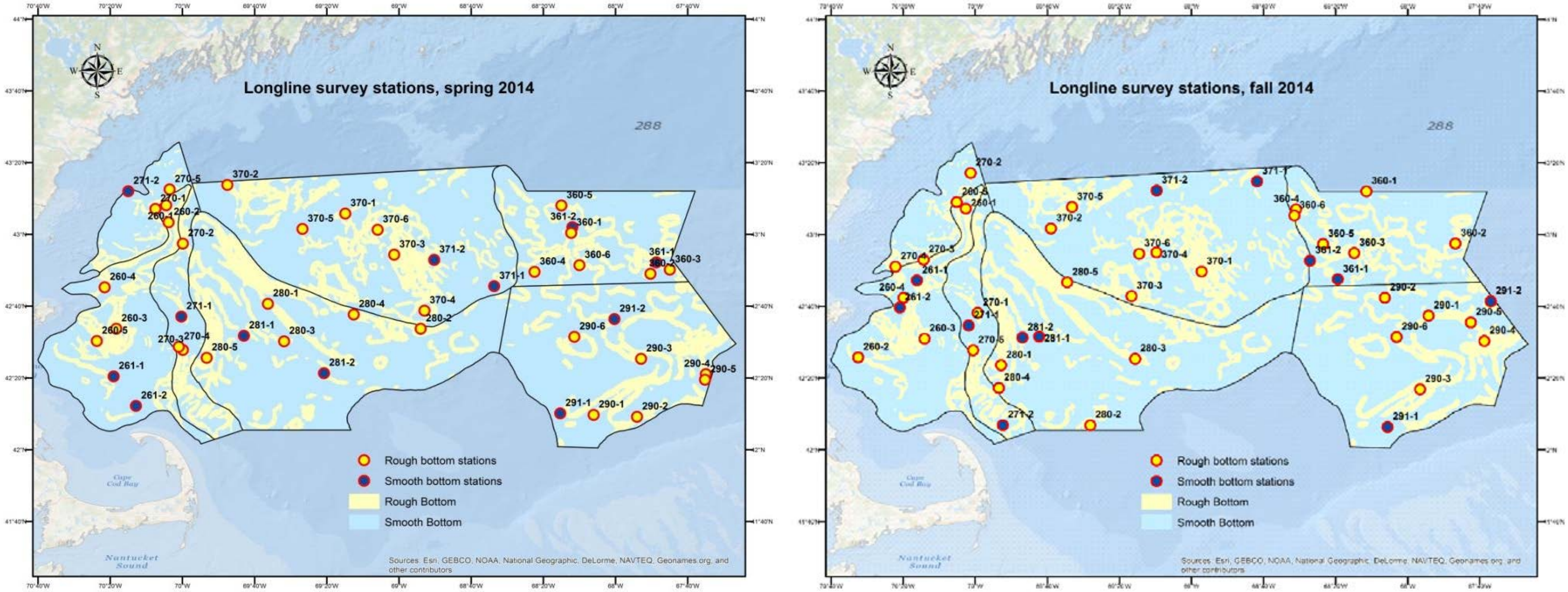


Figure 5. Bottom longline survey randomly drawn station locations by strata (26, 27, 28, 29, 36, and 37) and bottom type (rough and smooth) during 2014 spring (left panel) and 2014 fall (right panel).

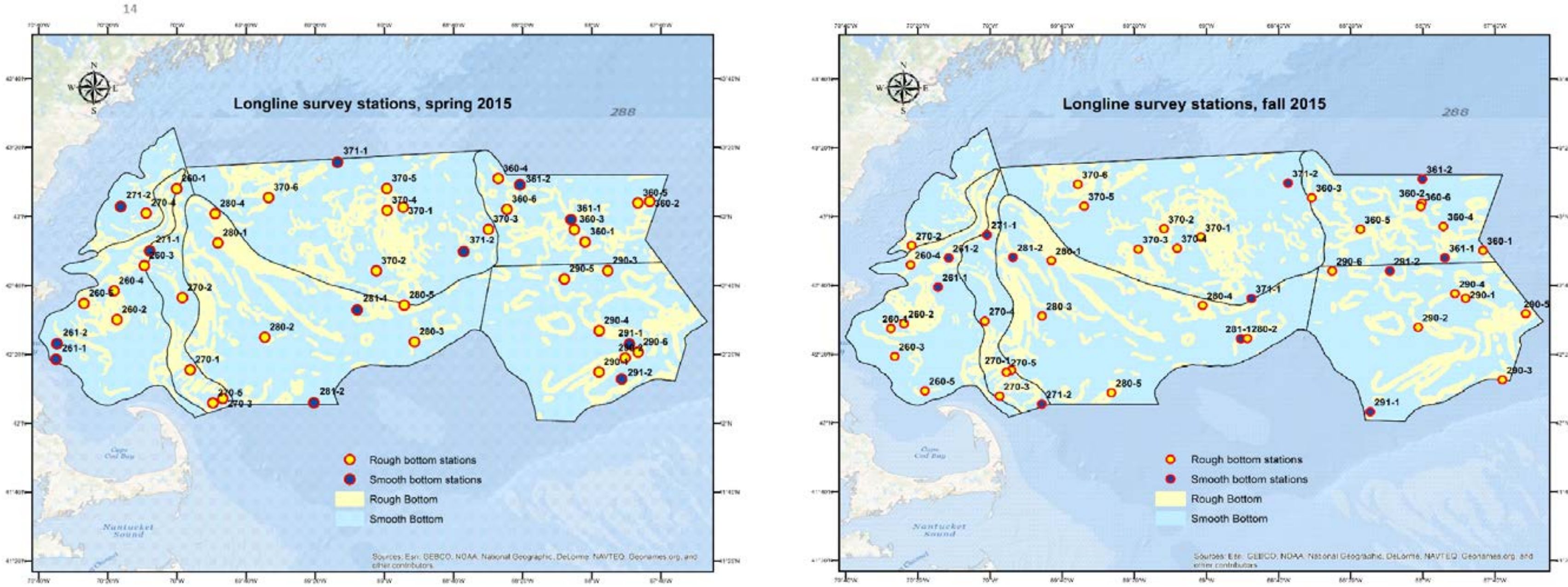


Figure 6. Bottom longline survey randomly drawn station locations by strata (26, 27, 28, 29, 36, and 37) and bottom type (rough and smooth) during 2015 spring (left panel) and 2015 fall (right panel).

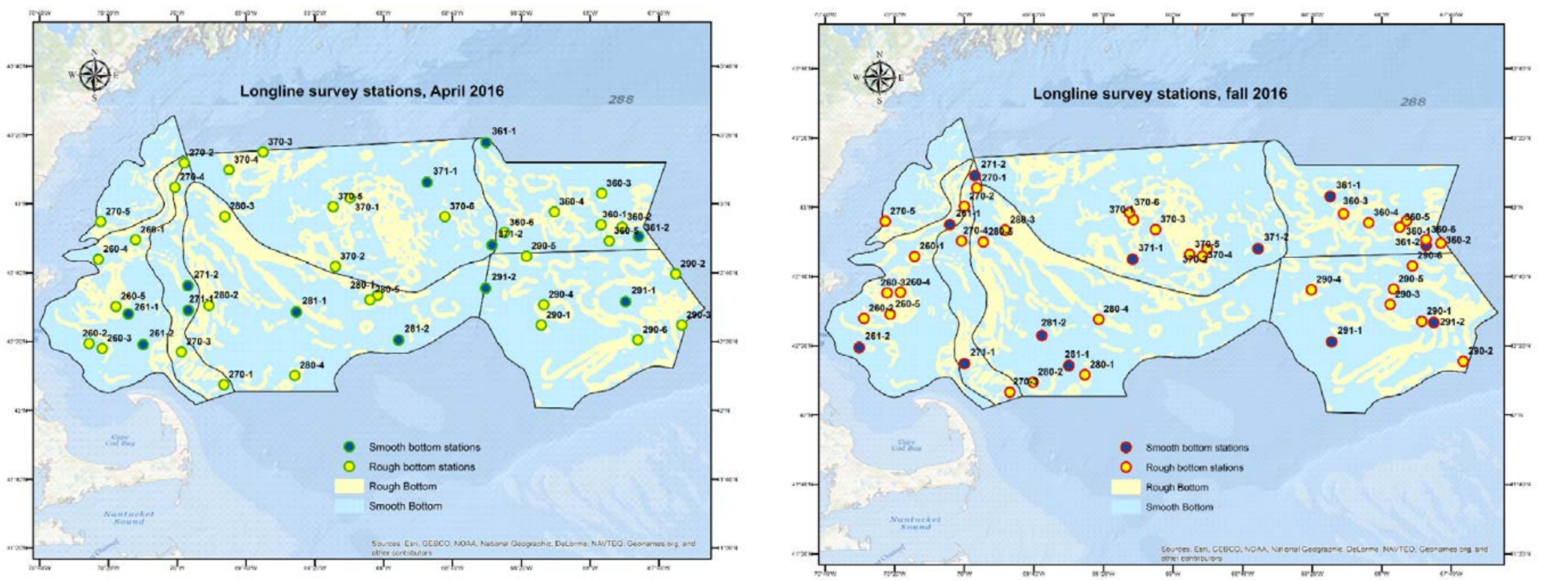
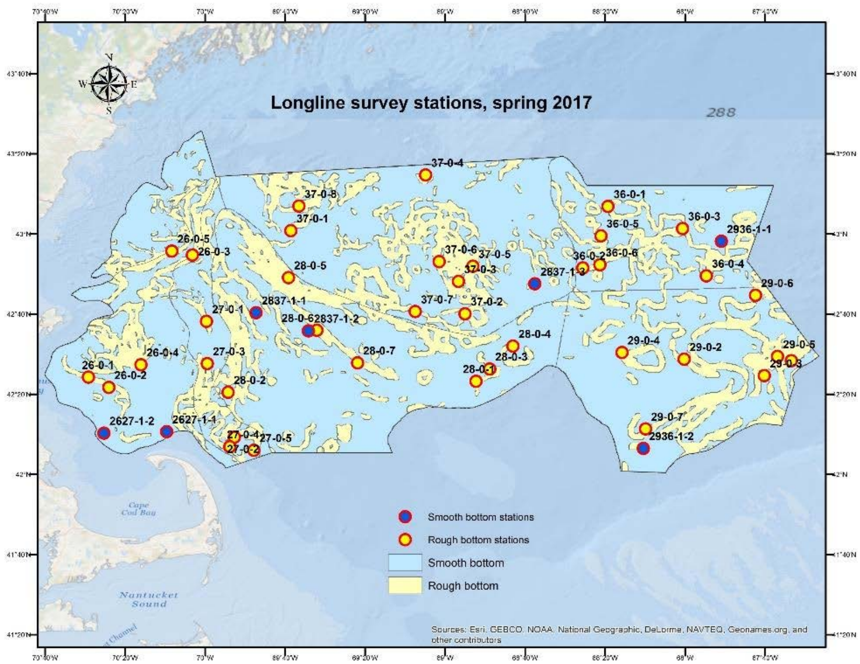


Figure 7. Bottom longline survey randomly drawn station locations by strata (26, 27, 28, 29, 36, and 37) and bottom type (rough and smooth) during 2016 spring (left panel) and 2016 fall (right panel).



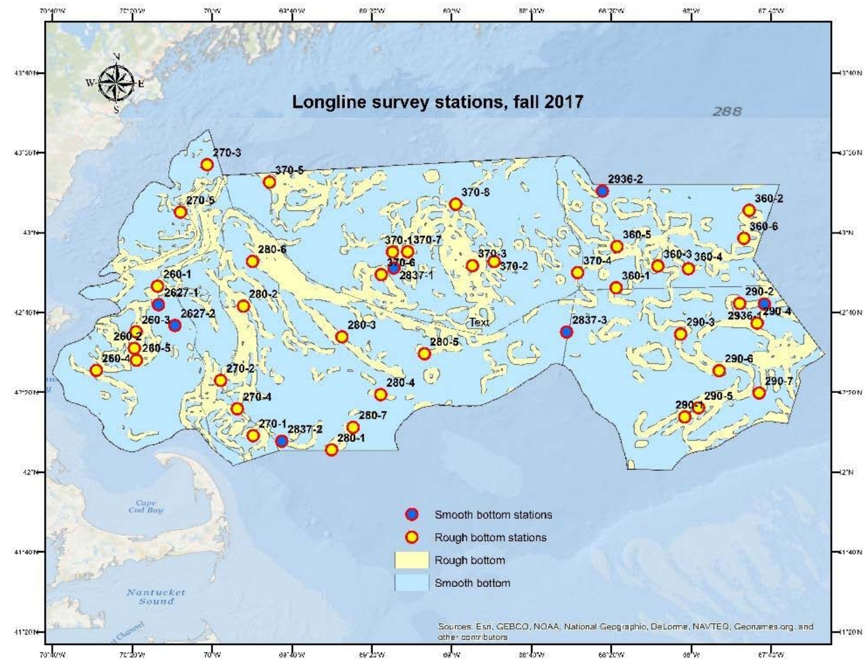


Figure 8. Bottom longline survey randomly drawn station locations by strata (26, 27, 28, 29, 36, and 37) and bottom type (rough and smooth) during 2017 spring (left panel) and 2017 fall (right panel).

Figure 9. The longline survey chartered the F/V *Mary Elizabeth* (top) and F/V *Tenacious II* (bottom) for survey operations.

Figure 10. (A) An anchor being deployed off the stern of one vessel (B) with a depth/temperature probe (C) inside an aluminum housing mounted on one vessel’s anchor, and a tote (D) of baited survey gear with a close up of some baited hooks.

A.

B.

Figure 11. (A) Deployment from the stern of a vessel of a SeaHorse Tilt Current Meter during a longline survey. (B) The instrument has its own 12 oz. mooring weight, and it is clipped to the fishing line close to the anchor, and thrown overboard at the same time as the anchor.

A. B.

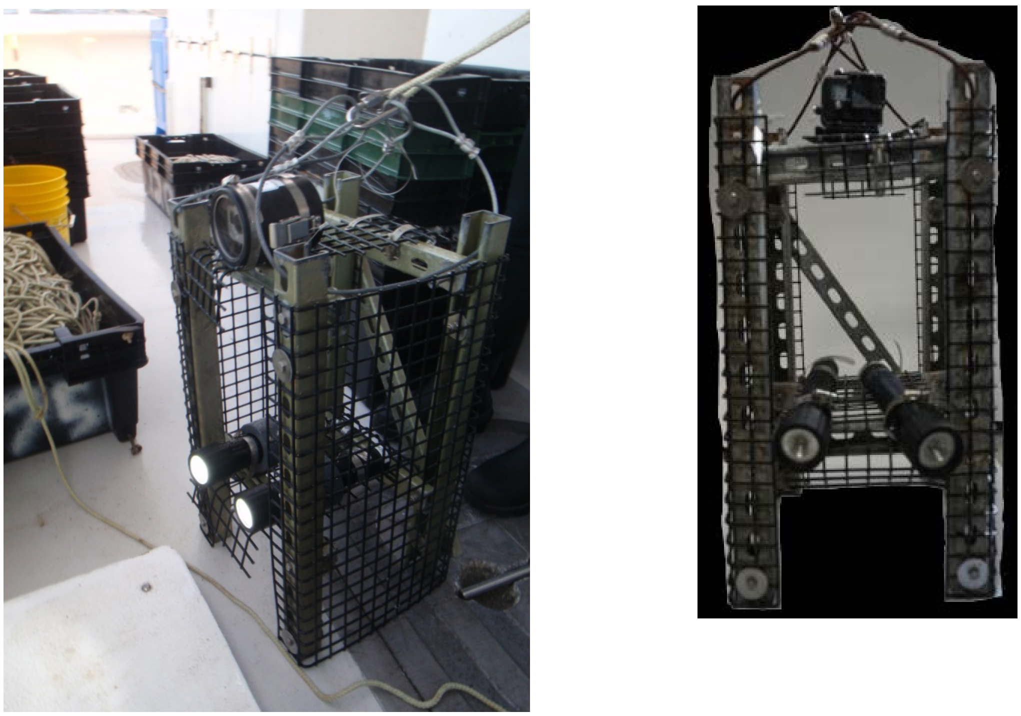


Figure 12. (A) Go-Pro camera housing and lights secured to weighted frame with one camera housing type used initially, and (B) a later housing type utilized on the majority of deployments. Lights and housings rated to 300 m depth.

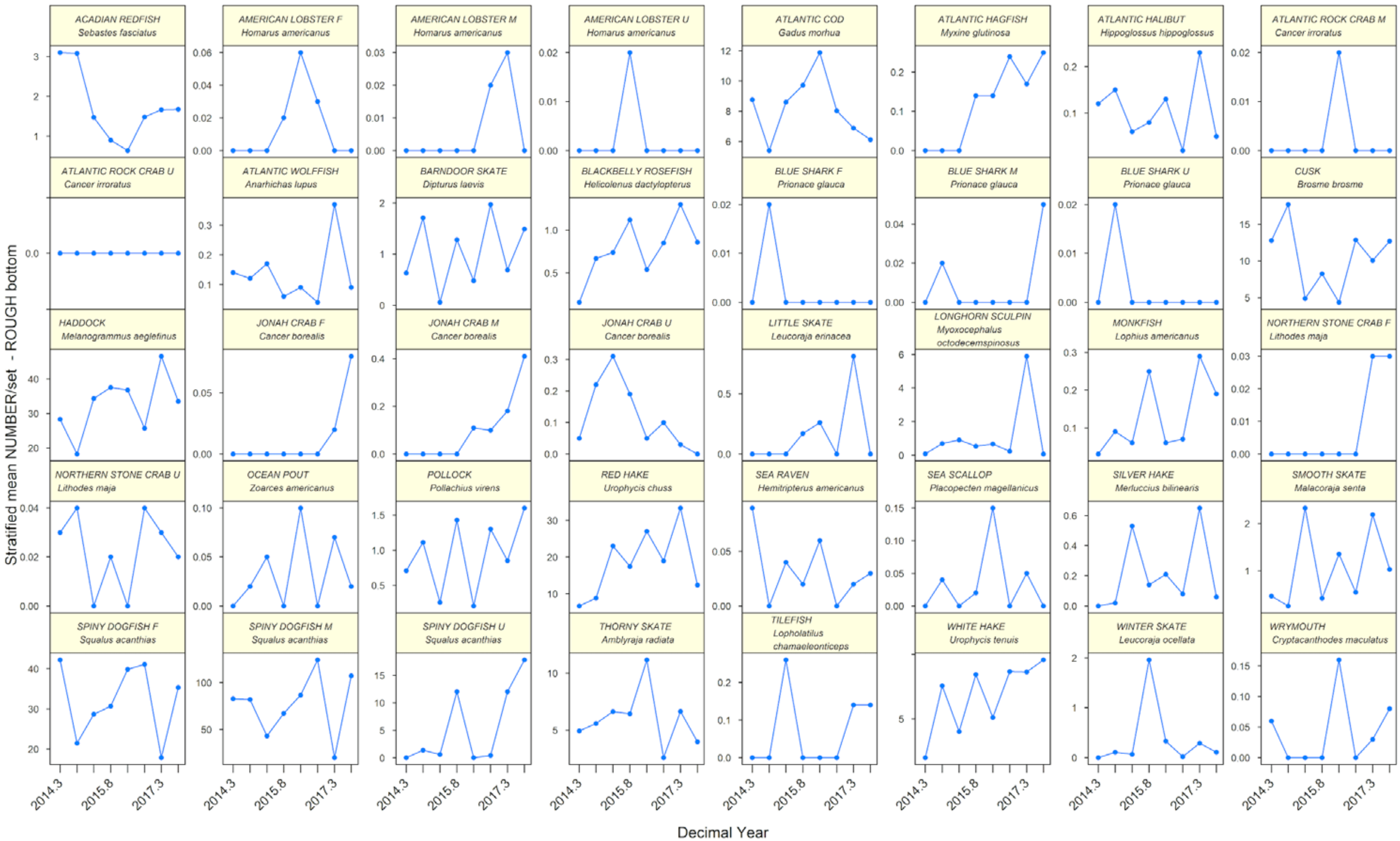


Figure 13. Stratified mean number per set for the predominant species-sex captured on rough bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

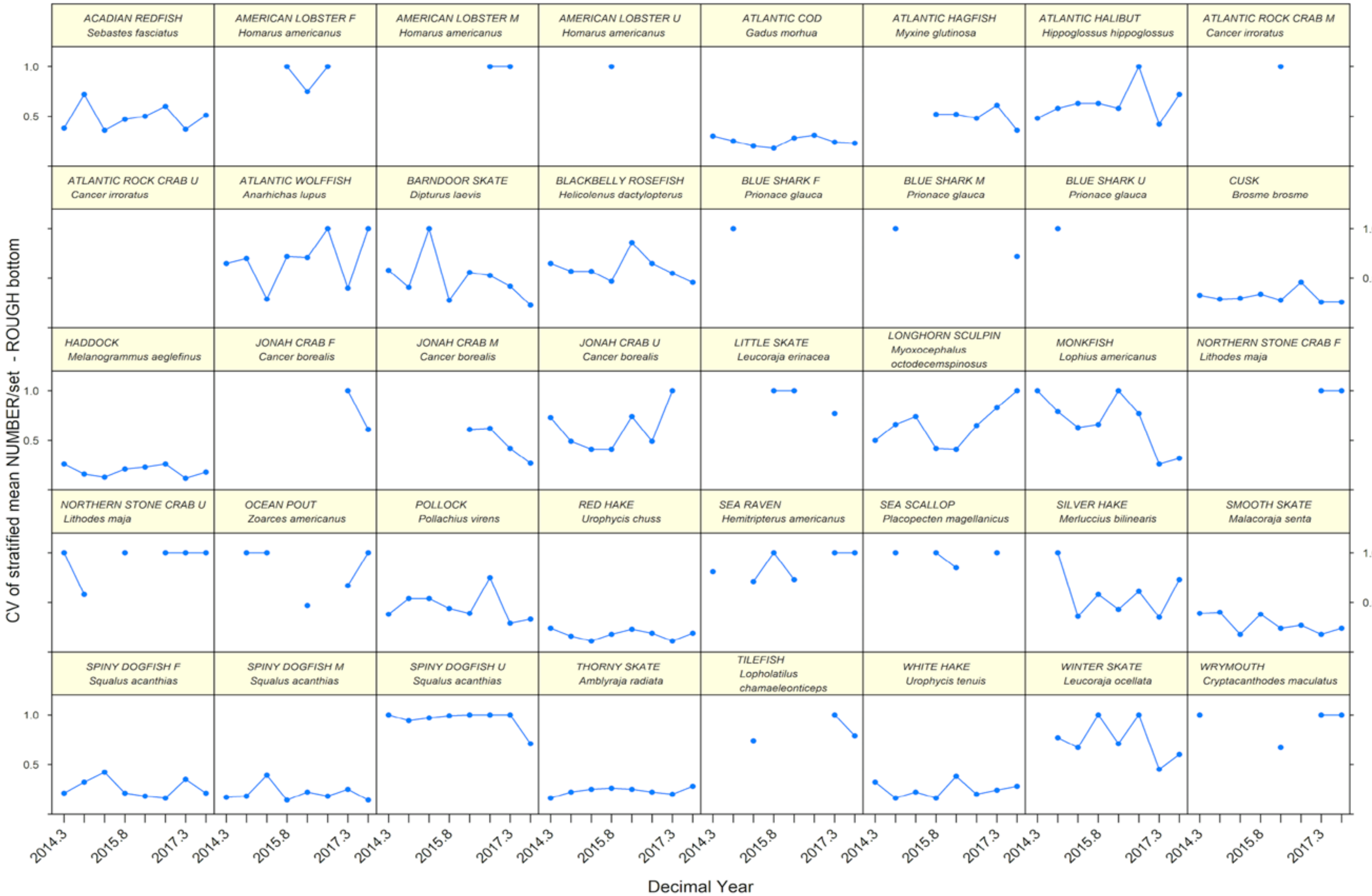


Figure 14. Coefficient of variation (CV) of stratified mean number per set for the predominant species-sex captured on rough bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

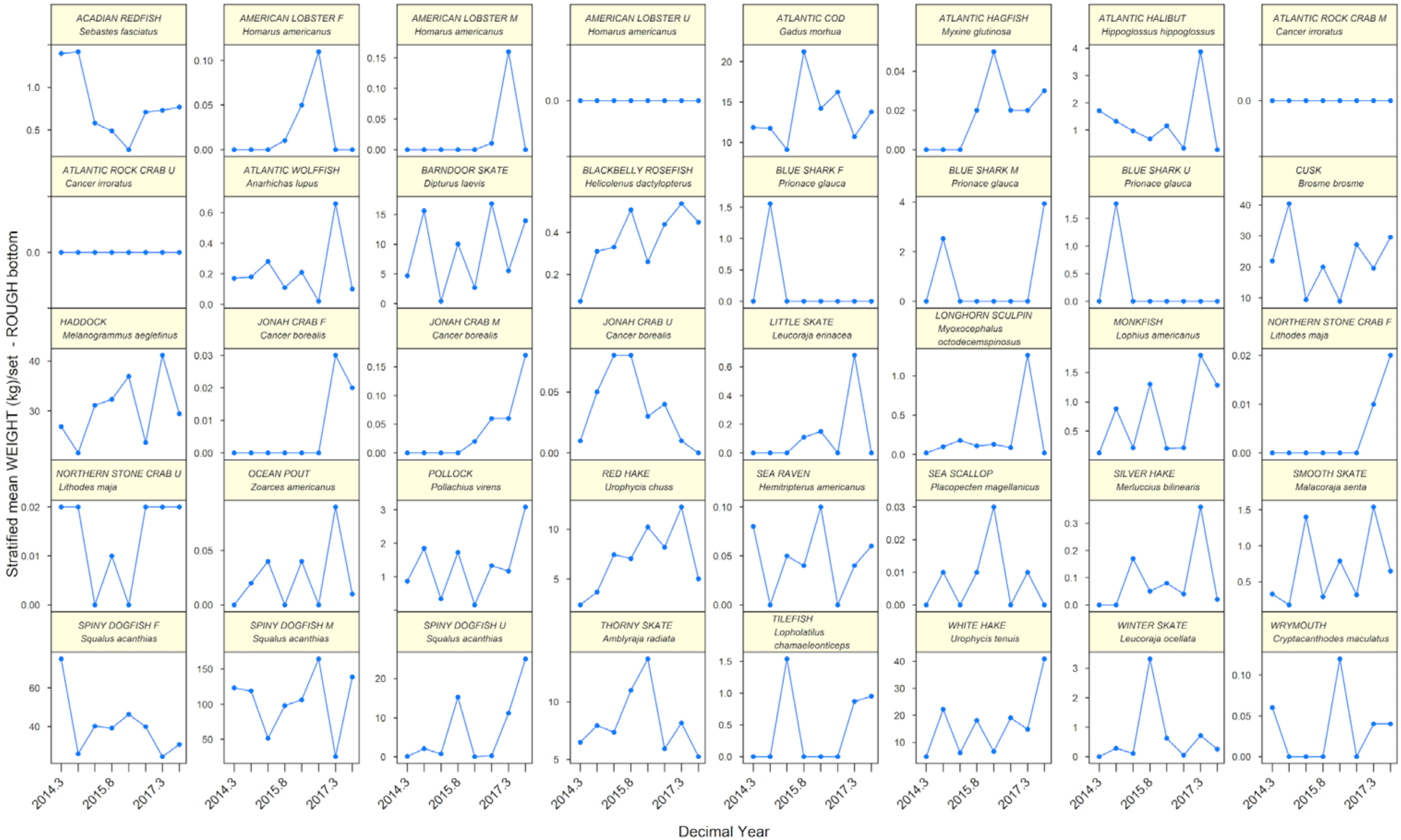


Figure 15. Stratified mean weight (kg) per set for the predominant species-sex captured on rough bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

Figure 16. Coefficient of variation (CV) of stratified mean weight (kg) per set for the predominant species-sex captured on rough bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

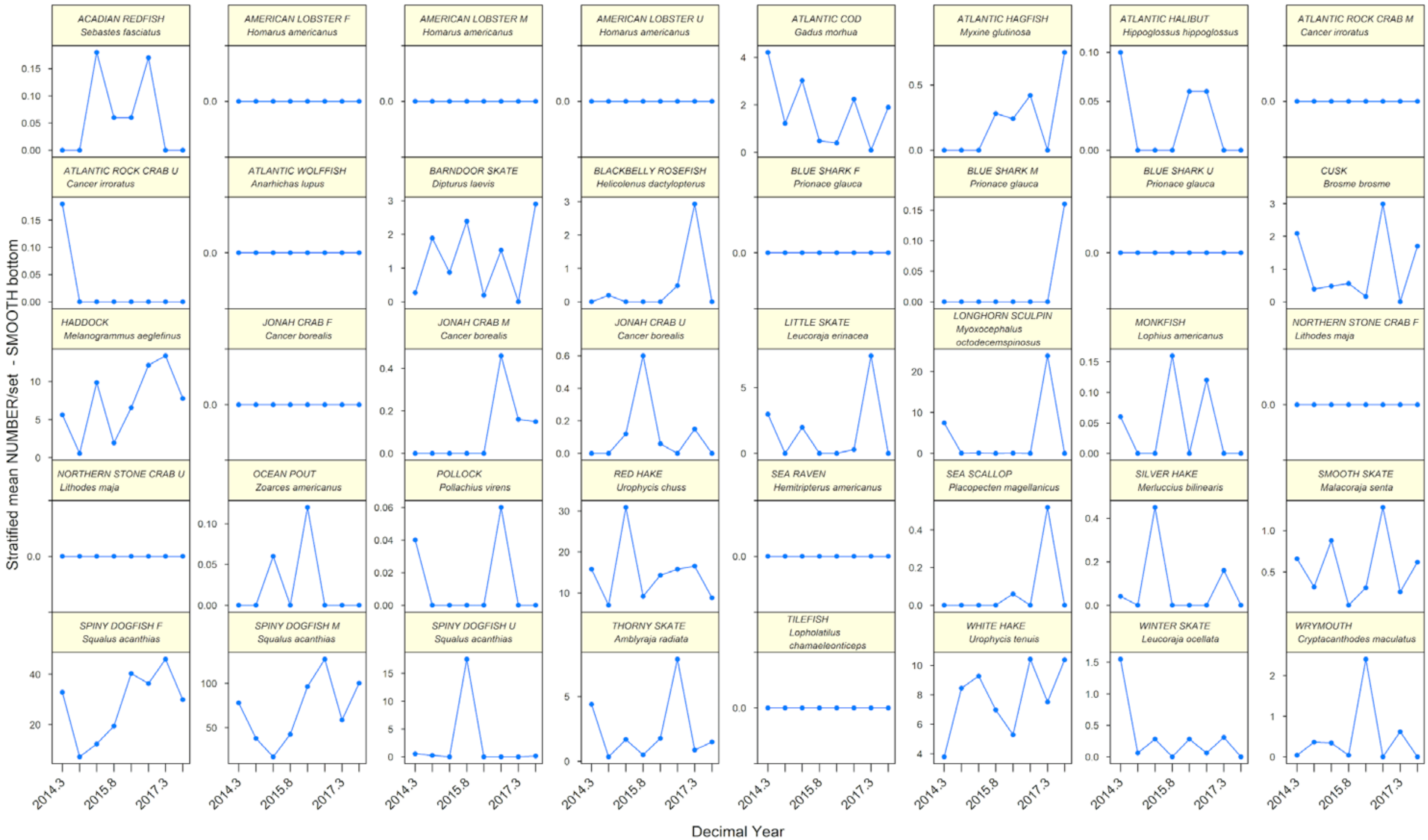


Figure 17. Stratified mean number per set for the predominant species-sex captured on smooth bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

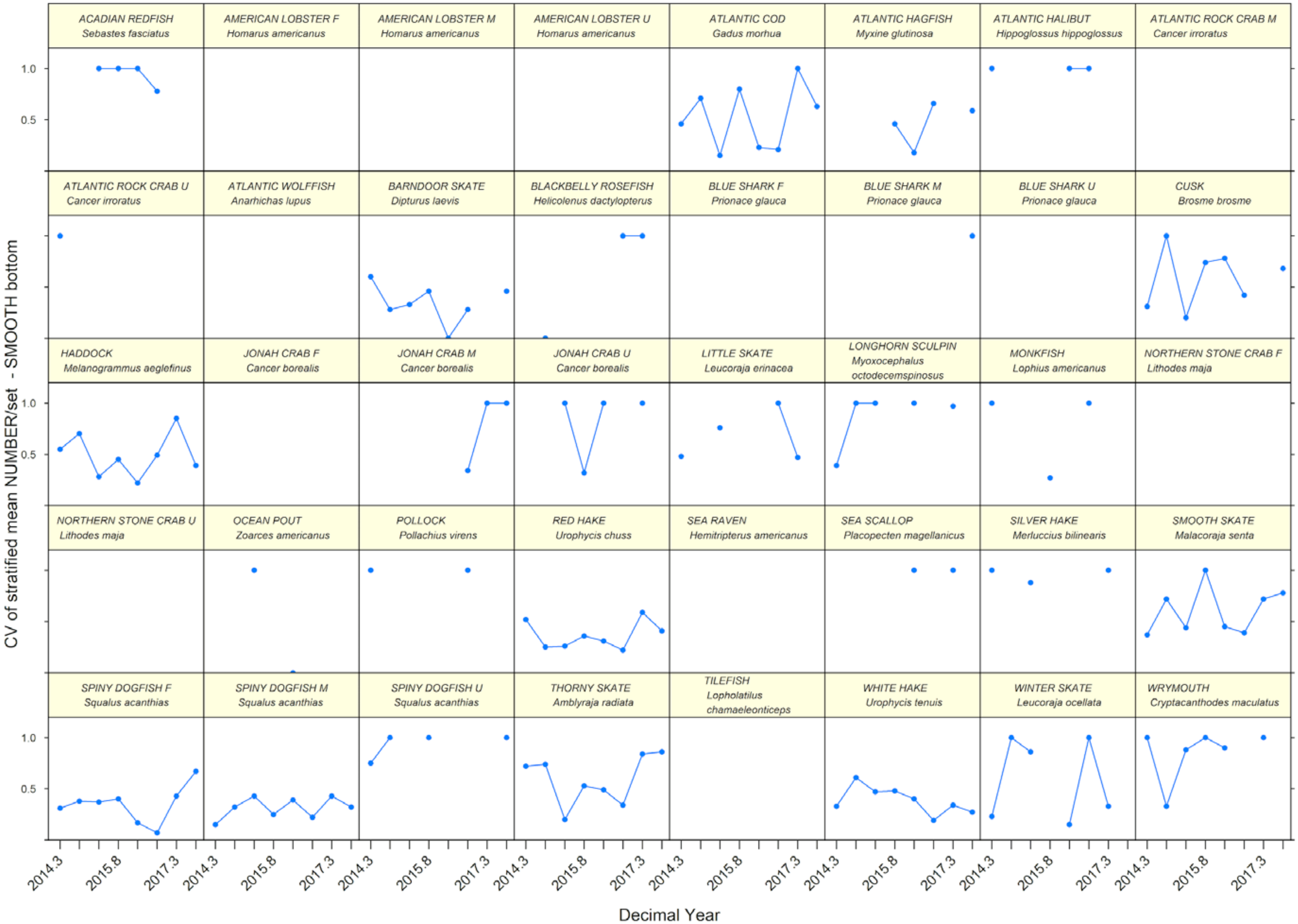


Figure 18. Coefficient of variation (CV) of stratified mean number per set for the predominant species-sex captured on smooth bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

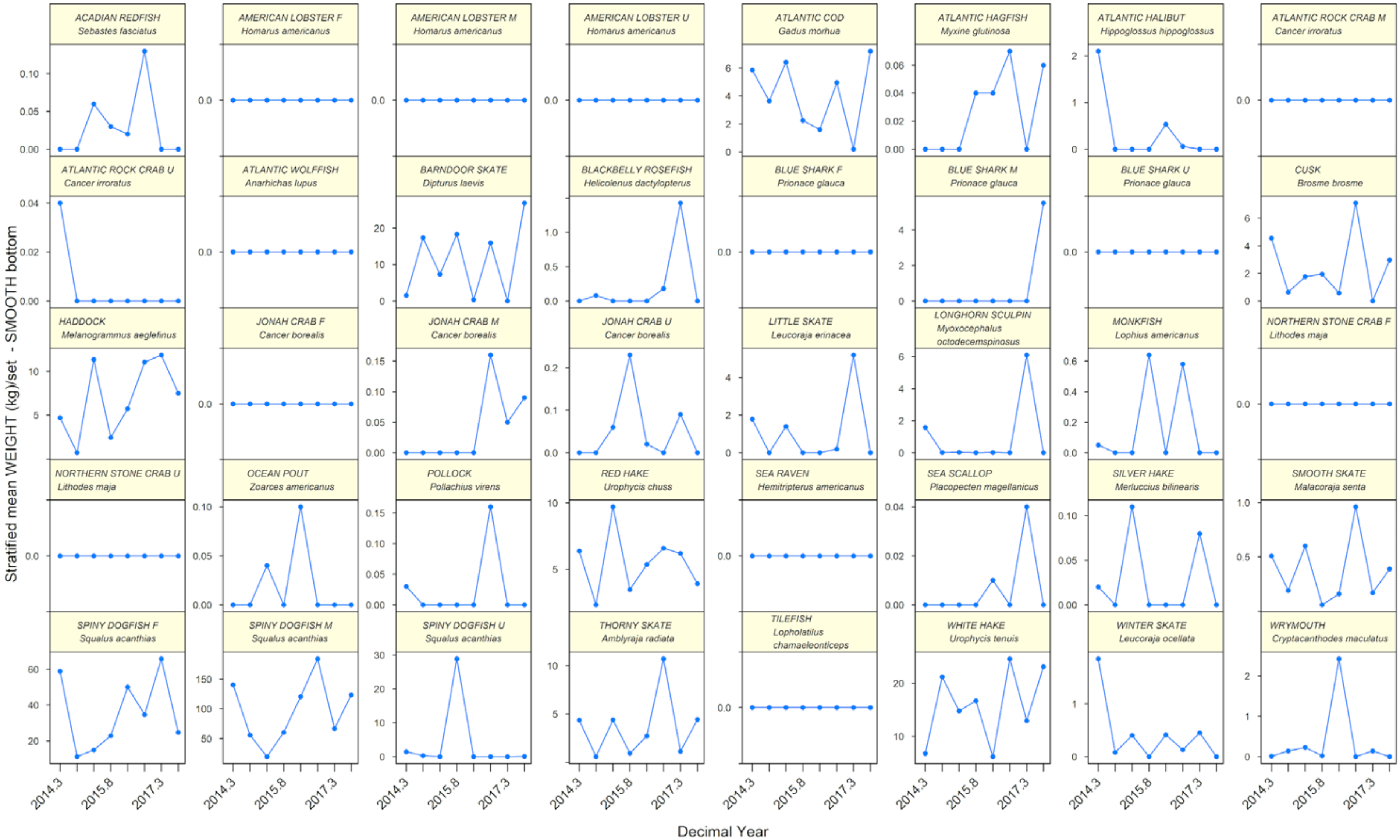


Figure 19. Stratified mean weight (kg) per set for the predominant species-sex captured on smooth bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

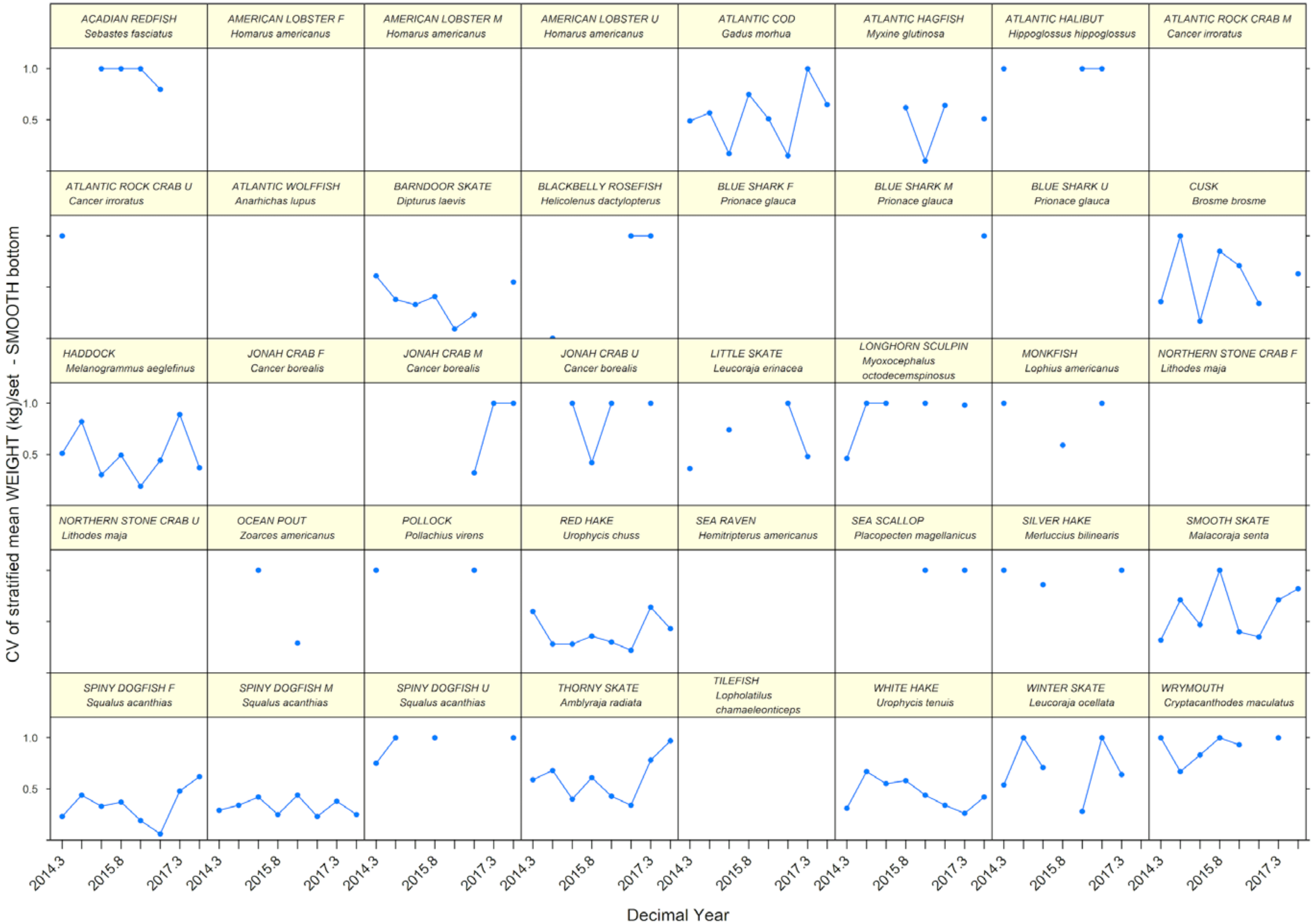


Figure 20. Coefficient of variation (CV) of stratified mean weight (kg) per set for the predominant species-sex captured on smooth bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

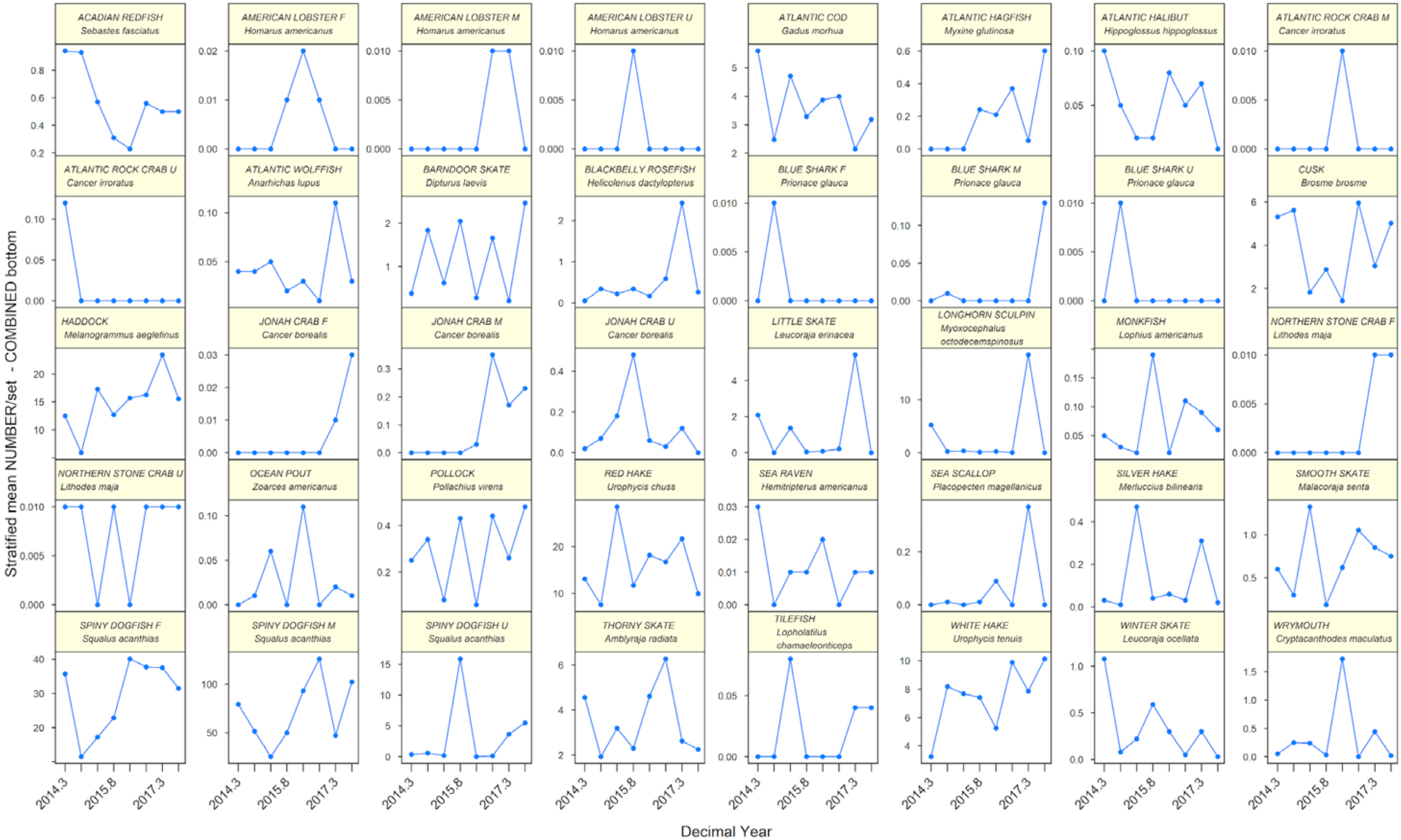


Figure 21. Stratified mean number per set for the predominant species-sex captured on combined (rough and smooth) bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

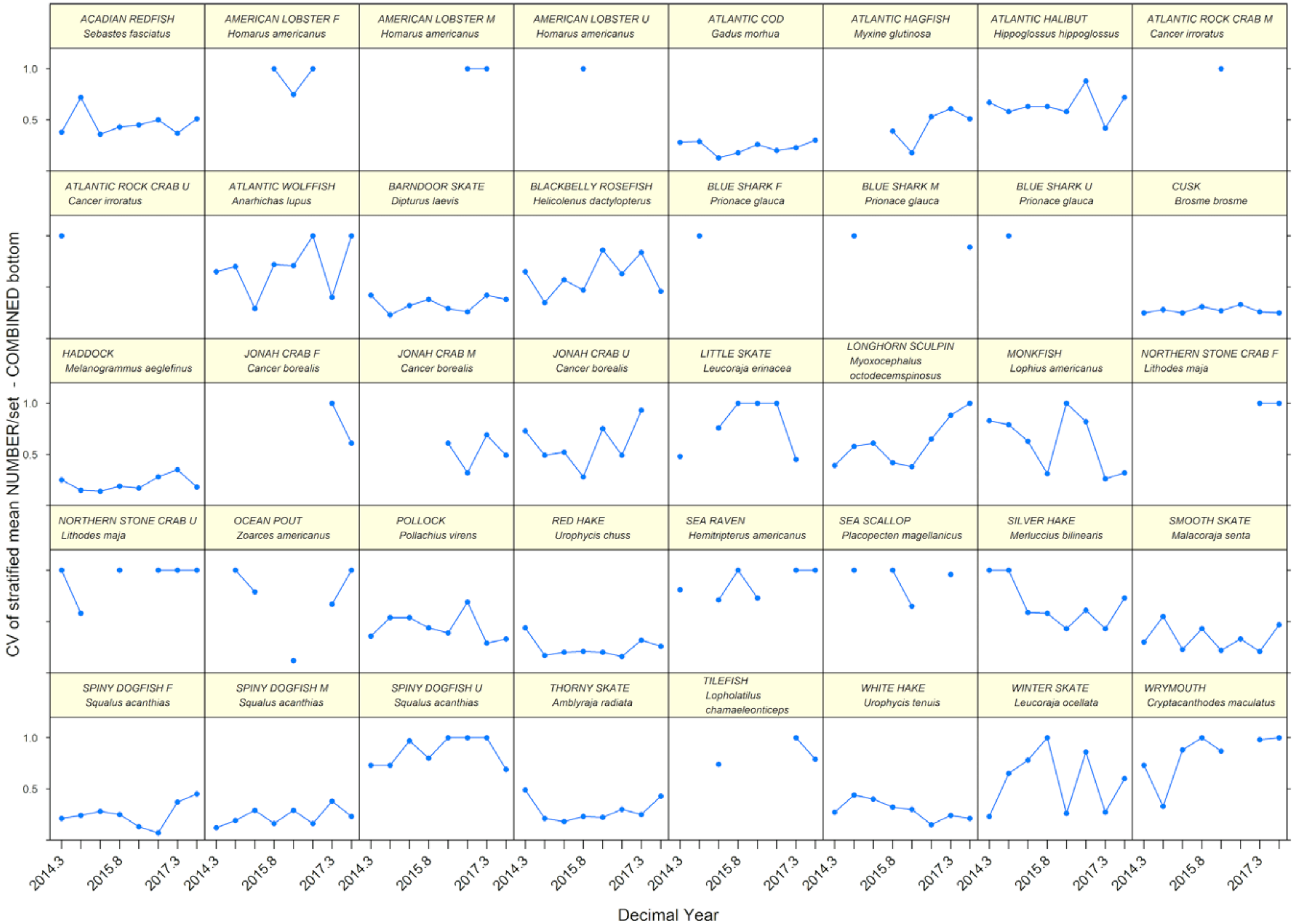


Figure 22. Coefficient of variation (CV) of stratified mean number per set for the predominant species-sex captured on combined (rough and smooth) bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

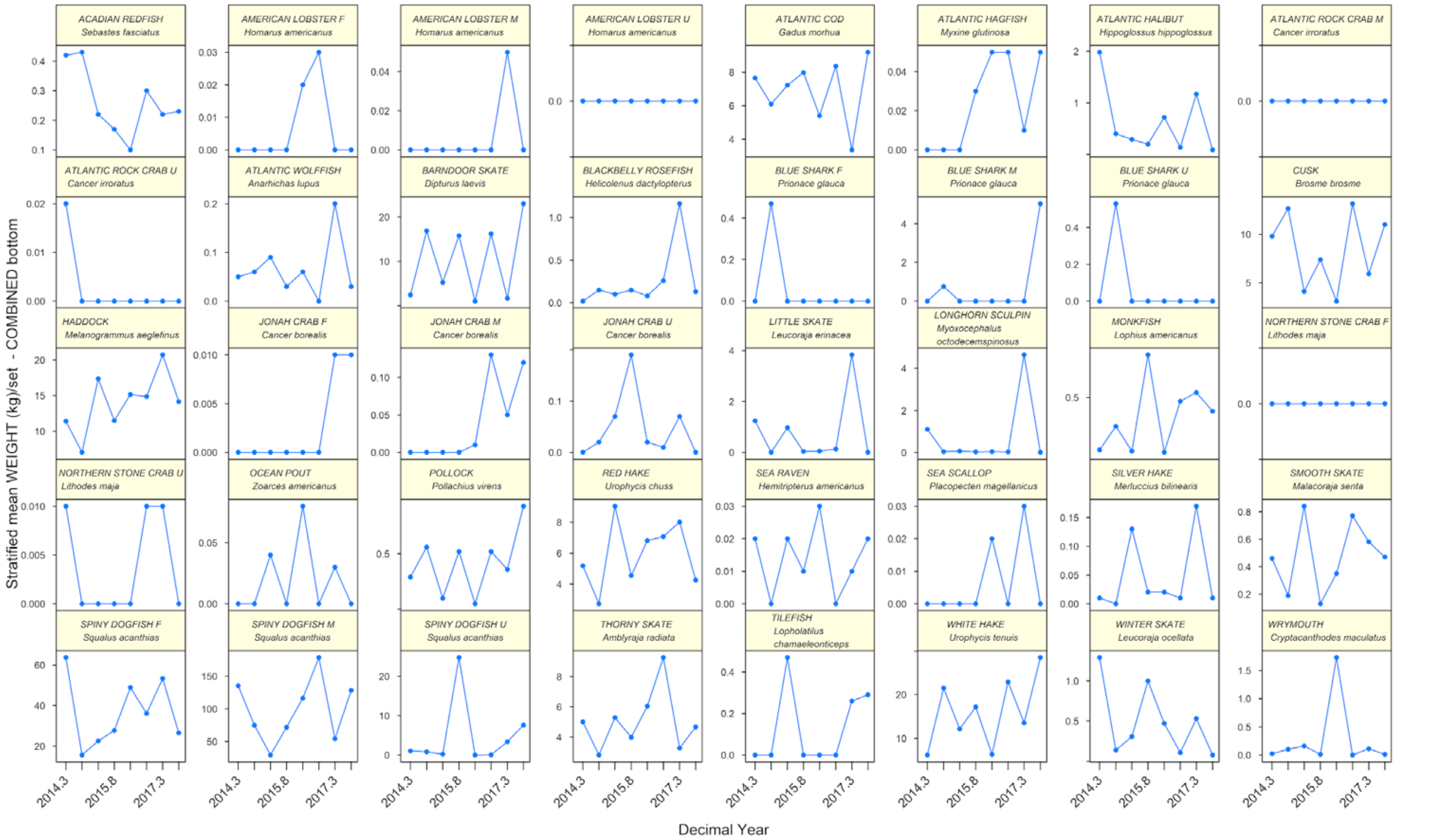


Figure 23. Stratified mean weight (kg) per set for the predominant species-sex captured on combined (rough and smooth) bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

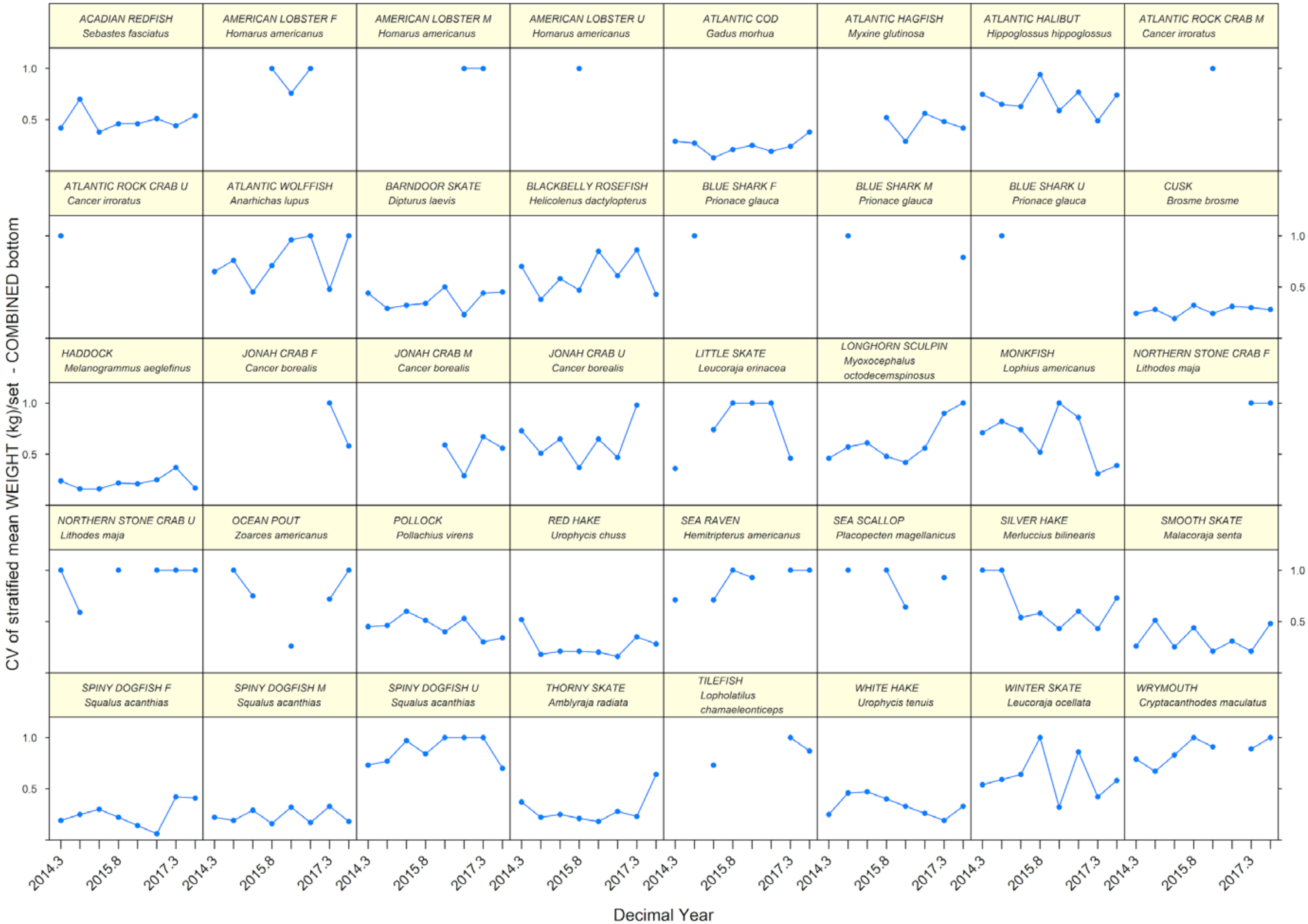


Figure 24. Coefficient of variation (CV) of stratified mean weight (kg) per set for the predominant species-sex captured on combined (rough and smooth) bottom by the bottom longline survey during spring (year + 0.3) and fall (year + 0.8), 2014-2017. Abbreviations are used for female (F), male (M), and unsexed (U).

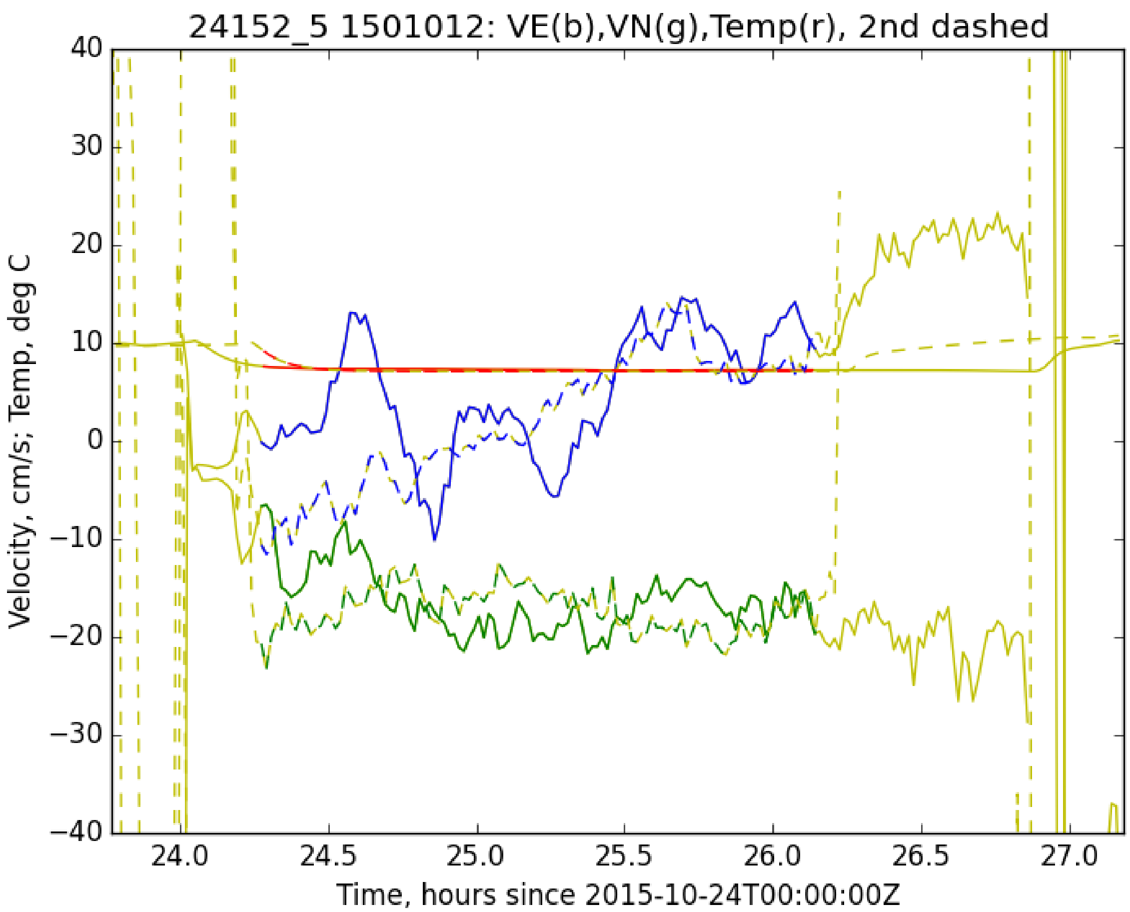


Figure 25. The velocity data from 2 SeaHorse Tilt Current Meters deployed at the ends of a longline (Station 24152_5, Fall 2015). The eastward components are in blue; the northward are in green. The solid curves are the first instrument; the dashed curves are the second instrument. The temperatures from the 2 instruments are also shown in red. The line periods in yellow indicate off bottom periods (e.g., on deck or during hauling).

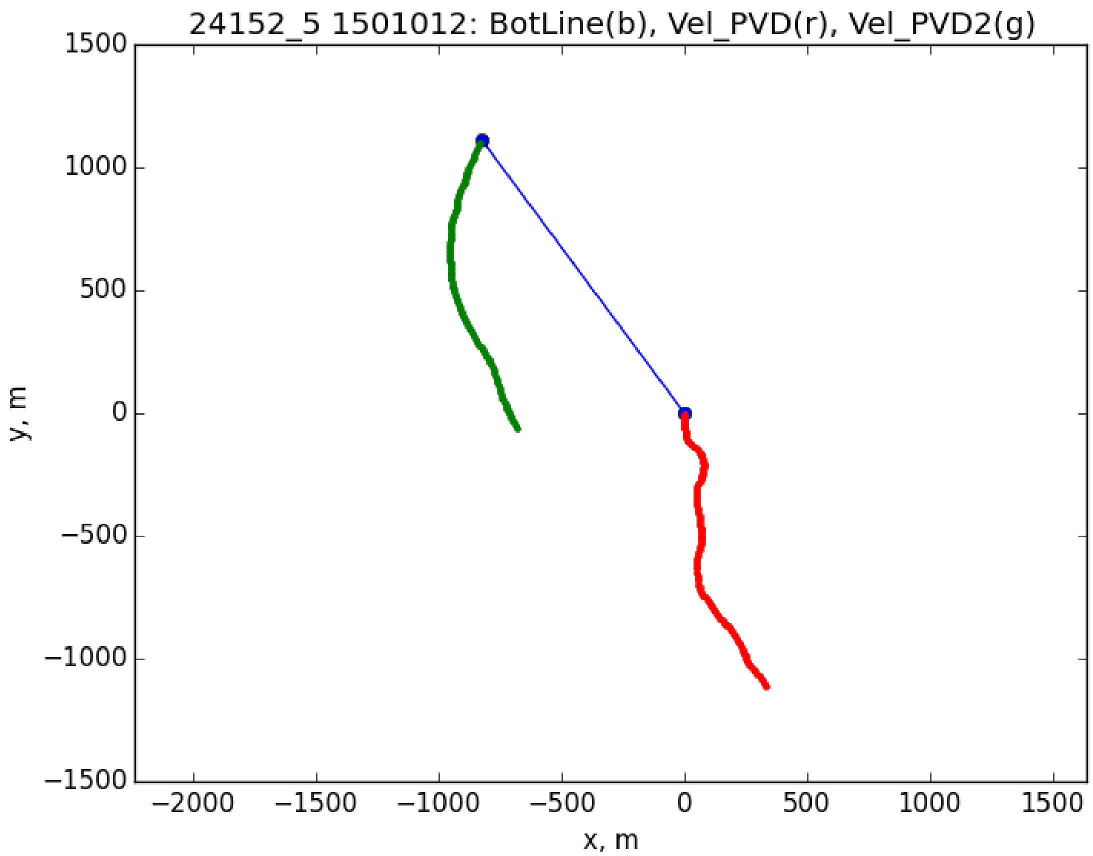


Figure 26. The progressive vector diagrams (PVD) based on velocity data from 2 SeaHorse Tilt Current Meters deployed at the ends of a longline (Station 24152_5, Fall 2015): the first instrument – red, the second – green. The blue line shows the longline connecting positions of the 2 anchors (blue dots). The eastward (x) and northward (y) distances are in meters.

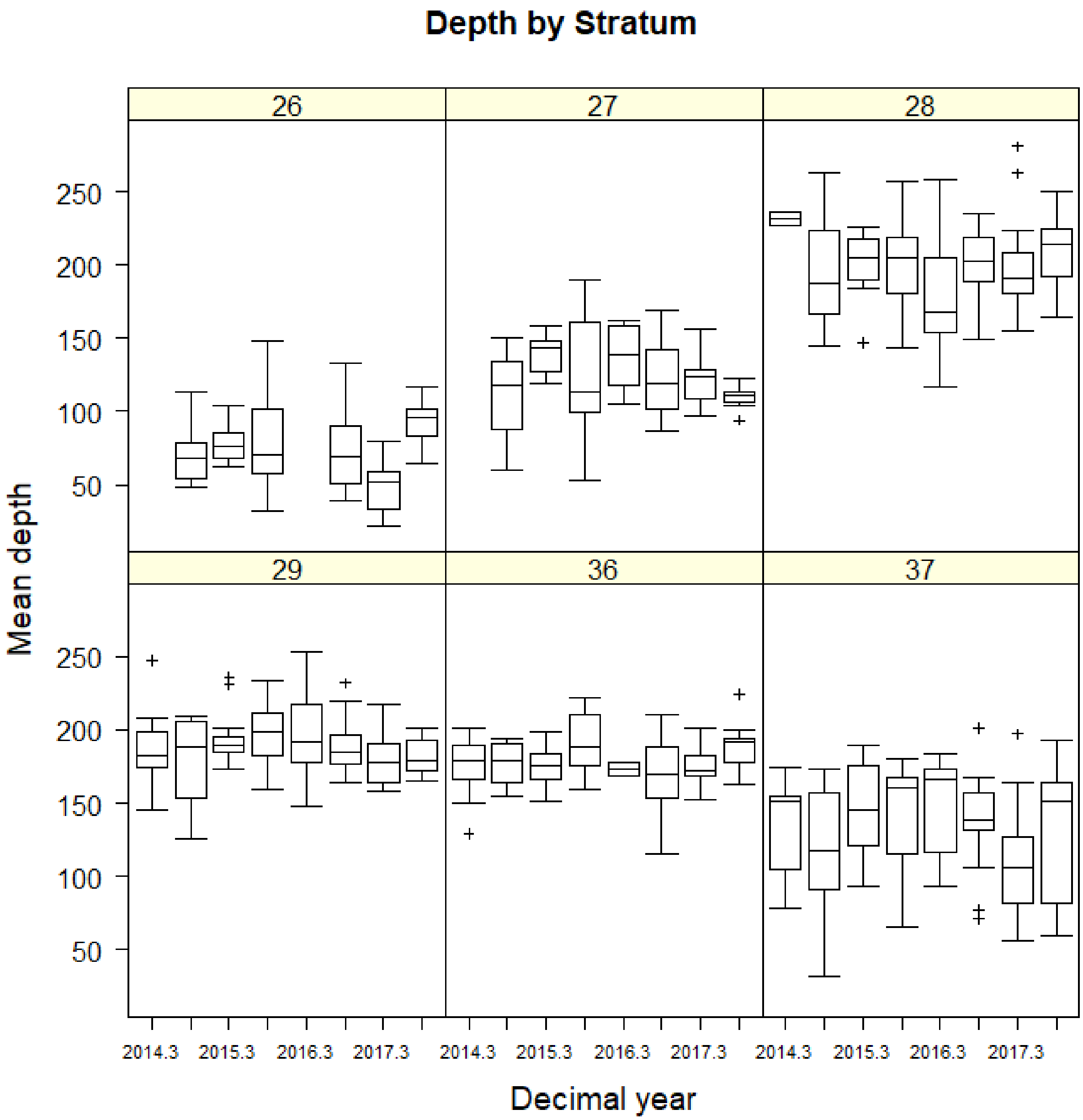


Figure 27. Mean depth (m) observed at bottom longline survey stations by stratum during spring (year + 0.3) and fall (year + 0.8), 2014-2017. The median mean depth is the black dot in the rectangle with the 25th quartile (lower horizontal line) and 75th percentile (upper horizontal line). Smooth stations for new combined strata in 2017 included in strata fished using old strata designations. Data from instruments with a standard error for the depth > 0.1m were excluded.

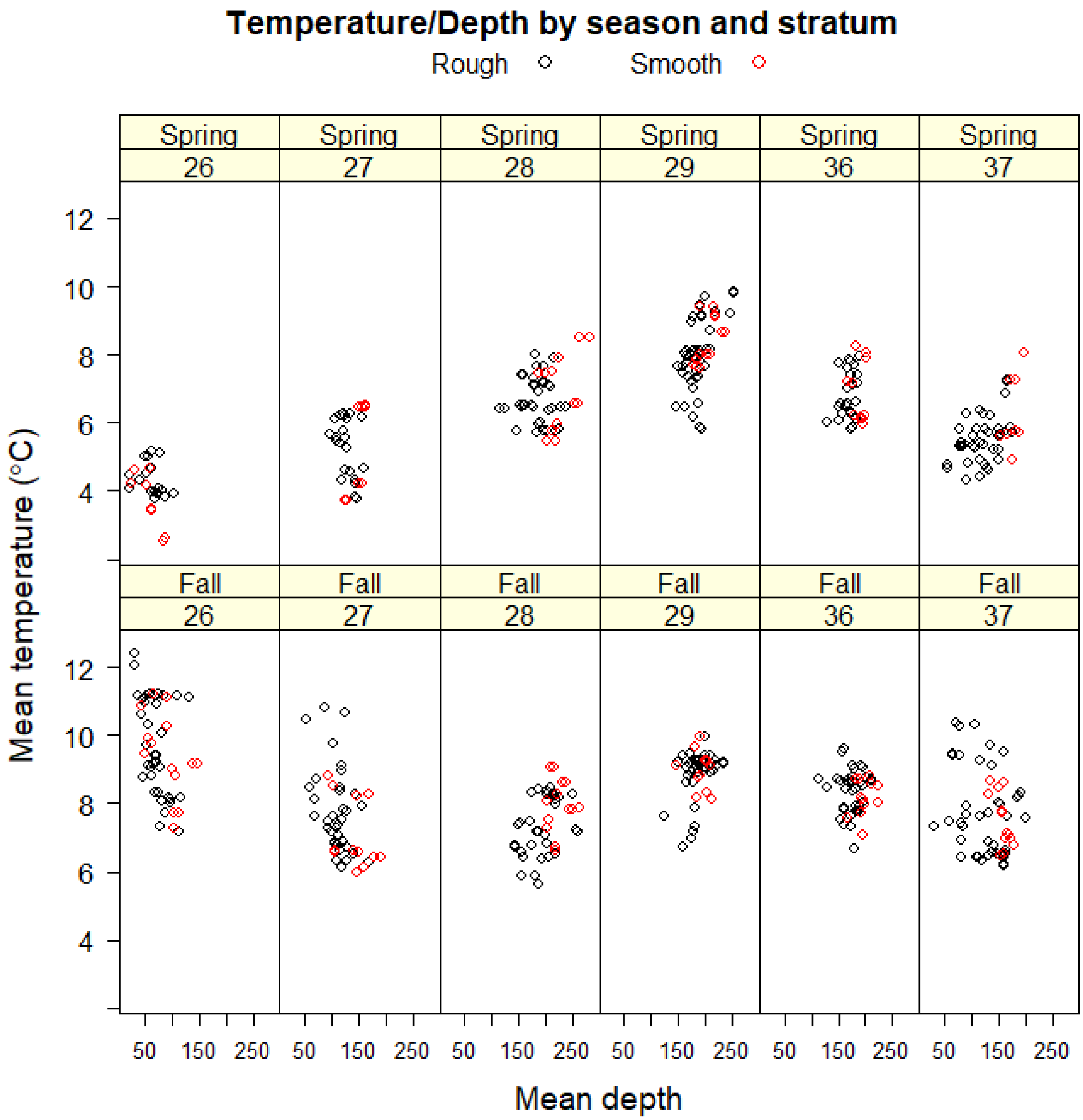


Figure 28. Mean temperature (°C) and depth (m) observed at bottom longline survey stations by stratum and bottom type (black = rough, red = smooth), 2014-2017. Smooth stations for new combined strata in 2017 included in strata fished using old strata designations. Data from instruments with a standard error for the depth > 0.1m were excluded.

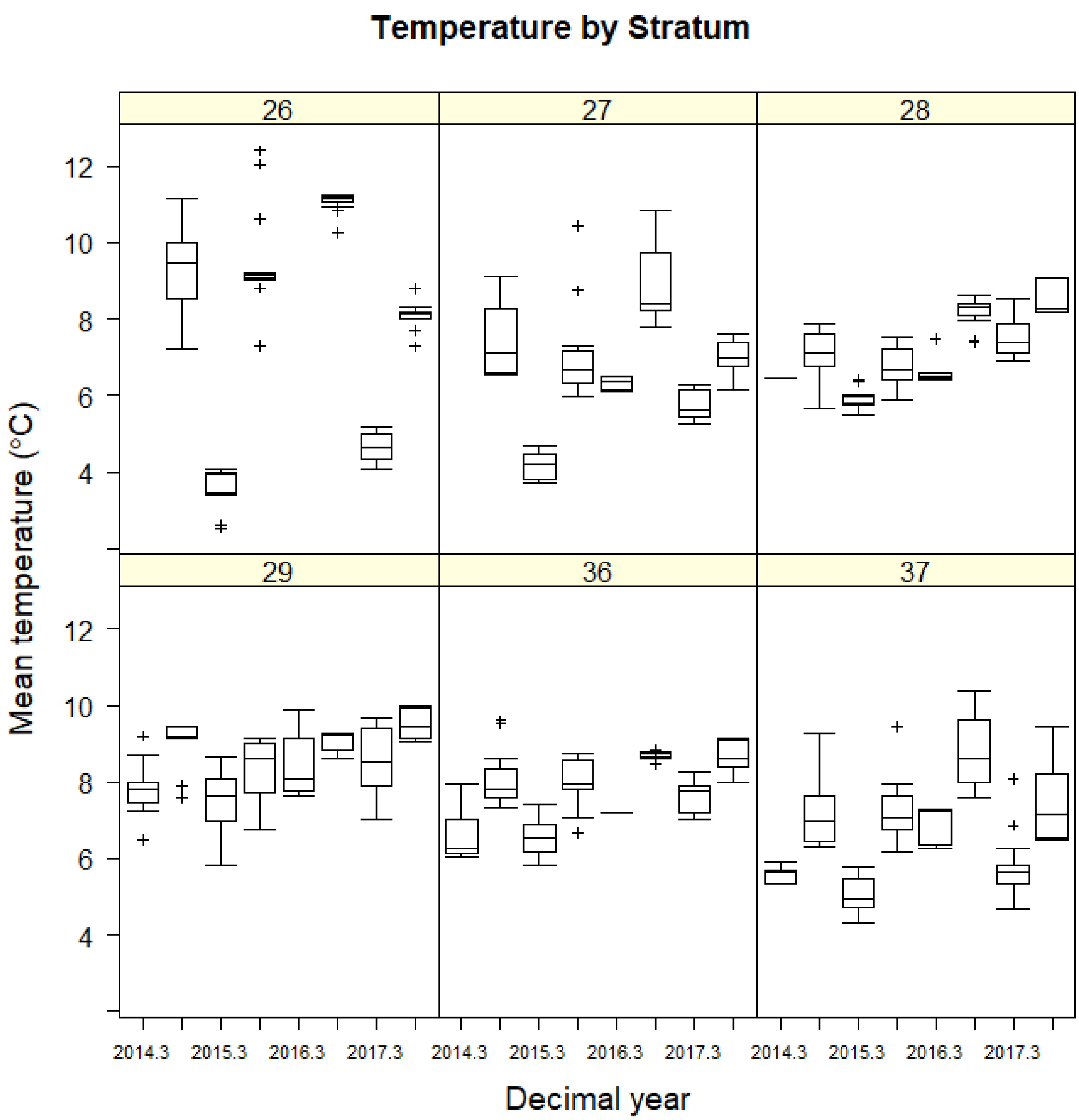


Figure 29. Mean temperature (°C) observed at bottom longline survey stations by stratum during spring (year + 0.3) and fall (year + 0.8), 2014-2017. The median mean depth is the black dot in the rectangle with the 25th quartile (lower horizontal line) and 75th percentile (upper horizontal line). Smooth stations for new combined strata in 2017 included in strata fished using old strata designations. Data from instruments with a standard error for the depth > 0.1m were excluded.

APPENDIX A.

Appendix A. The concise protocol available to staff while at sea for the bottom longline operations and catch sampling (V6, 2016).

Locating Stations

1. All effort shall be made to sample the station within a 1 nm radius of the preselected random location in accordance with the station habitat characterization (rough/smooth). A set is considered to be within the 1 nm radius if ANY portion of the on-bottom gear distance occurs within a 1 nm radius of the preselected location.
2. If no operable set path matching the assigned habitat (rough/smooth) is found after approximately 30 minutes of searching, the radius will be expanded to 3 nm. If any portion of the set occurs within the 3nm radius, it is considered to be within the 3 nm radius. (Record Station Type as BASE; record Location Assignment as BASE for original draw of random stations)
3. If no viable station path is found after approximately 1 hour, an alternate random station location will be identified, but only if safety precludes setting of the gear. Otherwise all attempts should be made to set on the initial random station.
4. If the station has limited habitat consistent with the station type, *make detailed comments in the effort notes field*.
5. If an alternate random station needs to be selected, it should match the original station type and be within the same strata. Select the alternate random location that is closest in proximity to the current location. (Record Location Assignment as ALTERNATE)
6. If an original base station had a problem that resulted in it being considered unrepresentative and was repeated on a later trip, list it as Station Type BASE, but Location Assignment as REPEAT.
7. Subsequent to completion of the 45 base survey stations, alternate stations or other experimental stations may be conducted. (Record the Type and Location Assignment type as appropriate).
8. Use the OKmap software to stay within the assigned strata boundary for each station. The first 2 digits of the station ID indicate the strata number. Staying within the strata boundary takes priority over finding the appropriate bottom type.
9. While surveying the area be alert for marine mammals (esp. right whales) for at least 30 min prior to the set, follow proper protected species protocol if one is sighted. If they are numerous or remain in the area, consider moving to an alternate site or coming back to the station as necessary.

Cruise Codes, Station Numbering, & Recording in FLDRS

1. Each vessel will have a cruise code particular to that vessel, but maintained for the entire season (24 for *Tenacious II*, 25 for *Mary Elizabeth*).
2. A trip ID will be assigned by Fisheries Logbook and Data Recording Software (FLDRS) each trip. In the trip level data record, the cruise code each trip.

3. Cruise code will be the same for all trips within a survey season for each vessel.
    a. First 2 digits for vessel, next 2 digits for year, last digit for season. Example: 24161 for *Tenacious II* spring; 25162 for *Tenacious II* autumn (25161 & 25162 for the *Mary-Elizabeth*).
4. Each station type (smooth/rough) will be recorded in FLDRS. Record the pre-assigned station ID (e.g., 260-1) in the dynamic data (DD) for each effort/station. For alternate stations indicate by selecting "alternate" in the location assignment drop down menu in the DD.
5. Assign station number in the DD for each effort. These numbers are sequentially assigned to each effort for the duration of the survey season for each vessel (it will not match effort number after the first trip).
6. Use cruise code and station number for labeling and linking all other data types.

Gear Conflicts

1. Survey the area prior to setting to avoid potential conflicts with other fishing operations

Tide Protocol

1. The captain will estimate the approximate time of slack tide for the sampling location.
2. All attempts to set the gear across the slack tide should be made. The target is 1 hour prior to slack time (± 0.5 hr).

Gear Setting and Data Collection

1. **Oceanographic instruments**
    a. **Temperature probe**
        i. Should be deployed in the housing mounted on each anchor (set at 20s freq).
        ii. Download probe data on EACH trip (see probe guide*). Save in the data folder for each survey. Include cruise code and station numbers in the file name, and save as a .dat file.
    b. **Current meter**
        i. Should be deployed on each end of the gear deployed, try to make sure it is 1-2 m from the anchor to avoid interference with compass
        ii. Record the current instrument number in DD of FLDRS for each end in order deployed
2. **Gear configuration and setting**
    a. 1000 hooks (4 totes) per set (record in FLDRS).
    b. Captain will add scope as appropriate for the depth.
    c. The captain may add sash weights to the gear as deemed appropriate to maintain bottom contact (e.g., on very rugged bottom where gear may become suspended) and to maintain consistent deployment speed of the gear (e.g., on very deep sets to get the gear down).
    d. The longline gear will be set out at idle speed (~3-5 kts).

e. The gear will be set in a manner the captain feels is most appropriate for the tide and sea conditions. The direction of the deployment should attempt to maintain as much of the gear as possible within the designated habitat type (smooth/rough).
f. Record both the start and end of gear setting.
    i. Start = first anchor released.
    ii. End = second anchor released.
g. Record in the effort notes any tangles (with approx. number of hooks) or other issues observed during gear deployment

3. **Record weather data in DD of FLDRS**
    a. Wind velocity, direction, and sea state. If environmental conditions impacted catch retention or changed significantly during the set, indicate impacts and representativeness of the set in DD menu (Environmental conditions drop down, 1-4). Also, note if birds may have removed a significant amount of bait, employ appropriate avoidance.
4. **Collect habitat video when at sea conditions allow**
    a. Deploy GoPro camera frame with lights only when conditions allow
    b. 5-10 min of bottom time.
    c. The captain will maneuver the vessel so the line to the frame remains straight vertical as the boat drifts. Maintain tension on the line and allow the frame to sit on the bottom and then hop it along as the boat drifts. Indicate if it was done with the Y/N DD selection.
    d. Download video onto portable hard drive.

Gear Hauling

1. Gear will be hauled after a 2hr soak time (from end of deployment), unless conditions become unsafe.
    a. Record both the start and end of hauling operations
        i. Start = first anchor off bottom.
        ii. End = second anchor aboard.
2. The captain will haul at a speed and direction determined appropriate to the conditions and that will attempt to minimize catch loss and maintain consistency.
3. Gear tangles, hangs, parting or gear conflict. See table of station coding values.
    a. Record the **date/time** of each major incident in the gear haul notes field in FLDRS DD.
    b. Record the estimated number of hooks impacted. Describe major issues in haul notes.
    c. For tangles, record relative value in Gear Evaluation drop down in DD (1-6). Record any gear damage, including mainline parting and hook loss, in Gear Damage DD element (1-5). Record any Gear Interactions and severity (1-4), and Type (1-9) in Gear Interaction DD elements. The chief scientist (CS) should indicate with the appropriate code if the conditions impacted whether the deployment was a representative station.

4. Any hard or soft corals including sea pens that are retrieved on the gear, record in catch notes, take photos and retain specimens to be frozen and identified later.

Catch Work Up

1. Species Identification

   a. Identify species to lowest level possible. If a species name is not found in FLDRS, record the next highest taxonomic level, and record the exact species name in the catch notes.
   b. Separate spiny dogfish and large decapod crustacean catch by sex.
   c. Any rare or difficult to identify species can be retained on ice and brought back.

2. Weighing catch

   a. Marel scales should be calibrated each day or as needed (see scale guide*).
   b. Record catch **mass** (in kg) of all fish and crustacean species.
   c. Ask captains to adjust vessel speed and direction if scale precision is impacted by conditions.
   d. Record an estimated mass and length for large species that cannot be brought onboard.

3. Measuring lengths

   a. Measure **lengths** of all catch in Data Trawler software on Allegro.
   b. Record mass and lengths *by sex* for dogfish, lobsters, and crabs. Record in DD in FLDRS.
      i. Dogfish sex ratio is often skewed - make sure to length all (if few) or a reasonable representation of the less abundant sex.
   c. If not all lengths for a species can be recorded
      i. Try to measure a *minimum* of 50% of the catch and measure some fish from all portions of the gear (length distributions may vary along the length of the gear).
      ii. Catch mass must be recorded separately for catch with and without lengths taken. There are separate columns on data sheets and in catch DD elements for recording the weights separately.

4. **Damaged catch**

   a. Must be recorded, but is tracked separately.
   b. Provide catch **mass** and **counts** of individuals on the data sheet (record mass as separate entry in FLDRS using ‘discard damaged’ category).
   c. Enter catch mass and counts in the catch DD, sex specific for dogfish and crustaceans. Record whether or not lengths were taken.
   a. Measure lengths when possible, and record independent of subsampled catch.
   b. Make a second species entry in the Allegro and put “damaged” in the notes.
   c. Record in catch notes in FLDRS likely cause for damage (dogfish, sand fleas, hagfish, etc).

d. For fish that a length cannot be obtained, remove both otoliths into a blank envelope (NO ID #), and label with the CC, STA, and species (on at least the first envelope, if not all, of a group).
   i. Try not to chip or fracture as otolith size will be used to back-calculate the fish length.
   ii. Store grouped by station in a ziplock bag or rubber band station-species together.

5. Biosampling

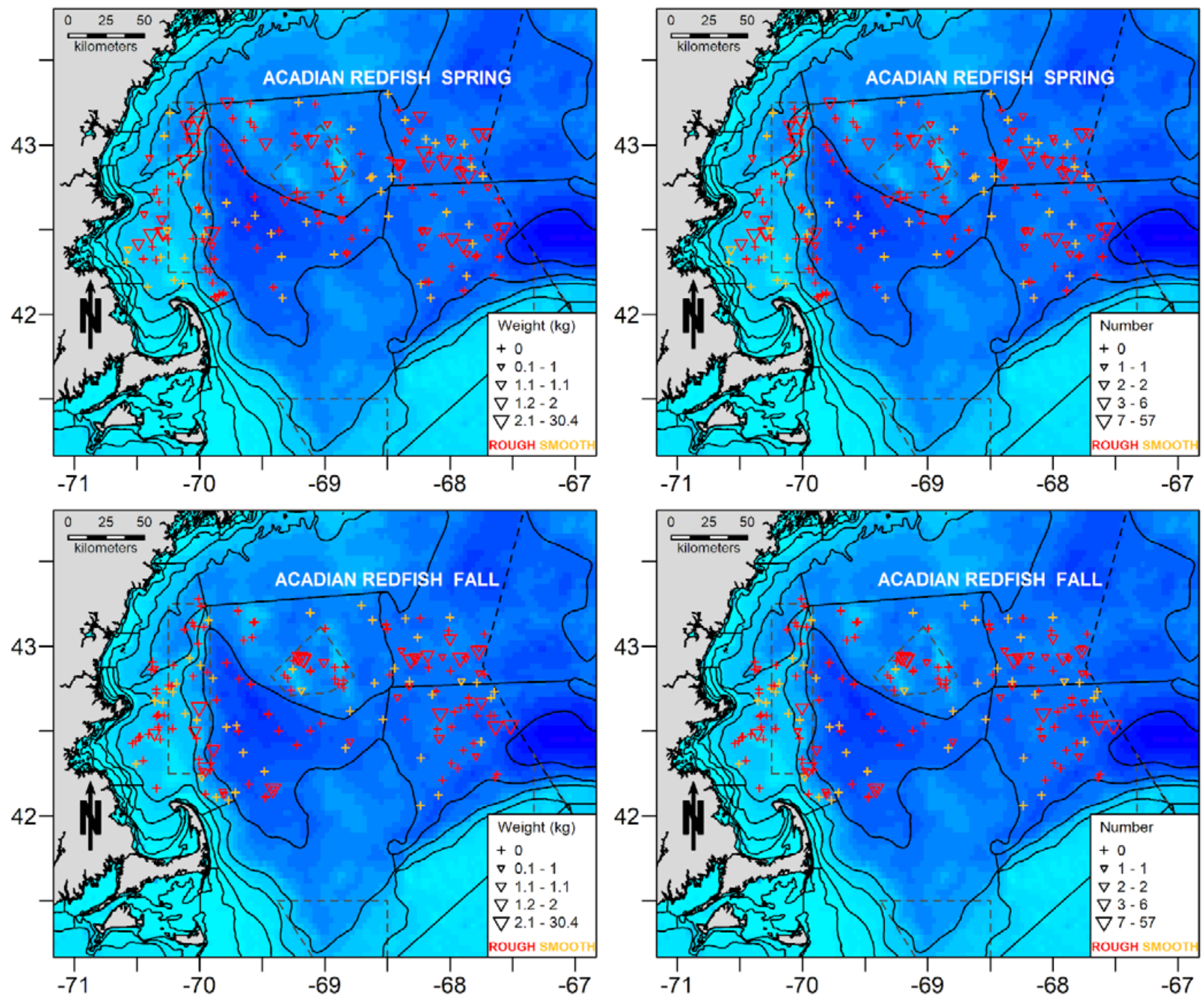
a. See biosampling guide* and species request table. Use biosampling data sheets.
b. Sample as much catch as logistically feasible in conditions.
c. Prioritize key species (cusk, halibut, wolffish, white hake, cod, ocean pout, tilefish, thorny, barndoor, and smooth skate).
d. Priority should be placed on collecting age samples on rare sizes or species.
e. **Age samples**
   i. Use barcoded envelopes marked “age only” if only age sampled
   ii. Record individual weight, sex, and macroscopic maturity.
   iii. For non-otolith age samples (heads/illicium)– store in a ziplock bag include envelope with barcode and a piece of write-in-rain paper with CC and STA #
f. **Histology samples** - collect gonad and liver mass, if conditions allow (in grams).
   i. Use envelopes labeled for “age & histology” – matched to ID number in vial.
   ii. Record last 6 digits of barcode # on data sheet.

6. FLDRS data entry and length data download

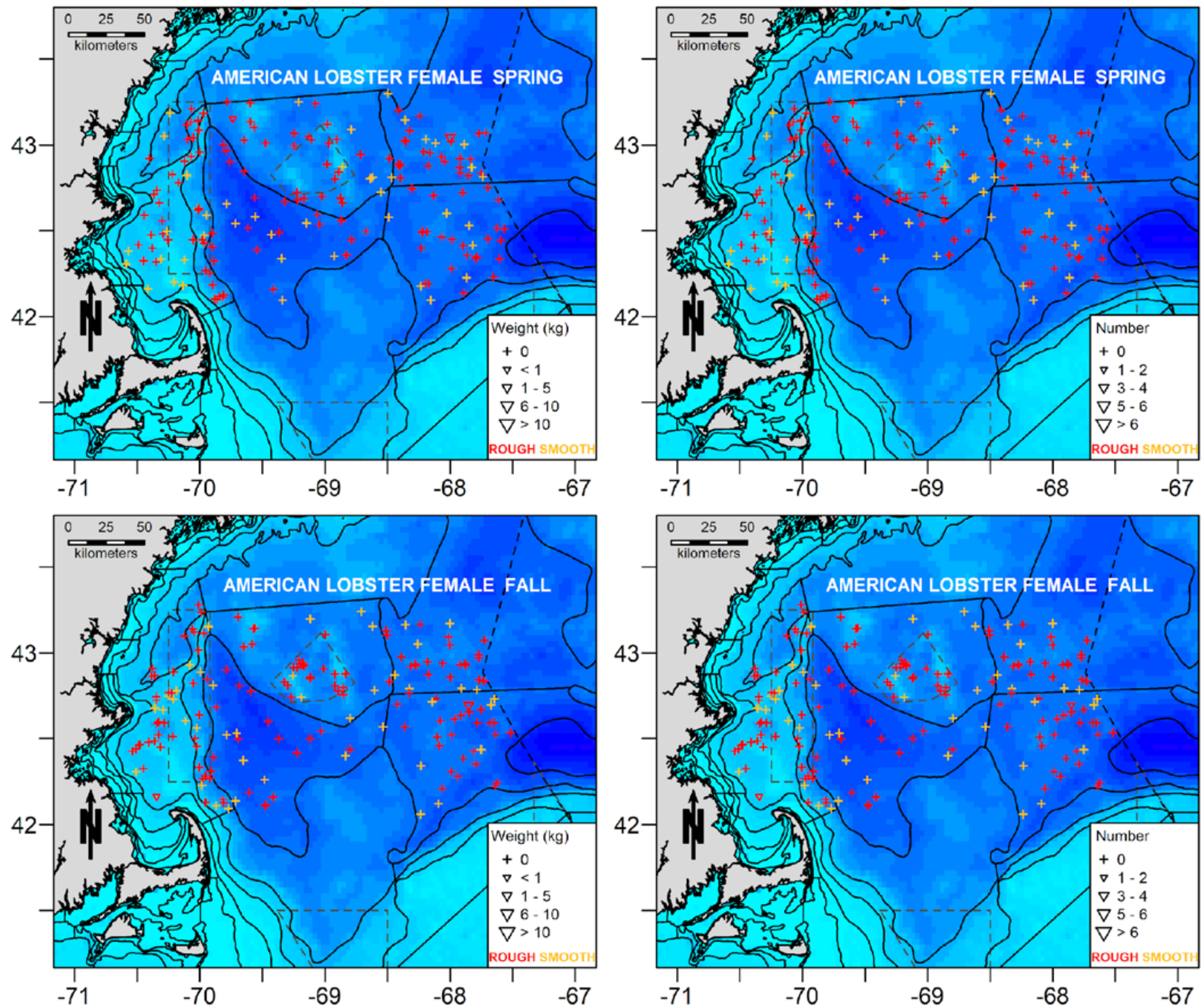
a. When recording catch weights into FLDRS **track ALL addition conducted for catch weight summation** in the excel “catch adding” file, labeling each tab with the station number. This will aid data auditing and identification of key entry errors.
b. *Download length file from Allegro after completion of each station* so that a copy is on the laptop in the folder for each cruise. Open the file to confirm the file downloaded properly and that it is labeled with the appropriate station number. Back up all data files on portable hard drive.
c. Record any unusual occurrences, loss of catch, or equipment malfunctions during hauling and catch work up. **When in doubt take notes.** Record in the Data Acquisition DD element if the issues were significant (1-4).

*Guides, protocols, and manuals included in folders on desktop of vessel’s laptop. Most in hard copy in folders in biosampling box.

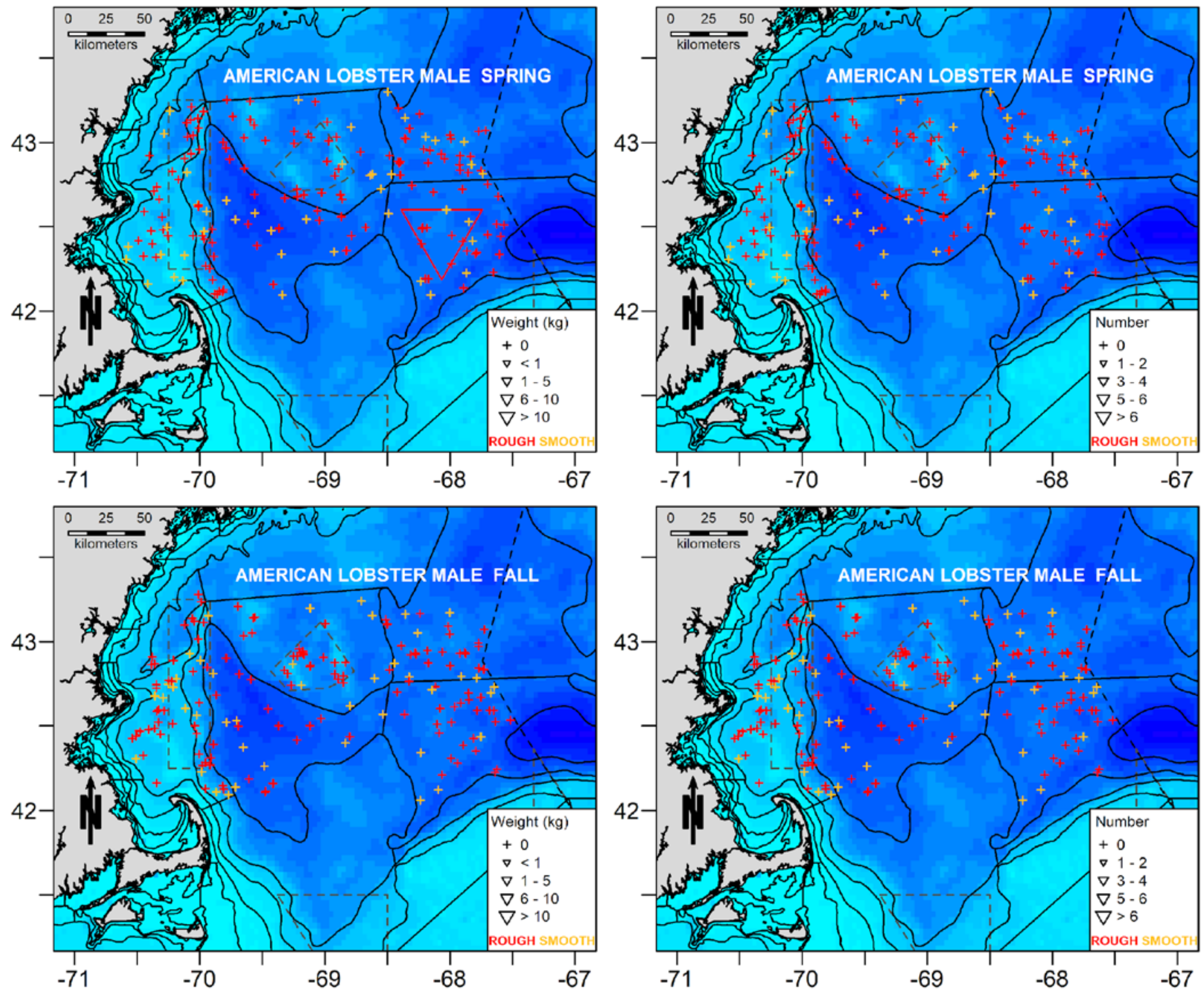
APPENDIX B.



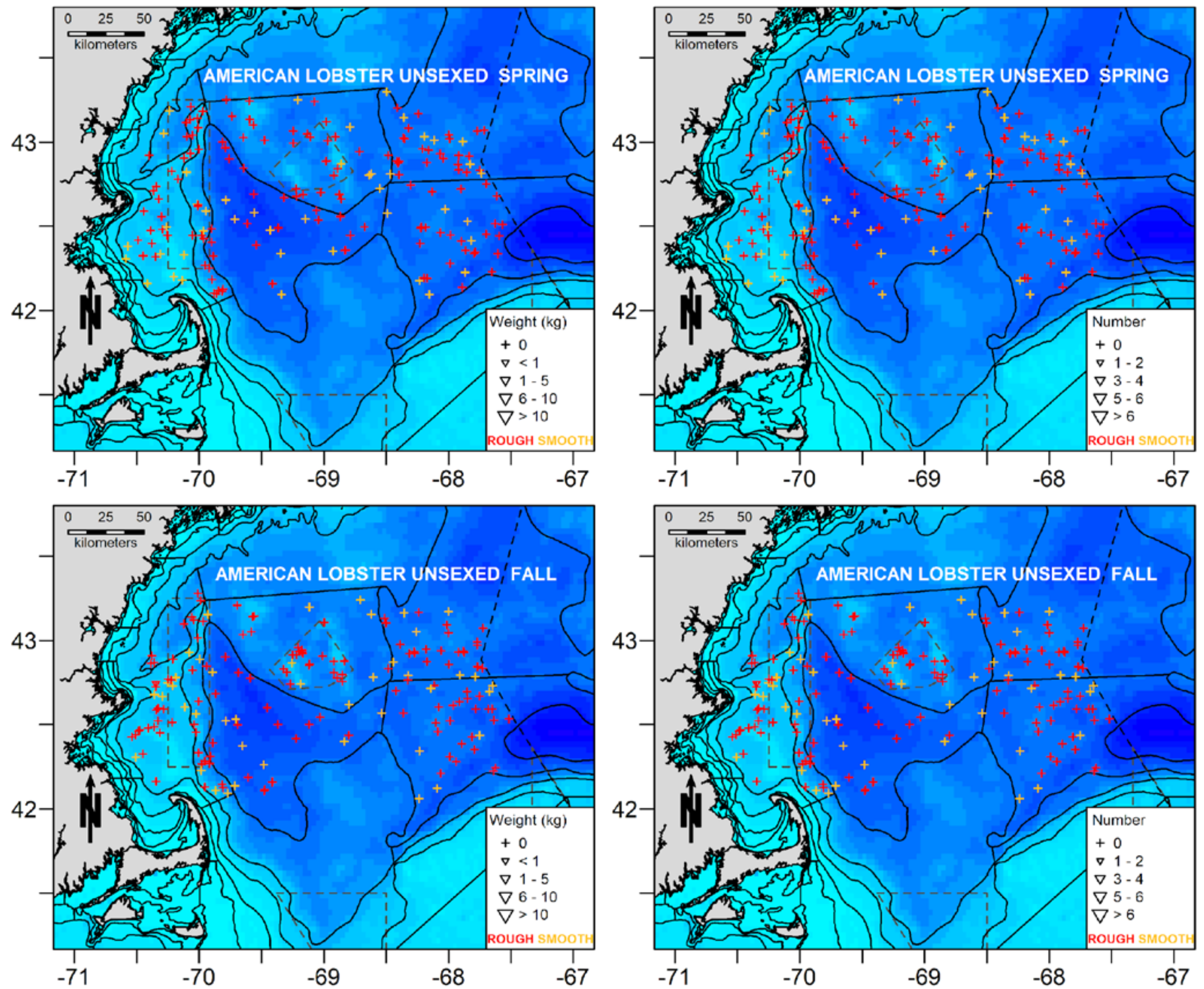
Appendix B. Figure 1. Distribution of Acadian redfish (*Sebastes fasciatus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



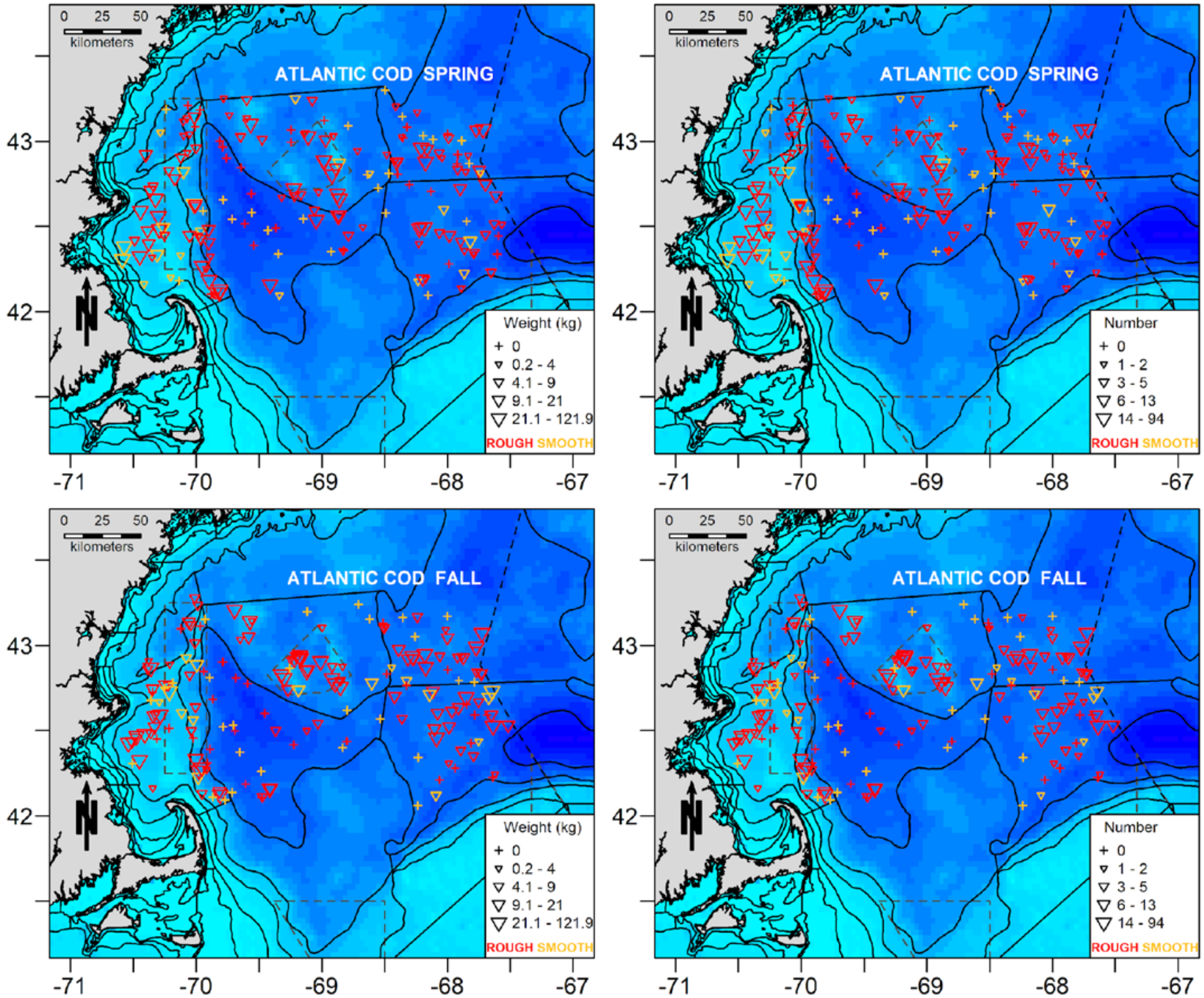
Appendix B. Figure 2. Distribution of female American lobster (*Homarus americanus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



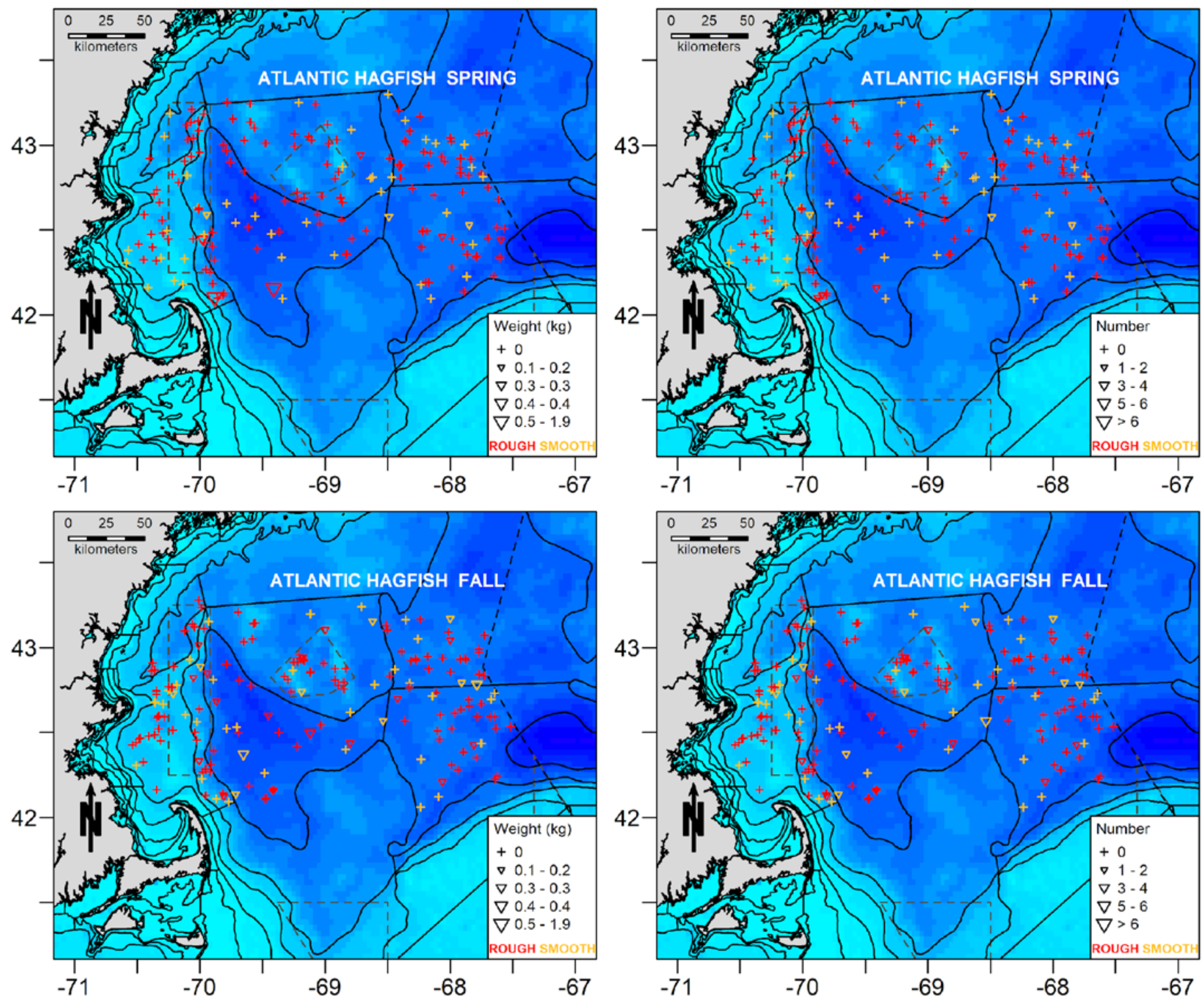
Appendix B. Figure 3. Distribution of male American lobster (*Homarus americanus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



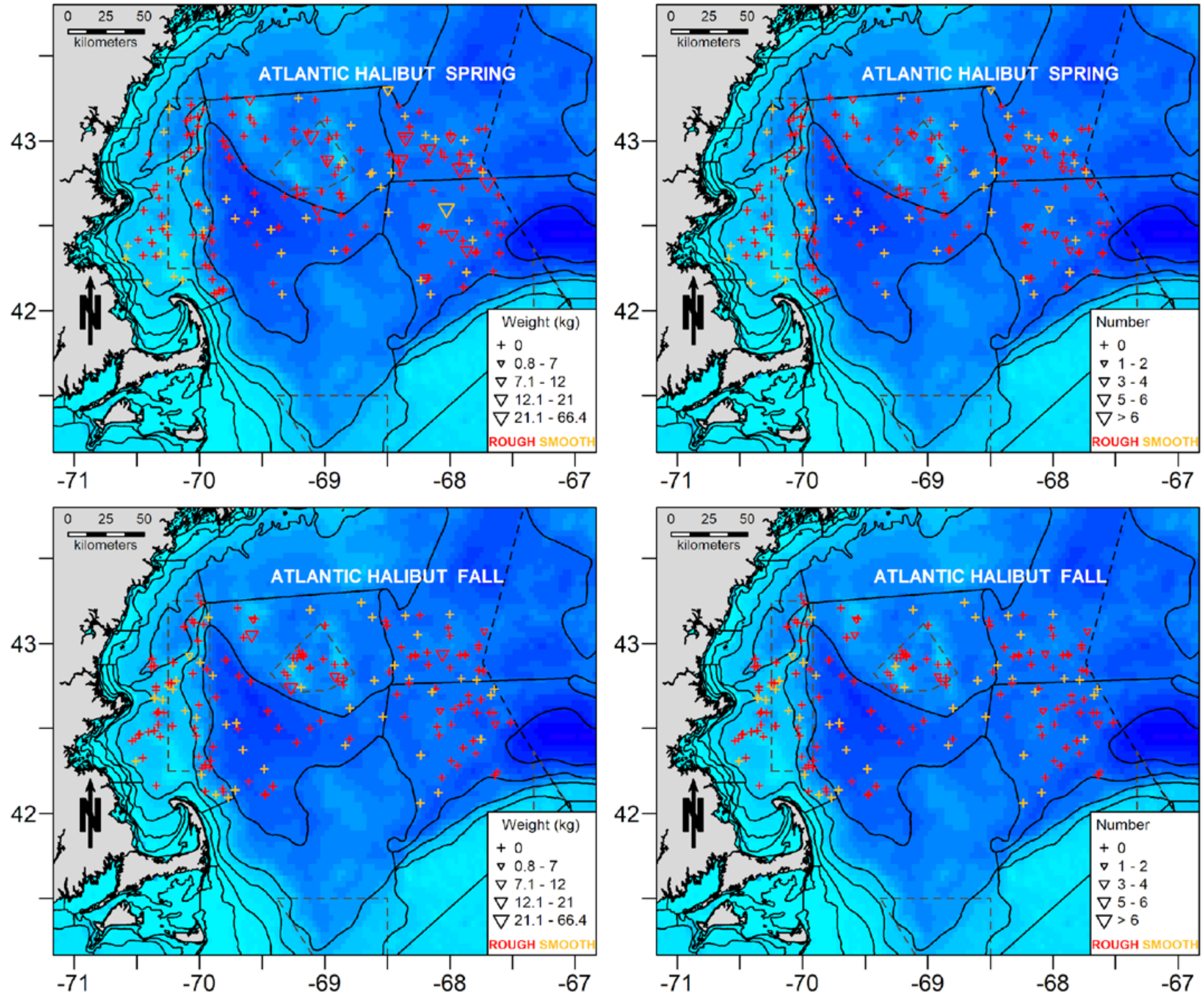
Appendix B. Figure 4. Distribution of unsexed American lobster (*Homarus americanus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



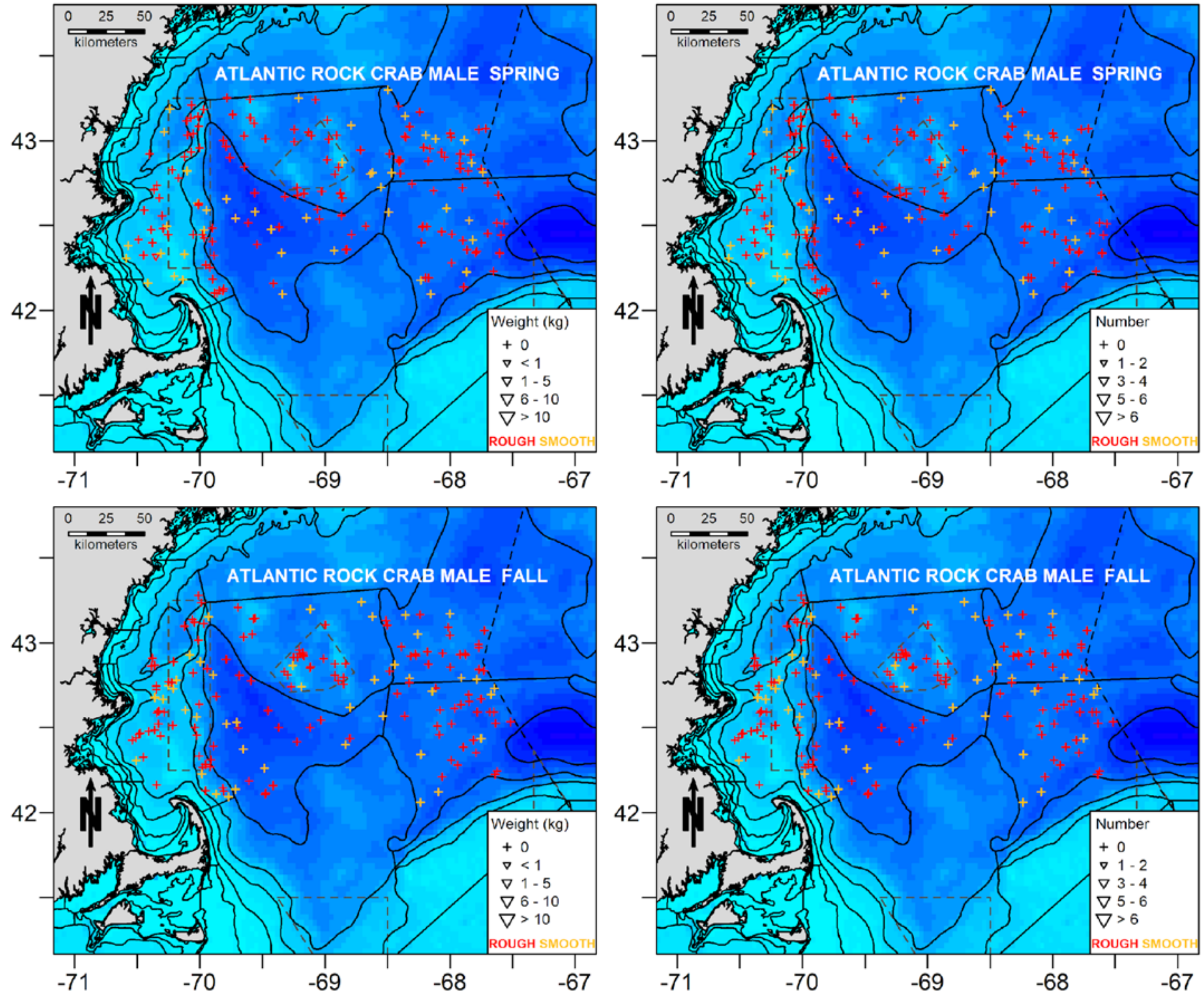
Appendix B. Figure 5. Distribution of Atlantic cod (*Gadus morhua*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



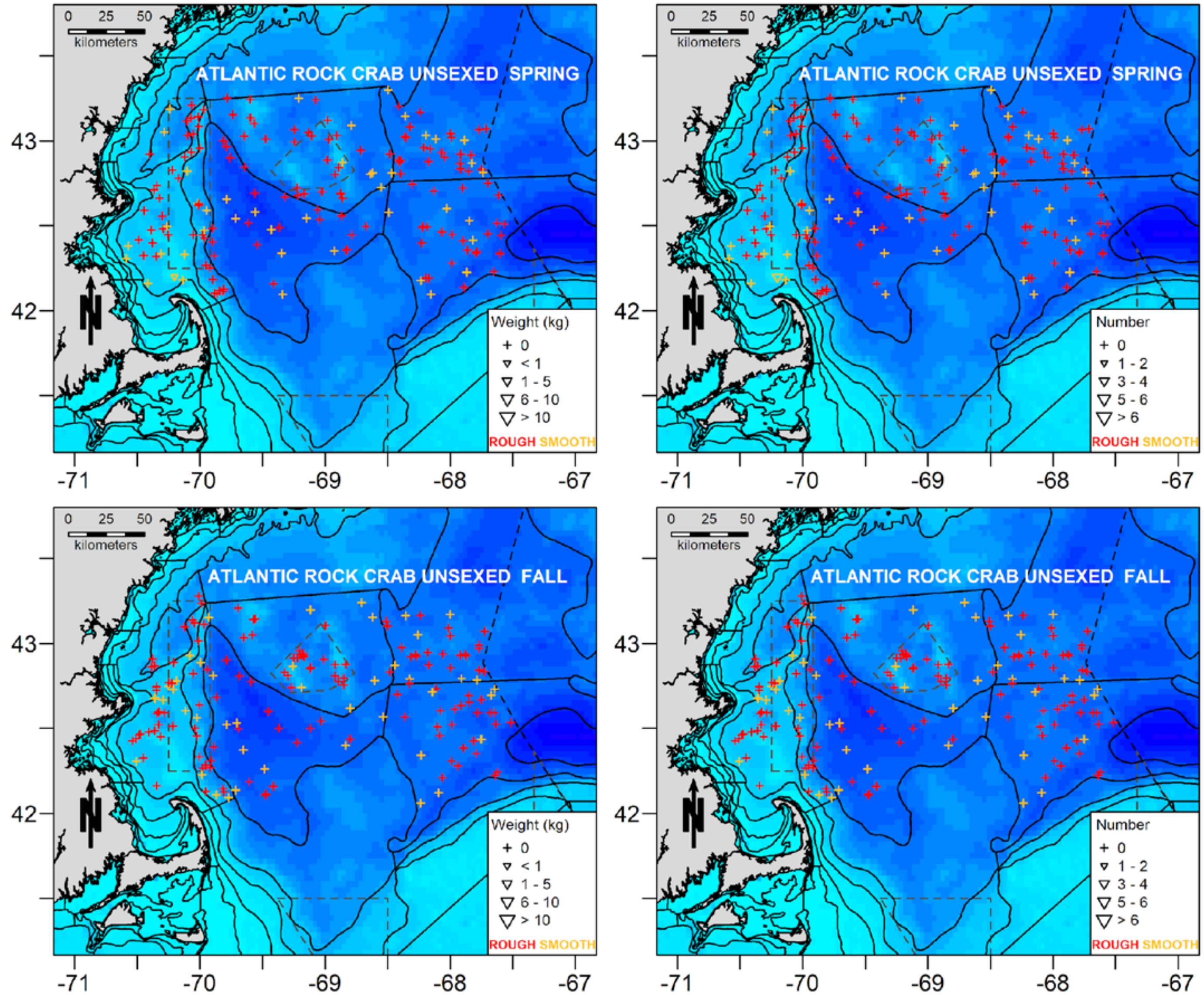
Appendix B. Figure 6. Distribution of Atlantic hagfish (*Myxine glutinosa*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



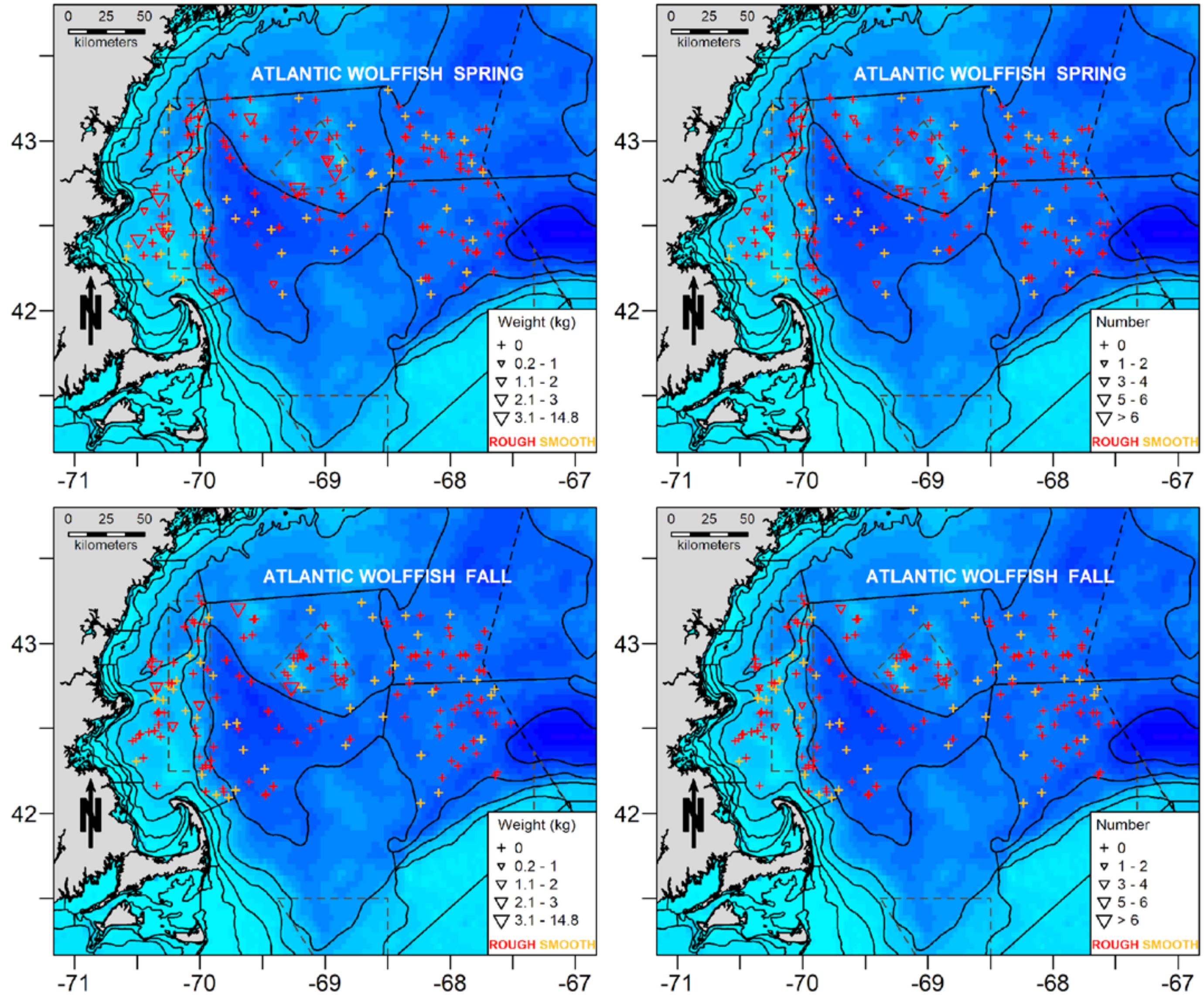
Appendix B. Figure 7. Distribution of Atlantic halibut (*Hippoglossus hippoglossus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



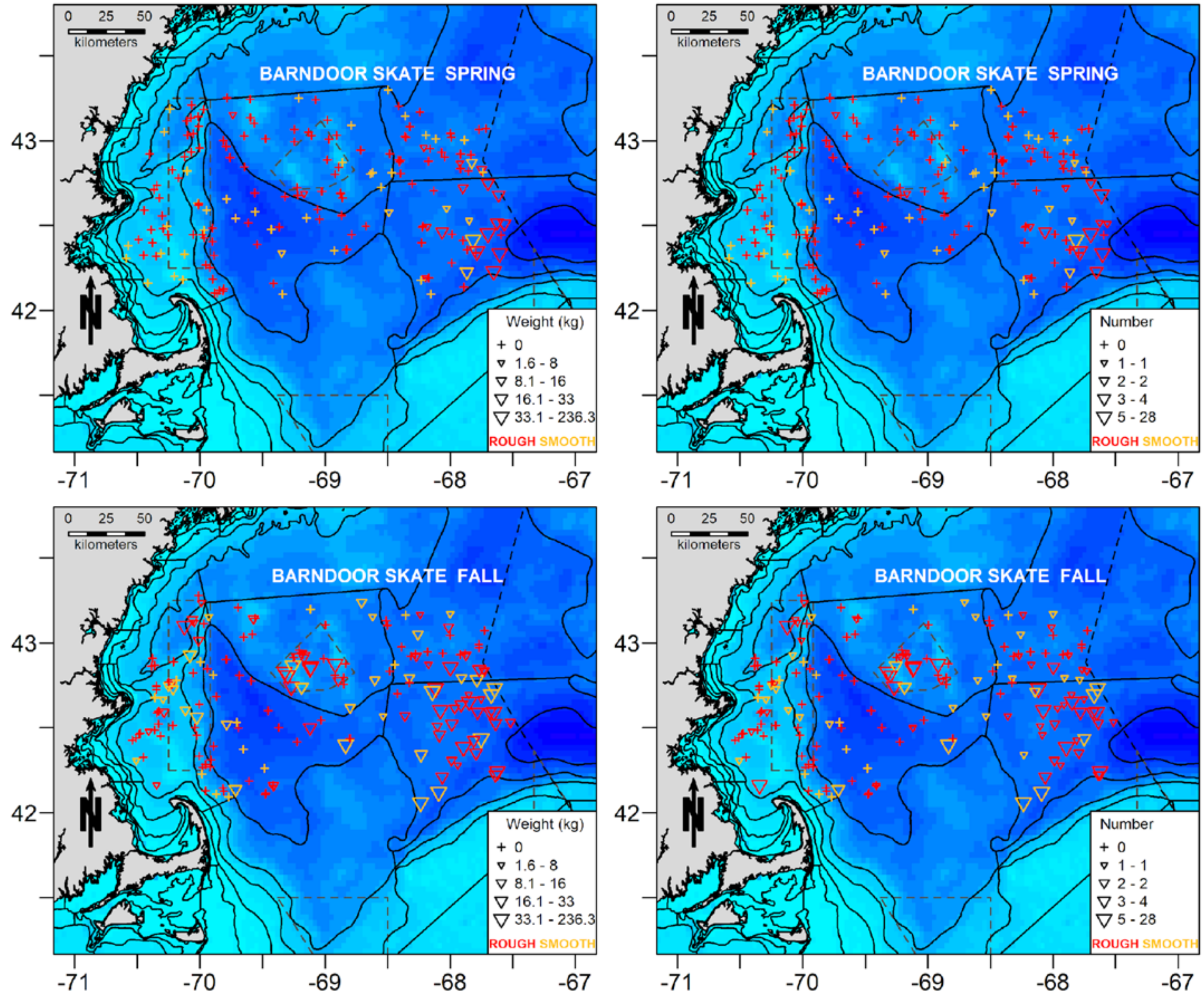
Appendix B. Figure 8. Distribution of male Atlantic rock crab (*Cancer irroratus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



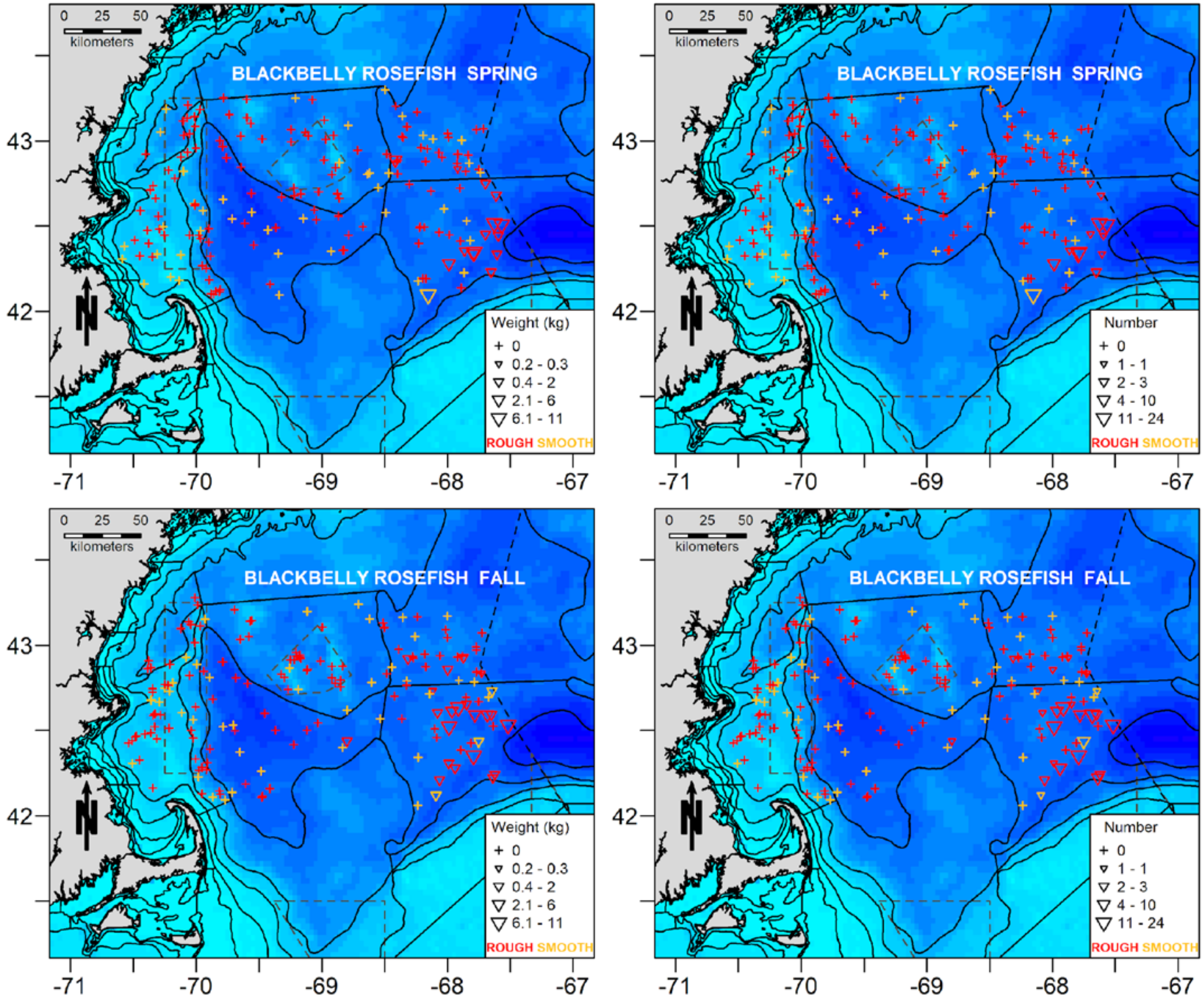
Appendix B. Figure 9. Distribution of unsexed Atlantic rock crab (*Cancer irroratus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



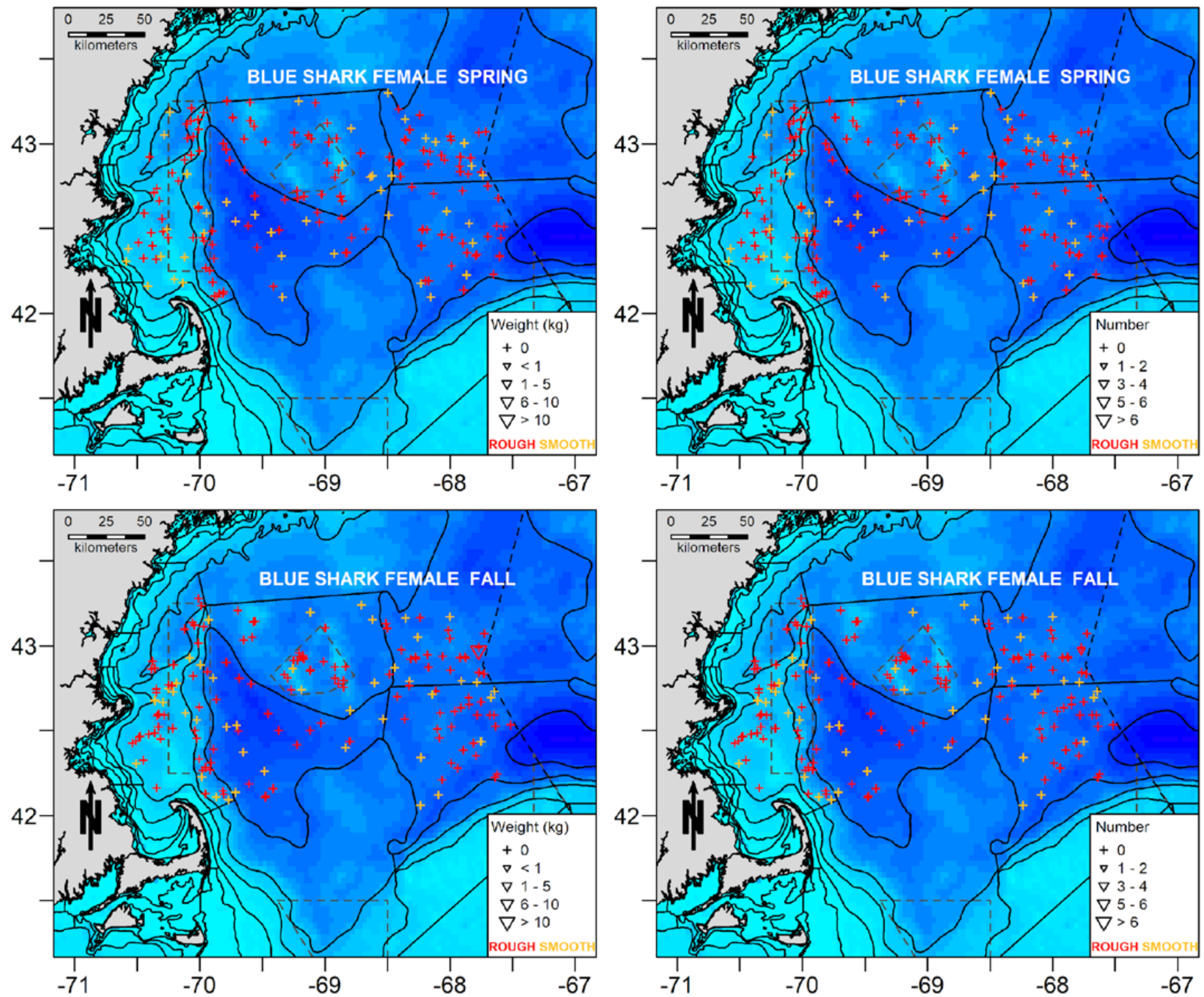
Appendix B. Figure 10. Distribution of Atlantic wolffish (*Anarhichas lupus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



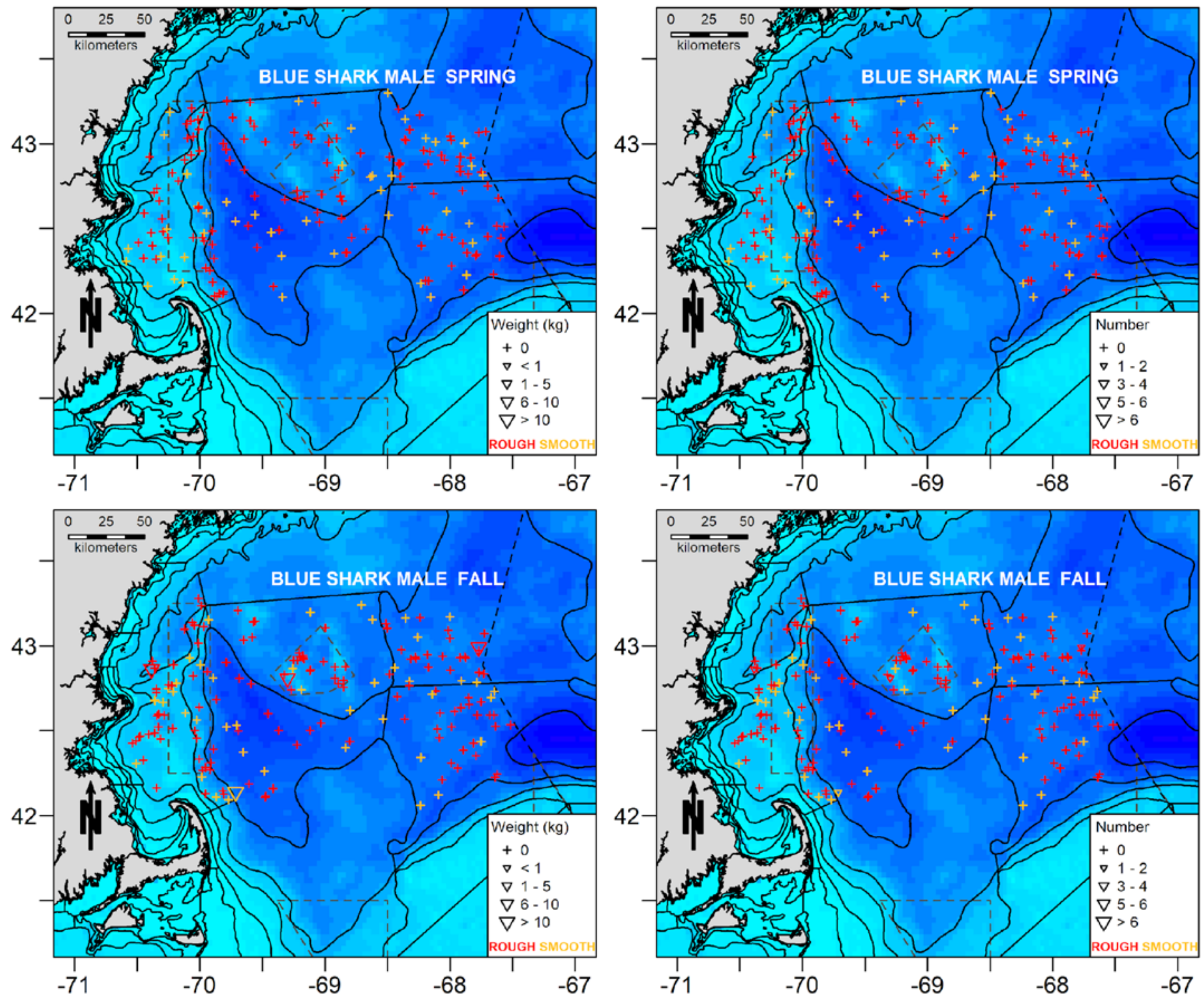
Appendix B. Figure 11. Distribution of barndoor skate (*Dipturus laevis*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



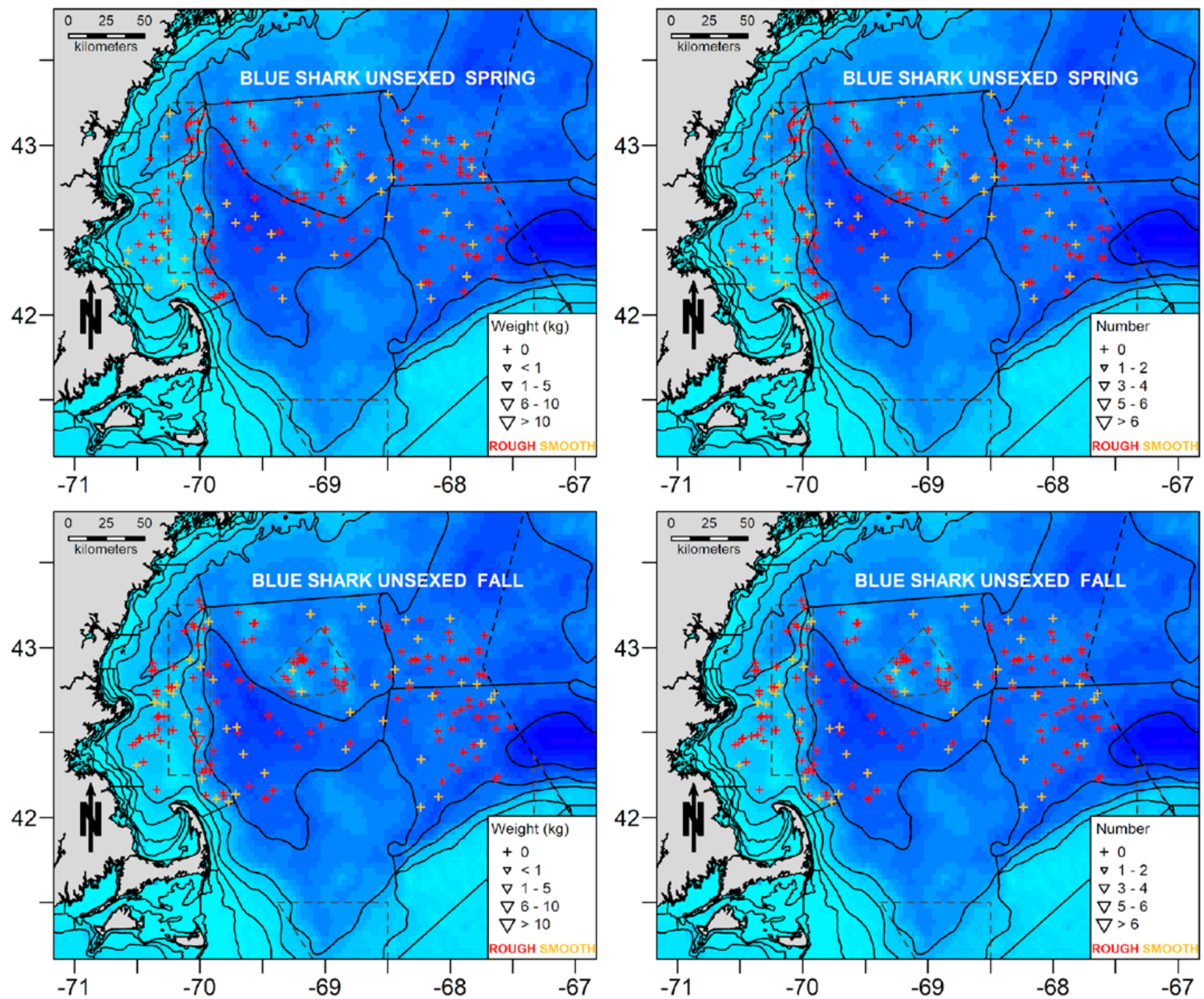
Appendix B. Figure 12. Distribution of blackbelly rosefish (*Helicolenus dactylopterus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



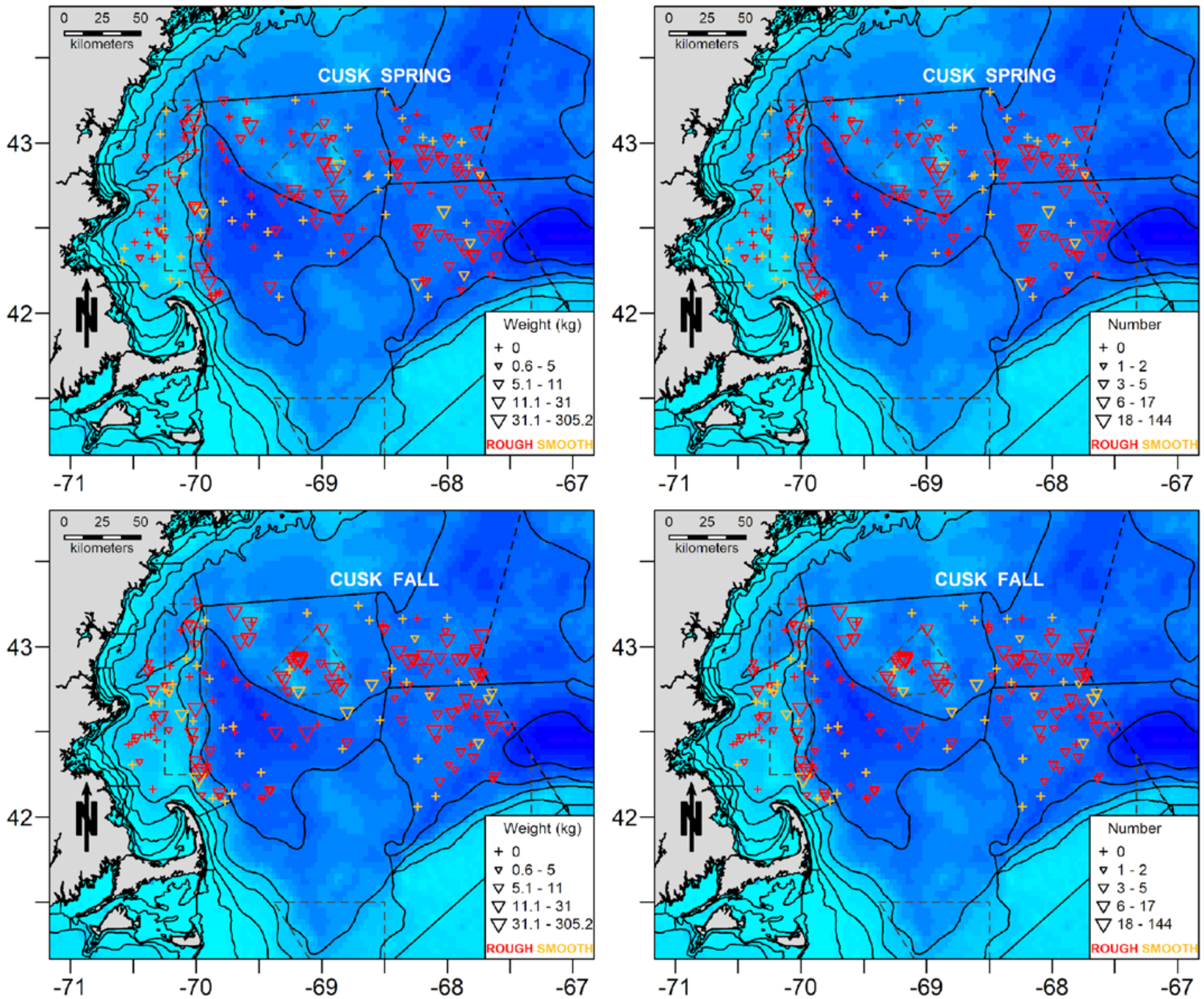
Appendix B. Figure 13. Distribution of female blue shark (*Prionace glauca*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured. Weights are estimates as sharks were released alive at the side of the vessel.



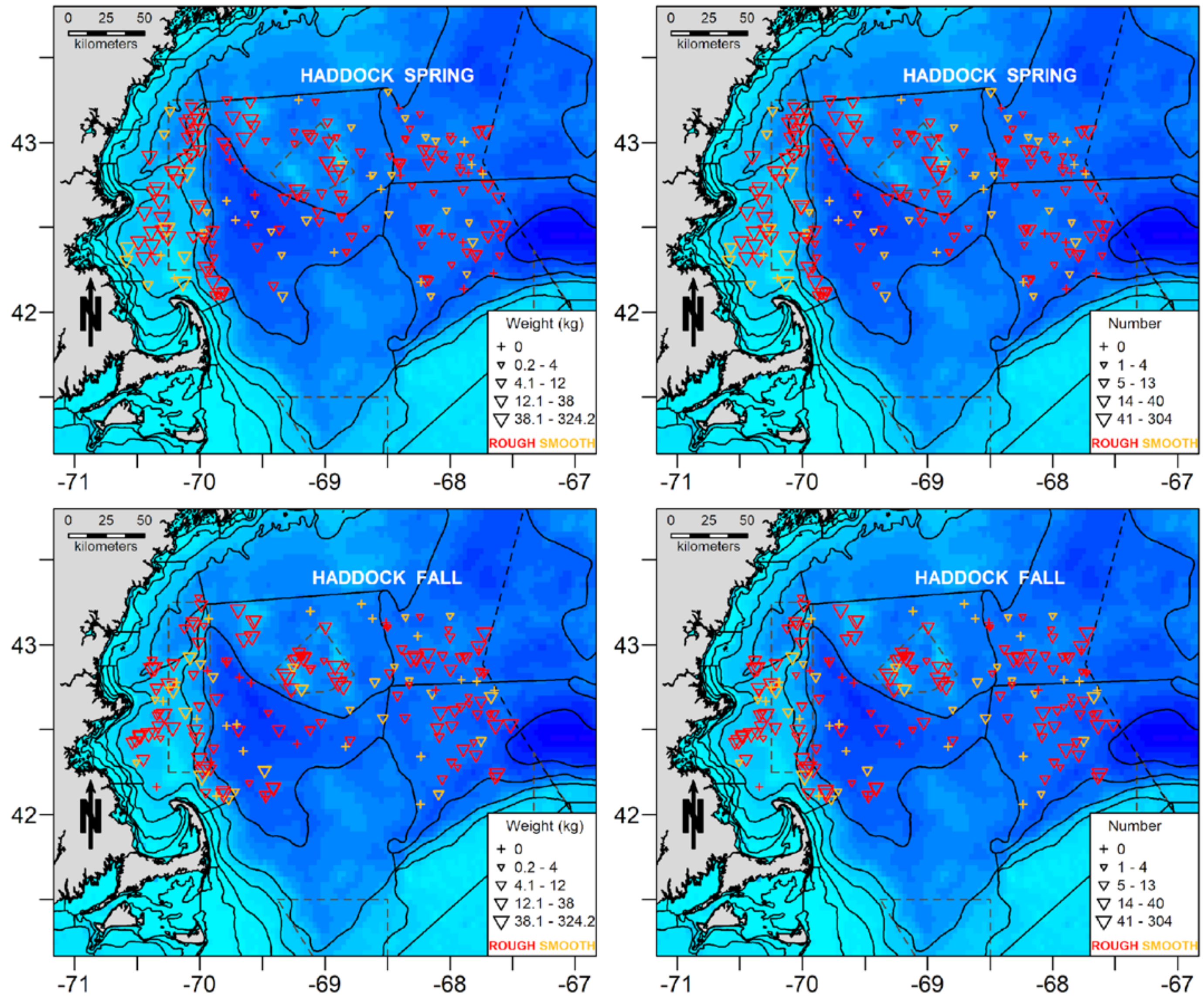
Appendix B. Figure 14. Distribution of male blue shark (*Prionace glauca*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured. Weights are estimates as sharks were released alive at the side of the vessel.



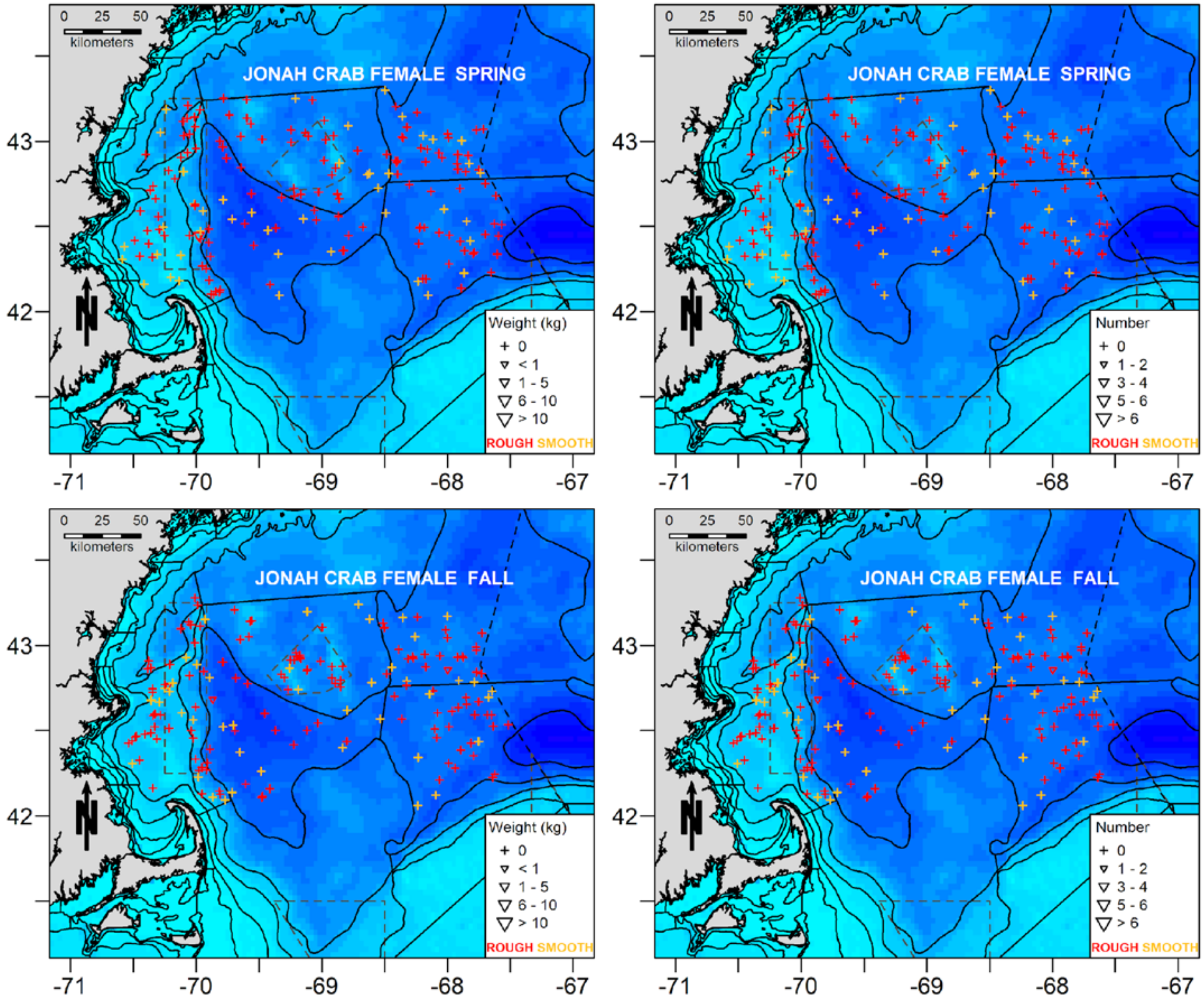
Appendix B. Figure 15. Distribution of unsexed blue shark (*Prionace glauca*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured. Weights are estimates as sharks were released alive at the side of the vessel.



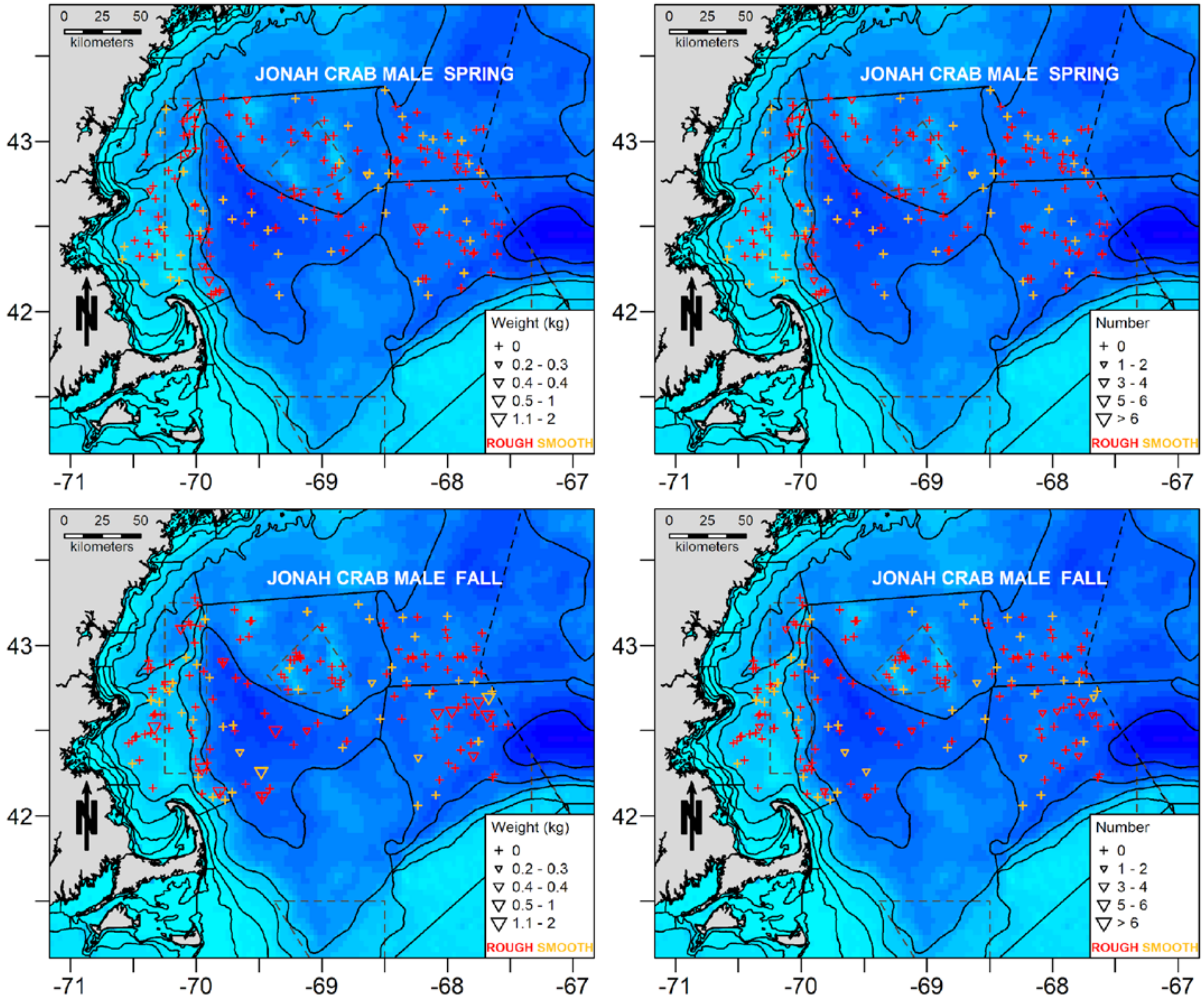
Appendix B. Figure 16. Distribution of cusk (*Brosme brosme*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2016. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



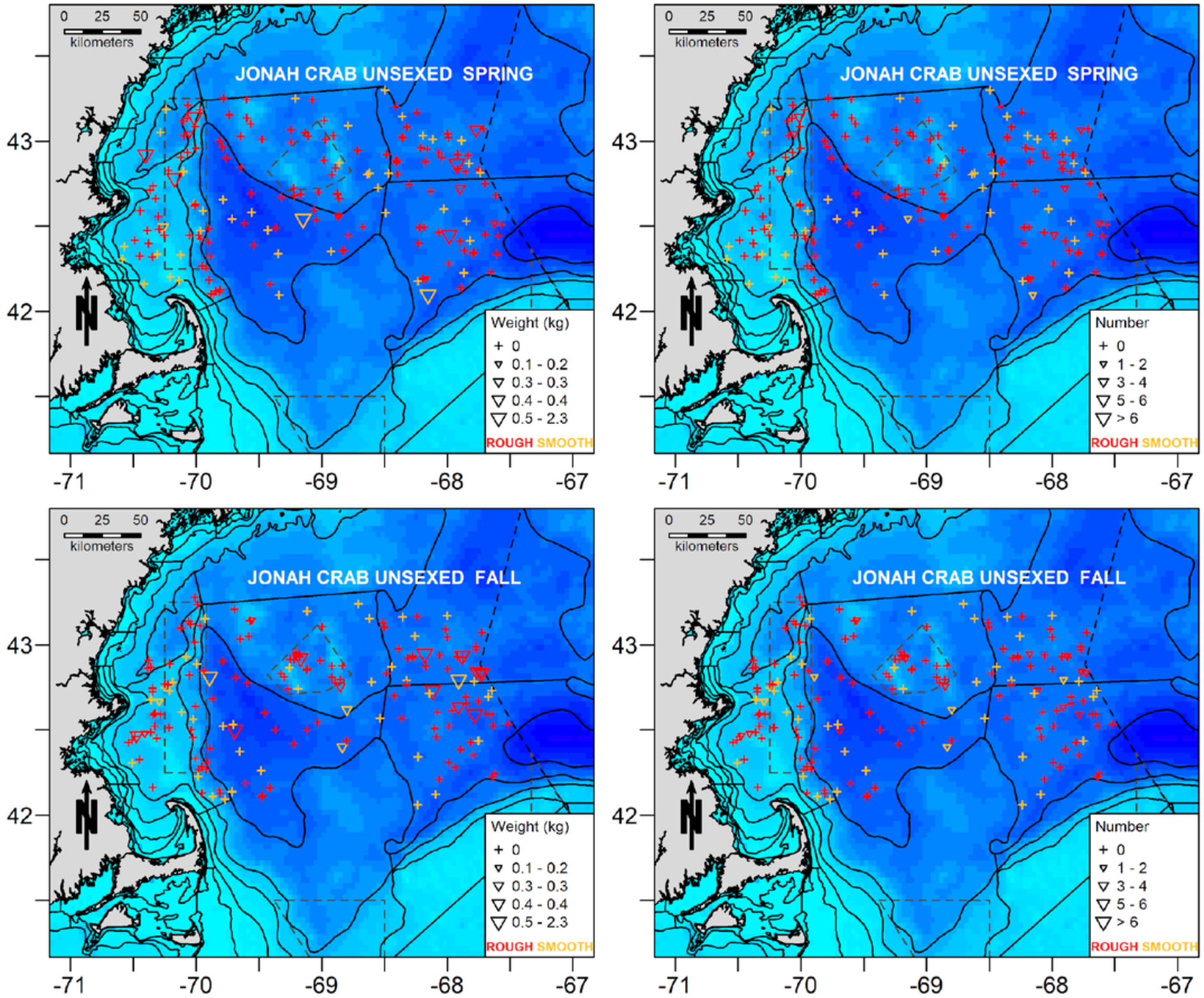
Appendix B. Figure 17. Distribution of haddock (*Melanogrammus aeglefinus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



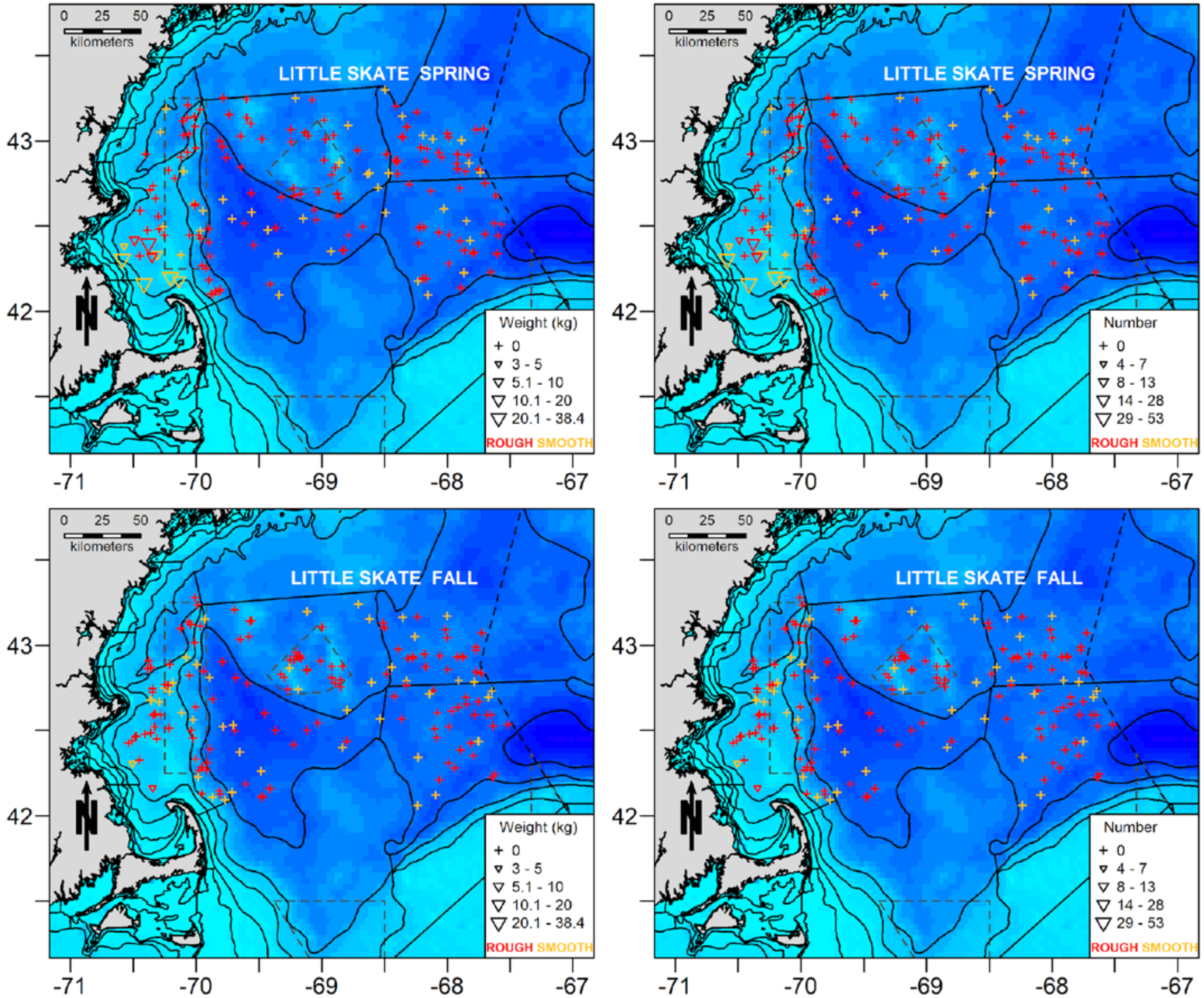
Appendix B. Figure 18. Distribution of female Jonah crab (*Cancer borealis*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



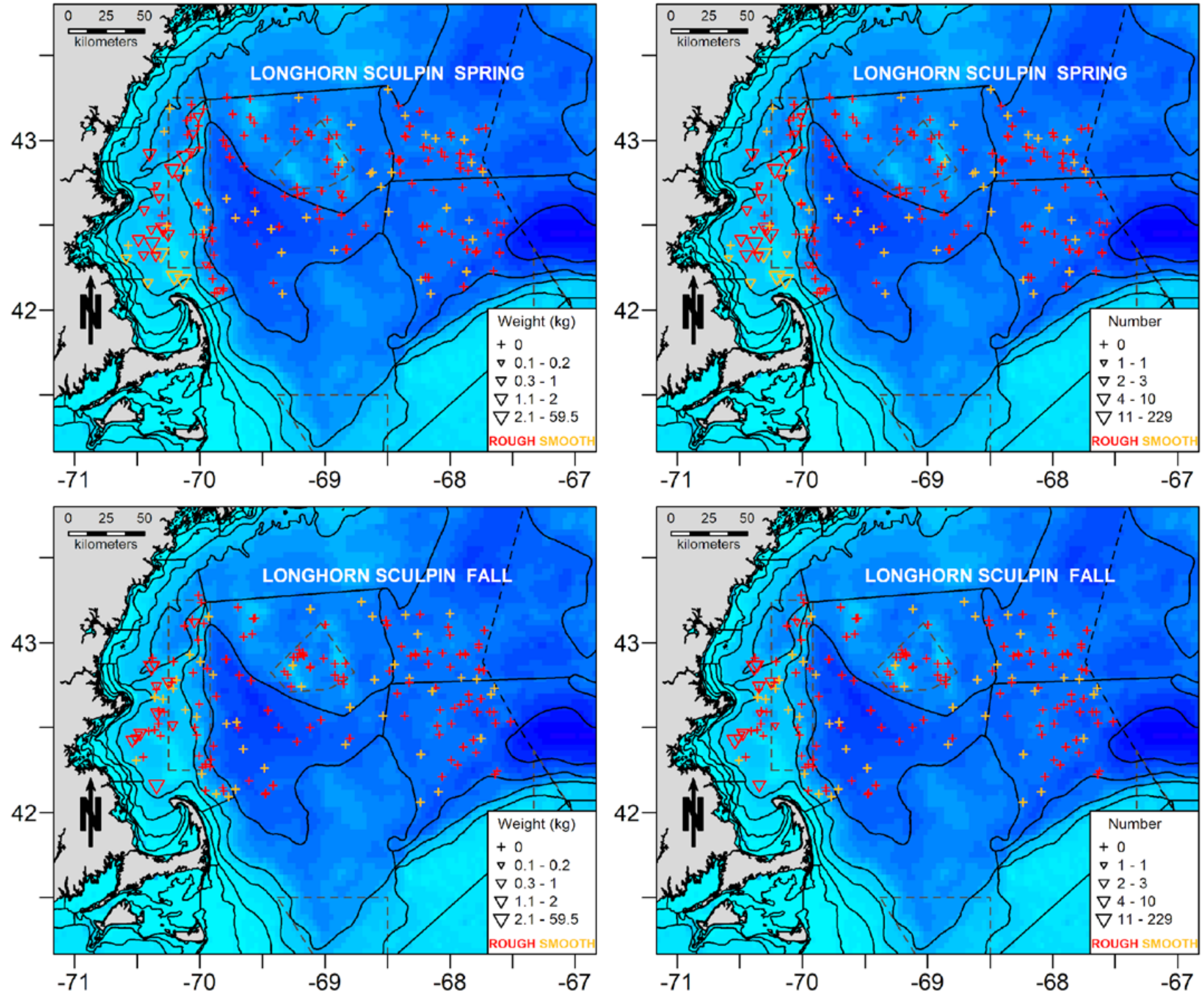
Appendix B. Figure 19. Distribution of male Jonah crab (*Cancer borealis*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



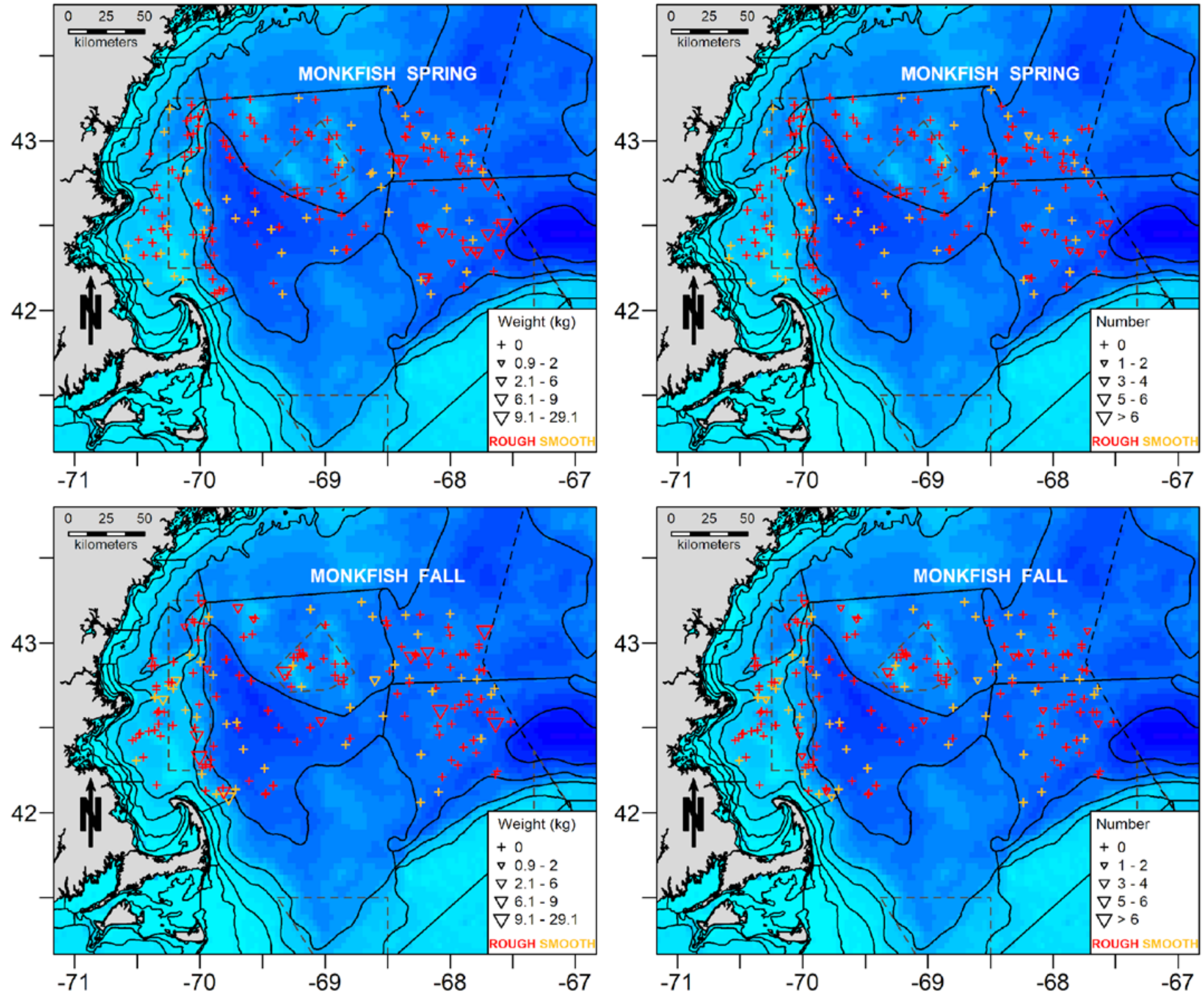
Appendix B. Figure 20. Distribution of unsexed Jonah crab (*Cancer borealis*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



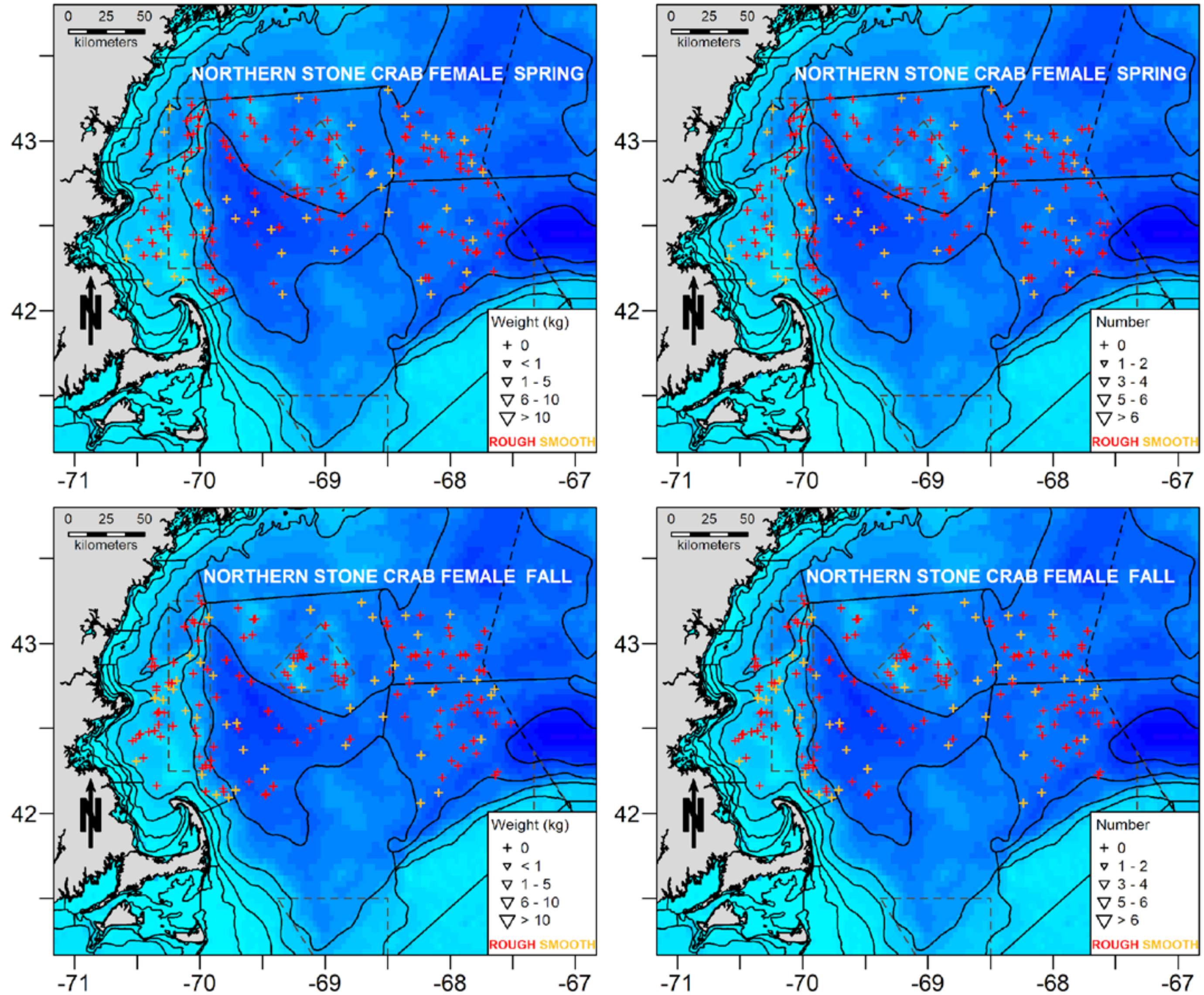
Appendix B. Figure 21. Distribution of little skate (*Leucoraja erinacea*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



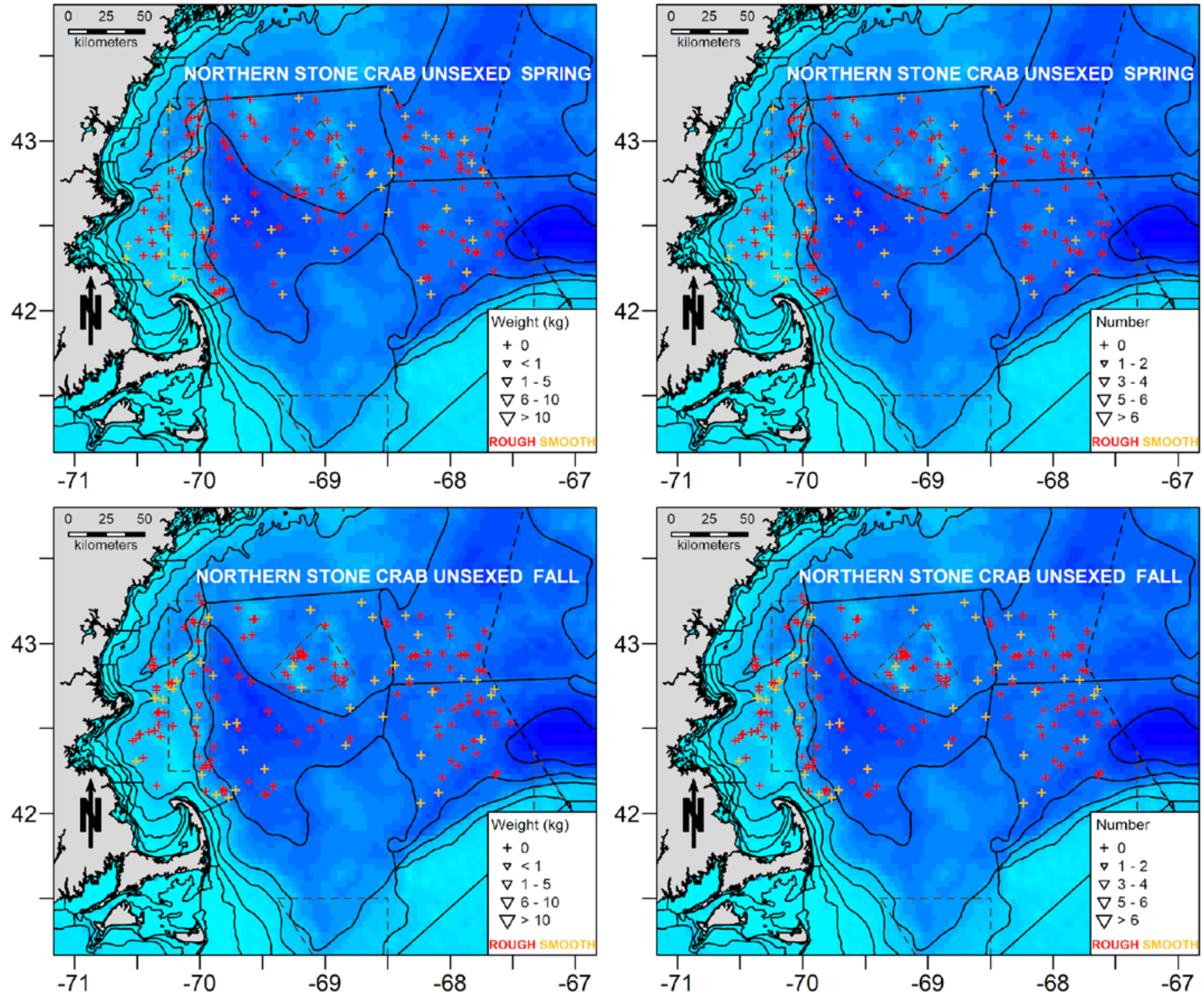
Appendix B. Figure 22. Distribution of longhorn sculpin (*Myoxocephalus octodecemspinosus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



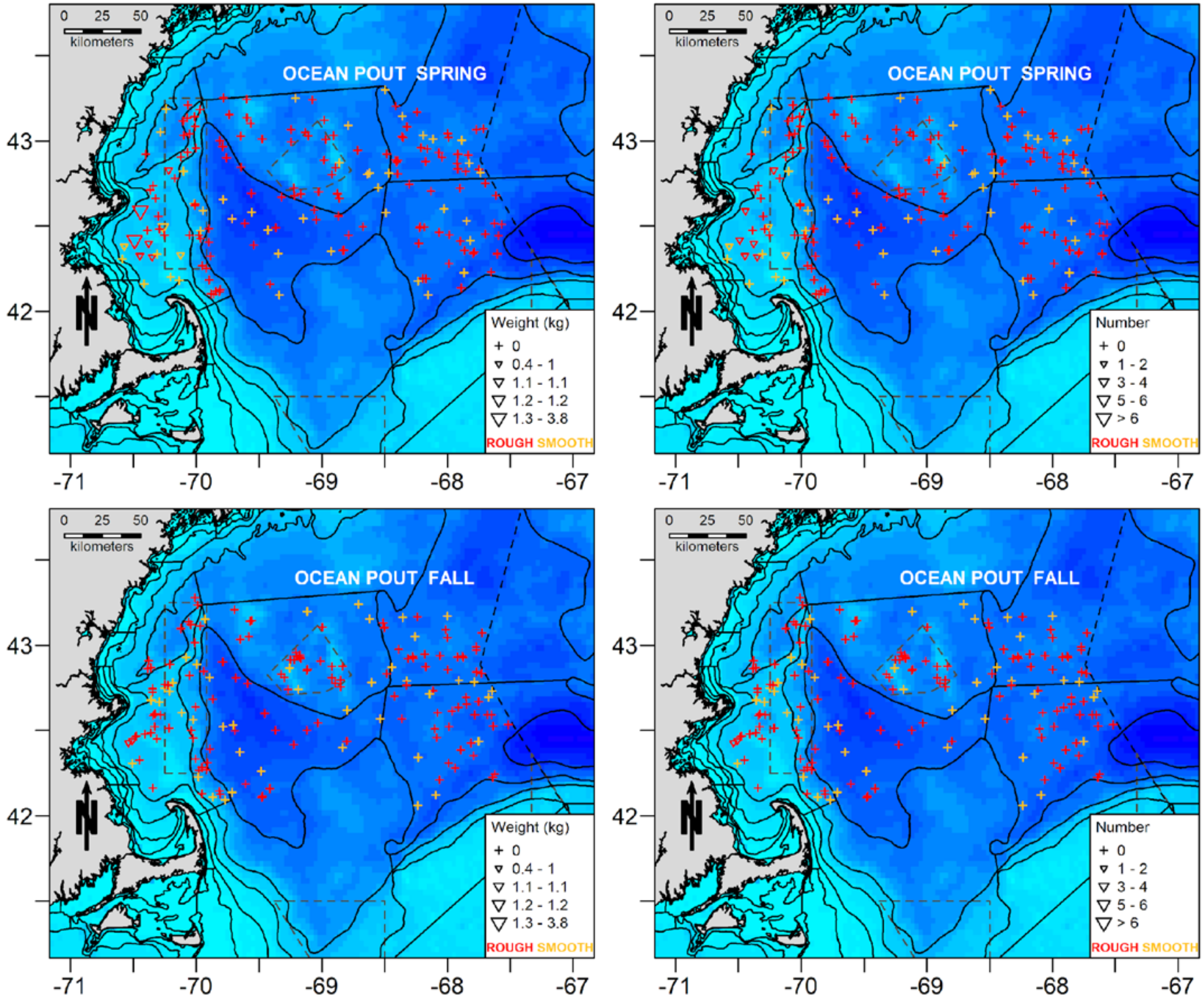
Appendix B. Figure 23. Distribution of monkfish (*Lophius americanus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



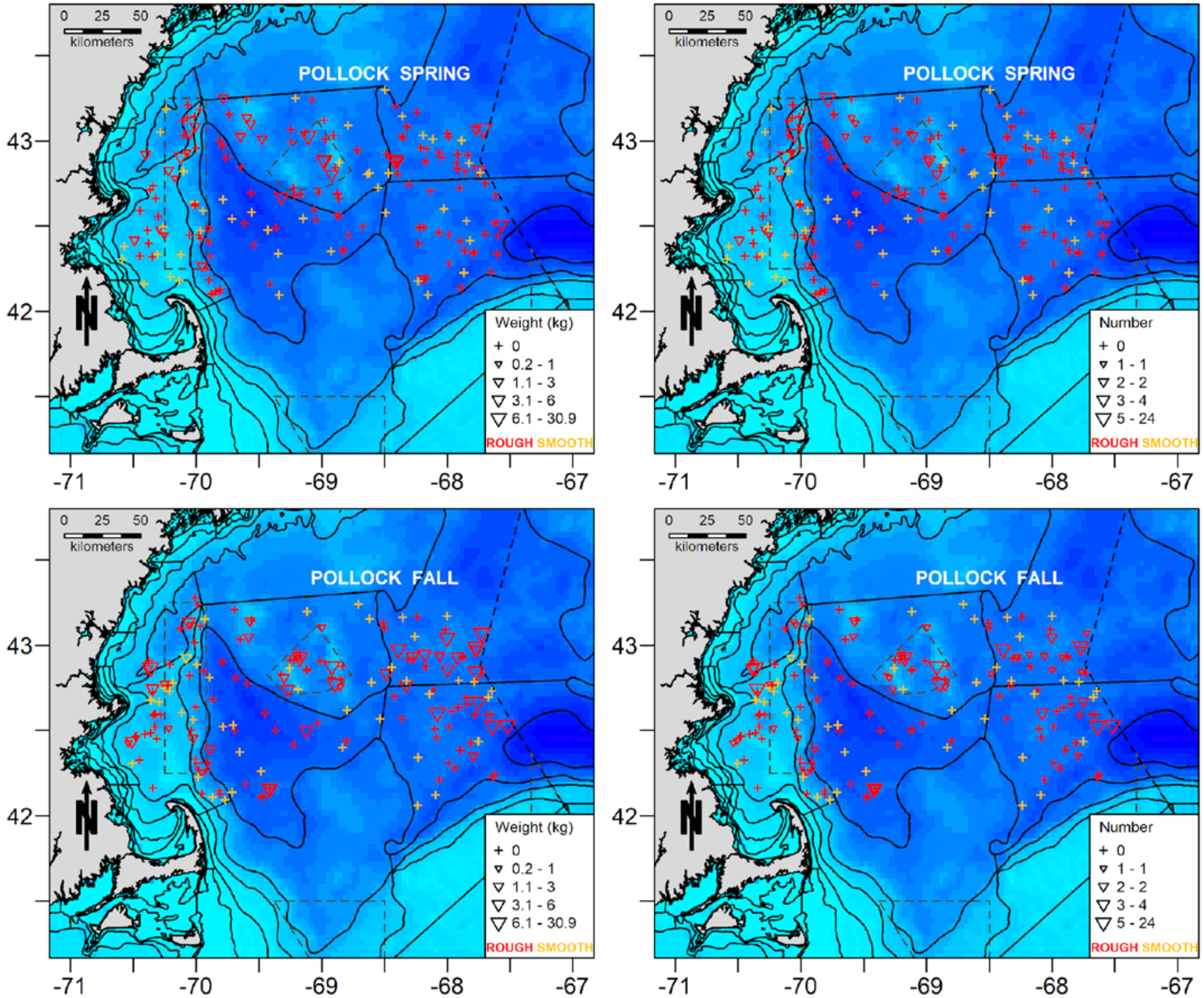
Appendix B. Figure 24. Distribution of female northern stone crab (*Lithodes maja*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



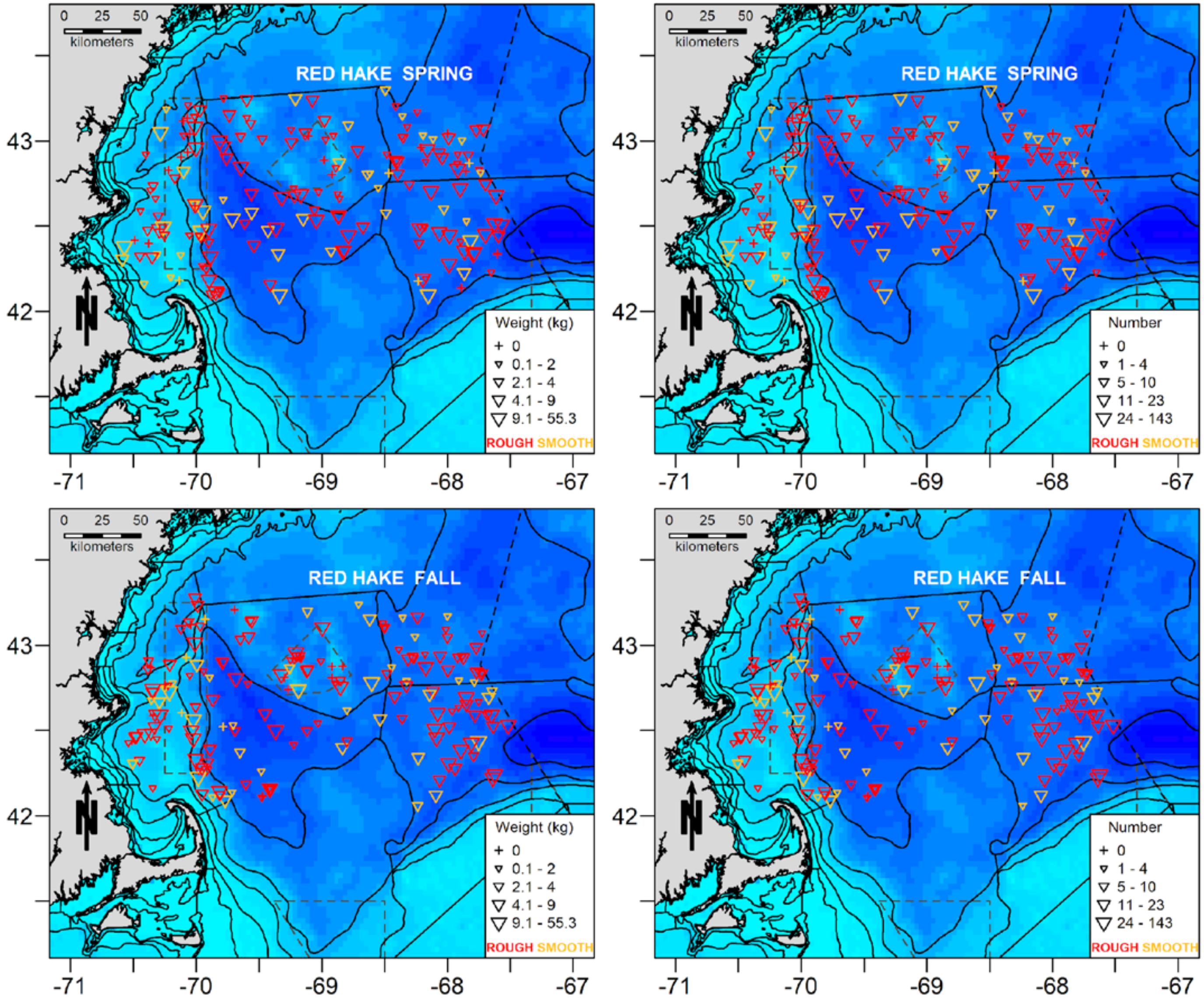
Appendix B. Figure 25. Distribution of unsexed northern stone crab (*Lithodes maja*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



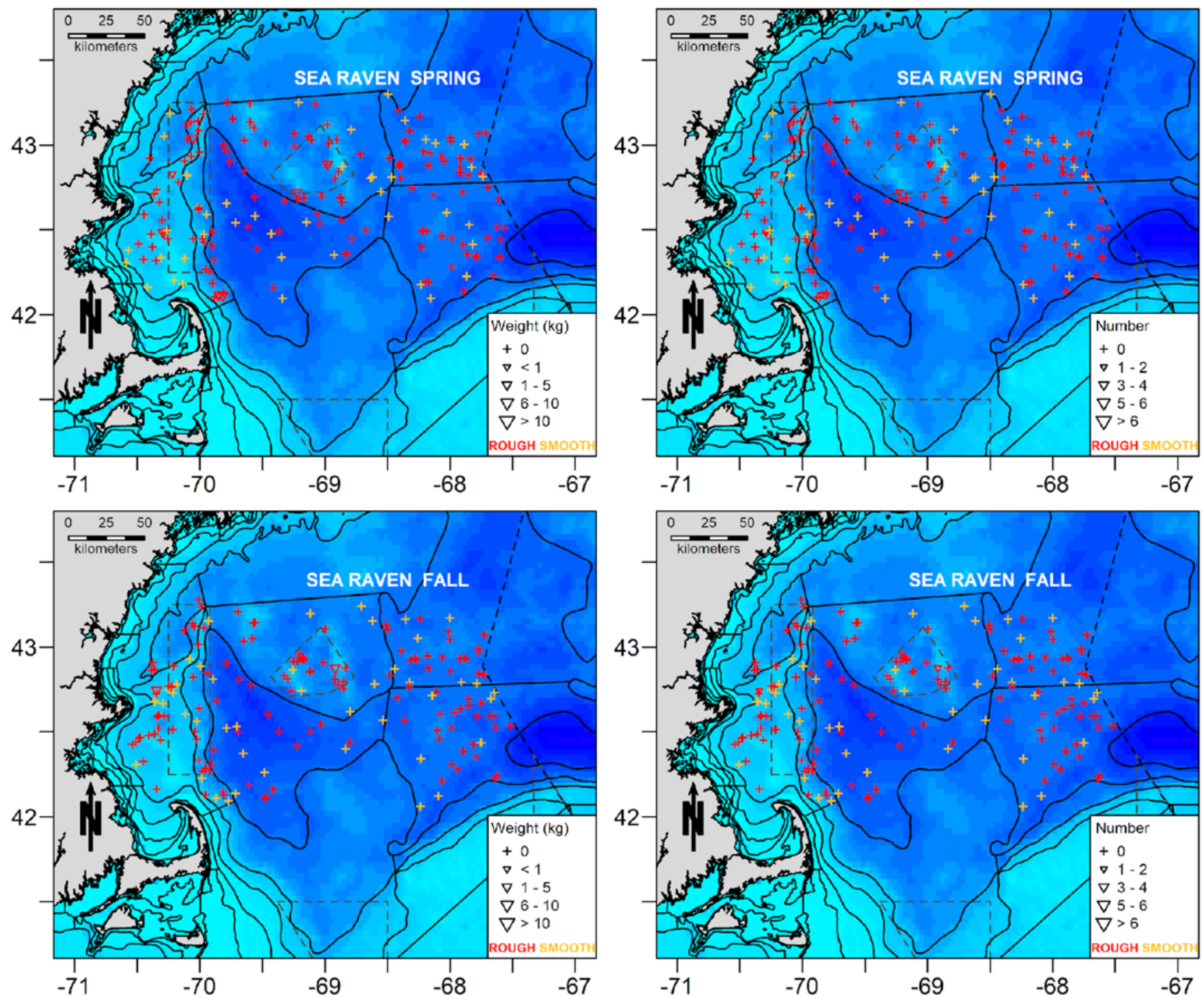
Appendix B. Figure 26. Distribution of ocean pout (*Zoarces americanus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



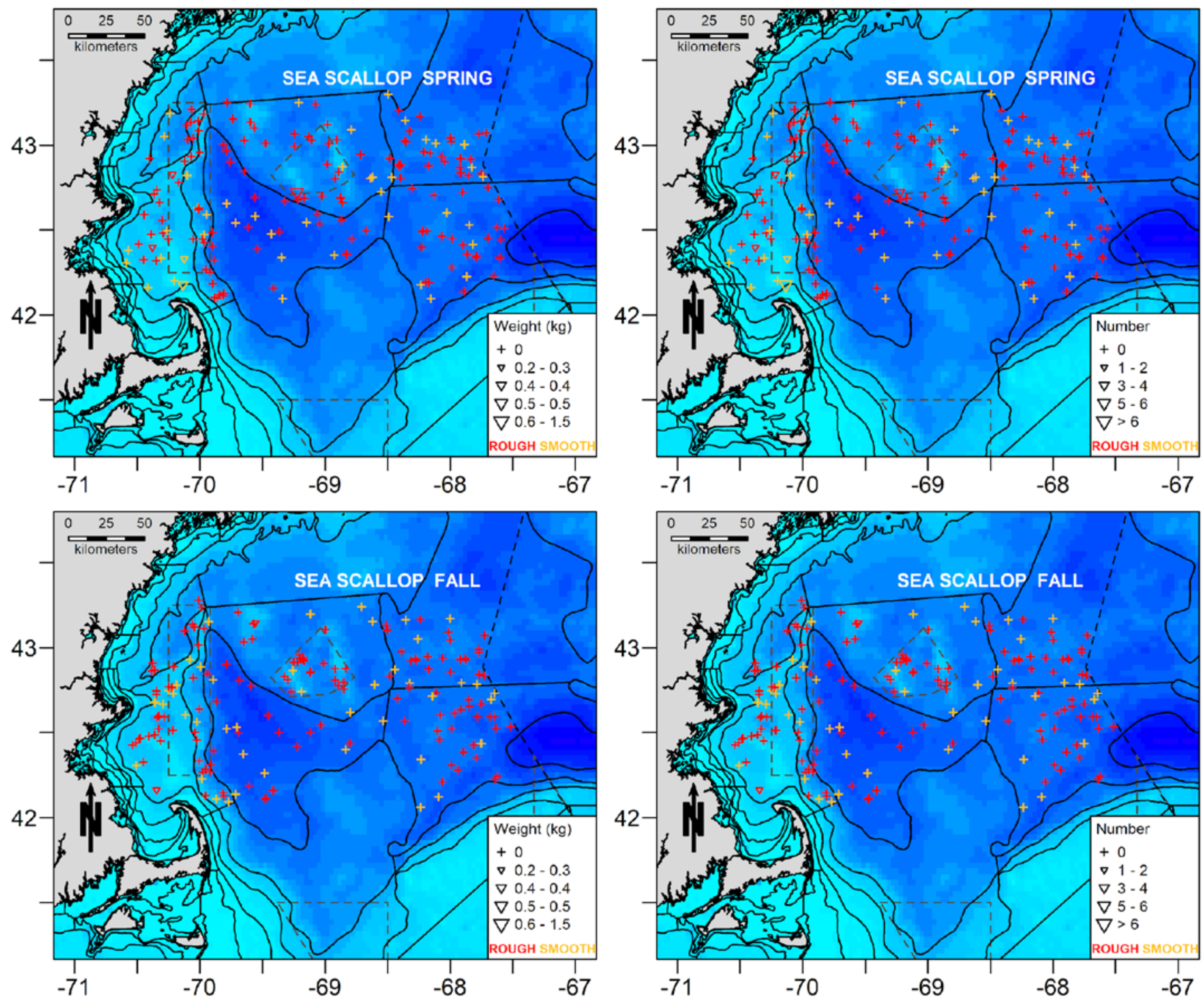
Appendix B. Figure 27. Distribution of pollock (*Pollachius virens*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



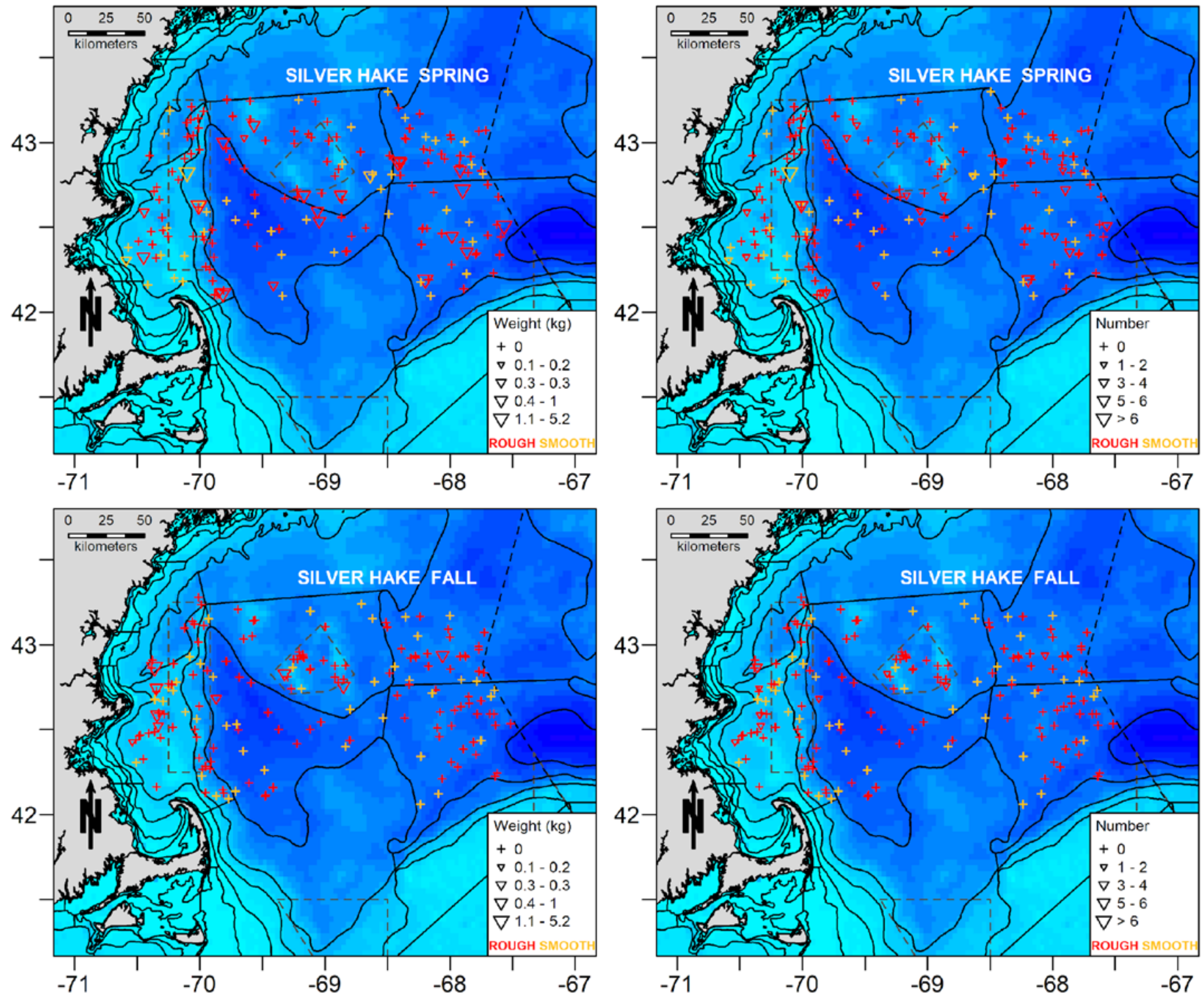
Appendix B. Figure 28. Distribution of red hake (*Urophycis chuss*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



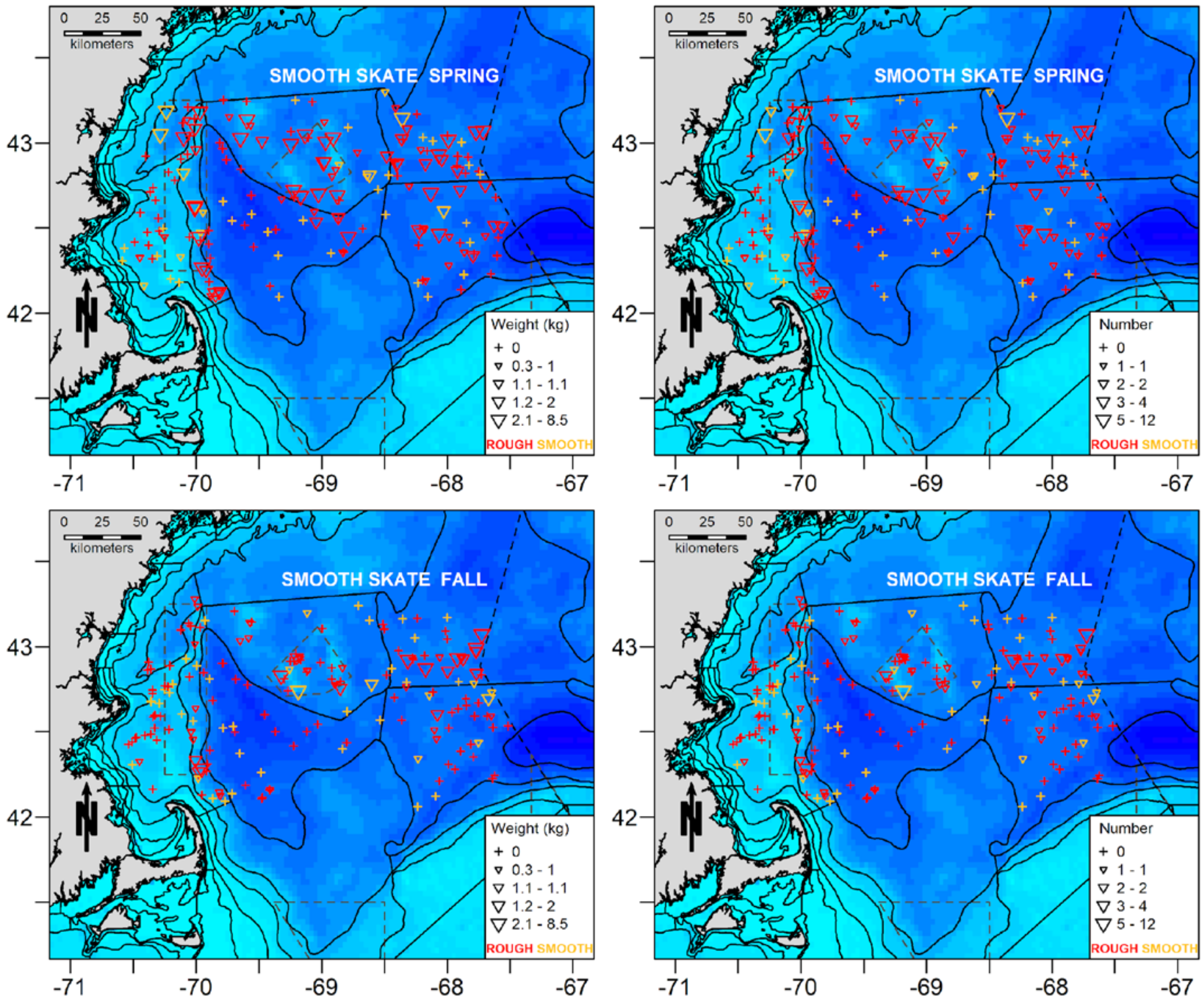
Appendix B. Figure 29. Distribution of sea raven (*Hemitripterus americanus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



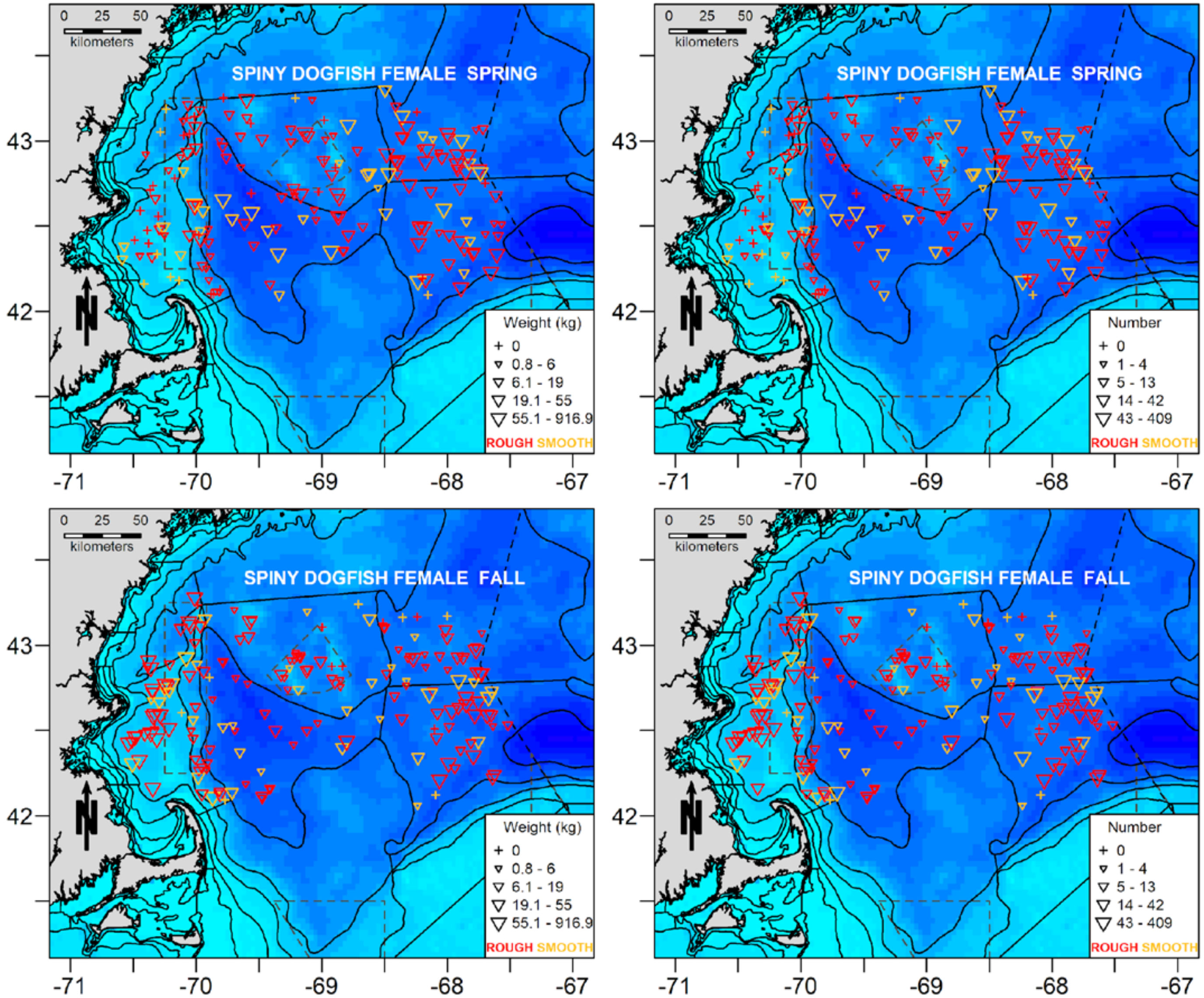
Appendix B. Figure 30. Distribution of sea scallop (*Placopecten magellanicus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



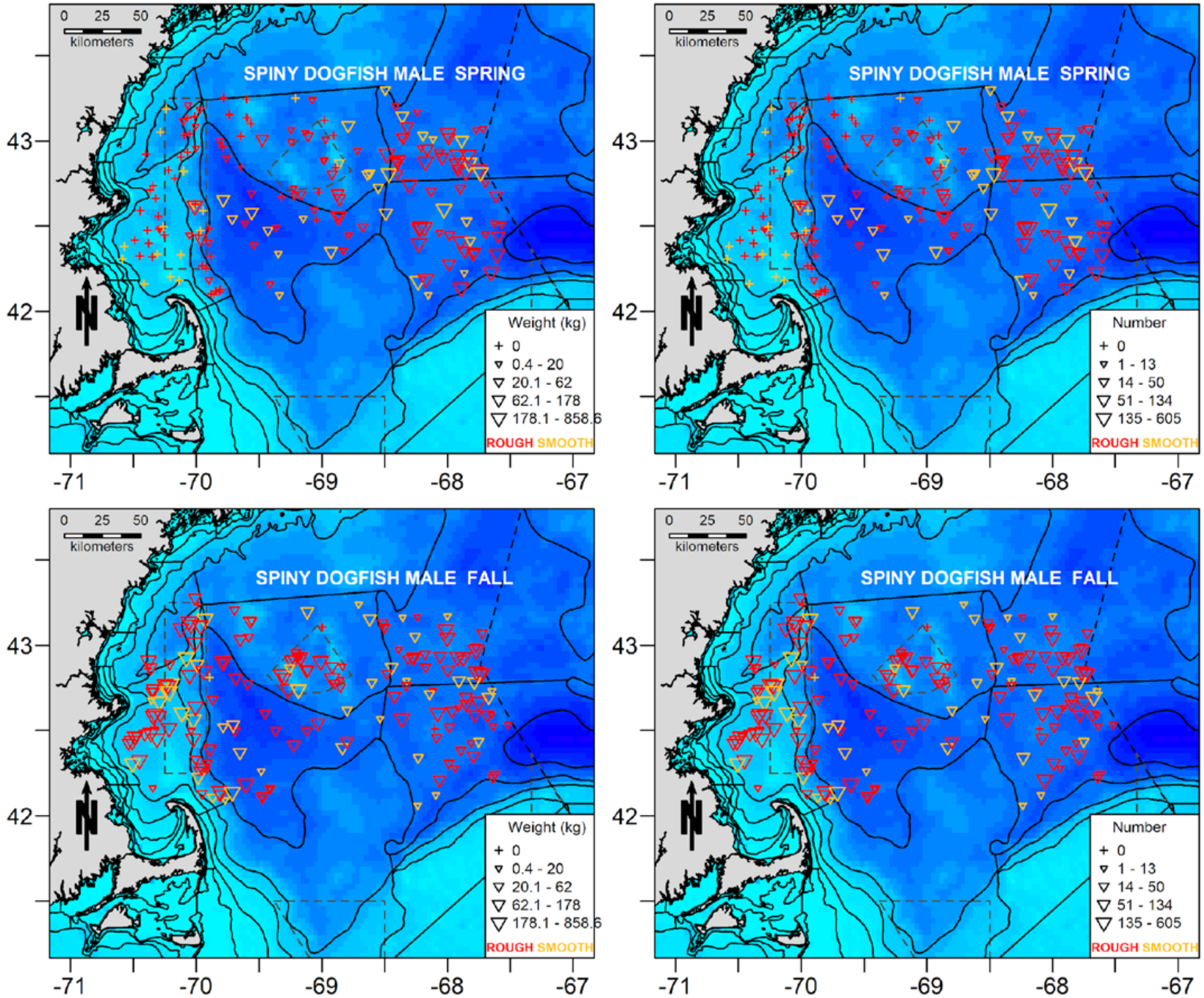
Appendix B. Figure 31. Distribution of silver hake (*Merluccius bilinearis*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



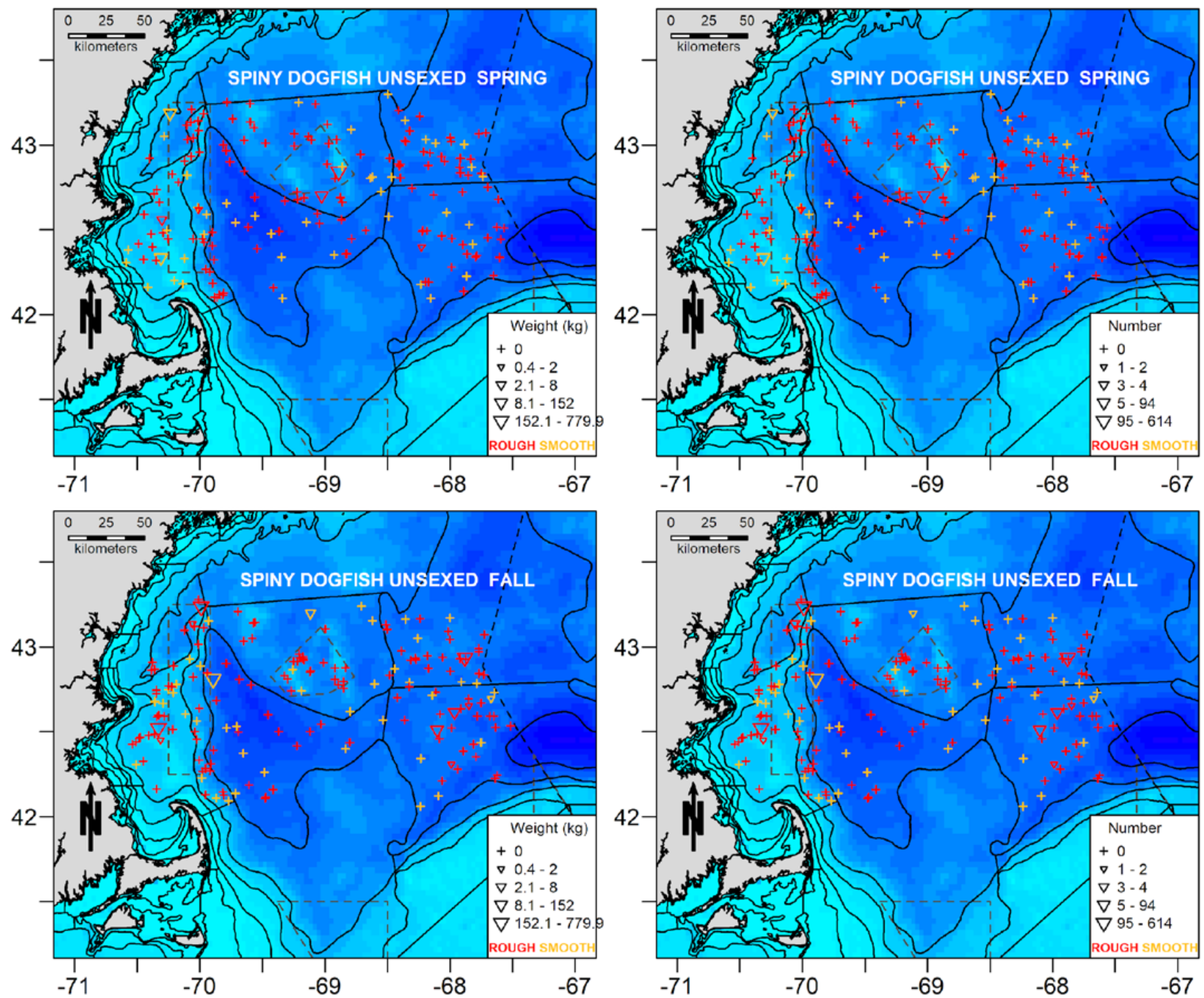
Appendix B. Figure 32. Distribution of smooth skate (*Malacoraja senta*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



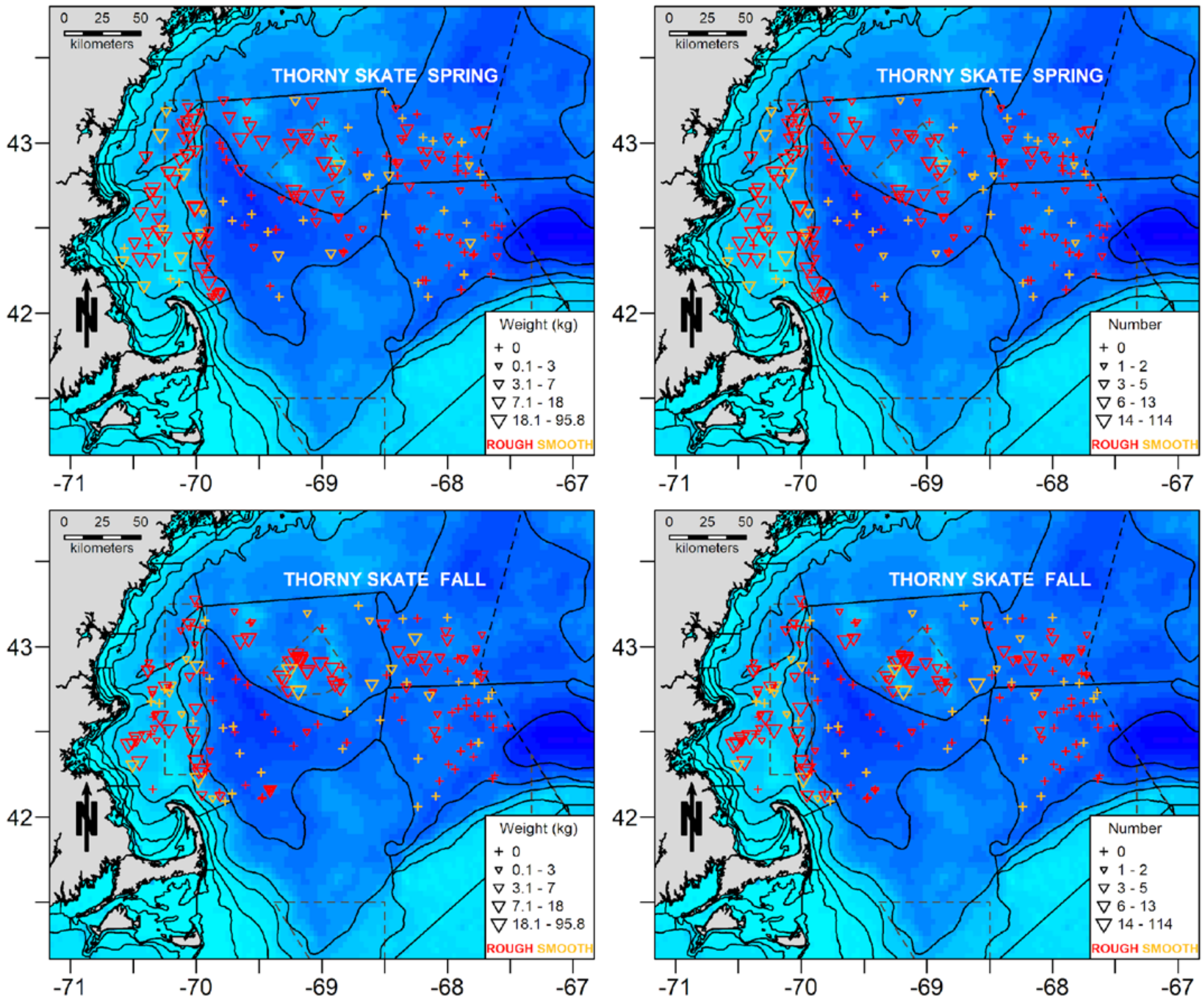
Appendix B. Figure 33. Distribution of female spiny dogfish (*Squalus acanthias*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



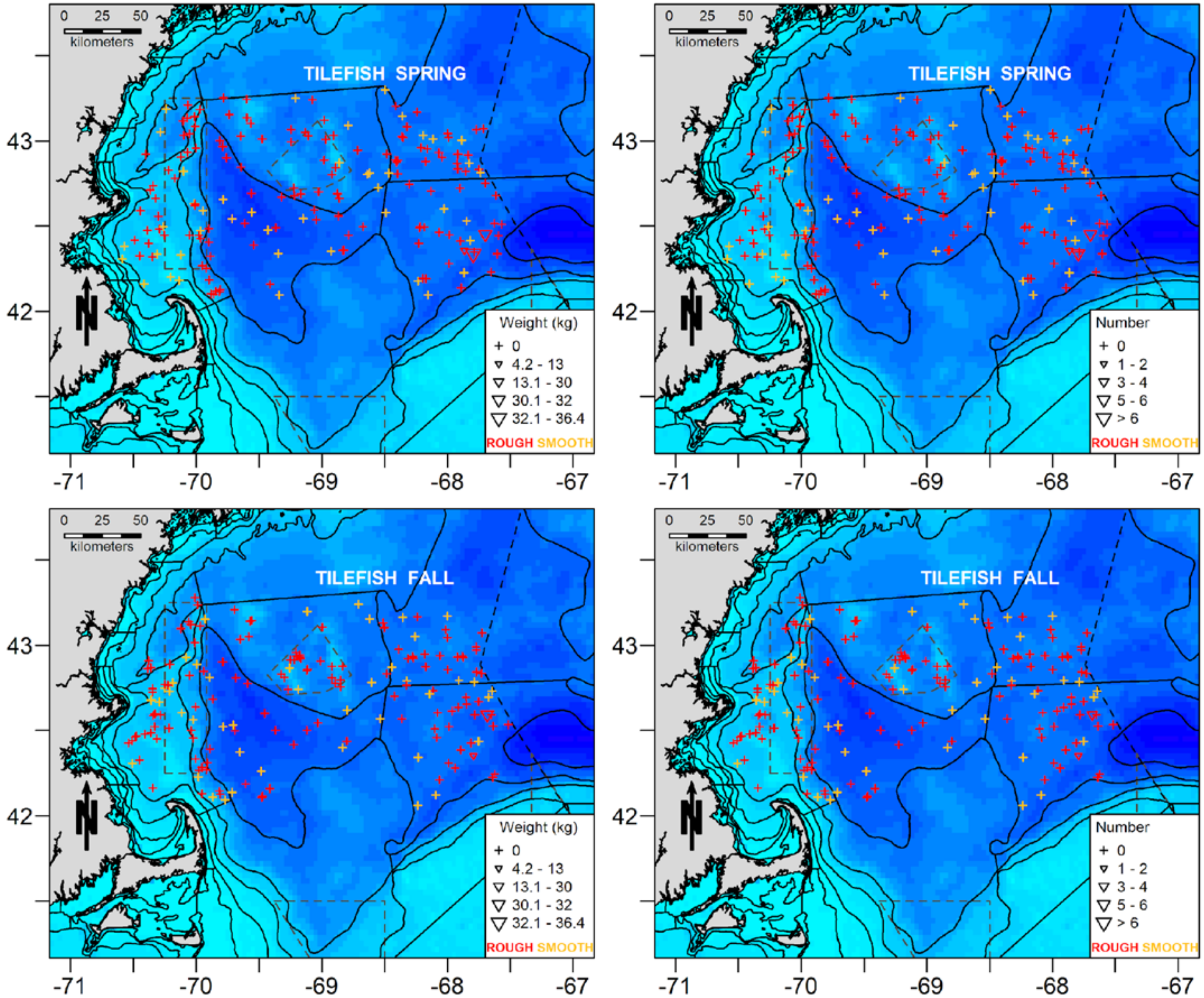
Appendix B. Figure 34. Distribution of male spiny dogfish (*Squalus acanthias*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



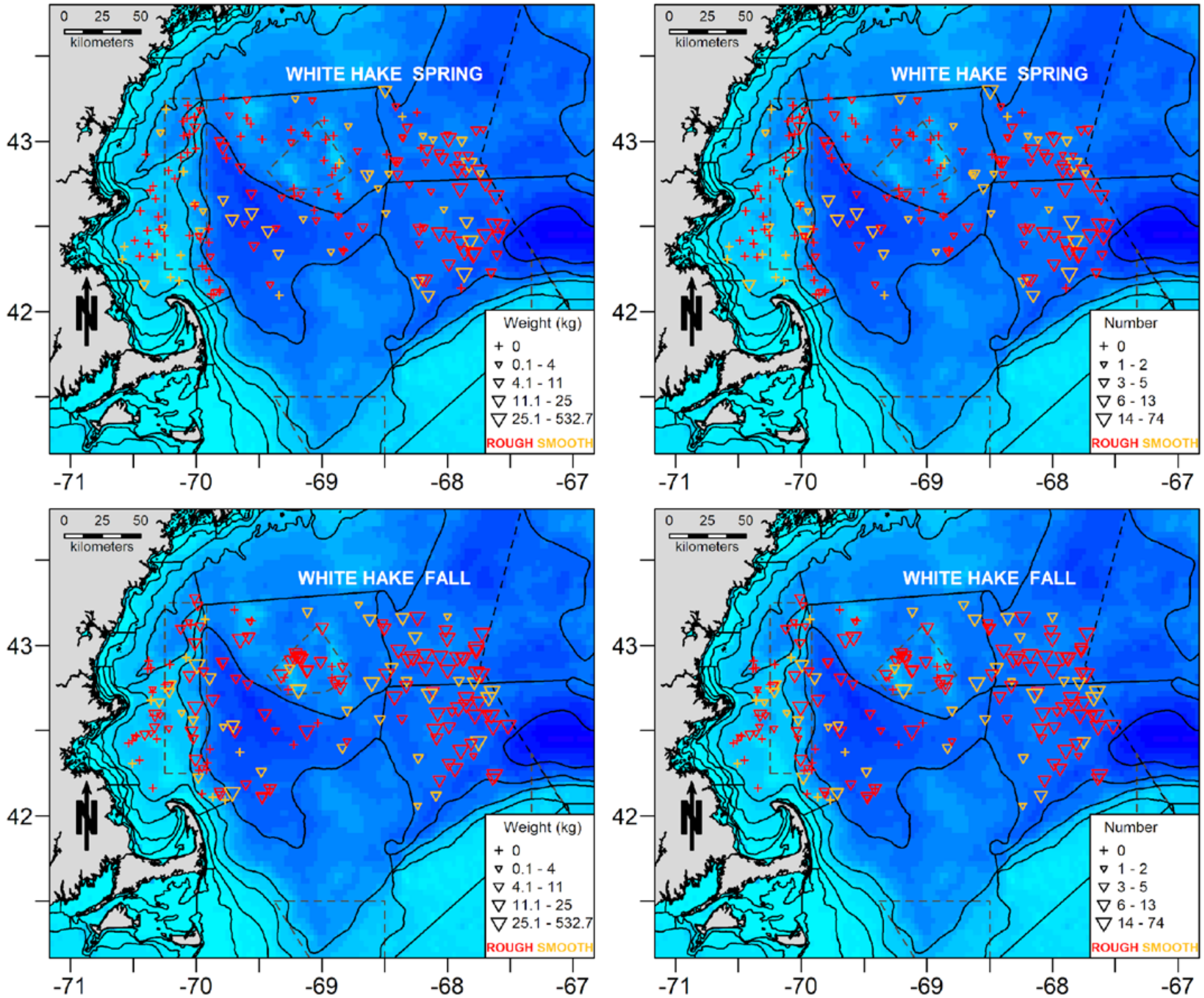
Appendix B. Figure 35. Distribution of unsexed spiny dogfish (*Squalus acanthias*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



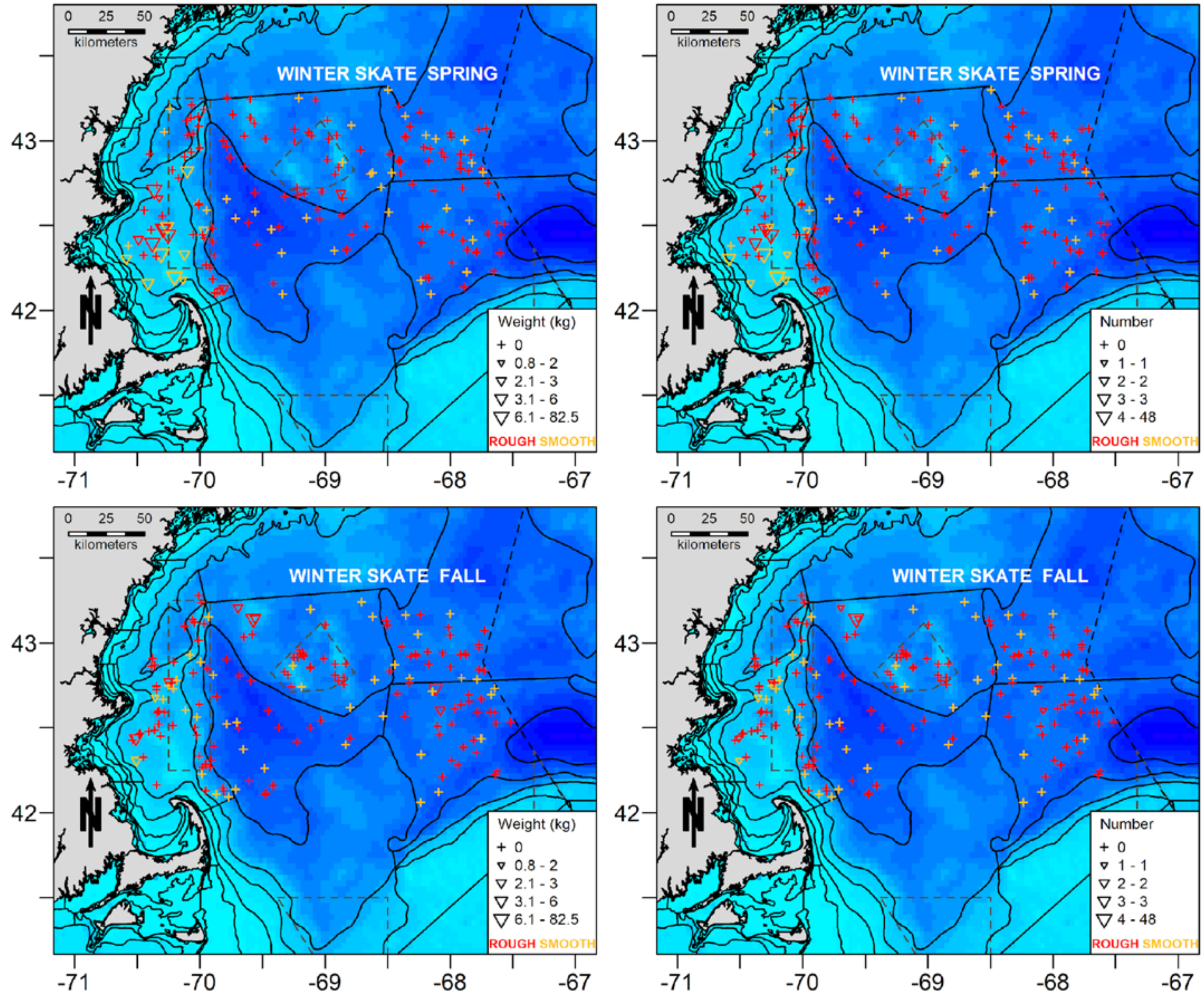
Appendix B. Figure 36. Distribution of thorny skate (*Amblyraja radiata*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



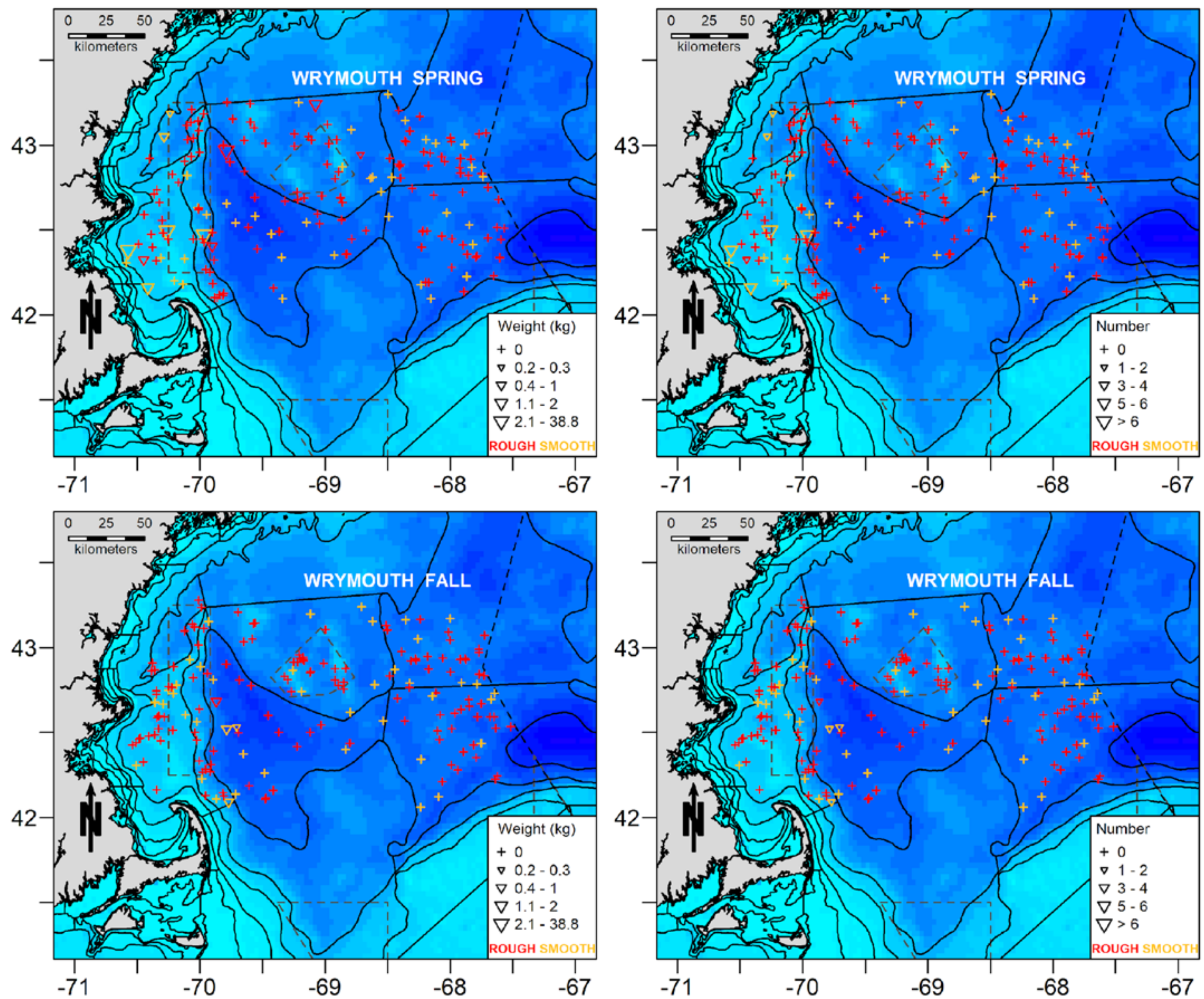
Appendix B. Figure 37. Distribution of tilefish (*Lopholatilus chamaeleonticeps*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.



Appendix B. Figure 38. Distribution of white hake (*Urophycis tenuis*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.

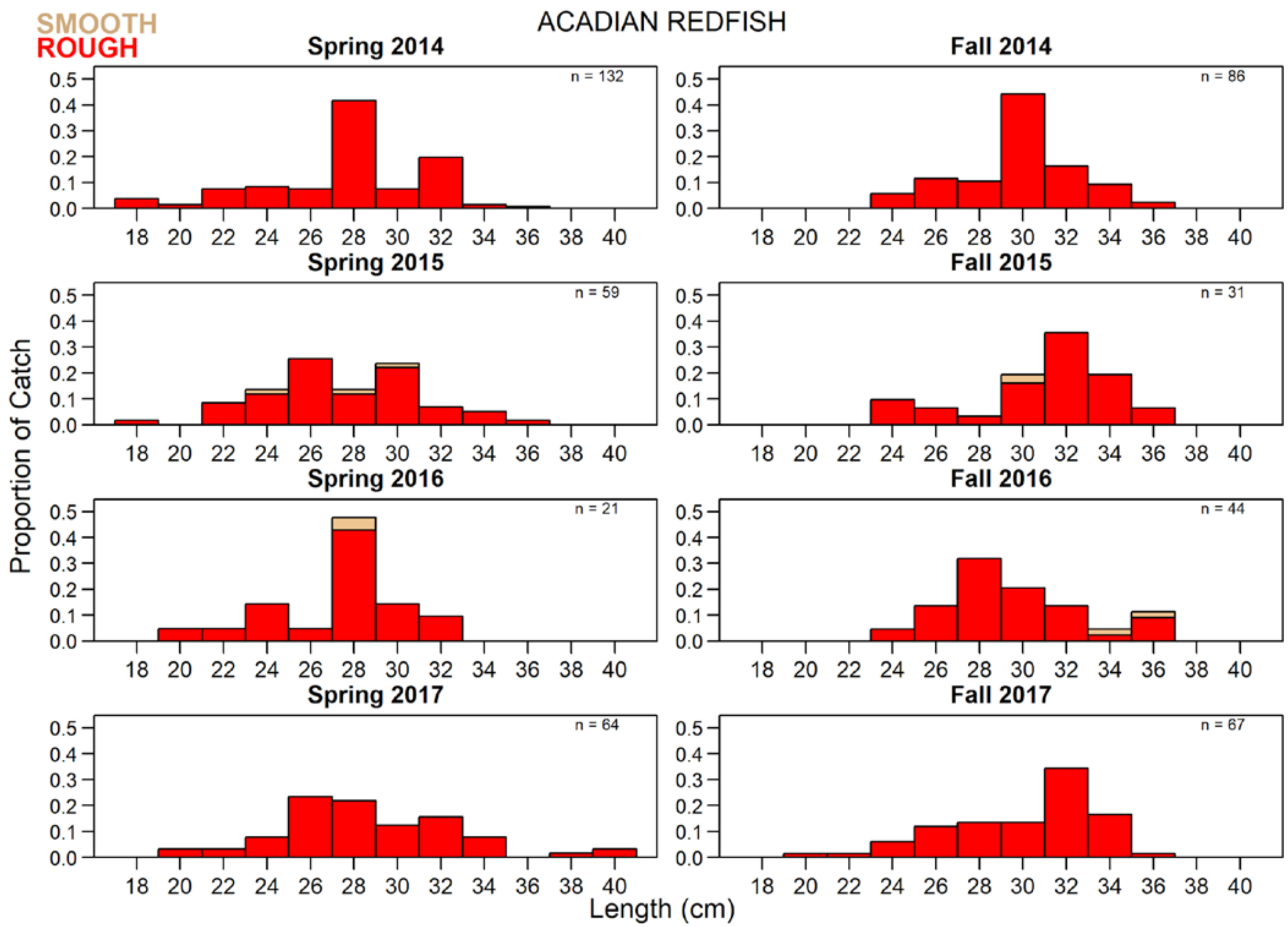


Appendix B. Figure 39. Distribution of winter skate (*Leucoraja ocellata*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.

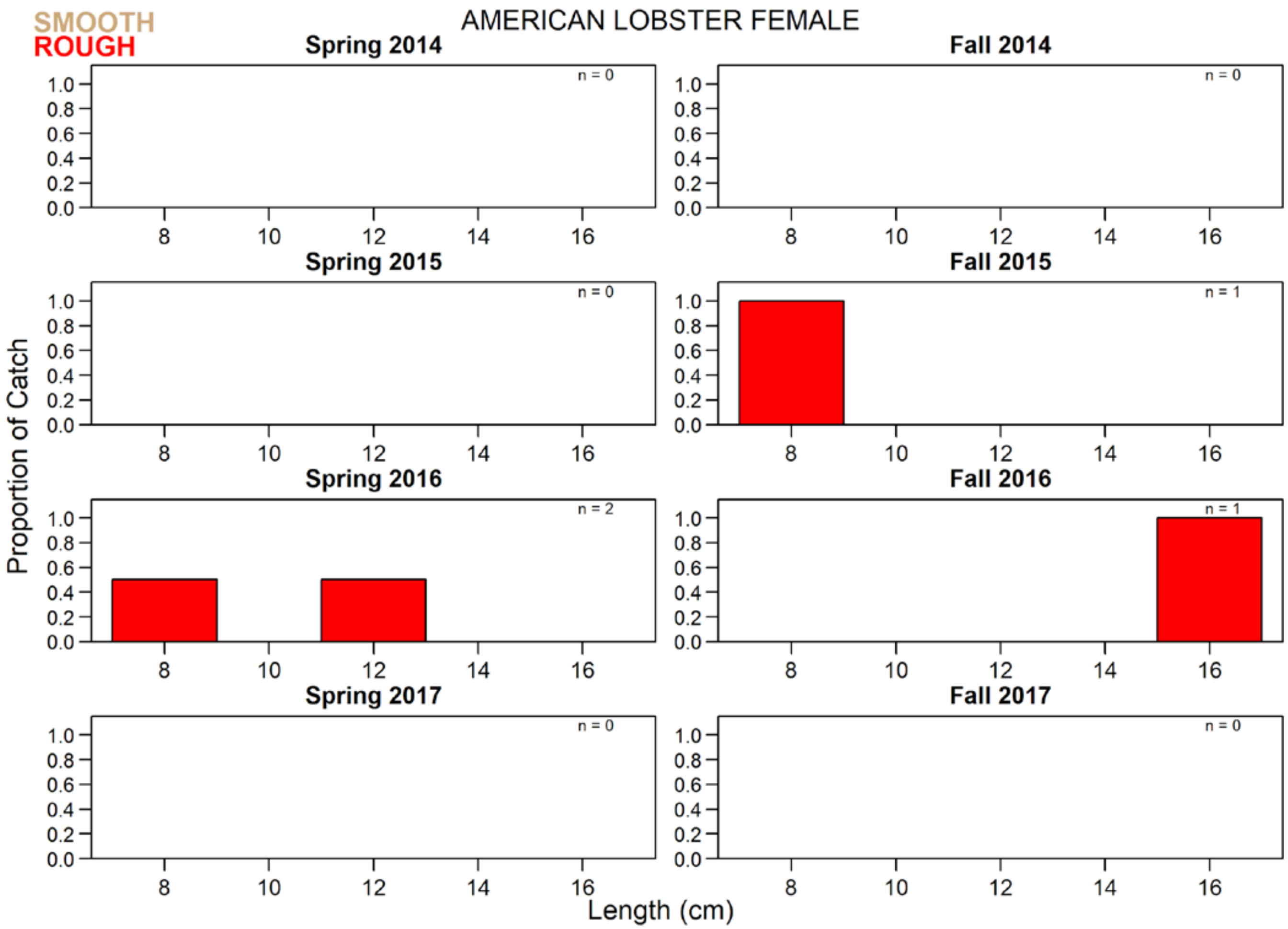


Appendix B. Figure 40. Distribution of wrymouth (*Cryptacanthodes maculatus*) by weight (left column) and count (right column) in the bottom longline survey during spring and fall, 2014 - 2017. Points scaled to the quartiles of the catch weight or number, unless fewer than 6 individuals were captured.

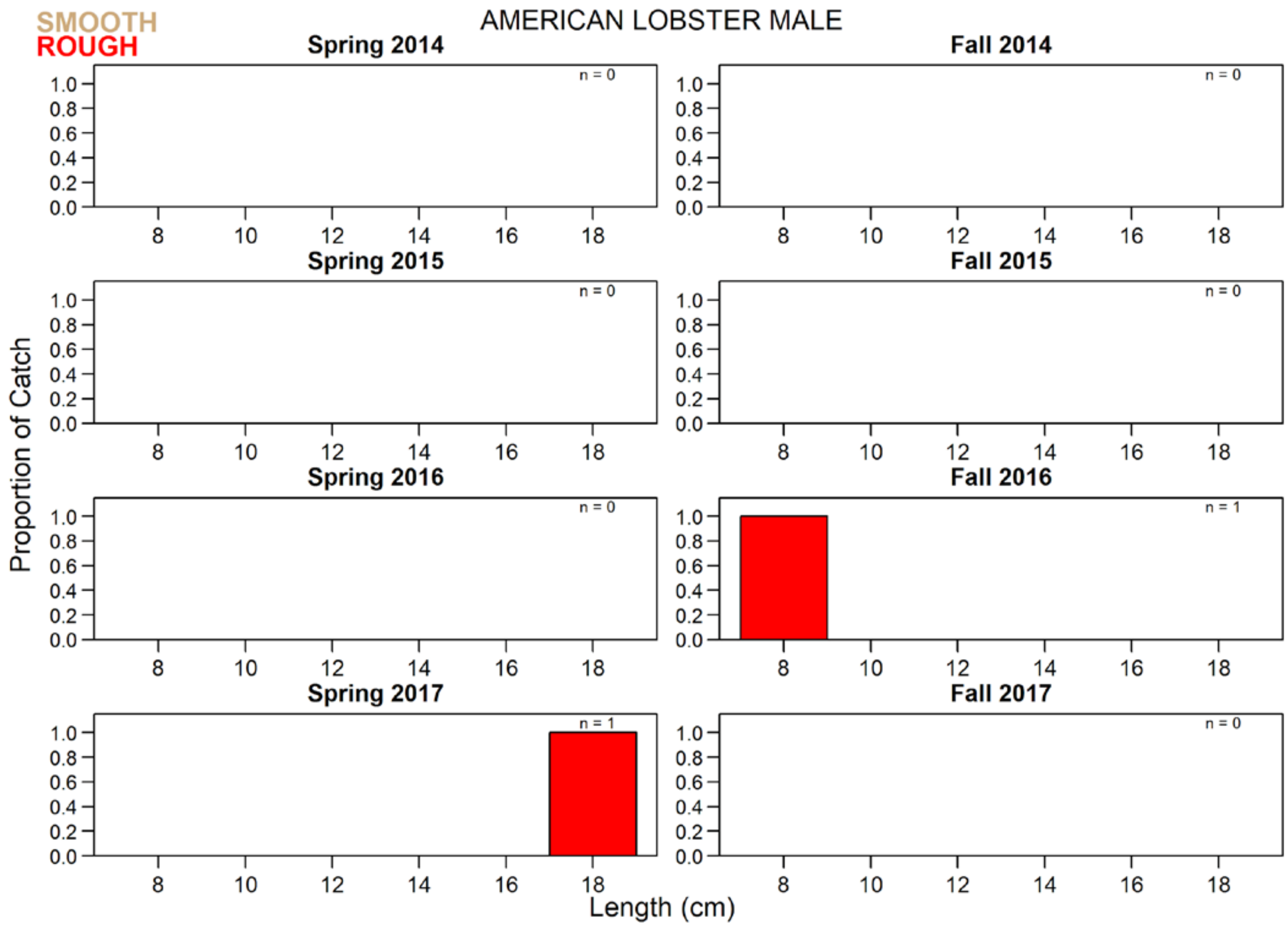
APPENDIX C.



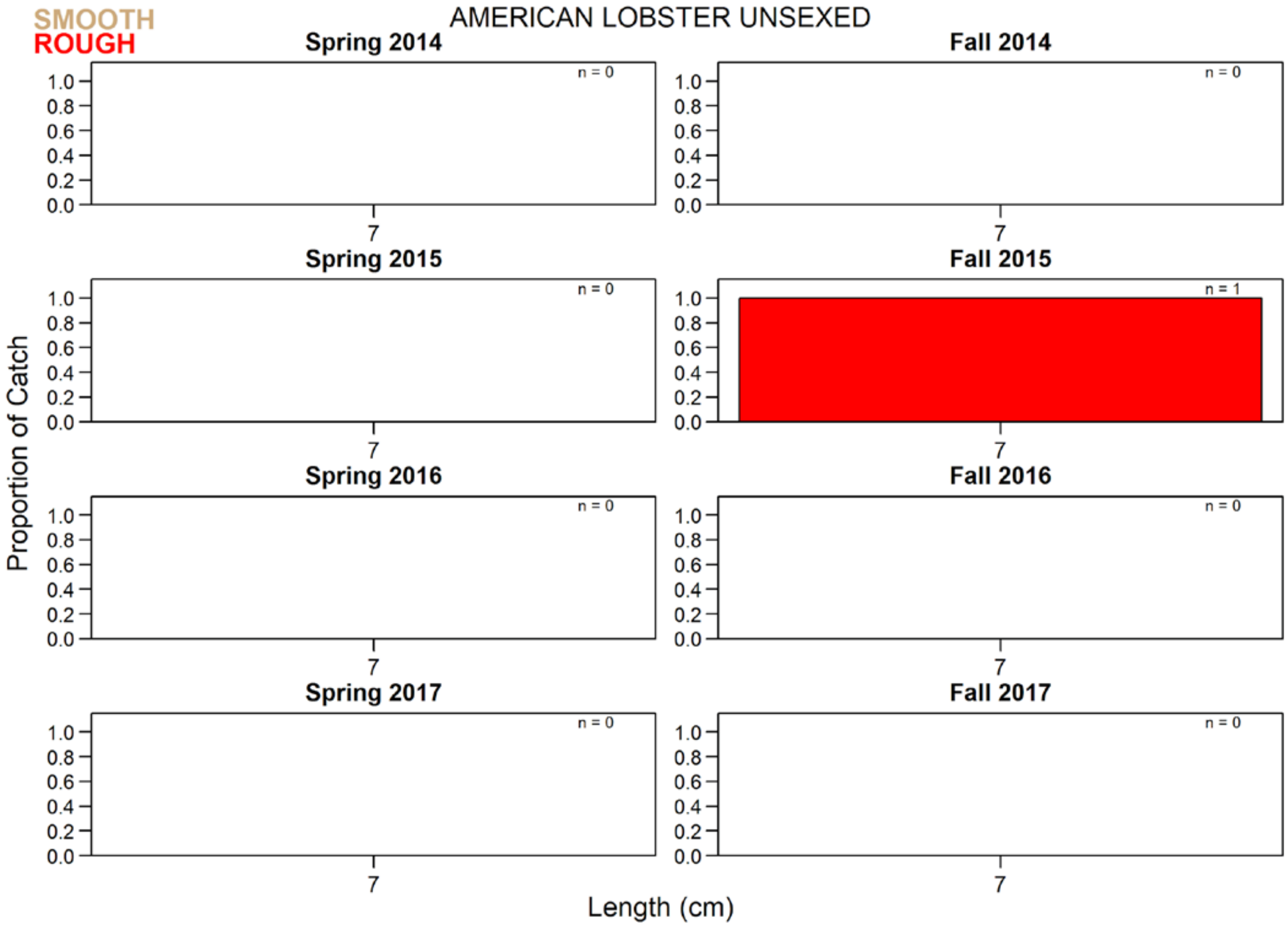
Appendix C. Figure 1. Length frequency of Acadian redfish, *Sebastes fasciatus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



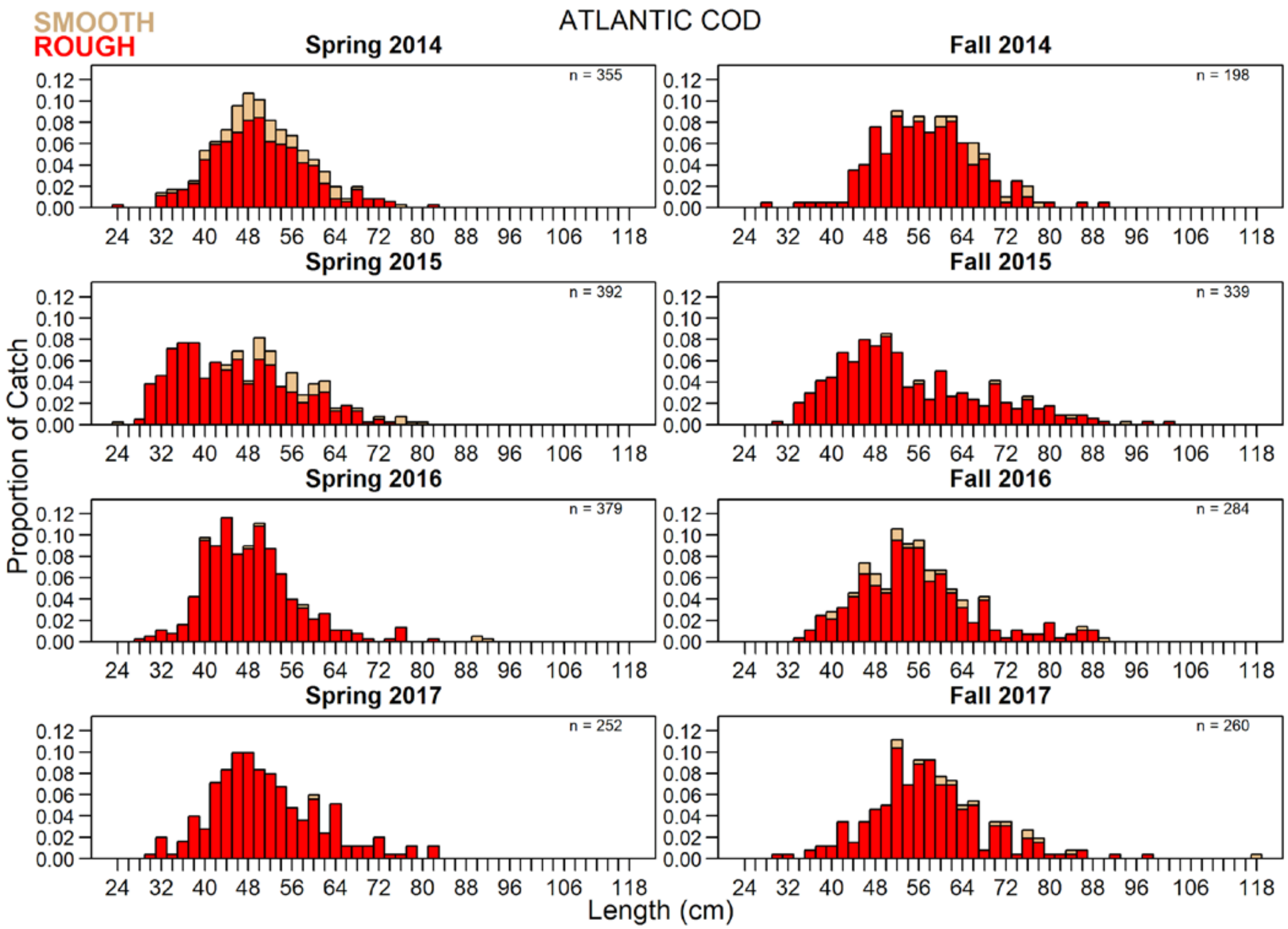
Appendix C. Figure 2. Length frequency of female American lobster, *Homarus americanus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



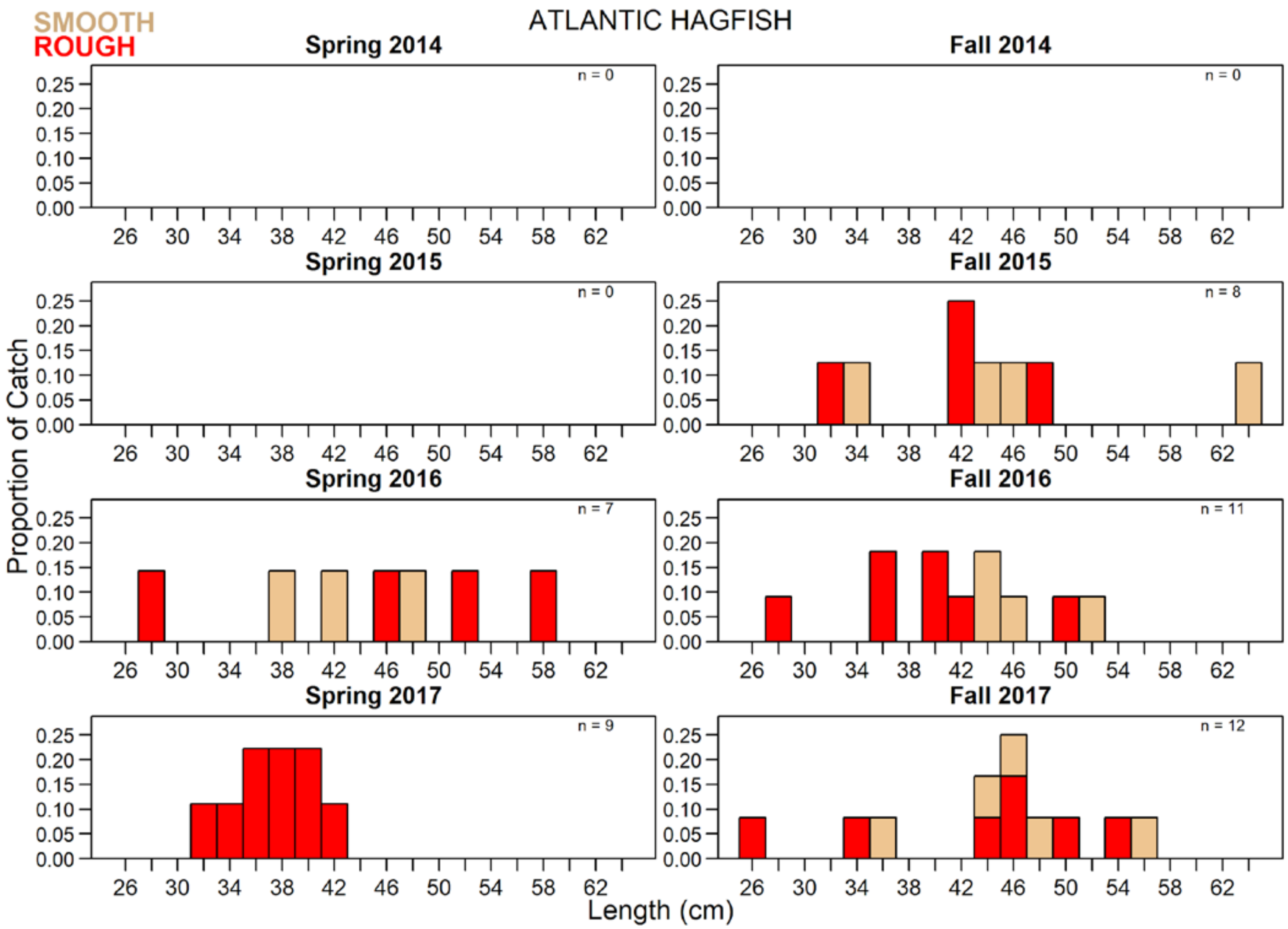
Appendix C. Figure 3. Length frequency of male American lobster, *Homarus americanus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



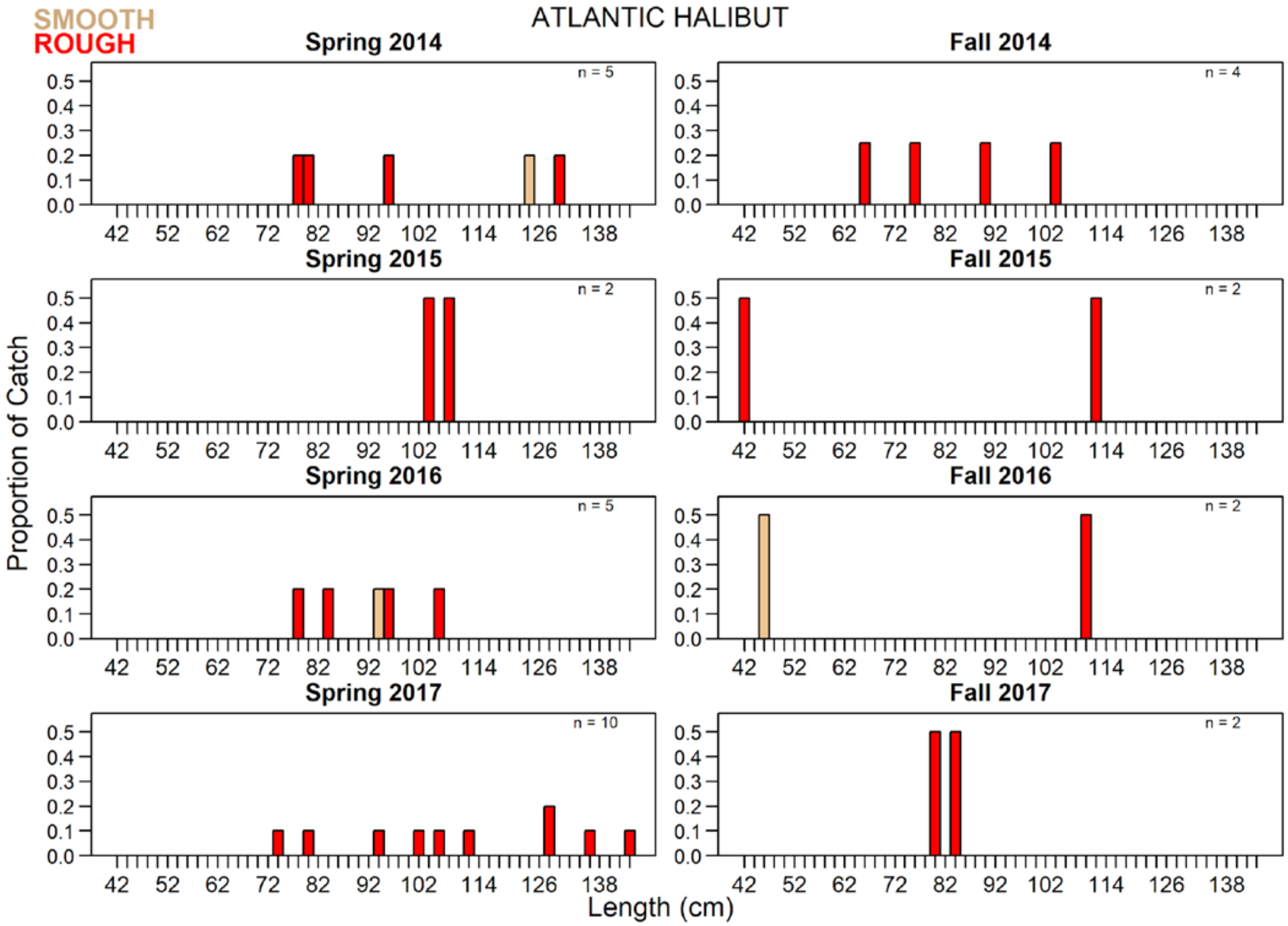
Appendix C. Figure 4. Length frequency of unsexed American lobster, *Homarus americanus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



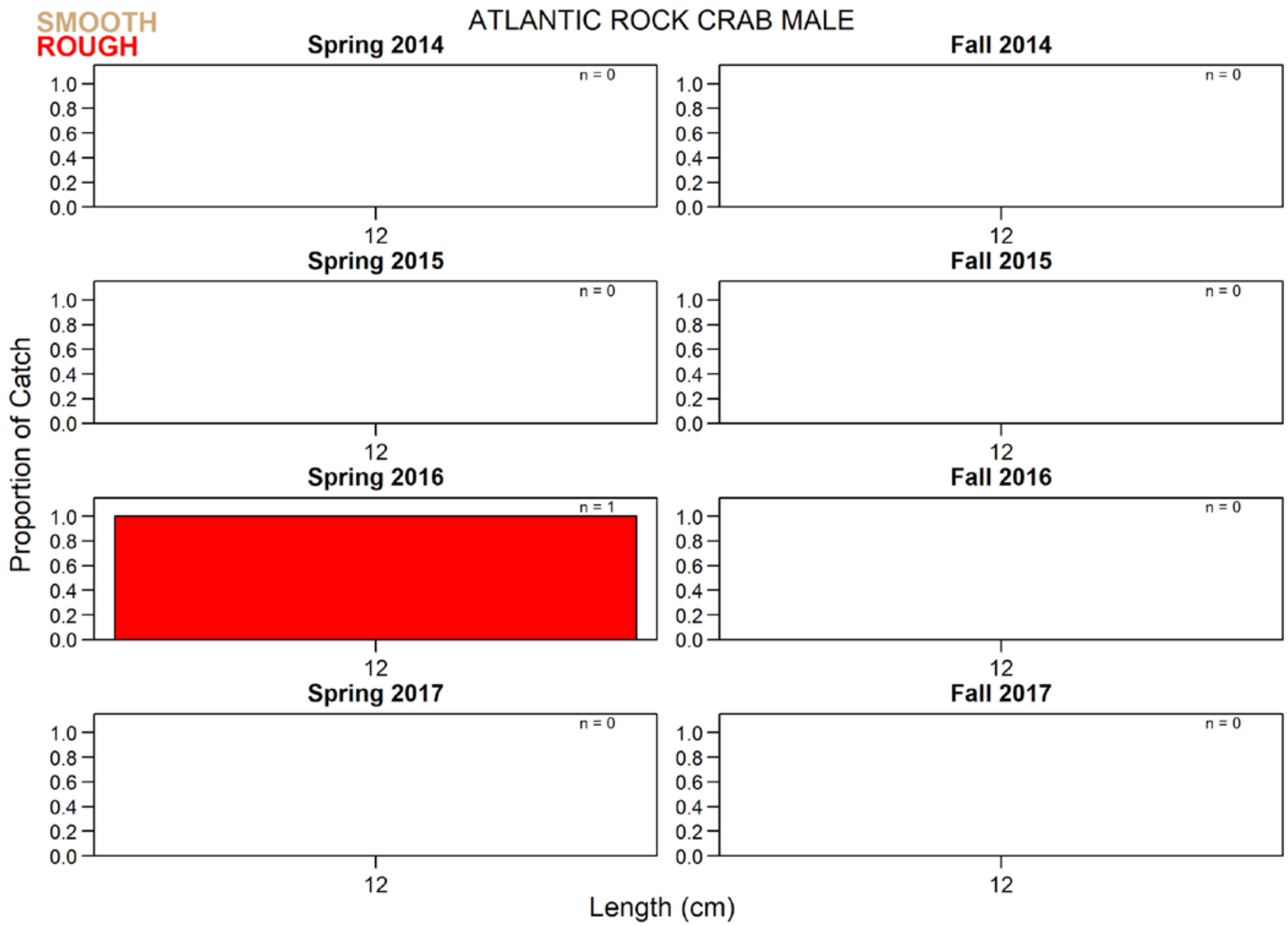
Appendix C. Figure 5. Length frequency of Atlantic cod, *Gadus morhua*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



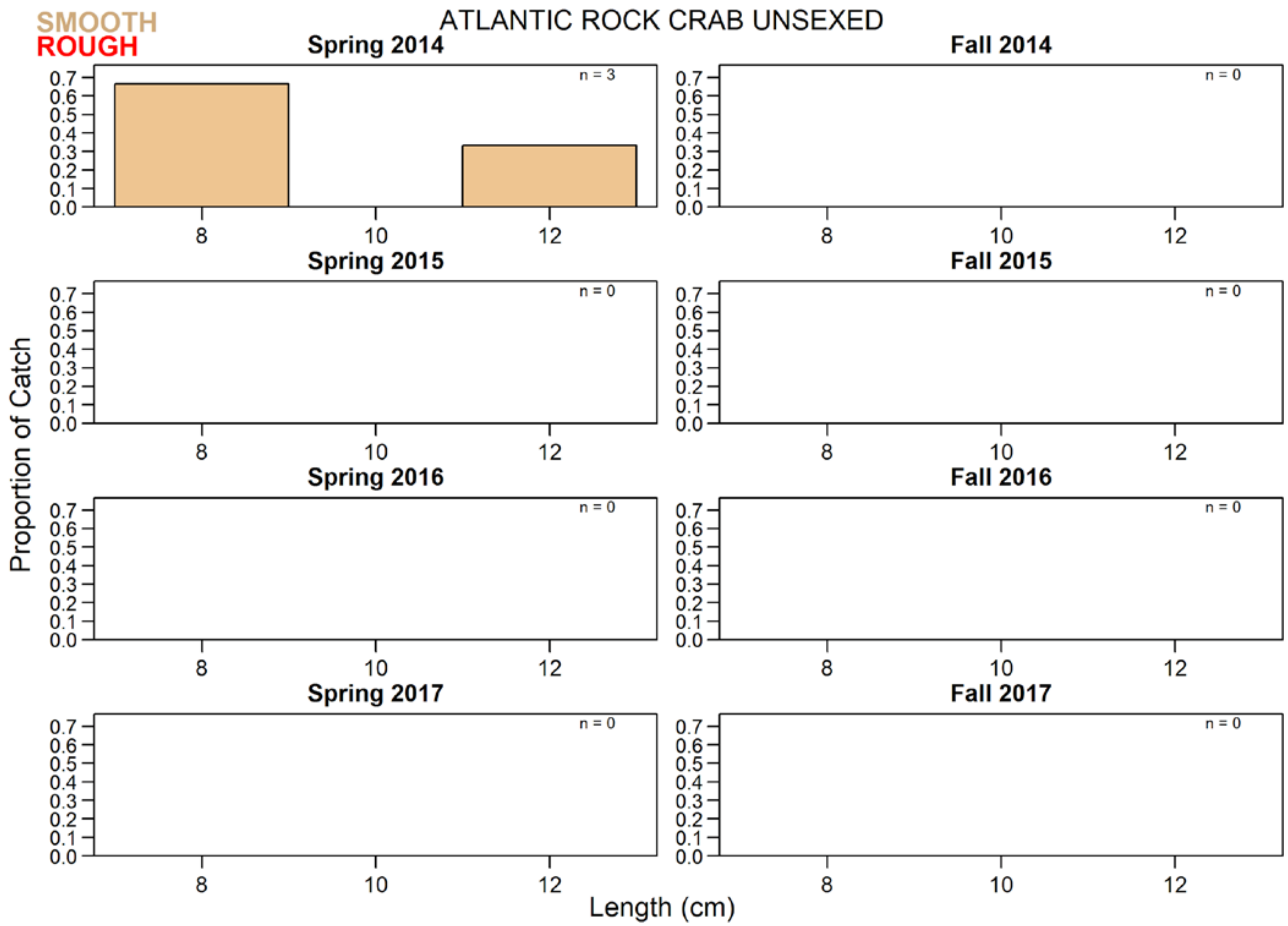
Appendix C. Figure 6. Length frequency of Atlantic hagfish, *Myxine glutinosa*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



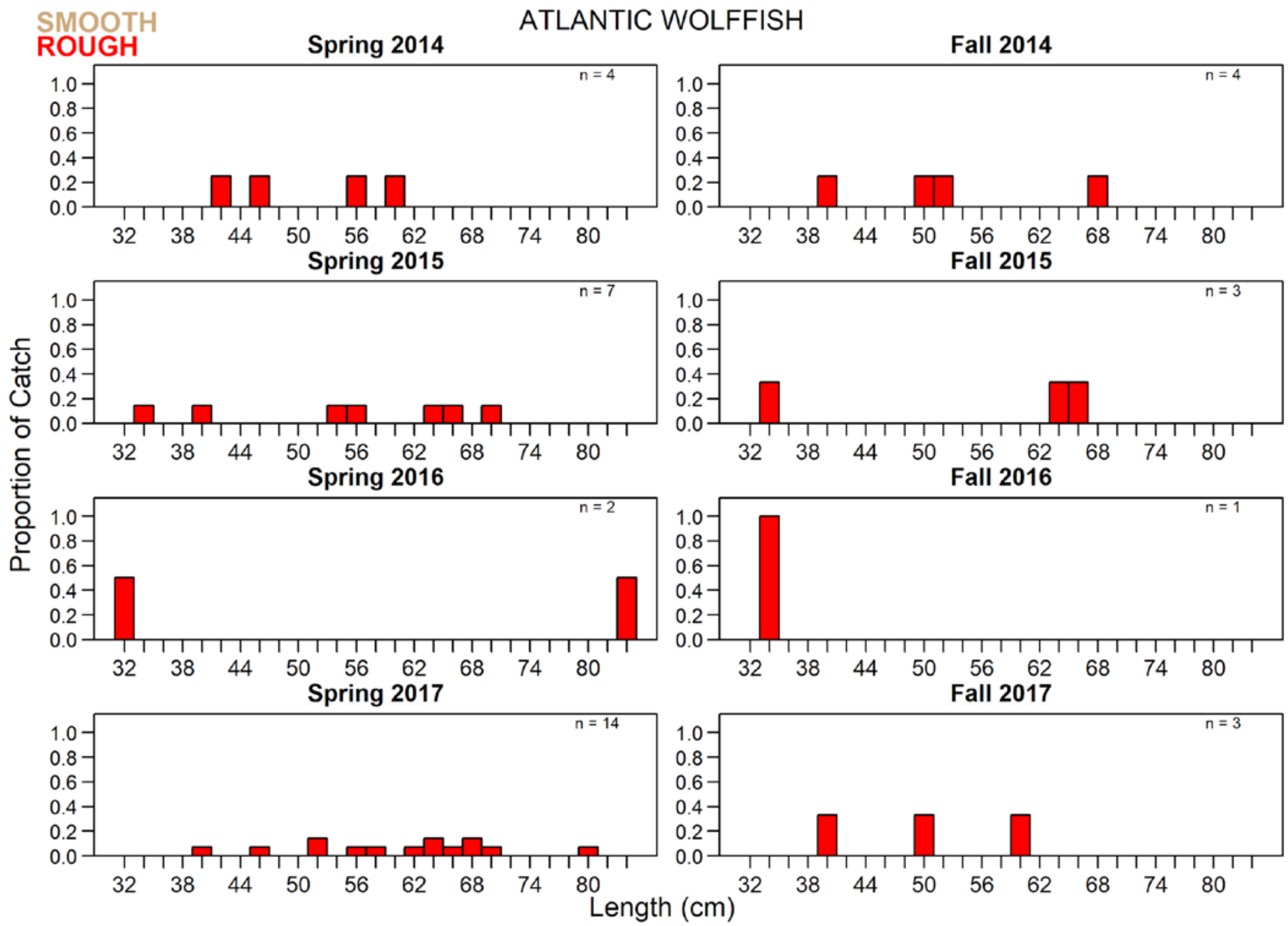
Appendix C. Figure 7. Length frequency of Atlantic halibut, *Hippoglossus hippoglossus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



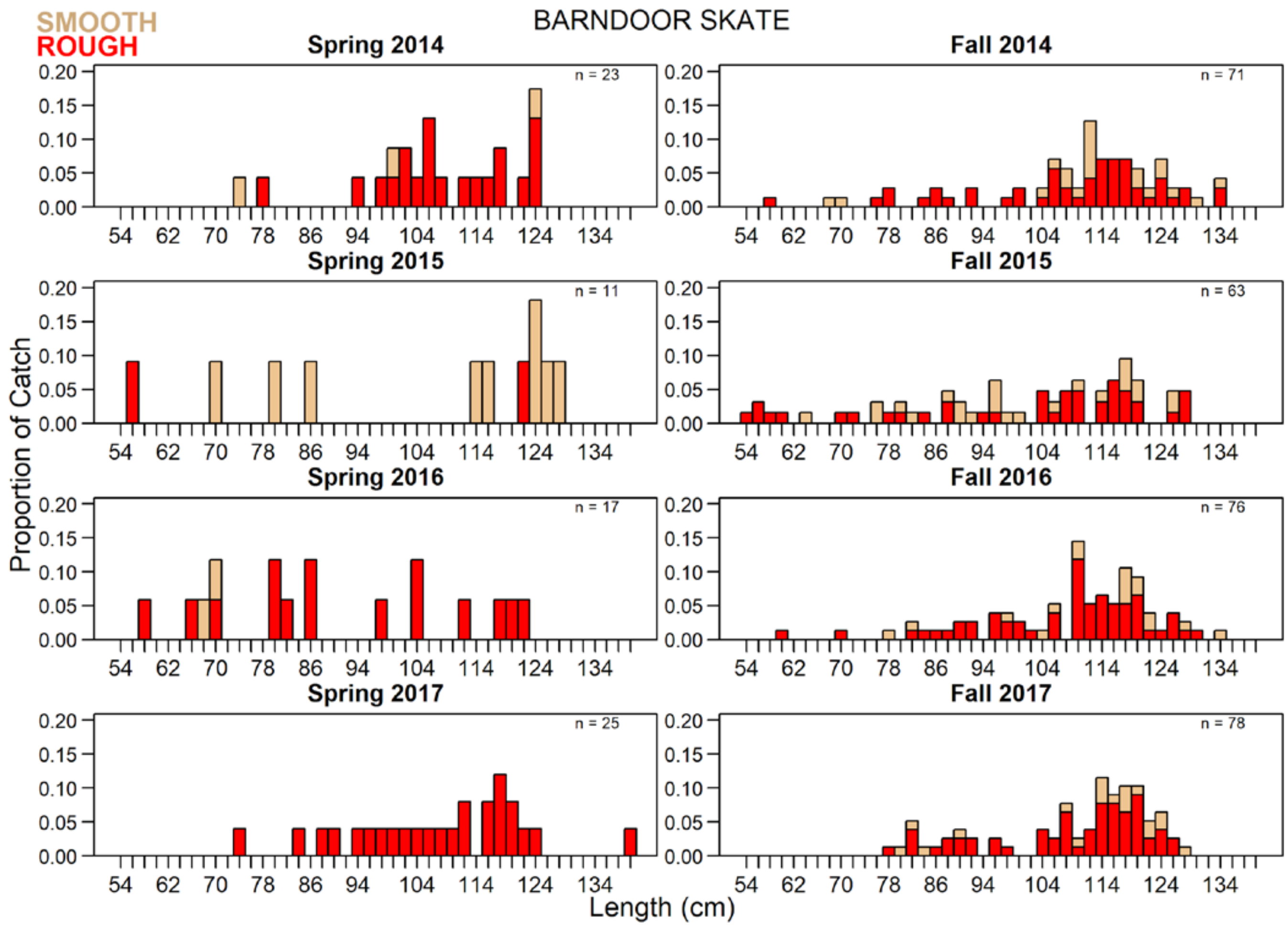
Appendix C. Figure 8. Length frequency of male Atlantic rock crab, *Cancer irroratus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



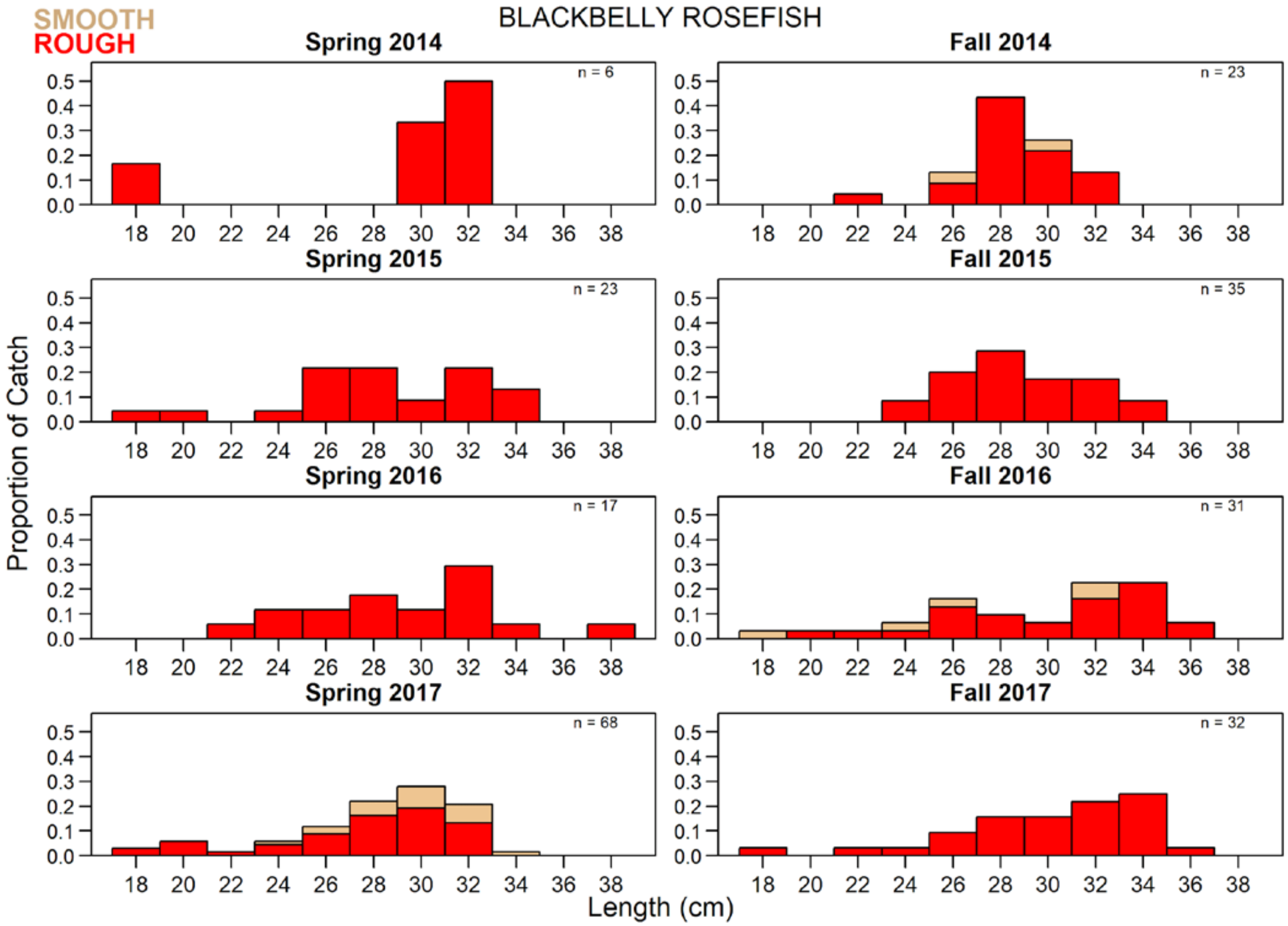
Appendix C. Figure 9. Length frequency of unsexed Atlantic rock crab, *Cancer irroratus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



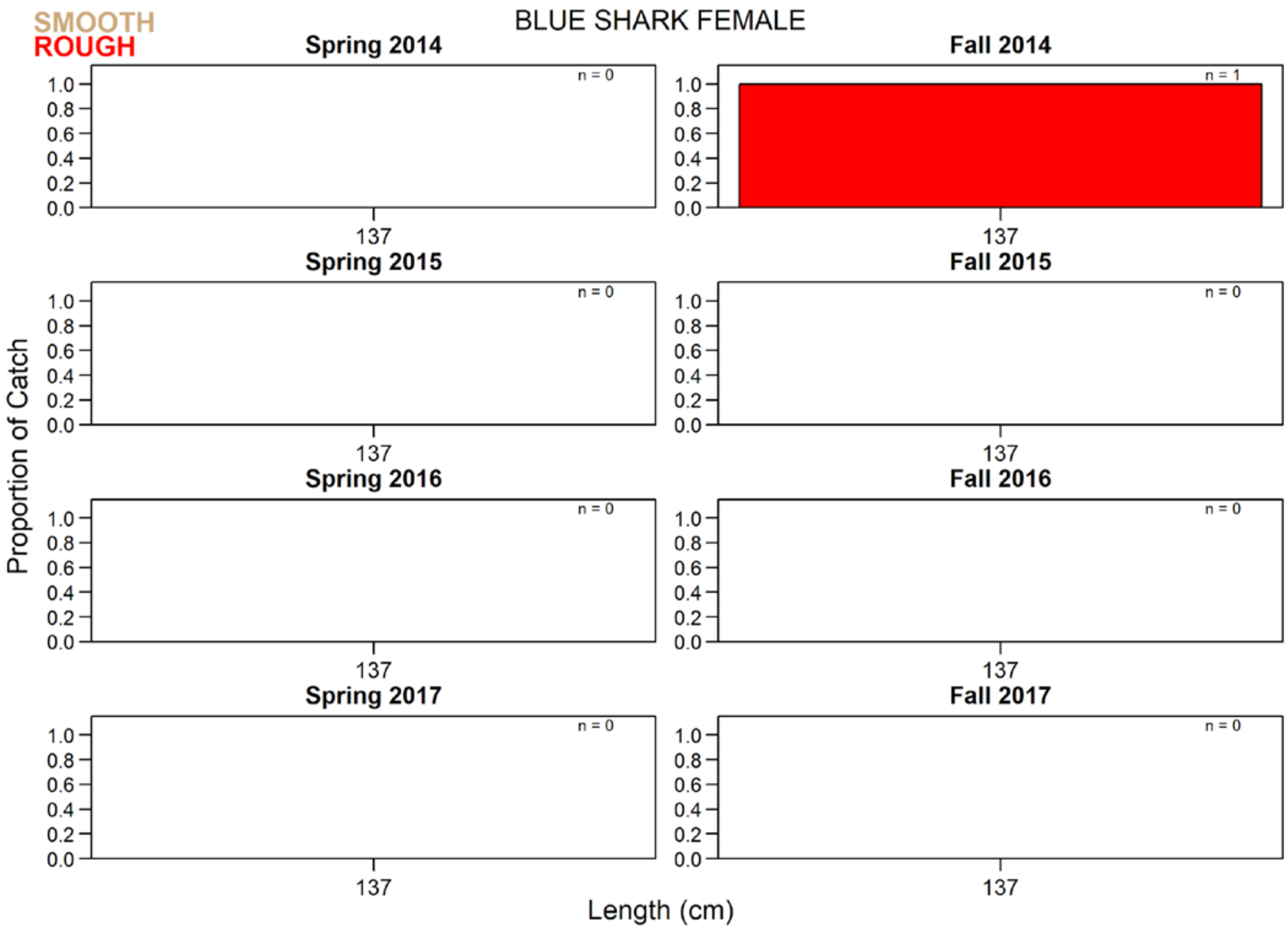
Appendix C. Figure 10. Length frequency of Atlantic wolffish, *Anarhichas lupus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



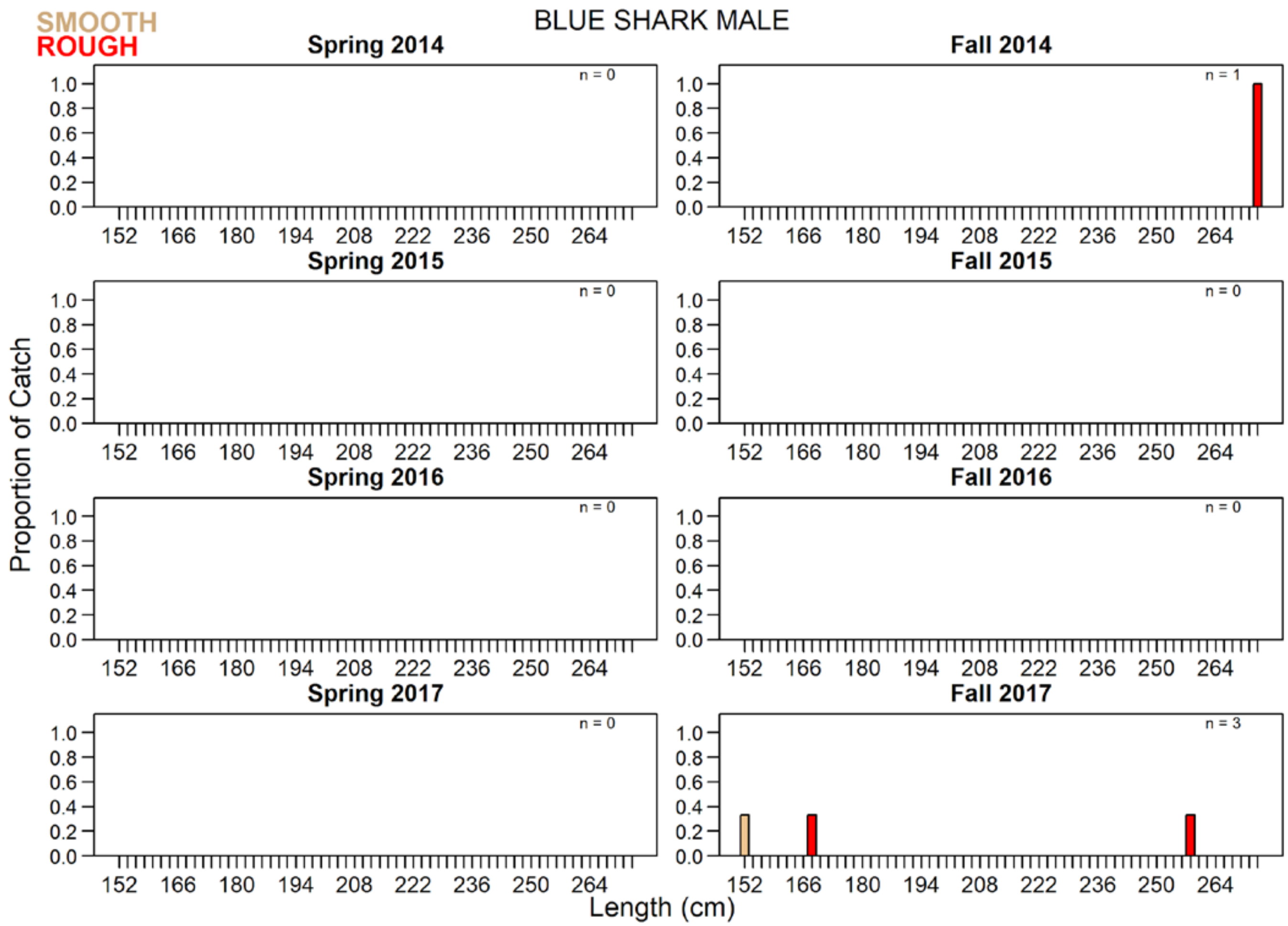
Appendix C. Figure 11. Length frequency of barndoor skate, *Dipturus laevis*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



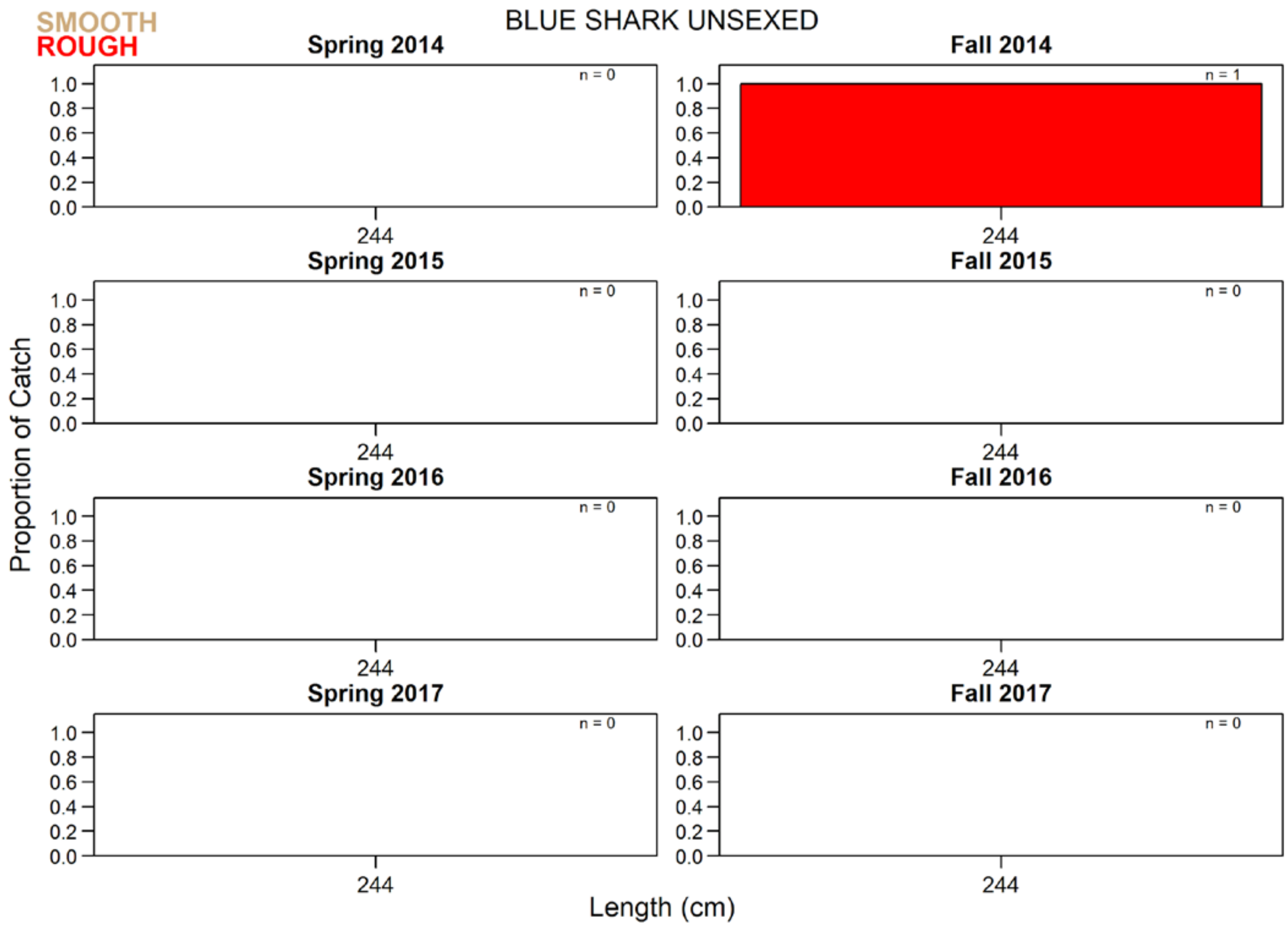
Appendix C. Figure 12. Length frequency of blackbelly rosefish, *Helicolenus dactylopterus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



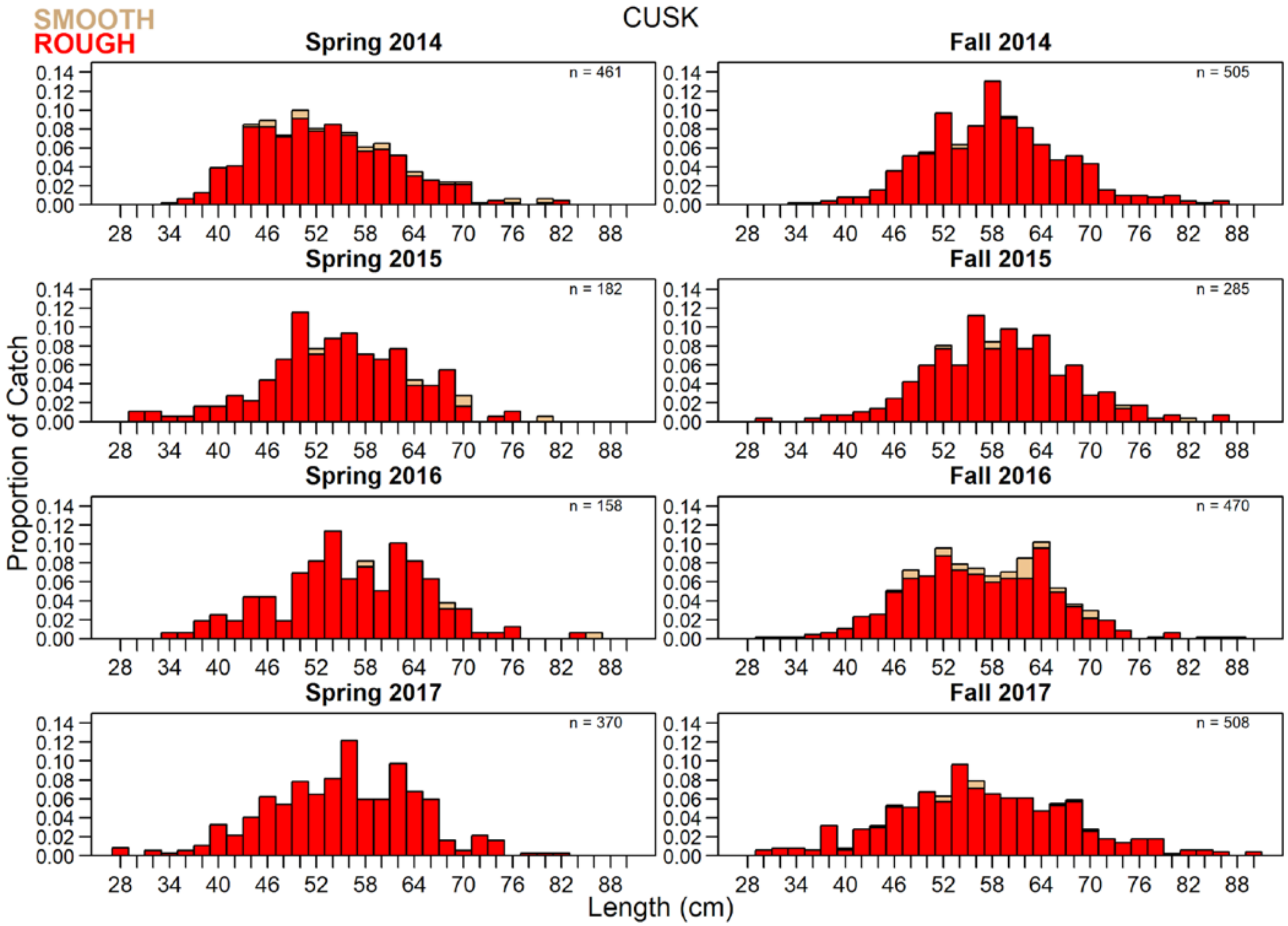
Appendix C. Figure 13. Length frequency of female blue shark, *Prionace glauca*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches. Lengths are estimates as sharks were released alive at the side of the vessel.



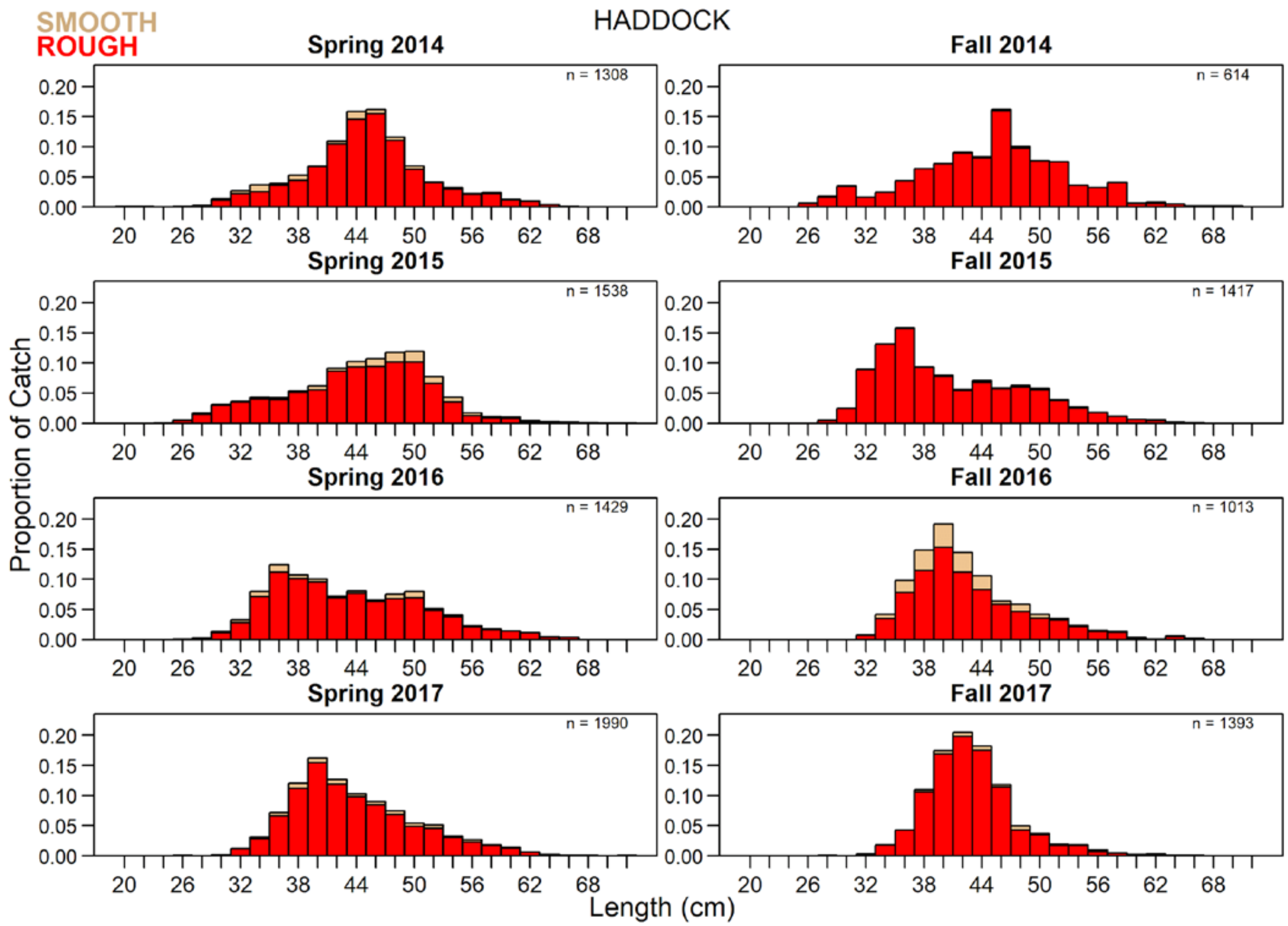
Appendix C. Figure 14. Length frequency of male blue shark, *Prionace glauca*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches. Lengths are estimates as sharks were released alive at the side of the vessel.



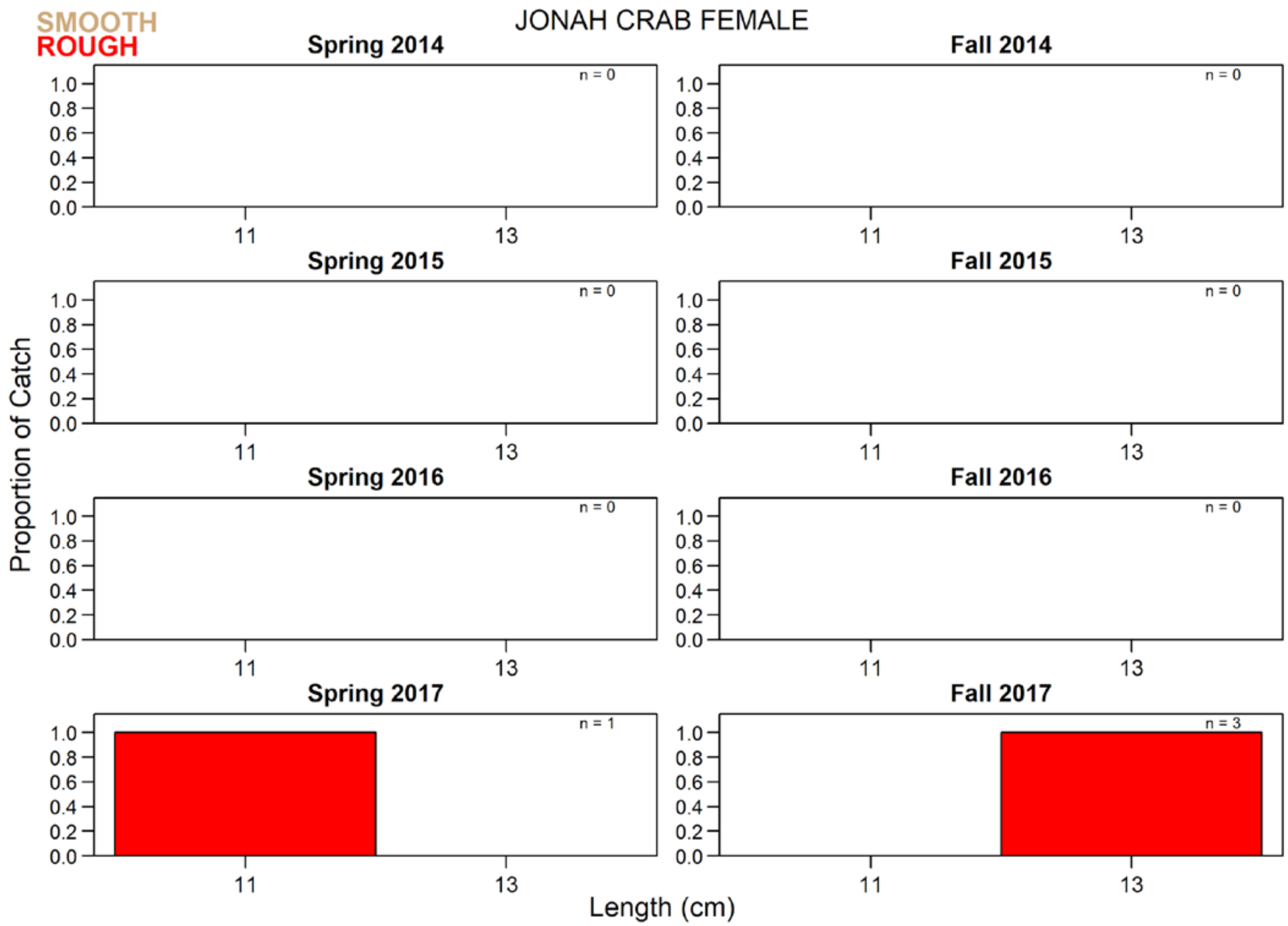
Appendix C. Figure 15. Length frequency of unsexed blue shark, *Prionace glauca*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches. Lengths are estimates as sharks were released alive at the side of the vessel.



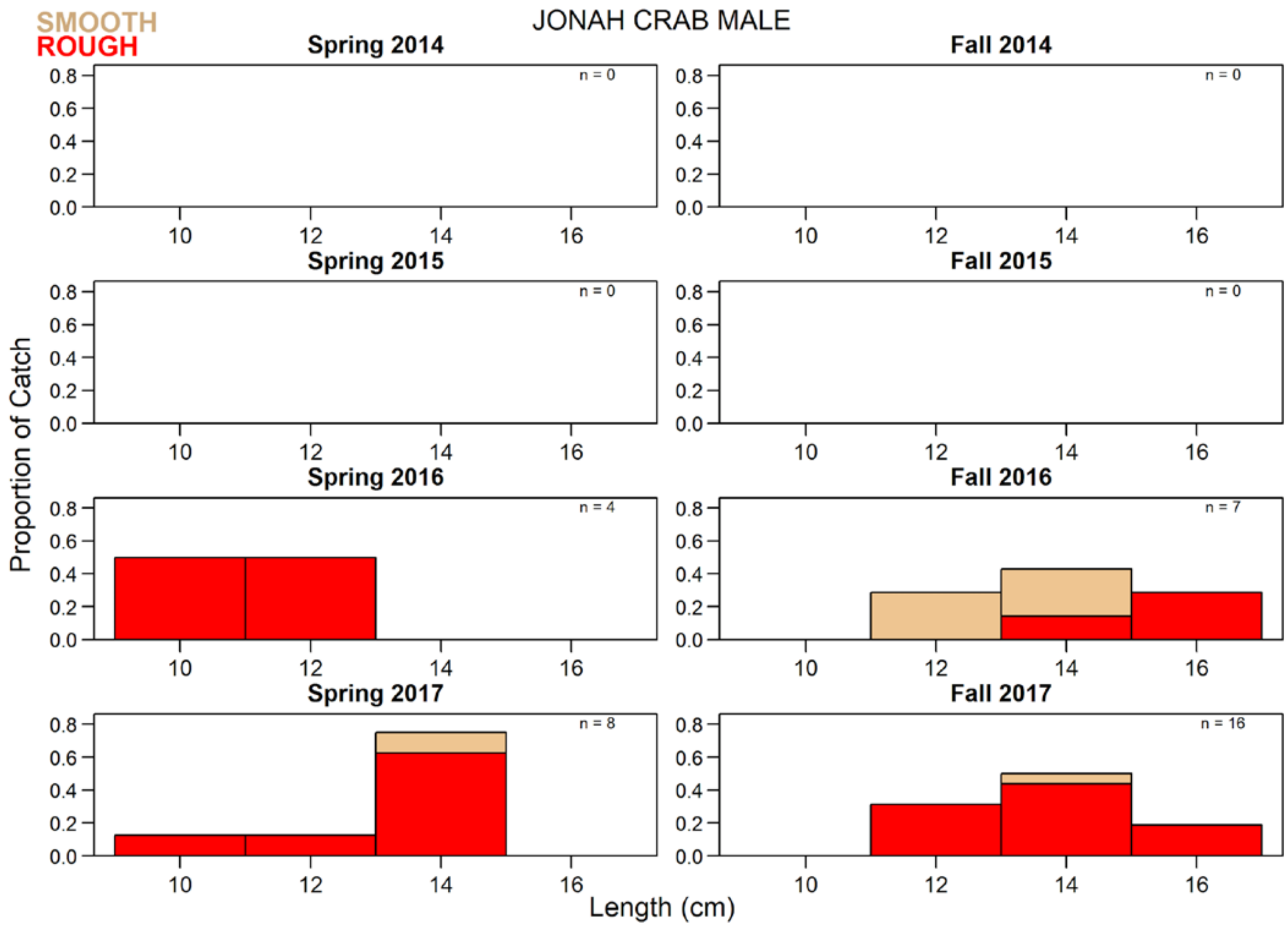
Appendix C. Figure 16. Length frequency of cusk, *Brosme brosme*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



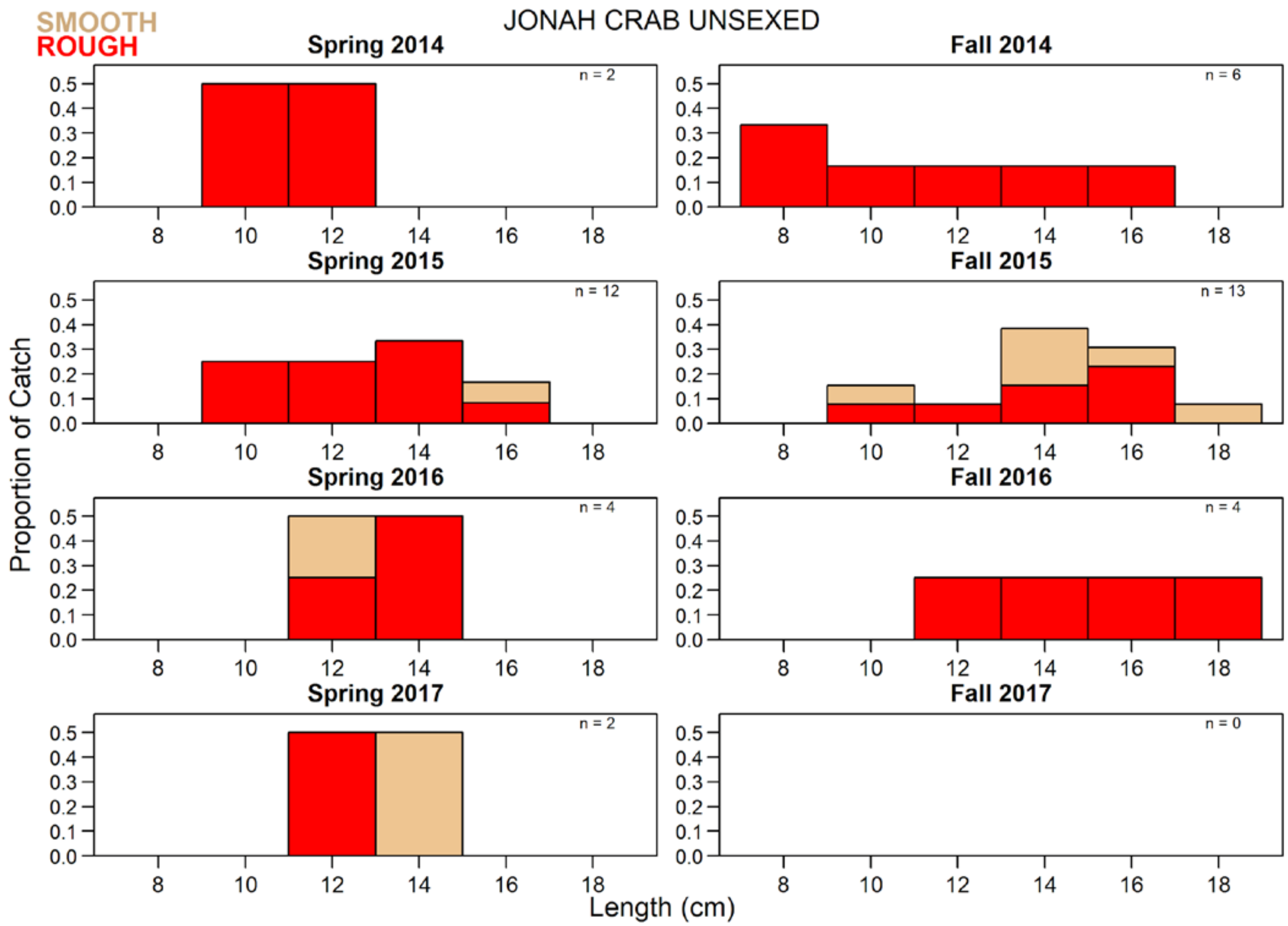
Appendix C. Figure 17. Length frequency of haddock, *Melanogrammus aeglefinus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches; lengths of damaged fish estimated by using back-calculation from the otolith size.



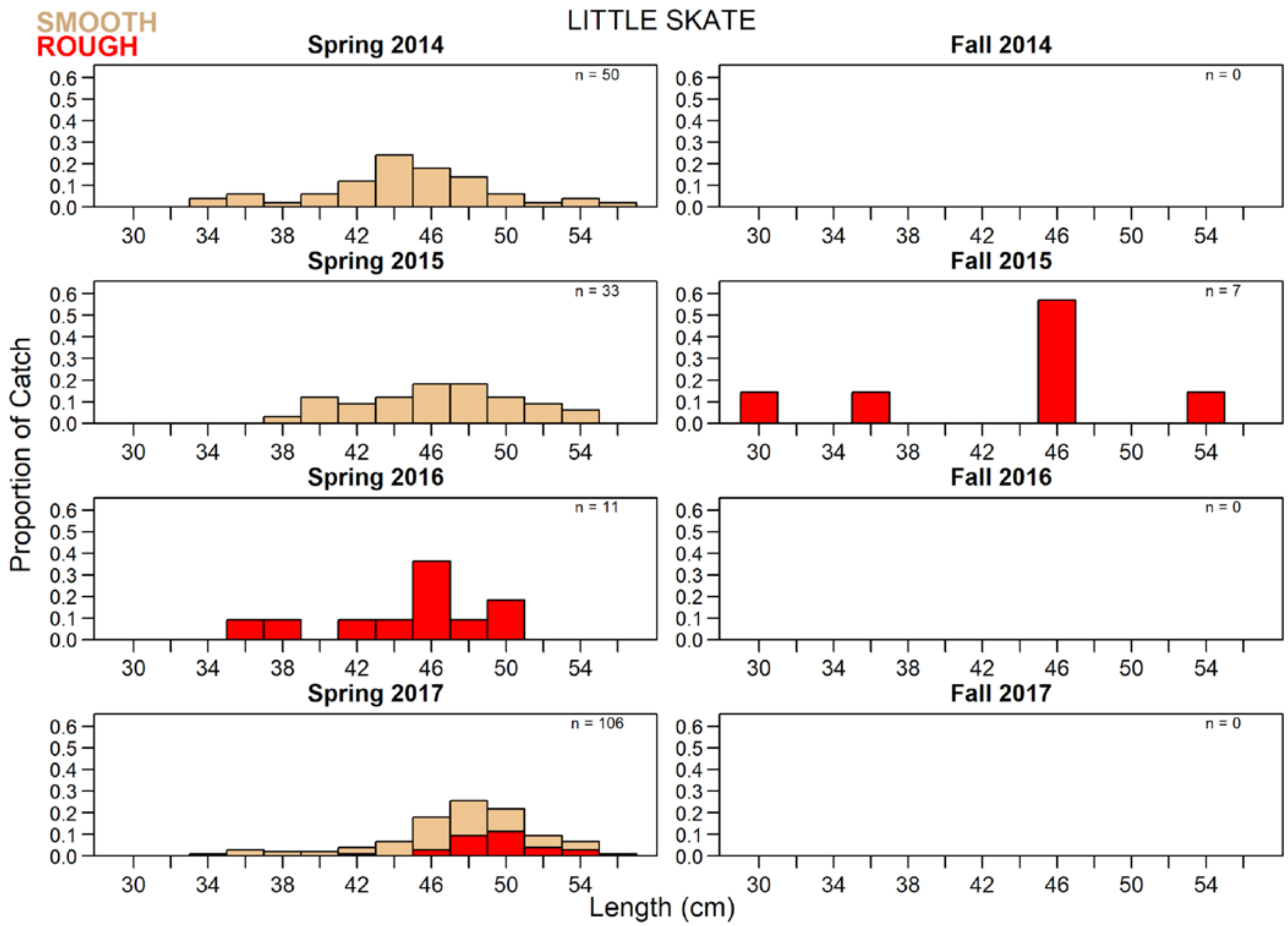
Appendix C. Figure 18. Length frequency of female Jonah crab, *Cancer borealis*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



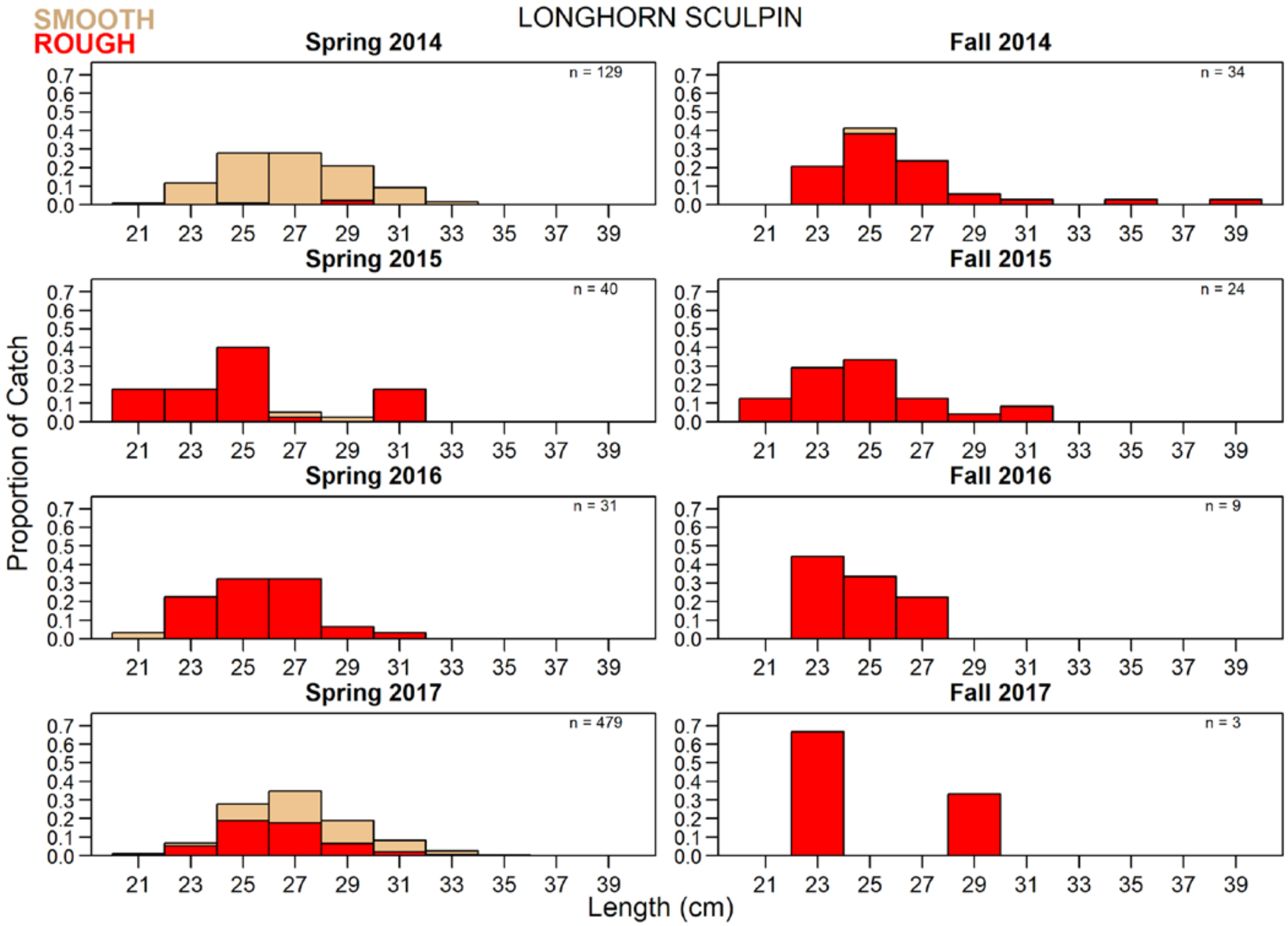
Appendix C. Figure 19. Length frequency of male Jonah crab, *Cancer borealis*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



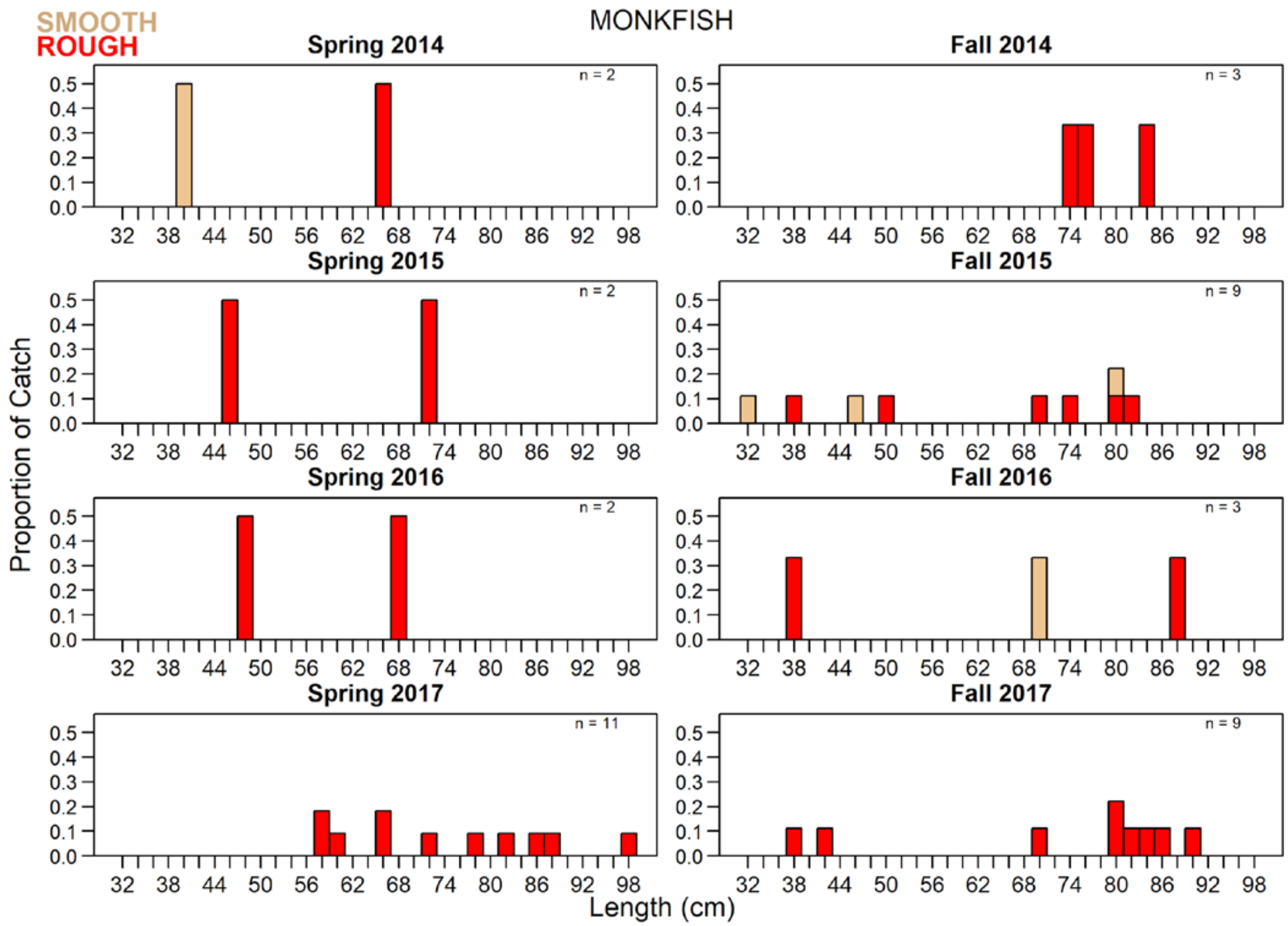
Appendix C. Figure 20. Length frequency of unsexed Jonah crab, *Cancer borealis*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



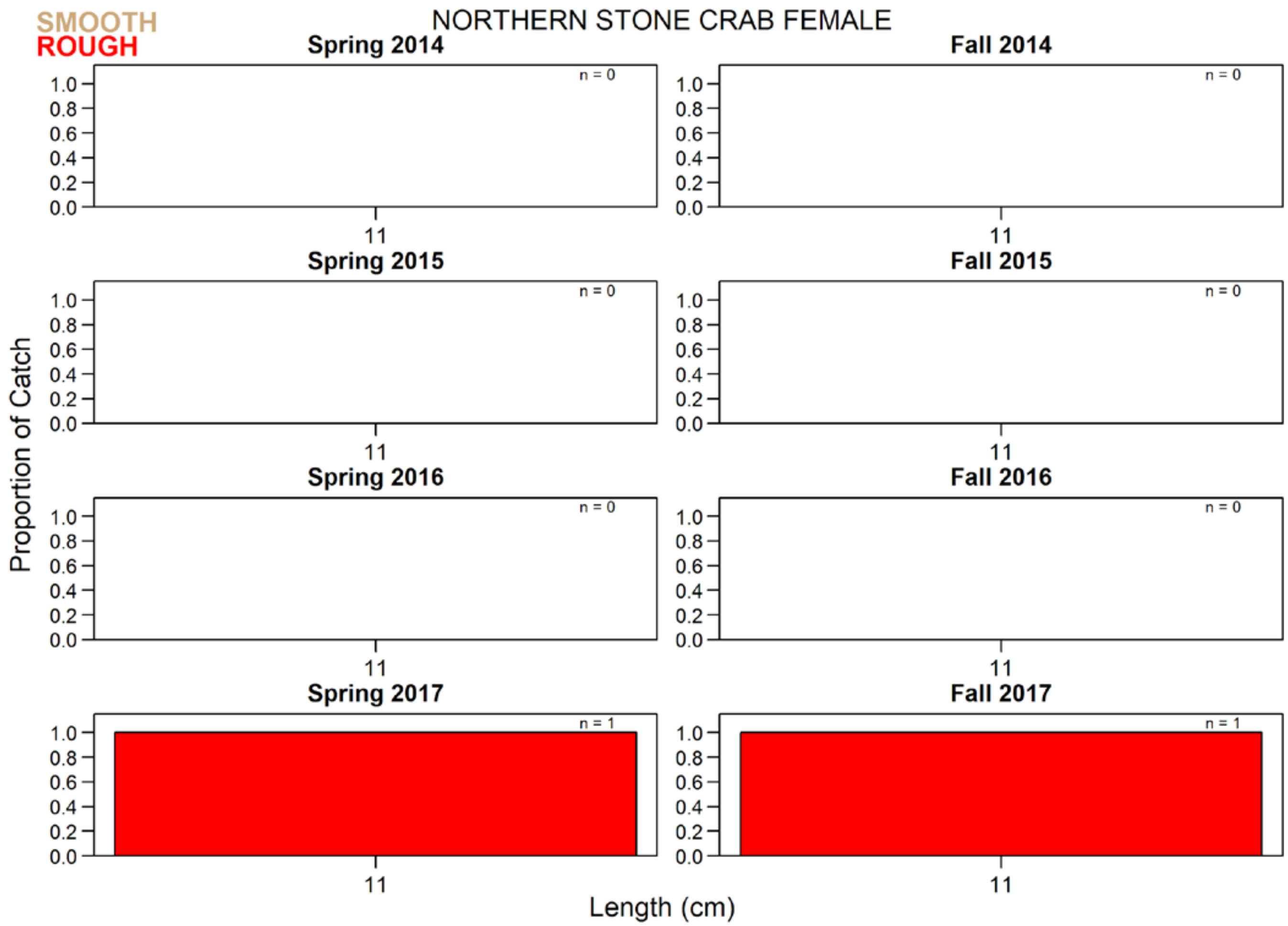
Appendix C. Figure 21. Length frequency of little skate, *Leucoraja erinacea*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



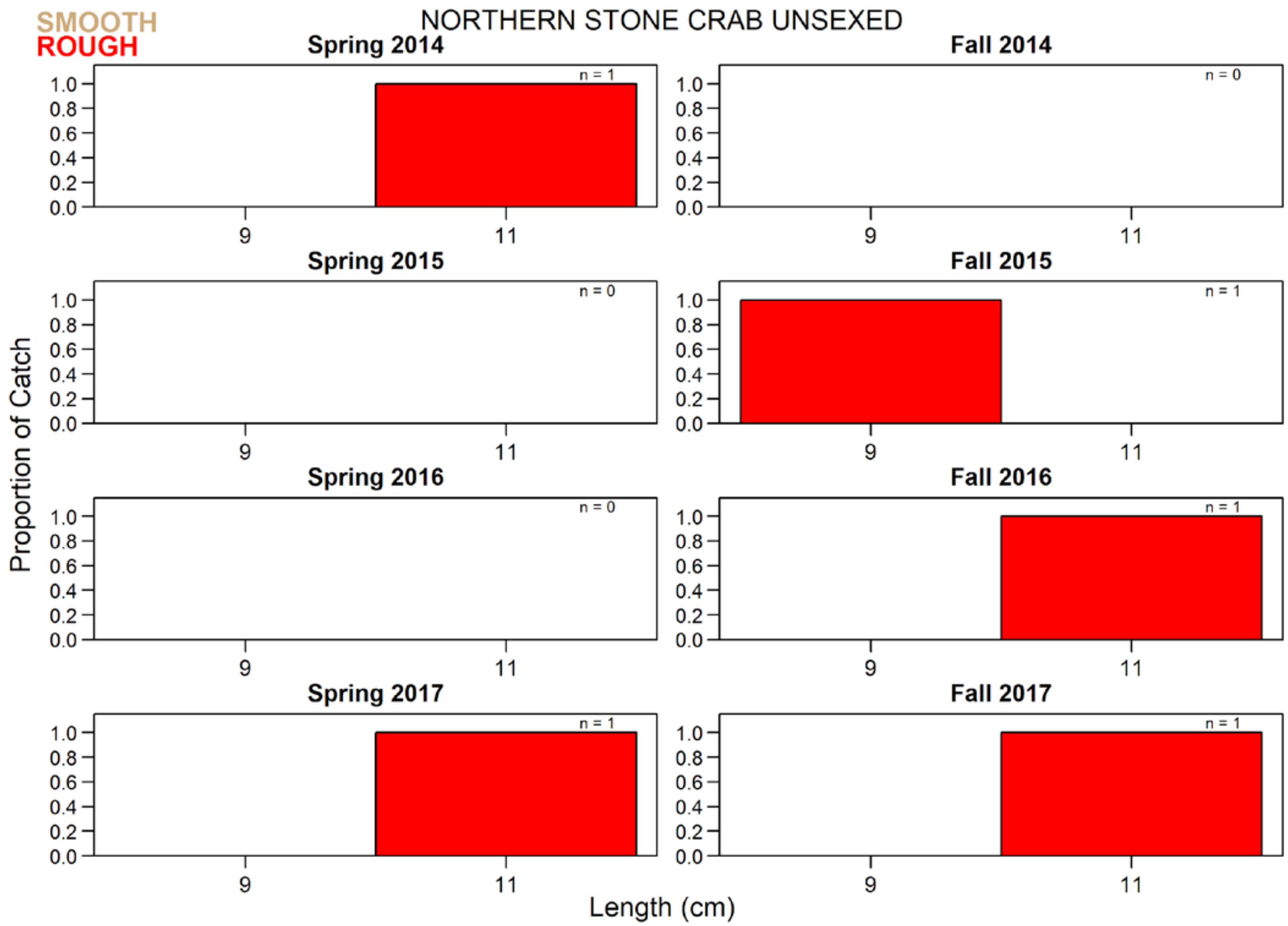
Appendix C. Figure 22. Length frequency of longhorn sculpin, *Myoxocephalus octodecemspinosus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



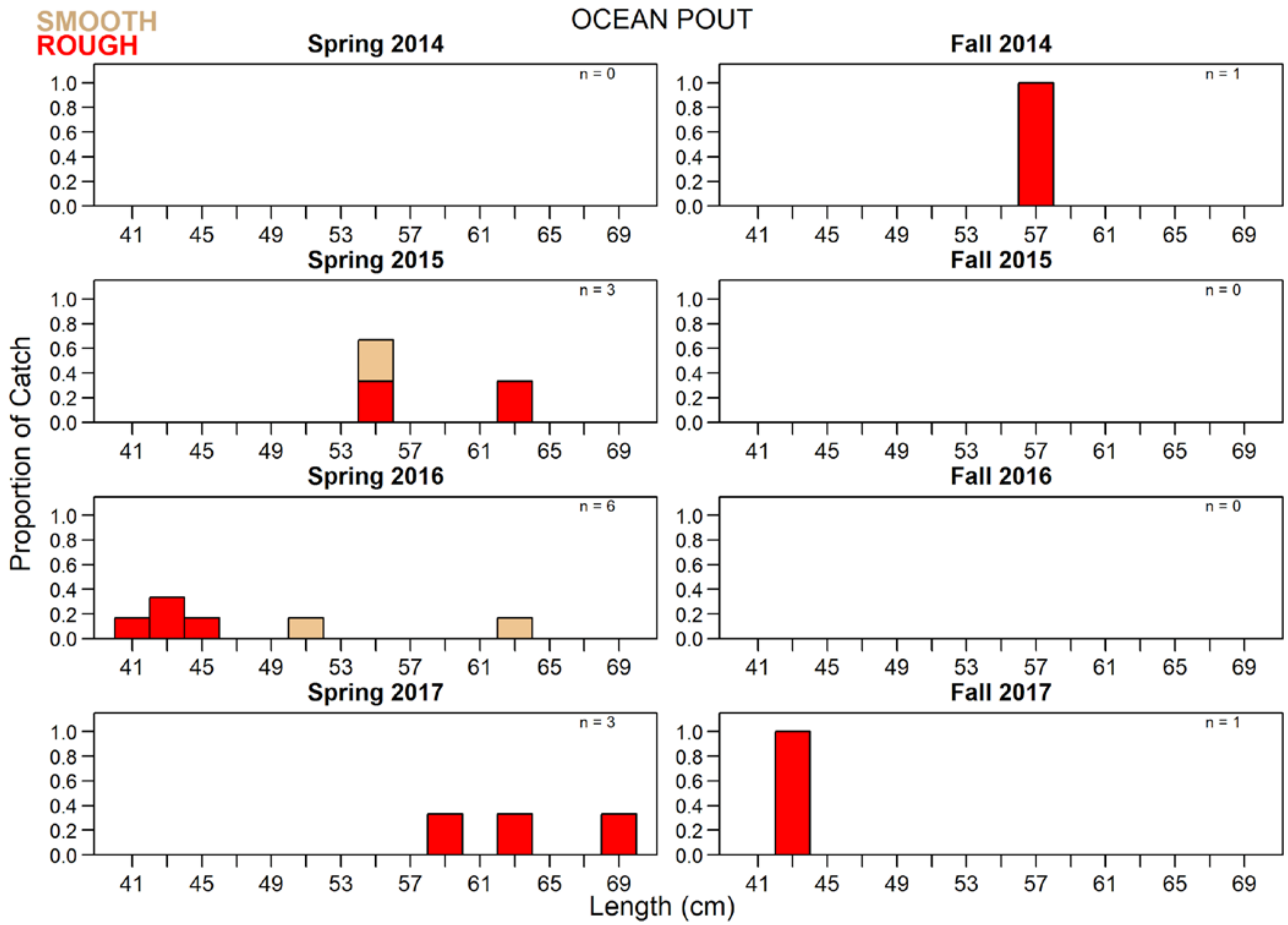
Appendix C. Figure 23. Length frequency of monkfish, *Lophius americanus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



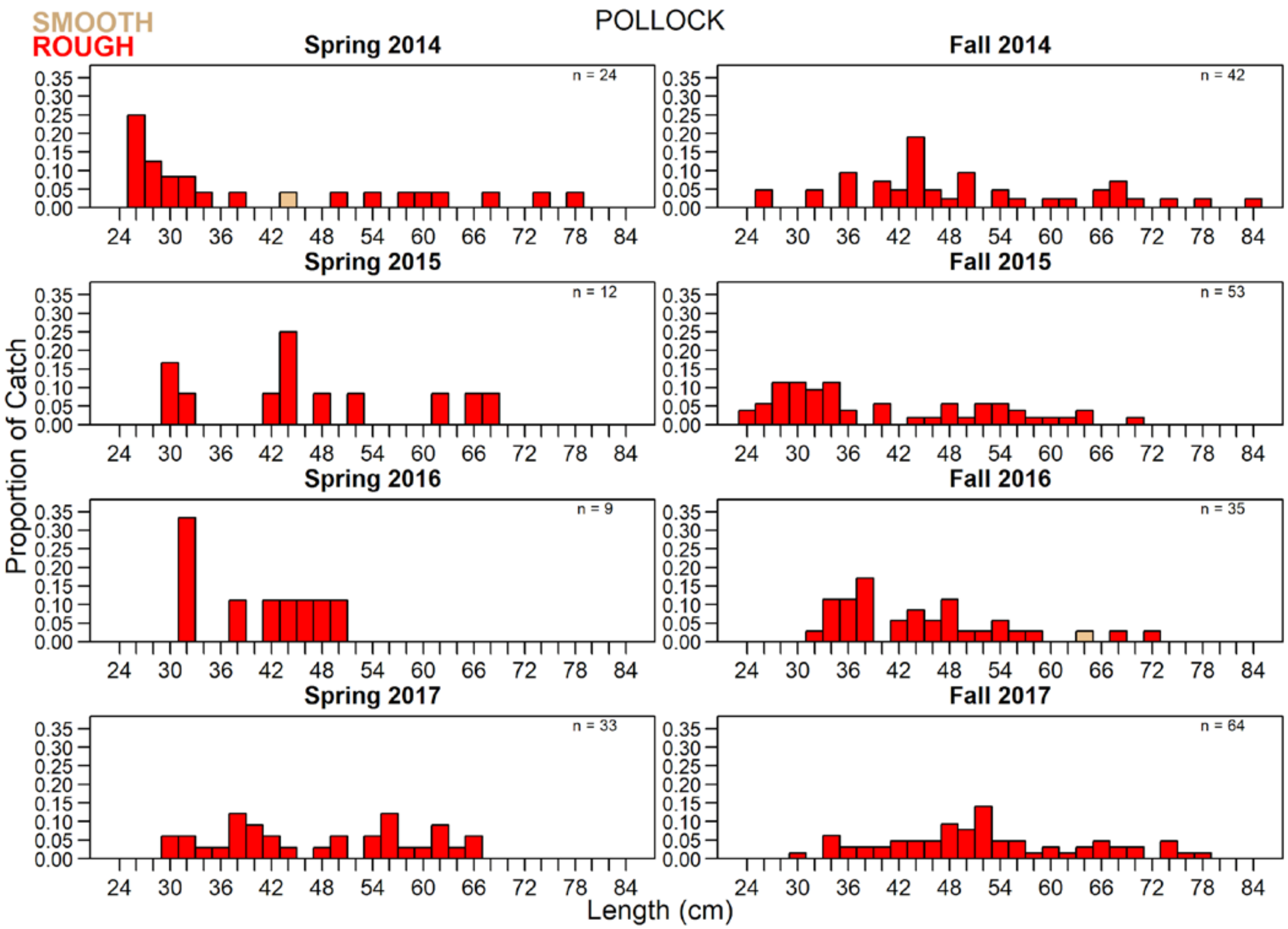
Appendix C. Figure 24. Length frequency of female northern stone crab, *Lithodes maja*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



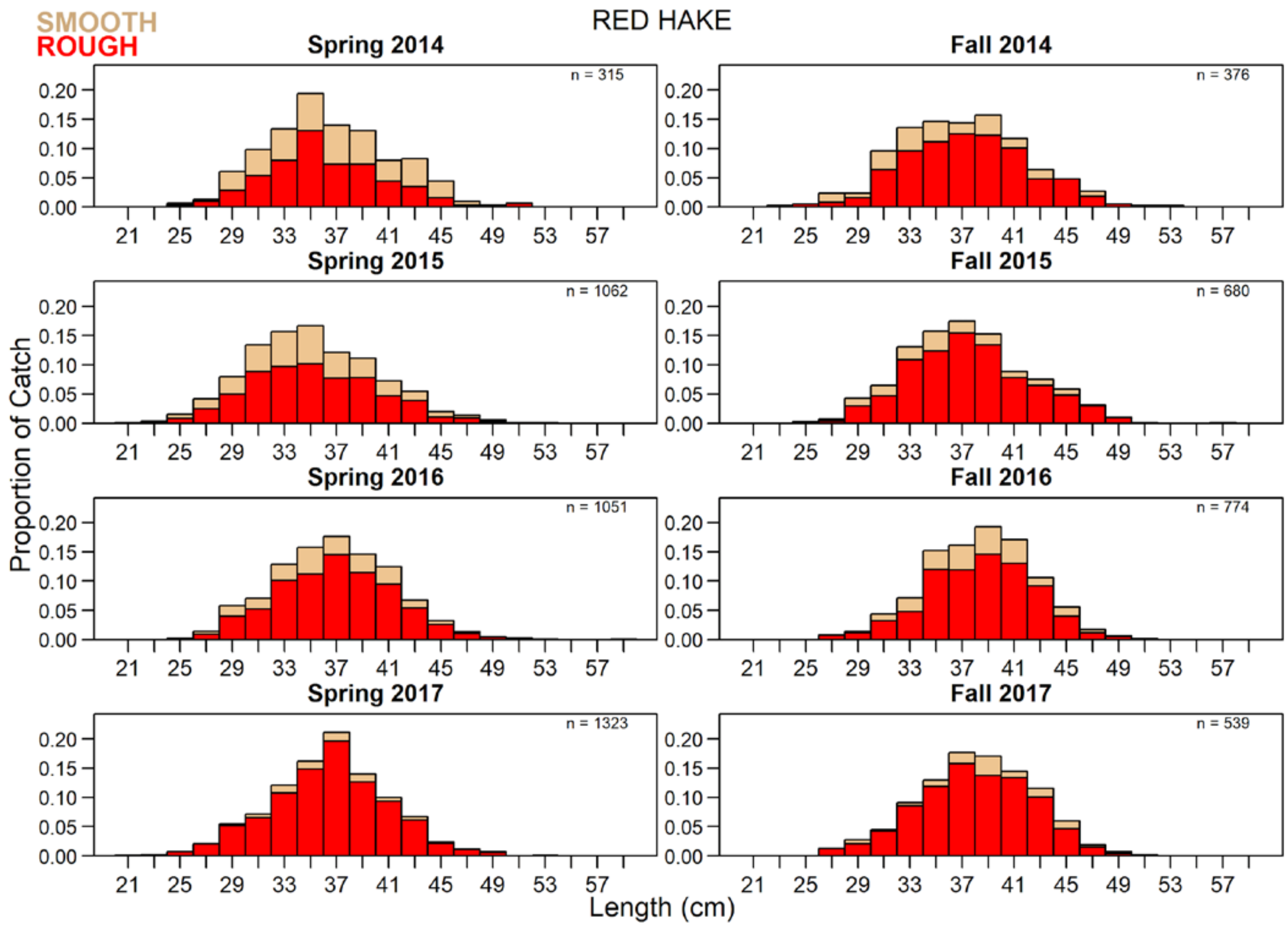
Appendix C. Figure 25. Length frequency of unsexed northern stone crab, *Lithodes maja*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



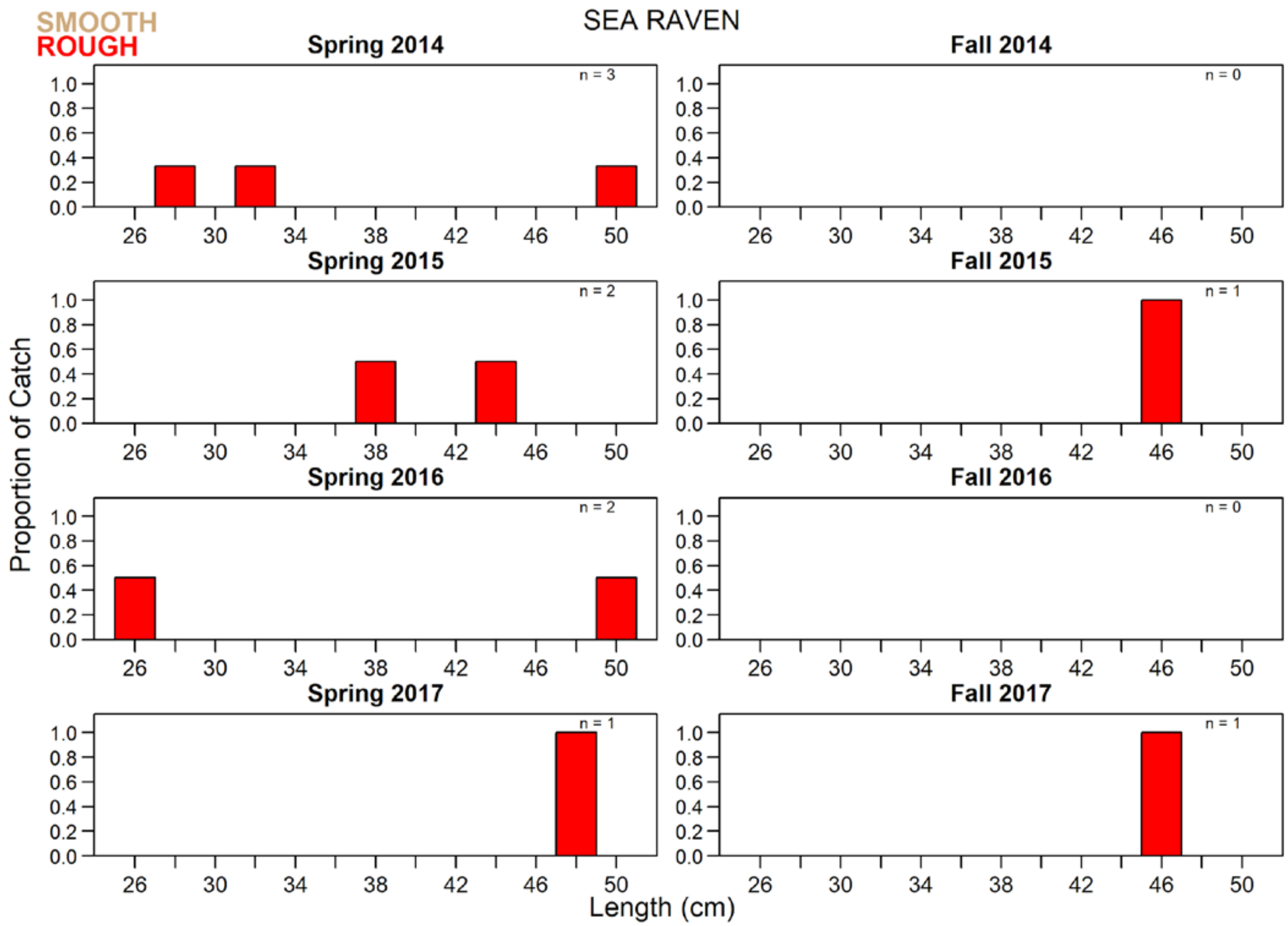
Appendix C. Figure 26. Length frequency of ocean pout, *Zoarces americanus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



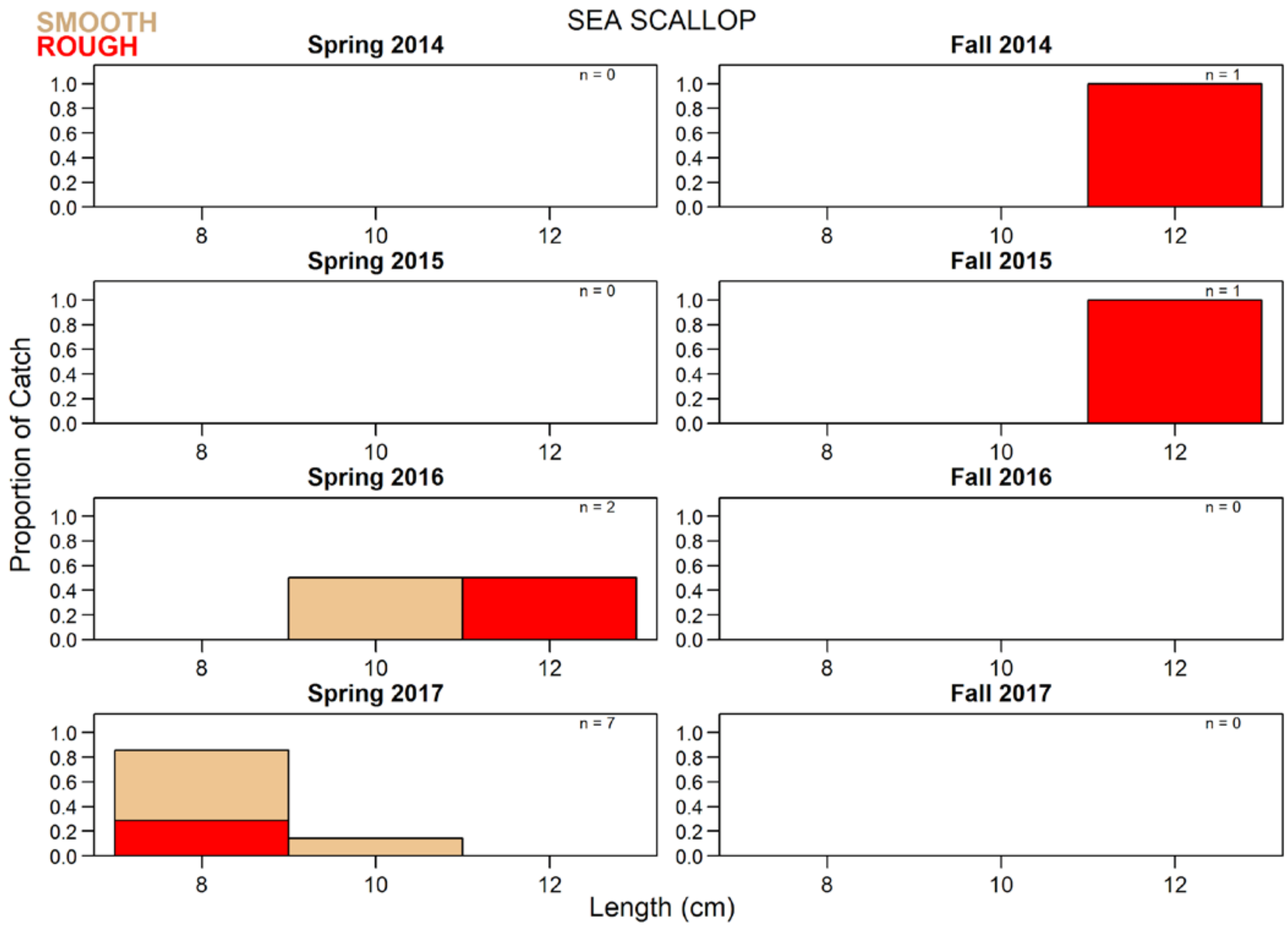
Appendix C. Figure 27. Length frequency of pollock, *Pollachius virens*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



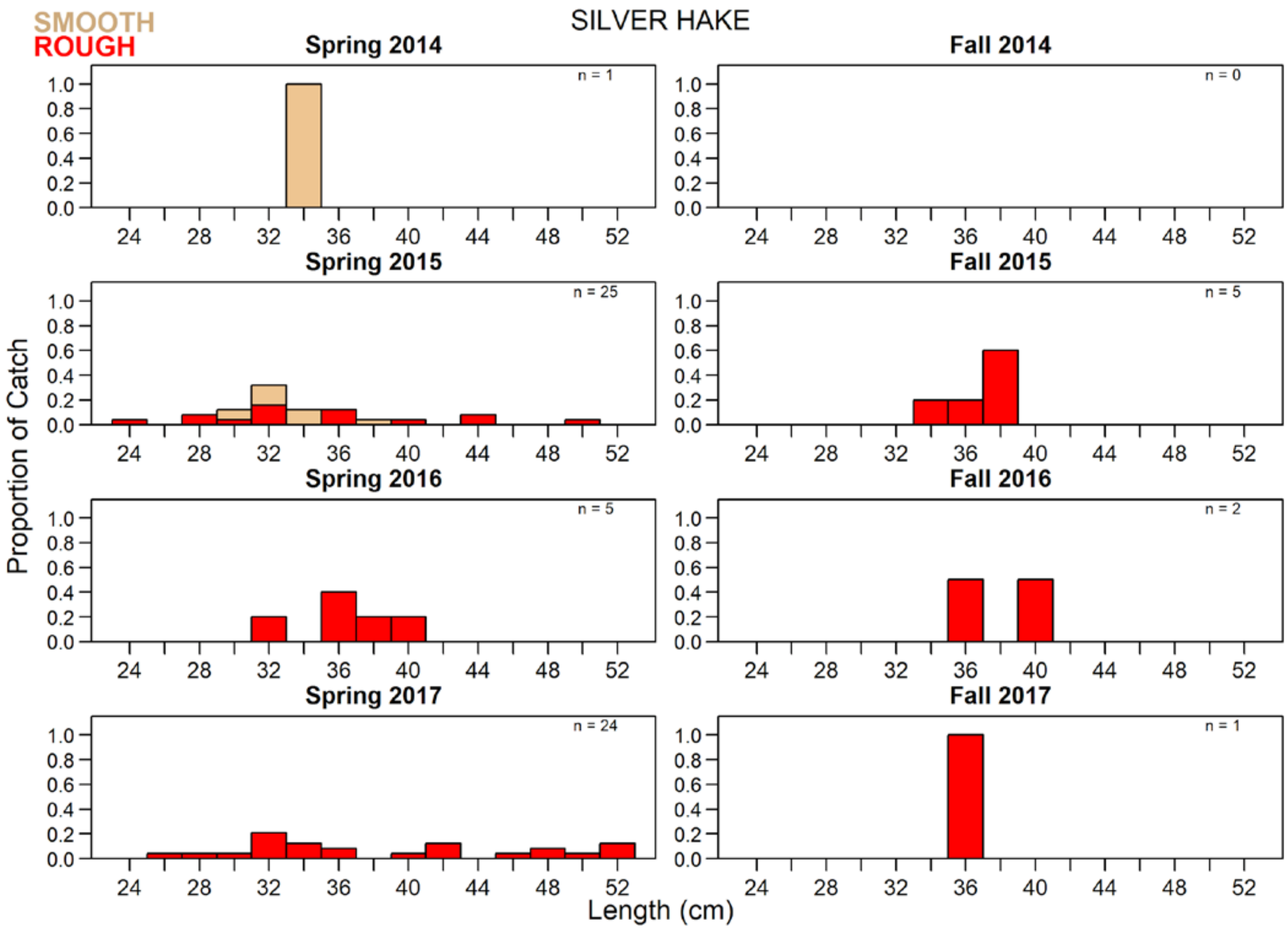
Appendix C. Figure 28. Length frequency of red hake, *Urophycis chuss*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches; lengths of damaged fish estimated by using back-calculation from the otolith size.



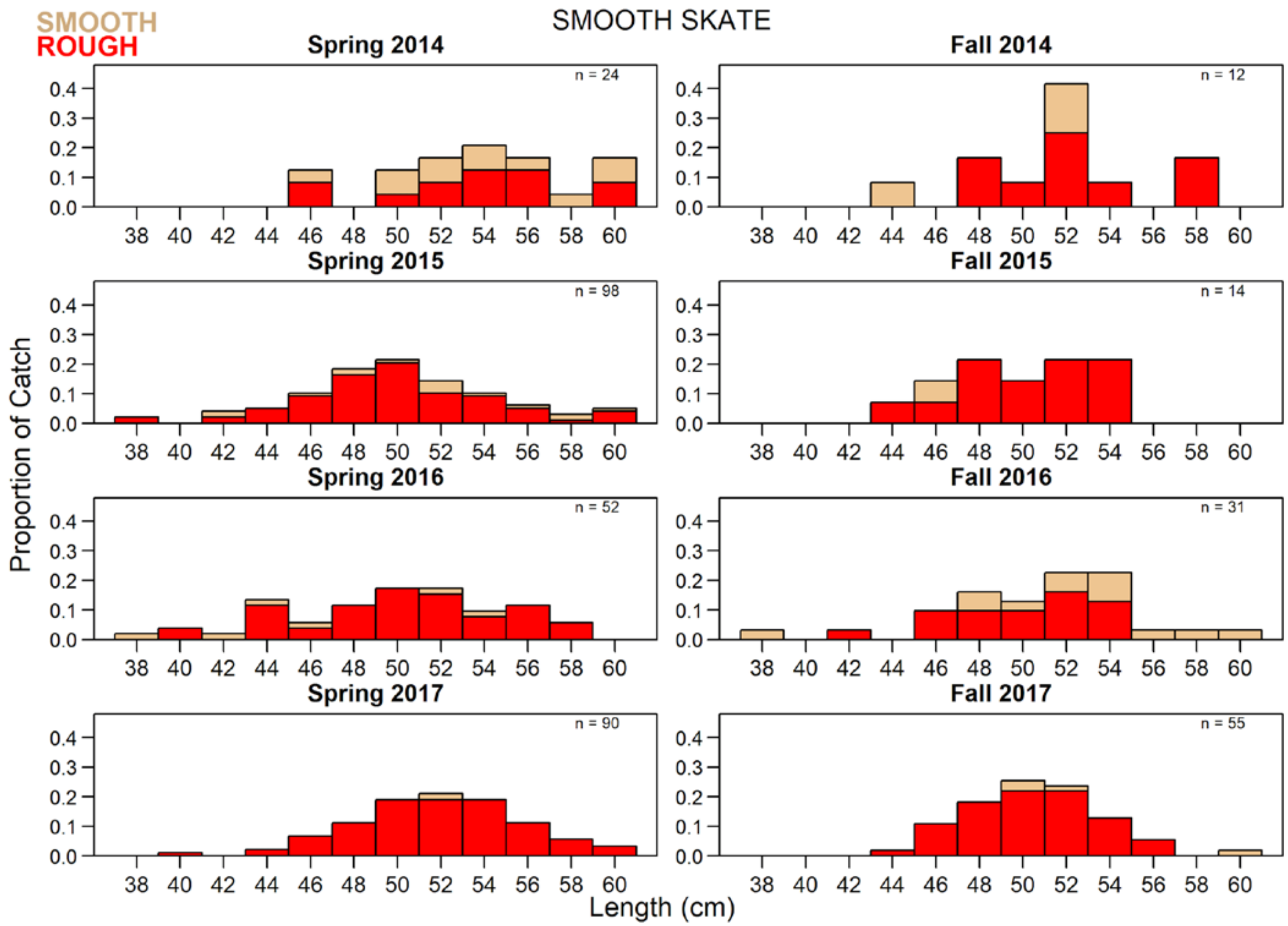
Appendix C. Figure 29. Length frequency of sea raven, *Hemitripterus americanus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches; lengths of damaged fish estimated by using back-calculation from the otolith size.



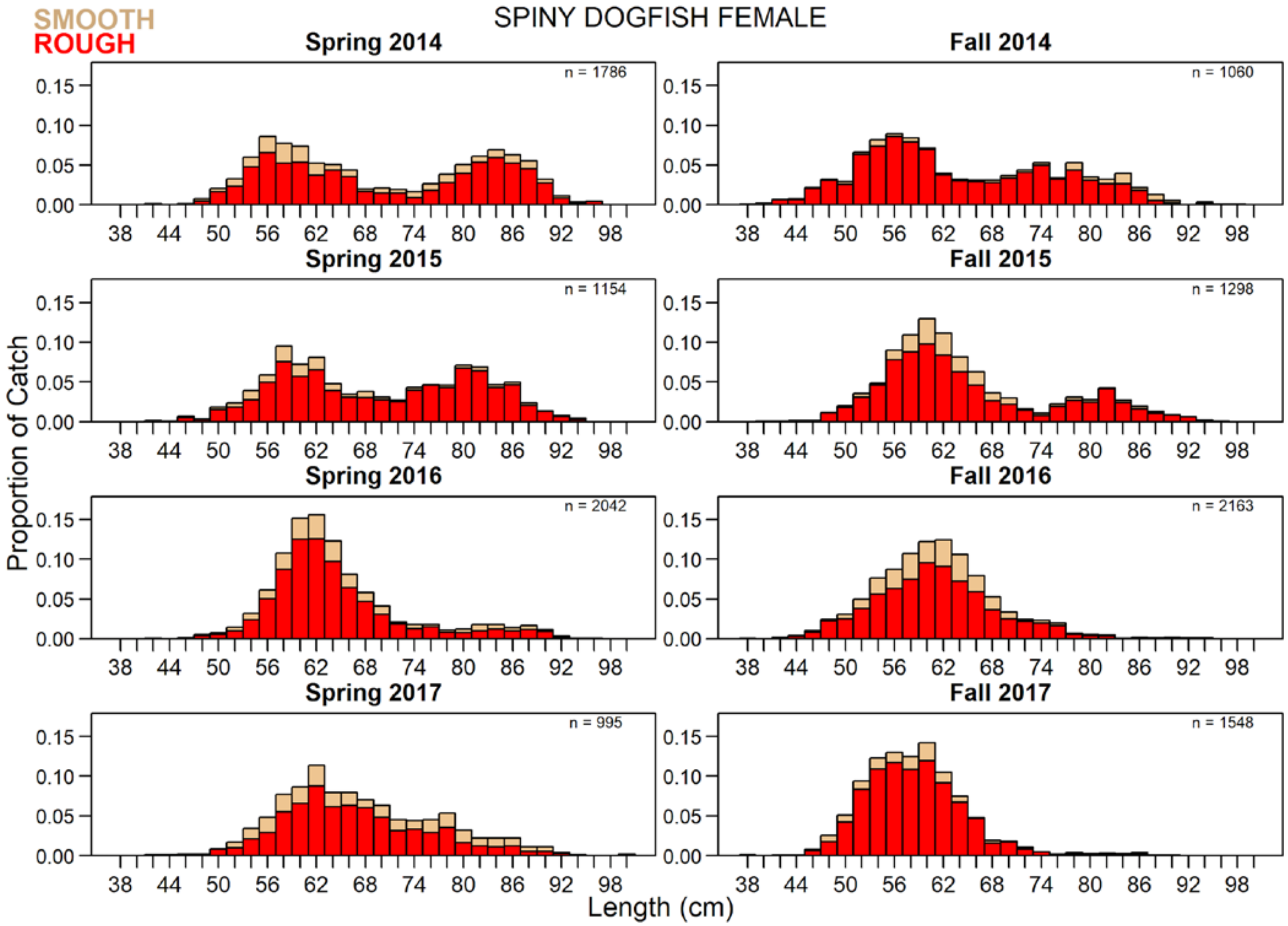
Appendix C. Figure 30. Length frequency of sea scallop, *Placopecten magellanicus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches; lengths of damaged fish estimated by using back-calculation from the otolith size.



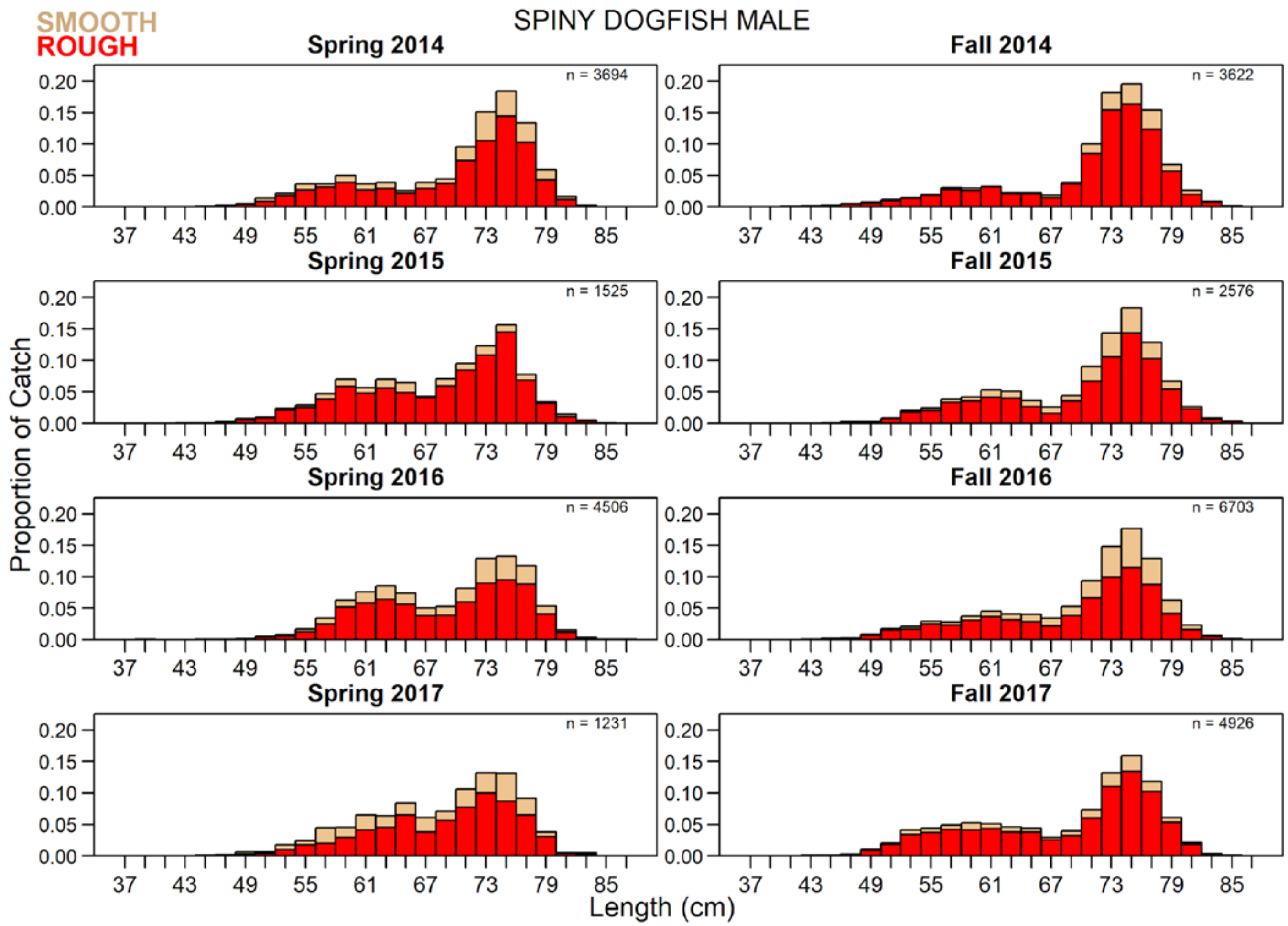
Appendix C. Figure 31. Length frequency of silver hake, *Merluccius bilinearis*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



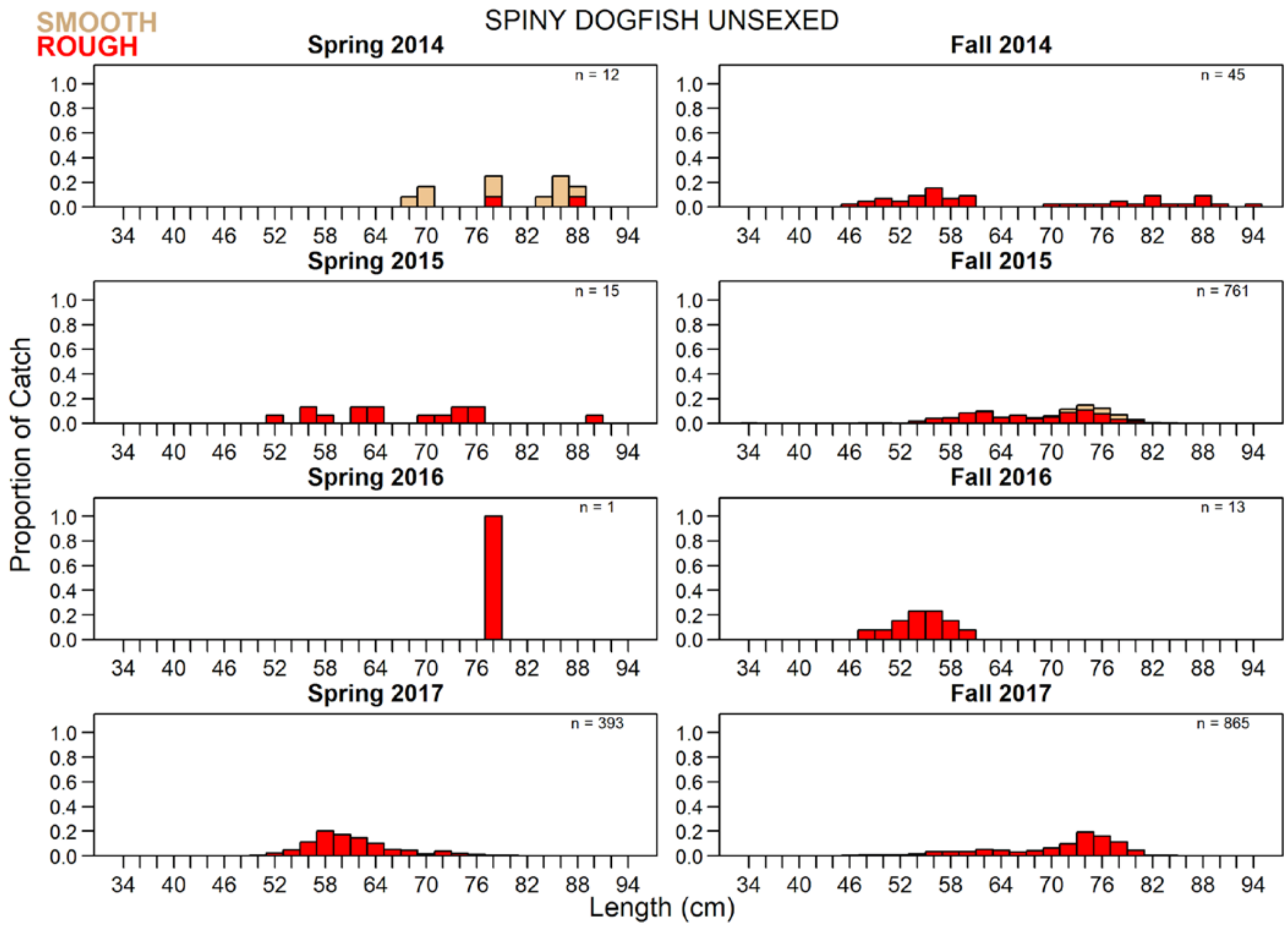
Appendix C. Figure 32. Length frequency of smooth skate, *Malacoraja senta*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



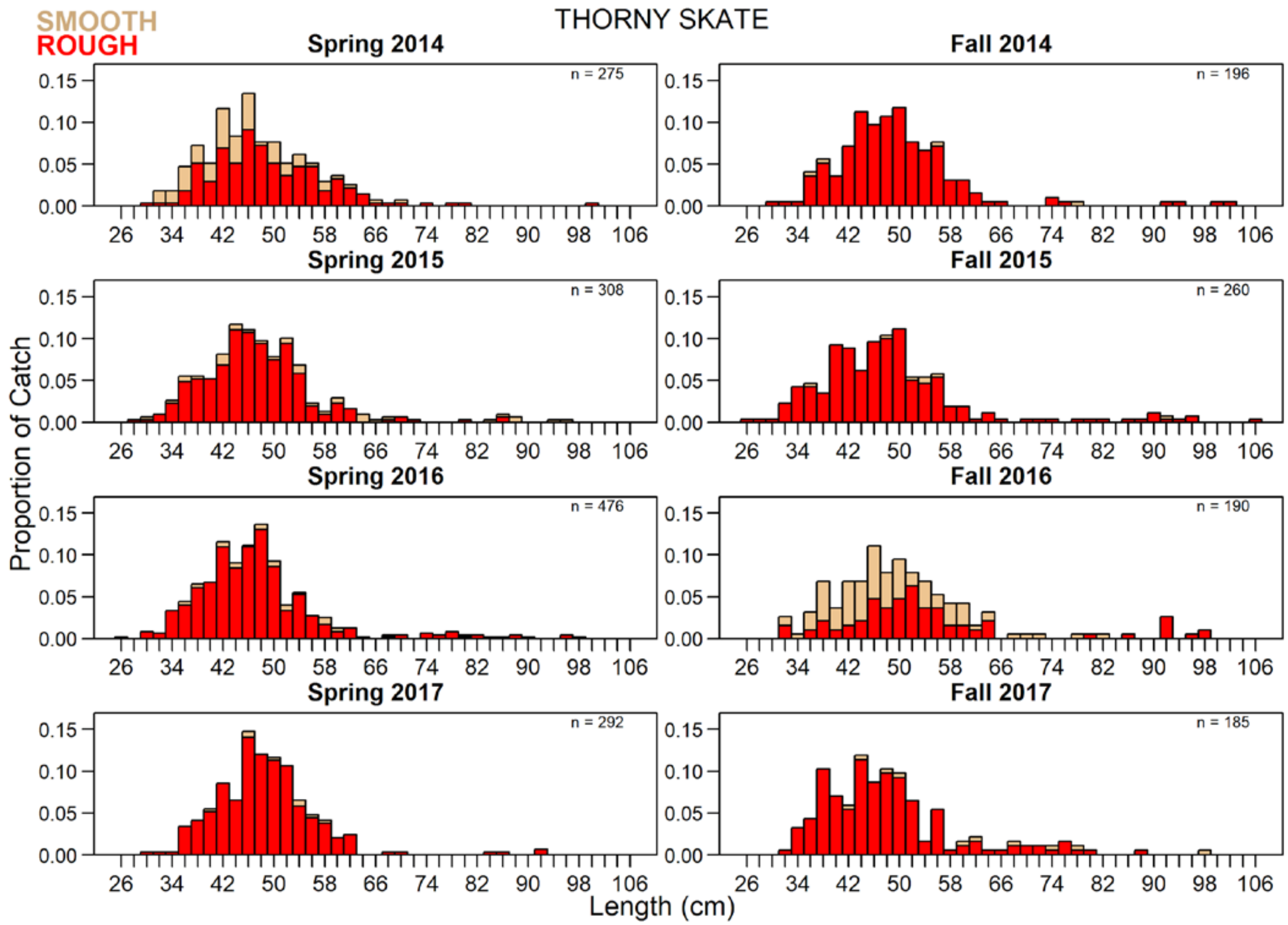
Appendix C. Figure 33. Length frequency of female spiny dogfish, *Squalus acanthias*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches. Dogfish with unknown sex excluded.



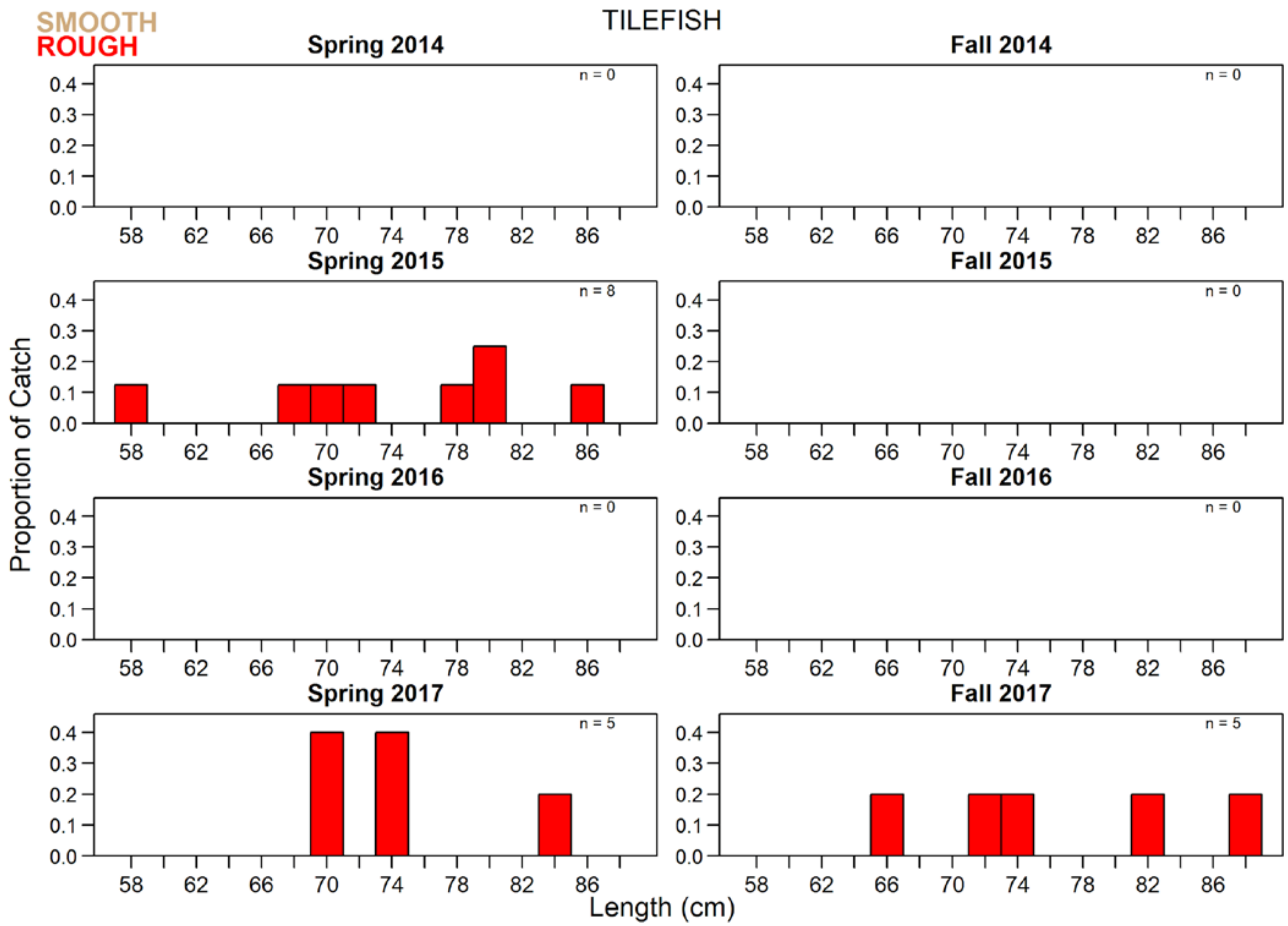
Appendix C. Figure 34. Length frequency of male spiny dogfish, *Squalus acanthias*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches. Dogfish with unknown sex excluded.



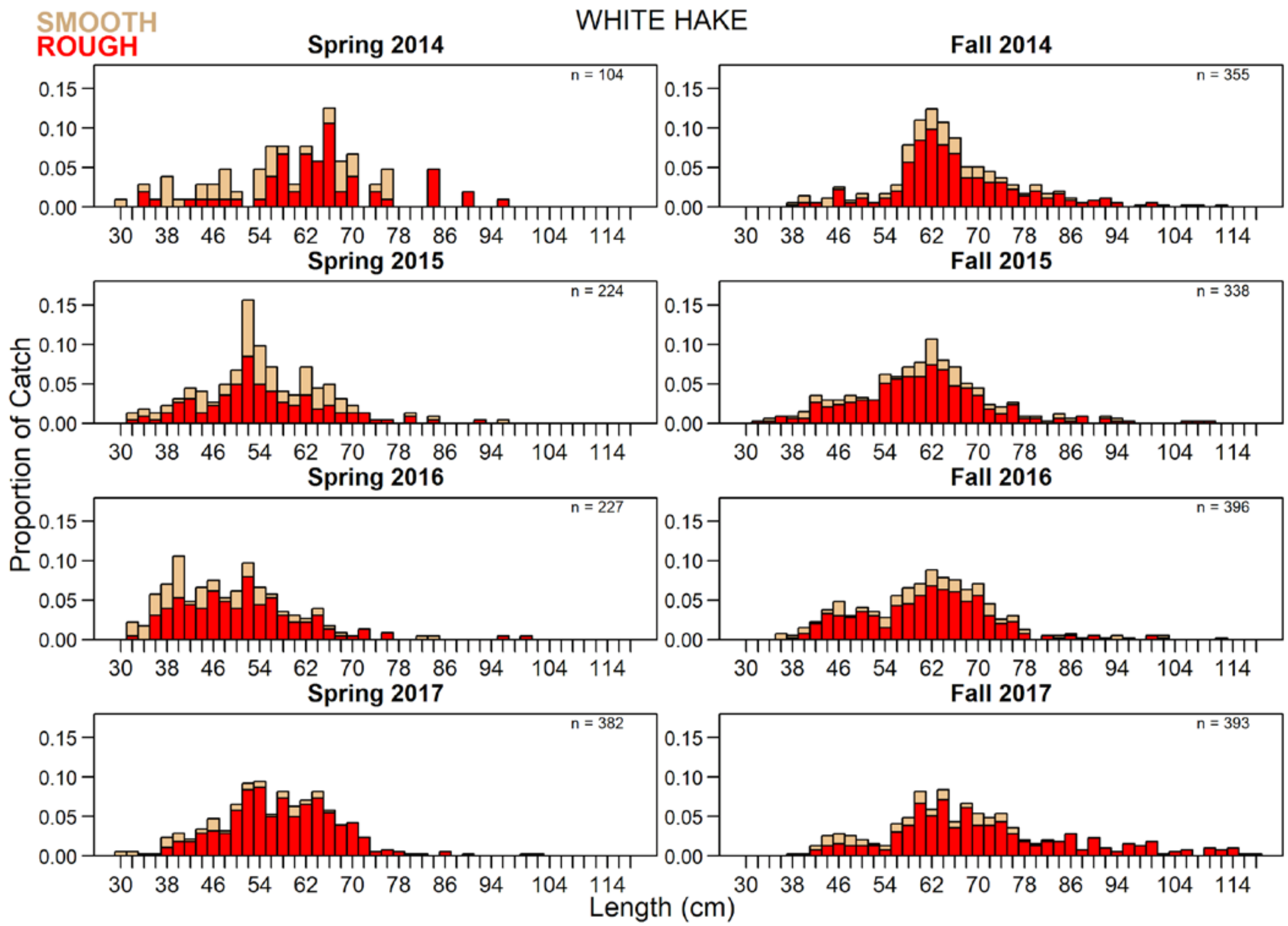
Appendix C. Figure 35. Length frequency of unsexed spiny dogfish, *Squalus acanthias*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches. Dogfish with unknown sex excluded.



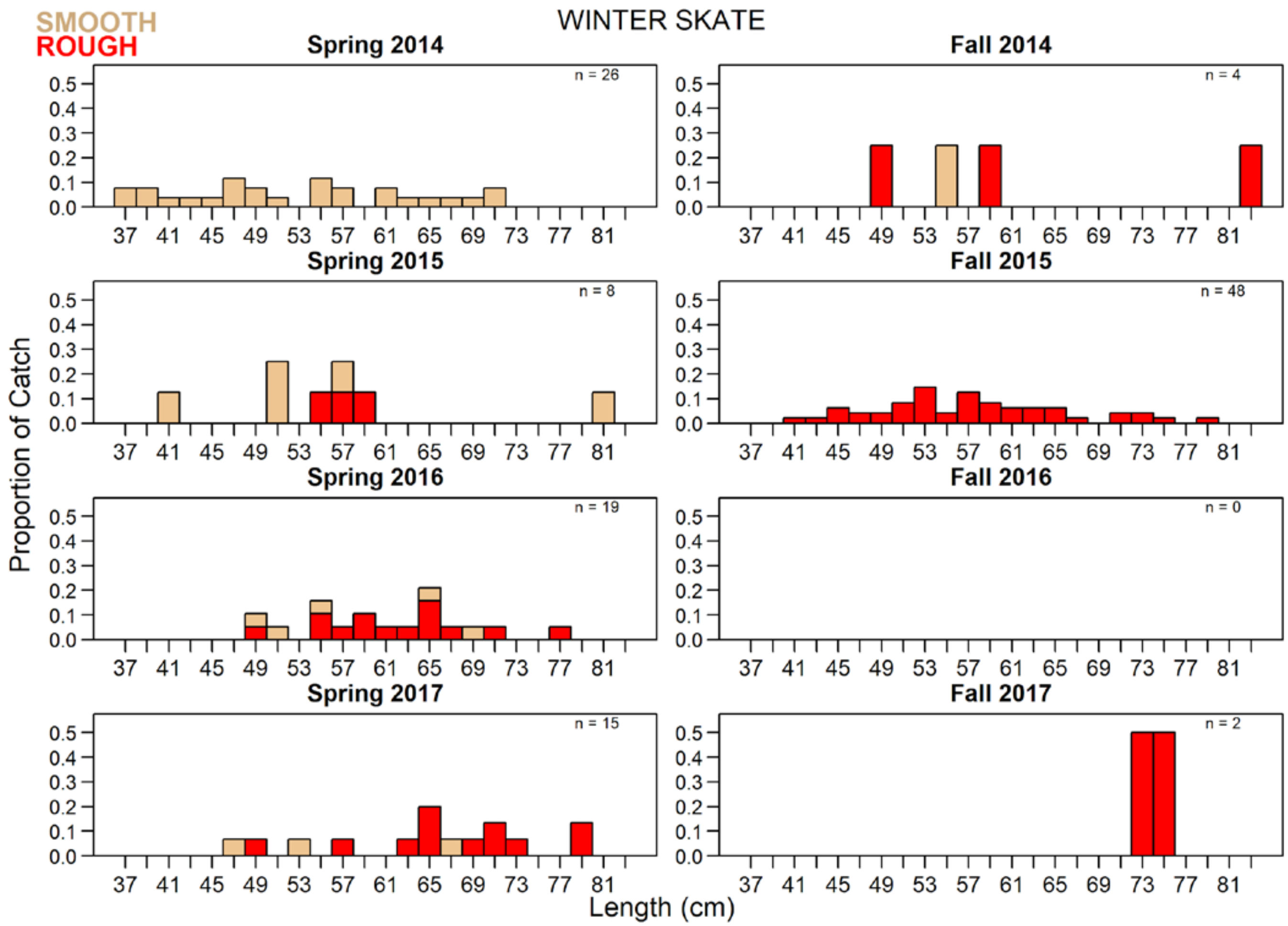
Appendix C. Figure 36. Length frequency of thorny skate, *Amblyraja radiata*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



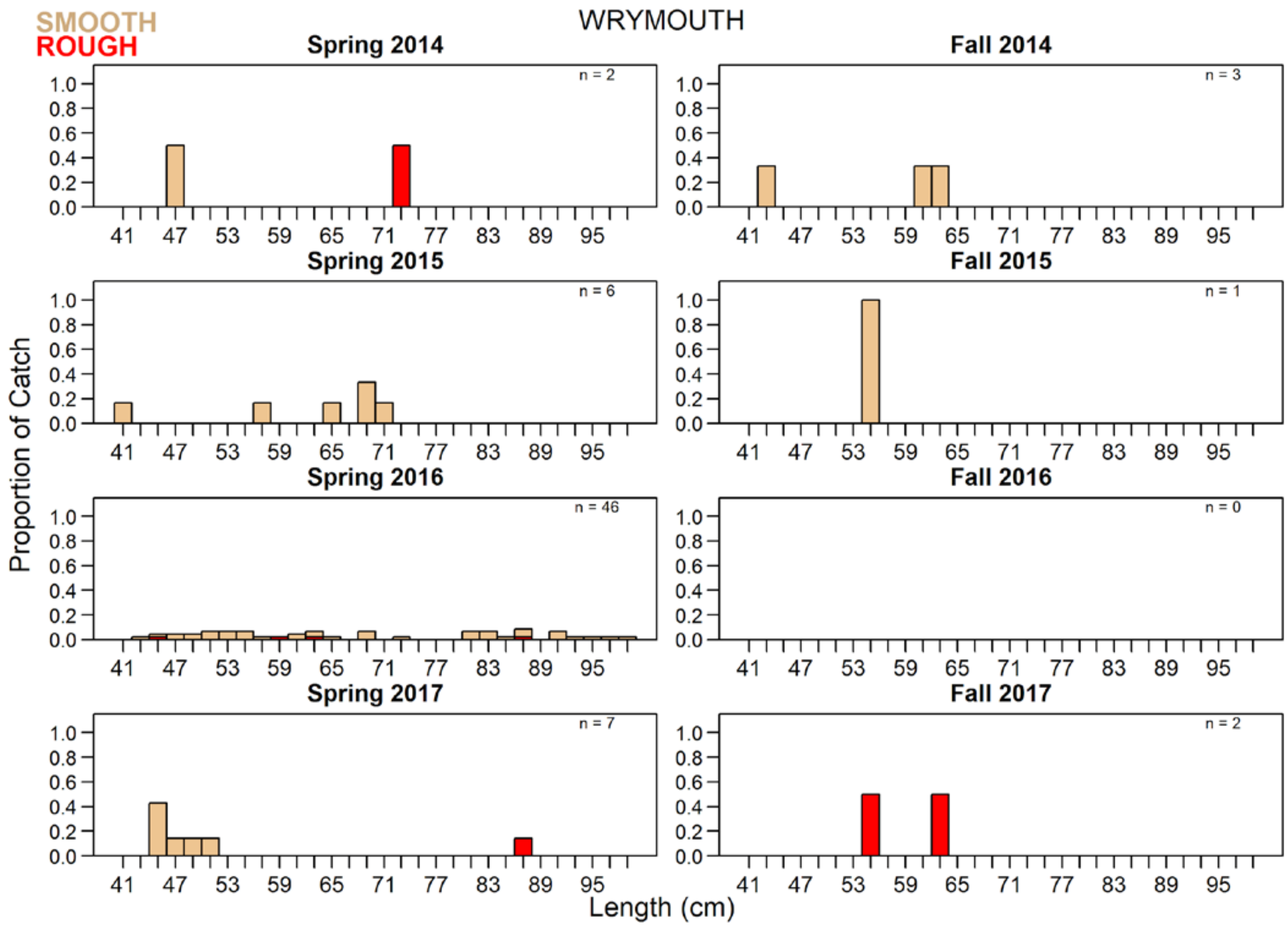
Appendix C. Figure 37. Length frequency of tilefish, *Lopholatilus chamaeleonticeps*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



Appendix C. Figure 38. Length frequency of white hake, *Urophycis tenuis*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



Appendix C. Figure 39. Length frequency of winter skate, *Leucoraja ocellata*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.



Appendix C. Figure 40. Length frequency of wrymouth, *Cryptacanthodes maculatus*, (in 2 cm bins) as a proportion of the catch in the bottom longline survey for each season, year, and bottom type (rough or smooth). Sample size (n) includes frequencies expanded for subsampled catches.

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