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UPDATE OF THE 2011 SUMMER SCOTIAN SHELF AND BAY OF FUNDY RESEARCH VESSEL SURVEY

by

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ABSTRACT

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DFO has conducted summer research vessel surveys in the Maritimes Region, Northwest Atlantic Fisheries Organization Divisions 4VWX and a small portion of 5Y, using a standardized protocol since 1970. Results of these surveys provide information on trends in abundance for most groundfish and other fish and invertebrate species on the Scotian Shelf and in the Bay of Fundy. While these data reflect trends in biomass and abundance and are a critical part of science-based stock assessments, a full assessment, including other sources of data, would be required to evaluate the impacts of management measures on population status. Data are presented for the major commercial species, for species that comprise a large part of the survey catch, and for species where the 2011 catch was either unusually high or low. In 2011, five additional survey tows were completed in deeper water off the shelf edge (750 – 1,800 m), and a total of twelve valid sets were also completed in strata 5Z1 and 5Z9 on the northern edge of Georges Bank. Catches from these additional tows are not included in the biomass index estimates, to ensure that comparability with other years is maintained. The 2011 summer RV survey successfully fulfilled objectives for most survey strata and recorded the highest number of sets completed since the beginning of the series.

RÉSUMÉ

Emberley, J. and Clark, D.S. 2011. Update of the 2011 summer Scotian Shelf and Bay of Fundy research vessel survey. Can. Data Rep. Fish. Aquat. Sci. 1240.

Le MPO effectue des relevés par navire scientifique selon un protocole normalisé dans la région des Maritimes. Des relevés sont faits dans les divisions 4VWX et une petite partie de la division 5Y de l’Organisation des pêches de l’Atlantique Nord-Ouest depuis 1970. Les résultats obtenus nous renseignent sur les tendances de l’abondance de la plupart des espèces de poissons de fond, d'autres poissons et d'invertébrés sur le plateau néo-écossais et dans la baie de Fundy. Si les résultats de ces relevés reflètent les tendances de la biomasse et de l’abondance et constituent un élément essentiel des évaluations scientifiques des stocks, une évaluation intégrale qui fait appel à d’autres sources de données est toutefois nécessaire pour évaluer les effets des mesures de gestion sur l’état des populations marines. Les données concernent la plupart des espèces commerciales, pour les espèces qui représentent une grande partie des prises effectuées dans le cadre du relevé, et pour les espèces pour lesquelles les prises de 2011 étaient inhabituellement élevées ou basses. En 2011, cinq traits de relevé supplémentaires ont été effectués dans les eaux plus profondes au large du bord du plateau (750 à 1 800 m), et au total, douze traits valides ont été également réussis dans les strates 5Z1 et 5Z9 sur la bordure nord du banc de Georges. Les prises issues de ces traits supplémentaires ne sont pas incluses dans les estimations de l'indice de la biomasse pour pouvoir continuer à les comparer à celles des autres années. Le relevé d'été par navire de recherche en 2011 a atteint les objectifs fixés pour la plupart des strates de relevé et a enregistré le plus grand nombre de traits réussis depuis le début de la série.

INTRODUCTION

The DFO summer Scotian Shelf and Bay of Fundy research vessel (RV) survey, hereafter referred to as the summer RV survey, has been conducted annually in Northwest Atlantic Fisheries Organization (NAFO) Divisions 4VWX5Y since 1970. The summer RV survey follows a stratified random sampling design (Halliday and Kohler 1971), and includes both hydrographic sampling and sampling of fish and invertebrates using a bottom otter trawl. These survey data are the primary data source for monitoring trends in species distribution, abundance, and biological condition within the region, and also provide data to the Atlantic Zonal Monitoring Program (AZMP) for monitoring hydrographic variability. This document is intended to provide a synopsis of the findings of the 2011 survey and to examine these data in the context of long term survey results (see also DFO 2012). The results from 2010 can be found in Clark and Emberley 2011 and DFO 2011a.

The bottom trawl survey was originally planned to provide biomass and abundance trends for fish and invertebrates residing at depths from about 50 m to 400 m, and was extended to cover depths down to 750 m in 1999. Survey indices are expected to be proportional to biomass and abundance for most species. The distribution of some species, however, such as cusk and Greenland halibut, may not be fully covered by the survey. Biomass and abundance trends for theses species may only provide an indication of the direction of change over time. Catches of pelagic species, such as Atlantic herring, may also not reflect the true abundance trends. For all these species, other biological information, such as length and weight are still relevant and are available on the Maritimes Regional Ecosystem Survey database.

There were changes to the net used and the vessel conducting the survey in 1982 and 1983. From 1970 – 1981 the RV *A.T. Cameron*, a side-trawler towing a Yankee 36 trawl, was used for the survey. In 1982, the stern trawler RV *Lady Hammond* was used, towing a Western IIA trawl. Since 1983, the *CCGS Alfred Needler* has been the primary survey vessel, and the Western IIA trawl has been used in all years. Conversion factors were calculated for net and vessel changes (Fanning 1985). There were, however, some difficulties in conducting the conversion studies, due to equipment problems (Koeller and Smith 1983) and the conversion factor calculated in that study is no longer used for cod (Clark *et al.* 1994; Mohn *et al*. 1998). A conversion of 1.2 is now used for cod. This is equivalent to the change in wingspread for the two nets, and is roughly equivalent to the difference in catchability coefficients for cod from the two nets calculated through population modelling (Clark 1997). Conversion factors were generally small for most species; for silver hake and pollock, however, a large conversion factor (>2) was calculated, but was not considered reliable (Fanning 1985). Given the magnitude of the calculated conversion factor, its poor precision, and the problems experienced during the conversion study, biomass data for silver hake are only used from 1982 to the present and a conversion is not used for pollock biomass.

There have also been some changes in data collection protocols. Invertebrate species other than lobster and short-fin squid were not recorded consistently before 1999. Individual fish weights were collected for very few species in the 1980s, so there is a gap in time series for condition factors for most fish species.

There are some species which are similar in appearance and have not been consistently distinguished throughout the time series. This is generally only a concern for uncommon species; it is, however, an issue for interpreting data for white hake. The common identification guide which was originally used at-sea (Leim and Scott 1966) synonymized red hake and white hake, and these were not consistently distinguished at-sea until about 1982. Bundy and Simon (2005) reviewed these data and concluded that because red hake comprise such a small part of the combined biomass for the two species, biomass trends were still useful for white hake for the entire survey series. While red hake are a small part of the biomass index, they are a large part of the combined catch for hake <35cm; including length frequency data from before 1982 would misrepresent the average catch at-length for white hake. In recognition of this, the long-term average catch-at-length for white hake only uses data from 1982 to the present.

For long-term averages, the most appropriate starting point has been selected for each species. In the case of white hake, biomass plots start in 1970 but the abundance index data only go back to 1982. For silver hake, biomass plots and abundance index data are used starting in 1982. This is in conjunction with the change in the type of trawl, from a Yankee 36 to a Western IIA, as well as more consistent identification of white hake and red hake.

In 2011, five additional survey tows were completed in deeper water off the shelf edge (750 – 1,800 m), a continuation from 2010 to investigate species composition and biomass in deeper waters. A total of twelve valid tows were also completed for Georges Bank Survey strata 5Z1 and 5Z9 on the northern edge of the Bank, mainly to investigate pollock distribution. Catches from these stations are not included in the biomass index estimates, to ensure that comparability with other years is maintained, but there are plans to include these data in future calculations of biomass and abundance indices for Western Component pollock.

The survey area has been divided into three zones based on oceanography and biogeography. Trends are shown for the entire shelf survey area, and also for three separate regions: eastern Scotian Shelf (4VW; strata 440 - 466), western Scotian Shelf (4X East; strata 470 - 481), and Gulf of Maine/Bay of Fundy (4X West; strata 482 - 495). Differences in patterns of fish abundance and species composition are apparent for these regions during the survey. Strata 496 - 498 (the shelf edge; 350 m – 750 m) have been sampled in most years since 1996, while strata 501 - 502 (750 m – 1,800 m) and strata 5Z1 and 5Z9 (edge of Georges Bank) have not been regularly sampled as part of the summer RV stratified random survey series. Tables of the entire catches from these areas are presented. These areas are considered separate biogeographic zones and since they have not been sampled in all years, are not included in the long-term biomass index estimates.

Data are presented for a list of species first identified in Clark and Emberley (2008). Additional species have been added to the list as data requests and monitoring requirements have dictated (see also DFO 2012).

SAMPLING OF TRAWL CATCH

Basic data, total numbers and weight caught, and length frequencies (LF) were collected from all successful sets according to protocols documented by Koeller (1981). This was updated in 1995 and again in 2007 to record increased sampling details (M. Strong and S. Gavaris, DFO Maritimes Region, Manual bottom trawl surveys Marine Fish Scotia-Fundy Region, unpublished; B. Hatt and D. Clark, DFO Maritimes Region, Manual bottom trawl surveys Maritimes Region, unpublished).

Length stratified samples for individual fish weight, one per centimeter (by sex if required), were taken from each set for all fish species. In addition, otoliths were taken from cod, haddock, pollock, white hake, silver hake, cusk, and halibut. Maturity stages were assigned for silver hake. All sampling and set information was entered directly in a database with online data editing using an Oracle-based data entry system called the Groundfish Surveys at sea Entry system (GSE).

Stomachs were collected from selected species according to length stratified requirements. Identification of stomach contents was conducted at sea when possible while some stomachs were frozen for later analysis.

HYDROGRAPHIC OBSERVATIONS

At 256 summer RV survey stations, profiles of temperature, conductivity (salinity), oxygen concentration, fluorescence, and irradiance (PAR extinction) were obtained with a SBE-25 Conductivity, Temperature and Depth (CTD) meter fitted on a Carousel Rosette deployed by the *CCGS Alfred Needler*. Niskin bottles attached to the Rosette collected water from the bottom, 25m and 50m (intermediate depths) when possible, and from 5m (near surface) for the following sampling:

- 5m: salinity (x1), nutrients (x2), chlorophyll-a (x2) and oxygen determination (x2);
- 25m: nutrients (x2), chlorophyll-a (x2);
- 50m: nutrients (x2), chlorophyll-a (x2); and
- bottom: salinity (x1), nutrients (x2), chlorophyll-a (x2) and oxygen determination (x2).

Oxygen measurements were performed after the CTD cast using an ORION 842 bench meter. Salinity determinations were made using a Guildline 'Portasal' salinometer for calibration with the CTD measurements. Chlorophyll-a samples were processed onboard with a Turner-Designs fluorometer. Surface temperatures were measured using a VEMCO SEATEMP temperature probe. VEMCO depth/temperature miniloggers were attached to the trawl to monitor bottom water/fishing depth temperature.

Additional sampling was undertaken for the AZMP. At 34 selected stations across the shelf in close proximity to Standard Hydrographic Lines, vertical zooplankton tows (202 micron mesh ring-net) were made from bottom to surface.
The Halifax hydro station was occupied three times during the course of the 2011 mission. On each occasion the following sampling was conducted:

- vertical CTD profile of the entire water column (including a fluorometer sensor and dissolved oxygen probe),
- two vertical zooplankton net tows from bottom to surface; one with each of the 76 and 202 micron ring-nets,
- Secchi depth measurement, and
- Niskin bottles on CTD rosette sampled at 10 depths through the water column – samples analyzed for oxygen, nutrients, salinity, chlorophyll-a, and phytoplankton enumeration.

TRAWL MENSURATION

SCANMAR sensors were used to document the trawl characteristics. Wing spread, door spread, headline height and clearance were all recorded for sets, when possible. A MARPORT system was also used to record trawl characteristics during the 2011 summer RV survey, including door pitch and door roll.

RESULTS

The annual summer RV survey was conducted on the *CCGS Alfred Needler* between July 5 and August 8, 2011. A total of 266 fishing stations were completed during the survey. In strata 470 – 495 (NAFO Divisions 4X5Y), 87 valid tows were completed, while 156 valid tows were completed in strata 440 – 466 (NAFO Divisions 4VW), 6 valid tows were completed in strata 496 - 498 (Scotian shelf edge; 365 - 750 m), 5 valid tows were completed in strata 501 - 502 (750 - 1800 m), and a total of 12 valid tows were completed in strata 5Z1 and 5Z9 (edge of Georges Bank) (Figure 1). Twelve tows were designated as unrepresentative either due to net damage or because tow duration was less than 20 minutes.

The 2011 survey started on time and there were only a few minor mechanical problems so that loss of sea time was minimal. Also, less time was spent scoping out the bottom before trawl deployment. Consequently, more sets were completed this year than has ever been accomplished for this survey.

There were 104 species of fish recorded from the shelf and shelf edge portion of the survey (strata 440 – 498; Table 1). The most frequently captured fish were American plaice, silver hake, haddock, and Atlantic herring while those contributing most to the weight caught were redfish, pollock, haddock, Atlantic herring, silver hake and cod.

There were 132 separate invertebrate codes recorded from the shelf and shelf edge portion of the survey (strata 440 – 498; Table 2). This is more than the number recorded in 2010 and considerably more than in 2006 when only 63 invertebrate species were recorded. This increase in the number of invertebrates identified was a result of the high sampling density in 2011, a broader sampling strategy introduced in 2007 and the increased experience of survey personnel in identification of invertebrates. The most frequently captured invertebrates were short-fin squid, pink shrimp, sponges, and snow

crab while orange footed sea cucumber, northern shrimp, American lobster and pink shrimp contributed most to the weight of the invertebrate catch.

The deep sets in strata 501 – 502 captured 62 vertebrate species (Table 3) and 24 invertebrate species (Table 4), in addition to a number of species that were recorded as unidentified and retained for later identification.

Along the edge of Georges Bank in strata 5Z1 and 5Z9, 38 vertebrate species codes (Table 5) and 30 invertebrate species codes (Table 6) were recorded.

A variety of special samples were collected in addition to those required as part of the standard sampling protocol (Table 7). Any species recorded at sea as unidentified were retained for later identification. Some unidentified vertebrates were delivered to the Bedford Institute of Oceanography (BIO) for identification while others were sent to the Atlantic Reference Center (ARC). Unidentified cephalopods were retained and shipped to Elizabeth Shea at the Delaware Museum of Natural History (DMNH) for further identification. Sea urchins retained were sent to Jason Addison at the University of New Brunswick (UNB). Other unidentified invertebrates such as shrimp were retained and delivered to the ARC for further identification.

DISTRIBUTION, ABUNDANCE AND CONDITION OF SAMPLED SPECIES

The total biomass estimate for the survey at depths less than 365 m (strata 440 – 495; hereafter referred to as the Shelf strata) is displayed in Figure 2. Prior to 1999, data were not collected on most invertebrate species; therefore, this estimate is restricted to all vertebrate species plus lobster and squid and does not include catches from the shelf edge, deep tows, or the edge of Georges Bank. The total biomass index for 4VW was at the second highest level since 1991. In both 4X East and 4X West total biomass indices were variable throughout the time series. This estimate can be heavily influenced by a small number of species. For example, a large catch of dogfish from 4X East in 2007 resulted in the highest biomass estimate for this area in the time series. In 2011, this was not the case.

The total catch weight of invertebrates and vertebrates was investigated by set and by strata. The percentage of total catch weight by strata attributed to invertebrates was noticeably higher for several strata in 4VW, especially in areas around Sable Island Bank, Western Bank and Middle Bank. For the sets with the highest percentage of invertebrate catch in 4VW, the bulk of species captured were common sea cucumbers, northern shrimp, snow crab and pink shrimp. Sets in 4X where the total catch weight was comprised mostly of invertebrates, mainly occurred in the Bay of Fundy strata. The invertebrate species composition at these set locations was somewhat different from 4VW with American lobster contributing most to catch weight.

The species composition appears quite distinct in the different depth zones. The shelf edge (350 m - 750 m) has limited overlap in species composition with the shelf strata, and also limited overlap with deeper water. Greenland halibut was the only species which was widely observed in both shelf and deepwater sets.

Distribution, biomass, catch at size, and condition trend plots are included for some of the more abundant fish and invertebrate species in the survey catch and for other species of commercial importance (Figures 3 to 84). Catch weight data for each species are adjusted to the survey area and used to produce a biomass index (Halliday and Koeller 1981). Plots of total catch at size for each species are derived from the stratified total number caught at length. The total number at length is calculated for the survey area and is used as an abundance index (Halliday and Koeller 1981). The number at length plots for cod (DFO 2011b), silver hake (Showell *et al.* 2005), pollock (Stone *et al.* 2009), redfish (Branton 1999; Power 2000) and Atlantic halibut (DFO 2010b) are produced for the particular area used in the assessments for these species. For select commercial species where individual fish weights have been collected throughout most of the time series, trends in condition (Fulton's K: weight/length^3) are also included (Ricker 1975).

INDIVIDUAL SPECIES TRENDS

An index of individual species summaries and associated figures is located in Table 8 of this document. Biomass comparisons are made for some species using the current year's estimate (2011), last year's estimate (2010), short term (2005-2009) average, medium term (1995-2009) average, and long term (1970-2009) average and are shown in Table 9. Maps of NAFO Divisions, strata boundaries, banks and basins on the Scotian Shelf are provided in Appendix A, Appendix B and Appendix C, respectively, to accompany text on distribution and trend for each species.

Atlantic cod catches were widespread in the survey area, with the largest catches occurring in 4VW (Figure 3). The biomass index for 4VW, while low in recent years compared to the long-term average, was above both short and medium-term averages in 2010 and 2011. The biomass index has declined from 2009, which was above the long-term average and the highest since 1987. Biomass indices increased from 2010 levels in both 4X East and 4X West in 2011, but remained below recent, medium and long-term averages in both areas (Figure 4, Table 9). Abundance at size for 4Vn cod was well below average for most lengths in 2011, with the exception of fish size 3-8 cm and 21-26 cm (Figure 5). In 4VsW, length stratified abundance indices were also below average for most lengths, and above average for the smallest lengths and also from 28-34 cm (Figure 6). Cod abundance in 4X East and 4X West was below average for all lengths except for some length groups below 20 cm (Figures 7 and 8). Cod condition declined in 4VW and 4X East and was below average. In contrast, condition increased in 4X West to near the highest in the series (Figure 9).

Haddock catches were widespread in 4WX in 2011 (Figure 10). The biomass indices declined in 4VW to the lowest seen since 1976 and were below short, medium and long-term averages in both 2010 and 2011. In 4X East, the 2011 biomass index increased but was below short-term average and above medium and long-term averages. The biomass index declined in 4X West for 2011 and was below short, medium and long-term averages (Figure 11, Table 9). The 4VW haddock abundance at size in 2011 was below average for most lengths above 11 cm but above average below 11 cm (Figure 12). Length stratified abundance indices for 4X East and 4X West show three distinct modes

where abundance was above average (Figures 13 and 14). Haddock condition declined in 4VW and 4X West, but increased in 4X East. Condition in all areas remains at a low level (Figure 15).

White hake remain distributed throughout the survey area, with the largest catches in the Gulf of Maine (4Xpq) and in 4Vn (Figure 16). Biomass indices in 4VW and 4X West were below the short, medium and long-term averages in 2011, but remained above the short and medium-term averages in 4X East (Figure 17, Table 9). Abundance indices in 2011 were below average for most lengths in 4VW (Figure 18), 4X East (Figure 19) and 4X West (Figure 20). Condition in 2011 increased for 4VW and 4X East but declined in 4X West and remains below average in all areas (Figure 21).

Catches of **silver hake** in the 2011 survey were widespread in 4W and 4X (Figure 22). The biomass index in 4VW increased in 2011 and remained well above short, medium and long-term averages. In 4X East, biomass remained close to the 2010 estimate and was above short and medium-term averages, but below the long-term average. In 4X West, biomass declined from the anomalously high value observed in 2010 (due to one large catch in 4Xs) and was above the short-term average but below the medium and long-term averages (Figure 23; Table 9). Indices of abundance are displayed for silver hake based on the assessment area, which comprises strata 440-483 (4VWXmnop). The 2011 abundance indices were above average for lengths from 17 - 25 cm, but below average for most other lengths (Figure 24). Silver hake condition has been declining since 2007 and was below average in 2011 (Figure 25).

Pollock catches were widespread in 4WX and 5Z. Several large catches were taken in the Eastern component strata (4VWXmn) and in 5Z; however, no large sets were taken in the strata used for calculating indices for the Western component (4Xopqrs5Y) of Pollock (Figure 26). This is the first year that the Georges Bank strata have been included in the summer RV survey and these sets are not included in biomass calculations. Biomass in 4VW increased in 2011 and was above the short, medium and long-term averages. In 4X East the 2011 estimate was the highest in the survey series. The biomass estimate in 4X West was similar to 2010 and was the lowest observed since 1983; well below short, medium and long-term averages (Figure 27, Table 9). Abundance indices in the Eastern component were well above average in 2011 for most lengths below 64 cm (Figure 28). In the Western component, the abundance indices were well below average in 2011 for almost all lengths, similar to what was observed in 2010 (Figure 29). Pollock condition increased in all areas in 2011 but remained below average (Figure 30).

Redfish catches were widespread throughout the survey area (Figure 31). The biomass index in 4VW increased annually since 2007 and in 2011 was at its highest level in 20 years; higher than short, medium and long term averages. In 4X East the biomass index was the highest for the series in 2009 and although biomass declined in 2010, it increased in 2011 and was below short term average but above medium and long term averages. Redfish biomass in 4X West was also below the short term average but above medium and long term averages (Figure 32, Table 9). In Unit II (strata 440-456, 464), redfish abundance in 2011 was near or above average for most lengths (Figure 33). Abundance indices for Unit III (strata 457-463, 465-485) redfish in 2011 were above

average for almost all lengths greater than 15 cm, but below average for small fish (Figure 34). In 2011, condition was below average for all areas (Figure 35).

Atlantic Halibut were caught throughout the survey area (Figure 36). Biomass decreased in 2011 for 4VW and 4X East, but increased in 4X West. Halibut biomass remained high for all areas and overall was above short, medium and long term averages (Figure 37, Table 9). Halibut abundance (4VWX5Y) was also high in 2011 and well above average for most lengths (Figure 38).

Winter flounder were caught mainly in the Bay of Fundy with catches also occurring on Browns Bank and Western Bank (Figure 39). In 4VW, biomass increased to its highest level since 2001. Biomass in 4X East increased in 2011 and was above short, medium, and long term averages. In 4X West, biomass decreased from the highest in the series in 2010 and was below the short, medium and long term averages (Figure 40, Table 9). Abundance of winter flounder in 4X East for 2011 was above average for lengths less than 40 cm, especially smaller fish, but below average for large fish (Figure 41). In 4X West, abundance was below average for all lengths, and there were no fish caught below 24 cm (Figure 42).

Witch flounder were caught throughout the survey area but the largest catches came from 4V (Figure 43). The biomass index for 4VW has shown a general increase since the early 1990s and in 2011 was below the short term average but was above the medium and long term averages. In 4X East, the biomass index remained below short, medium and long term averages. In 4X West biomass decreased for 2011 and was also below short, medium and long term averages (Figure 44, Table 9). Abundance indices for 4VW were similar to 2010 levels and remained above average for most lengths below 40 cm (Figure 45). In 4X East, abundance was above average for few scattered lengths but below average for most other lengths (Figure 46). Abundance in 4X West declined in 2011 and was below average at most sizes (Figure 49). Lengths greater than 46 cm continued to be absent from the survey catches in 4X.

American plaice were widespread throughout the survey area in 2011, with the largest catches primarily in 4V (Figure 48). Biomass indices for 4VW reached a recent peak in 2006 but have declined annually since then. The 2011 biomass estimate was below all averages and was the second lowest in the series (Figure 49, Table 9). Abundance indices decreased in 2011 and were below average at all lengths, with the exception of the lengths less than 14 cm (Figure 50).

Most **yellowtail flounder** catches in 2011 were caught in 4VsW, with a small percentage caught in 4X (Figure 51). The biomass index for 4VW reached a low in 2003 but has since shown a general increase. In 2011, the biomass index increased and was near the short term average, above the medium term average but below the long term average (Figure 52, Table 9). Abundance of yellowtail flounder in 2011 was similar to 2010 and above average for lengths less than 27 cm, but was less than average for all lengths greater than 27 cm (Figure 53).

Spiny dogfish were caught almost exclusively in 4X, with most catches coming from the Bay of Fundy and Gulf of Maine (Figure 54). Biomass has been variable from year to year with no clear trend (Figure 55).

The largest catches of **winter skate** in 2010 came from Browns Bank and the Bay of Fundy but some were also caught in 4Vs (Figure 56). Biomass decreased in all areas and remained at a low level (Figure 57).

Thorny skate were caught primarily in 4V during the 2011 survey (Figure 58). Thorny skate biomass increased in both 4VW to the highest level since 2007. Biomass also increased in 4X West but declined in 4X East (Figure 59).

Catches of **Greenland halibut** were mainly in 4V, with the exception of catches made in the deep sets off the edge in 4WX (Figure 60). Biomass indices have been variable but remained at a high level compared to the period prior to the 1990s (Figure 61).

Atlantic herring catches were widely distributed throughout the survey area (Figure 62). Biomass indices for 4VW and 4X East decreased in 2011 while biomass increased in 4X West (Figure 63). There remains no clear trend with herring biomass and it is not clear that survey catches reflect population biomass for herring, due to their primarily pelagic distribution.

Argentine catches were few but widely distributed along the shelf edge (Figure 64). Biomass indices overall decreased in 2011 from the highest in the series in 2010 (Figure 65). As with herring, it is not clear if survey catches are reflecting population biomass trends for argentine. These species are primarily pelagic, and small changes in vertical distribution may strongly influence bottom trawl catches.

Biomass of **northern sandlance** decreased in 4VW for 2011. They are uncommon in 4X East, but from 2008 to 2011 small catches occurred (Figure 66).

Catches of **cusk** have declined throughout the series in all areas. Biomass remained low in all areas for 2011 (Figure 67).

Atlantic Wolffish biomass has followed a declining trend since the 1980s and reached a low in 2009. In 2011, biomass increased in 4VW and 4X East but remained at a low level (Figure 68).

Monkfish have also shown a decline throughout the time series but increased for all areas in 2011 (Figure 69).

Biomass indices for **red hake** increased in 4VW and 4X East in 2011 but show no recent trend (Figure 70).

Biomass of **blackbelly rosefish** increased in both 4VW and 4X East for 2011 but remained at a low level. Biomass decreased in 4X West, but was relatively high compared to historical levels (Figure 71).

Ocean pout biomass declined in the 1990s but for 2011 has increased in all areas and was among the highest levels since 1999 (Figure 72).

Biomass of **northern hagfish** has been variable without trend throughout the series but has increased in all areas for 2011 (Figure 73).

American lobster catches came mainly from 4X, with minor catches in 4W (Figure 74). Biomass has increased since the 1990s and in 4X West has reached the highest level in the series. Biomass has remained variable at a high level in all areas (Figure 75).

Short-fin squid were caught throughout the survey area (Figure 76). Survey catches for short-fin squid show high inter-annual variability. In 2011, biomass was similar to levels recorded in 2010 (Figure 77).

Sea scallop catches in 2011 came mainly from Browns Bank and Western Bank (Figure 78). Biomass in 2011 was similar to 2010 with slight decreases in 4VW and 4X West and a slight increase in 4X East (Figure 79).

Catches of **snow crab** occurred primarily in the eastern portion of 4VW and were rarely encountered in 4X (Figure 80). Biomass in 4VW increased in 2011 (Figure 81).

Pink shrimp were distributed widely throughout the survey area (Figure 82).

Northern shrimp were primarily found in 4VW with few occurrences in 4X (Figure 83).

Catches of **orange footed sea cucumber** were mainly in 4VW with the largest catches coming from Banquereau Bank, around Sable Island and from Middle Bank (Figure 84).

BOTTOM TEMPERATURE AND SALINITY

Temperature and salinity data were collected at most standard stations from the 2011 survey. Contour plots of these data show the general patterns of water masses in the region (Figures 85 and 86). The general patterns are consistent with past years with the coldest water on the Eastern Scotian Shelf, warm saline water in the Central Scotain Shelf and Georges Basin, and warm water of low salinity in the Bay of Fundy. The differences between the averages by stratum in 2011 and the long term averages by stratum from 1970-2010 for both temperature and salinity are shown in Figures 87 and 88. Although there were no striking deviations from the longterm averages, temperature appeared to be generally higher throughout the survey area.

CONCLUSIONS

The 2011 summer RV survey started on schedule and minimal mechanical issues were encountered, resulting in the highest number of completed sets for a summer survey in the 41-year time series. Part of this success was attributed to limiting the time used for scoping out the bottom and setting the trawl on approach to the station. High catches were noted for several species, including Atlantic halibut, silver hake, redfish and American lobster. Exploratory sets were conducted in deep water (750 m – 1,800 m) and additional sets were also completed in strata 5Z1 and 5Z9. Only 5 deep water sets were

completed this year, with the species encountered being similar to 2010 deep sets. Although this is not enough data to create a biomass index, it does provide information on species composition and allowed staff to maintain species identification skills. Sets in 5Z1 and 5Z9 were conducted mainly in search of pollock as part of a request from industry and also to achieve more complete survey coverage of the Western Component of the pollock assessment area. The intention is to include this information in calculations of a Western Component pollock abundance index, provided there is continued sampling of these strata in the future.

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Table 1. Summary of vertebrate catch for strata 440-498 from the 2011 summer RV survey.

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number	Age Samples	Stomach Samples
10	Cod(Atlantic)	*Gadus morhua*	126	2179	3200	670	306
11	Haddock	*Melanogrammus aeglefinus*	148	4932	12457	1974	649
12	White Hake	*Urophycis tenuis*	96	660	892	596	251
13	Squirrel Or Red Hake	*Urophycis chuss*	73	85	575		154
14	Silver Hake	*Merluccius bilinearis*	154	2826	26657	1679	412
15	Cusk	*Brosme brosme*	6	11	6	6	6
16	Pollock	*Pollachius virens*	80	6188	4681	408	192
17	Tomcod(Atlantic)	*Microgadus tomcod*	4	4	130		
19	Off-Shore Hake	*Merluccius albidus*	2	9	4		
23	Redfish Unseparated	*Sebastes sp.*	131	14639	59406		339
25	Tile Fish	*Lopholatilus chamaeleonticeps*	1	13	1		
30	Halibut(Atlantic)	*Hippoglossus hippoglossus*	66	516	237	223	190
31	Turbot,Greenland Halibut	*Reinhardtius hippoglossoides*	39	307	523		96
40	American Plaice	*Hippoglossoides platessoides*	170	646	3600	485	449
41	Witch Flounder	*Glyptocephalus cynoglossus*	131	356	1923		266
42	Yellowtail Flounder	*Limanda ferruginea*	104	853	6231		234
43	Winter Flounder	*Pseudopleuronectes americanus*	58	387	1284		162
44	Gulf Stream Flounder	*Citharichthys arctifrons*	7	<1	10		
50	Striped Atlantic Wolffish	*Anarhichas lupus*	28	68	123		45
60	Herring(Atlantic)	*Clupea harengus*	139	2972	24636		
61	Shad American	*Alosa sapidissima*	15	30	58		
62	Alewife	*Alosa pseudoharengus*	35	48	459		
63	Rainbow Smelt	*Osmerus mordax*	1	<1	1		
64	Capelin	*Mallotus villosus*	14	18	1136		12
65	Salmon(Atlantic)	*Salmo salar*	1	3	1		
70	Mackerel(Atlantic)	*Scomber scombrus*	17	81	901		
112	Longfin Hake	*Urophycis chesteri*	23	29	335		45
114	Fourbeard Rockling	*Enchelyopus cimbrius*	36	4	144		1
115	Threebeard Rockling	*Gaidropsarus ensis*	1	<1	2		

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number	Age Samples	Stomach Samples
122	Cunner	*Tautogolabrus adspersus*	3	6	15		
123	Rosefish(Black Belly)	*Helicolenus dactylopterus*	22	41	381		
141	Summer Flounder	*Paralichthys dentatus*	1	7	15		
142	Fourspot Flounder	*Hippoglossina oblonga*	4	9	15		
143	Brill/Windowpane	*Scophthalmus aquosus*	4	2	9		
149	Longnose Greeneye	*Parasudis truculenta*	2	<1	3		
150	Lanternfish (NS)	*Myctophidae*	14	1	1050		
156	Short-Nose Greeneye	*Chlorophthalmus agassizi*	3	<1	22		
157	Glacier Lanternfish	*Benthosema glaciale*	1	<1	180		
158	Muller's Pearlsides	*Maurolicus muelleri*	4	<1	29		
159	Boa Dragonfish	*Stomias boa*	4	1	49		
160	Argentine(Atlantic)	*Argentina silus*	11	37	100		9
169	Viperfish	*Chauliodus sloani*	1	<1	1		
193	Hake (NS)	*Urophycis sp.*	1	<1	1		
200	Barndoor Skate	*Dipturus laevis*	13	68	14		
201	Thorny Skate	*Amblyraja radiata*	63	357	537		110
202	Smooth Skate	*Malacoraja senta*	32	30	99		46
203	Little Skate	*Leucoraja erinacea*	29	71	140		4
204	Winter Skate	*Leucoraja ocellata*	37	99	278		91
207	Round Skate	*Rajella fyllae*	1	<1	1		
220	Spiny Dogfish	*Squalus acanthias*	28	1101	658		78
221	Black Dogfish	*Centroscyllium fabricii*	1	43	88		
240	Sea Lamprey	*Petromyzon marinus*	1	1	1		
241	Northern Hagfish	*Myxine glutinosa*	38	5	86		
272	Sturgeons	*Acipenseridae f.*	2	2	5		
300	Longhorn Sculpin	*Myoxocephalus octodecemspinosus*	83	295	1899		211
301	Shorthorn Sculpin	*Myoxocephalus scorpius*	6	1	8		
302	Arctic Staghorn Sculpin	*Gymnocanthus tricuspis*	2	<1	3		
303	Grubby Or Little Sculpin	*Myoxocephalus aenaeus*	3	<1	79		
304	Mailed Sculpin	*Triglops murrayi*	36	3	258		
314	Spatulate Sculpin	*Icelus spatula*	1	<1	1		

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number	Age Samples	Stomach Samples
320	Sea Raven	*Hemitripterus americanus*	72	319	535		318
323	Hookear Sculpin (ns)	*Artediellus sp.*	1	<1	15		
340	Alligatorfish	*Aspidophoroides monopterygius*	53	1	302		
350	Atlantic Sea Poacher	*Leptagonus decagonus*	13	<1	22		
376	Polyipnus	*Polyipnus sp.*	1	<1	1		
400	Monkfish,Goosefish,Angler	*Lophius americanus*	37	97	67		50
410	Marlin-Spike Grenadier	*Nezumia bairdii*	16	3	58		17
411	Roughhead Grenadier	*Macrourus berglax*	1	4	3		
414	Roundnose Grenadier	*Coryphaenoides rupestris*	1	1	2		
455	Eels, Cutthroat (ns)	*Synaphobranchidae f.*	2	1	26		
501	Lumpfish	*Cyclopterus lumpus*	6	2	6		3
502	Atlantic Spiny Lumpsucker	*Eumicrotremus spinosus*	7	<1	25		
503	Atlantic Seasnail	*Liparis atlanticus*	2	<1	2		
505	Seasnail,Gelatinous	*Liparis fabricii*	1	<1	1		
512	Seasnail,Dusky	*Liparis gibbus*	2	<1	2		
595	Red Dory	*Cyttopsis rosea*	1	<1	1		
602	Gray's Cutthroat Eel	*Synaphobranchus kaupi*	3	<1	3		
603	Wolf Eelpout	*Lycenchelys verrilli*	3	<1	3		2
604	Snipe Eel	*Nemichthys scolopaceus*	5	<1	12		
610	Northern Sand Lance	*Ammodytes dubius*	59	302	18304		73
611	Sand Lance (ns)	*Ammodytes sp.*	1	<1	1		
616	Fish Doctor	*Gymnelis viridis*	1	<1	1		
620	Laval's Eelpout	*Lycodes lavalaei*	4	2	11		
621	Rock Gunnel(Eel)	*Pholis gunnellus*	3	<1	4		
622	Snake Blenny	*Lumpenus lumpretaeformis*	23	5	227		53
623	Daubed Shanny	*Lumpenus maculatus*	21	3	551		25
625	Radiated Shanny	*Ulvaria subbifurcata*	11	1	29		
630	Wrymouth	*Cryptacanthodes maculatus*	2	4	12		
637	Spotfin Dragonet	*Foetorepus agassizi*	1	<1	1		
640	Ocean Pout(Common)	*Macrozoarces americanus*	59	44	177		98
646	Atlantic Soft Pout	*Melanostigma atlanticum*	1	<1	2		

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number	Age Samples	Stomach Samples
647	Shorttailed Eelpout(Vahl)	*Lycodes vahlii*	21	26	434		34
694	Batfishes	*Ogcocephalidae f.*	1	<1	1		
700	Atlantic Silver Hatchfish	*Argyropelecus aculeatus*	1	<1	2		
701	Butterfish	*Peprilus triacanthus*	25	5	69		
704	American John Dory	*Zenopsis ocellata*	2	<1	2		
712	White Barracudina	*Notolepis rissoi*	13	1	53		
714	Simonyi's Frostfish	*Benthodesmus simonyi*	2	<1	2		
720	Atlantic Saury,Needlefish	*Scomberesox saurus*	2	<1	2		
741	Hatchetfish	*Sternoptychidae f.*	1	<1	1		
805	Tonguefish	*Symphurus sp.*	4	<1	5		
816	Tongue Fish	*Symphurus diomedeanus*	2	<1	5		
880	Hookear Sculpin,Atl.	*Artediellus atlanticus*	25	<1	101		
1054	Duckbill Barracudina	*Paralepis atlantica kroyer*	1	<1	2		

Table 2. Summary of invertebrate catch for strata 440-498 from the 2011 summer RV survey (Note: some invertebrates were not counted and show total number as "-")

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
4511	Short-Fin Squid	*Illex illecebrosus*	157	451	5302
2212	Pandalus Montagui	*Pandalus montagui*	130	672	189573
8600	Sponges	*Porifera*	117	100	406
2526	Snow Crab (Queen)	*Chionoecetes opilio*	99	469	2951
6120	Henrica	*Henrica*	95	3	1110
8300	Sea Anemone	*Anthozoa*	90	46	1519
6117	Hippasteria Phrygiana	*Hippasteria phrygiana*	88	32	340
6123	Spiny Sunstar	*Crossaster papposus*	82	21	595
6111	Asterias Rubens	*Asterias rubens*	80	115	1382
6411	Sea Urchin (Green)	*Strongylocentrotus droebachiensis*	80	228	3941
4521	Octopus	*Octopoda*	79	4	220

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
2550	American Lobster	*Homarus americanus*	76	979	1032
2559	Hermit Crabs	*Paguridae*	75	6	249
6611	Sea Cucumber (Common)	*Cucumaria frondosa*	71	4306	18745
8500	Jellyfishes	*Scyphozoa*	69	104	62
2513	Atlantic Rock Crab	*Cancer irroratus*	66	63	646
2527	Toad Crab	*Hyas araneus*	60	21	1364
4210	Whelks	*Buccinum*	58	25	357
2511	Jonah Crab	*Cancer borealis*	53	25	129
4321	Sea Scallop	*Placopecten magellanicus*	52	53	660
2211	Pandalus Borealis	*Pandalus borealis*	49	1168	178238
6121	Purple Sunstar	*Solaster endeca*	45	16	145
6200	Brittle Star	*Ophiuroidea*	43	41	8325
2411	Argis Dentata	*Argis dentata*	41	21	5967
6300	Basket Stars	*Gorgonocephalidae,asteronychidae*	40	105	153
6500	Sand Dollars	*Clypeasteroida*	40	16	890
6115	Mud Star	*Ctenodiscus crispatus*	38	5	882
2523	Northern Stone Crab	*Lithodes maja*	36	21	69
6114	Leptasterias	*Leptasterias*	36	21	201
1823	Sea Potato	*Boltenia*	35	7	130
6511	Echinarachnius Parma	*Echinarachnius parma*	32	8	207
6101	Ceremaster Granularis	*Ceremaster granularis*	28	1	81
1810	Tunicata	*Tunicata*	27	102	75
8347	Psilaster Andromeda	*Psilaster andromeda*	26	6	1266
8318	Sea Pen	*Pennatulacea*	25	8	4882
2312	Lebbeus Polaris	*Lebbeus polaris*	24	1	654
6125	Pteraster Militaris	*Pteraster militaris*	23	1	125
2521	Hyas Coarctatus	*Hyas coarctatus*	22	3	101
2990	Barnacles	*Cirripedia*	22	18	66
4322	Iceland Scallop	*Chlamys islandica*	22	8	146
6102	Porania Pulvilis	*Porania pulvilis*	22	5	88
3100	Bristle Worms	*Polychaeta*	21	1	511
2221	Pasiphaea Multidentata	*Pasiphaea multidentata*	20	12	4014

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
4536	Bobtail Squid	*Sepiolodae*	20	1	120
6116	Pseudarchaster	*Pseudarchaster*	20	14	2167
6109	Asterias Forbesi	*Asterias forbesi*	18	1	103
3212	Aphrodita	*Aphrodita*	17	2	26
6129	Poraniomorpha Hispida	*Poraniomorpha hispida*	17	<1	35
3200	Sea Mouse	*Aphrodita hastata*	16	2	41
8327	Soft Coral Unidentified	*Soft coral unidentified*	16	<1	26
4227	New England Neptune	*Neptunea decemcostata*	15	2	37
6213	Ophiura Sarsi	*Ophiura sarsi*	13	1	31
6600	Sea Cucumber (Unidentified)	*Holothuroidea*	13	15	72
2600	Krill Shrimp	*Euphausiacea*	12	9	32399
4228	Spindle Shell	*Colus*	11	1	17
5100	Sea Spider	*Pycnogonida*	11	<1	45
6211	Daisy	*Ophiopholis aculeata*	11	<1	31
2316	Spirontocaris Spinus	*Spirontocaris spinus*	10	2	1681
4330	Mussels	*Mytilidae*	10	19	23
6400	Sea Urchins	*Strongylocentrotus*	10	53	78
8324	Sea Cauliflower, Strawberries	*Eunephthya rubiformis*	9	<1	14
8601	Russian Hats	*Vazella pourtalesi*	8	106	5
2310	Spirontocaris	*Spirontocaris*	7	<1	71
4211	Wave Whelk,Common Edible	*Buccinum undatum*	7	2	44
6100	Asteroidea	*Asteroidea*	7	<1	48
2415	Pontophilus Norvegicus	*Pontophilus norvegicus*	6	<1	54
1900	Bryozoans	*Bryozoans*	5	112	-
2313	Spirontocaris Liljeborgii	*Spirontocaris liljeborgii*	5	<1	32
2414	Sclerocrangon Boreas	*Sclerocrangon boreas*	5	2	333
2419	Sabinea Sarsi	*Sabinea sarsi*	5	<1	78
2560	Paguroidea	*Paguroidea*	5	1	56
2980	Red Isopod	*Isopoda*	5	<1	16
4304	Ocean Quahaug	*Arctica islandica*	5	<1	12
6134	Slender Armed Sea Star	*Leptasterias tenera*	5	1	7
6413	Heart Urchin	*Brisaster fragilis*	5	4	741

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
8323	Bubble Gum Coral	*Paragorgia arborea*	5	38	-
2416	Crangon	*Crangon*	4	1	37
2611	Meganyctiphanes Norvegica	*Meganyctiphanes norvegica*	4	<1	303
4221	Northern Moonsnail	*Euspira heros*	4	1	16
4312	Bank Clam	*Cyrtodaria siliqua*	4	<1	7
4400	Sea Slugs	*Nudibranchia*	4	<1	5
8325	Gold-Banded/Bamboo Coral	*Keratoisis ornata*	4	2	-
2223	Sergestes Arcticus	*Sergestes arcticus*	3	6	8403
2532	Red Deepsea Crab	*Chaceon quinquedens*	3	13	57
2811	Gammaridae	*Gammaridae*	3	<1	49
4331	Common Mussels	*Mytilus edulis*	3	<1	7
4332	Horse Mussels	*Modiolus modiolus*	3	1	4
4380	Anomia Simplex	*Anomia simplex*	3	<1	5
6119	Blood Star	*Henricia sanguinolenta*	3	<1	29
8100	Comb Jellies	*Ctenophora*	3	<1	51
2319	Lebbeus Groenlandicus	*Lebbeus groenlandicus*	2	<1	7
2331	Eualus Macilentus	*Eualus macilentus*	2	3	1614
2333	Eualus Gaimardii	*Eualus gaimardii*	2	2	1414
2417	Crangon Septemspinosa	*Crangon septemspinosa*	2	<1	258
2556	Munida Valida	*Munida valida*	2	<1	4
2800	Amphipoda	*Amphipoda*	2	<1	4
4300	Bivalvia	*Bivalvia*	2	<1	2
4310	Clams	*Protobranchia, heterodonta*	2	<1	3
4318	Soft Shell Clam	*Mya arenaria*	2	<1	3
4334	Musculus Niger	*Musculus niger*	2	<1	2
8332	Coral	*Anthozoa*	2	<1	-
8335	Cup Coral	*Flabellum*	2	<1	2
8338	Chrysogorgia Agassizii	*Chrysogorgia agassizii*	2	<1	3
1279	Tremaster Mirabilis	*Tremaster mirabilis*	1	<1	1
1901	Lemonweed	*Lemonweed*	1	224	-
1930	Lampshells	*Bryozoans brachiopoda*	1	1	3
2210	Pandalus	*Pandalus*	1	<1	-

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
2213	Atlantopandalus Propinquus	*Atlantopandalus propinqvus*	1	<1	11
2507	Crab	*Crab*	1	<1	1
2541	Axius Serratus	*Axius serratus*	1	<1	2
2864	Amphipod	*Ampelisca macrocephala*	1	<1	1
2930	Oithona Spinirostris	*Oithona spinirostris*	1	<1	12
2999	Isopod	*Calathura branchiata*	1	<1	1
3000	Segmented Worms	*Annelida*	1	<1	2
3101	Large Polychaete, 3mm Dia	*Polychaeta ,large*	1	<1	16
3130	Nereis	*Nereis*	1	<1	1
3221	Chone	*Chone*	1	<1	1
3501	Lepidonotus Squamatus	*Lepidonotus squamatus*	1	<1	6
4200	Snails And Slugs	*Gastropoda*	1	<1	4
4212	Silky Buccinum	*Buccinum scalariforme*	1	<1	1
4311	Quahaug	*Venus mercenaria (obsolete)*	1	<1	4
4315	Razor Clam	*Siliqua*	1	<1	-
4340	Cockles	*Cardiidae*	1	<1	1
4355	Stimpson's Surf Clam, Arctic Surf Clam	*Mactromeris polynyma*	1	<1	1
4569	Gonatus	*Gonatus*	1	<1	1
6110	Asterias	*Asterias*	1	<1	51
6131	Diplopteraster Multipes	*Diplopteraster multipes*	1	<1	1
7500	Turbellaria	*Turbellaria*	1	<1	6
8322	Sea Corn	*Primnoa resedaeformis*	1	<1	1
8326	Acanthogorgia Armata	*Acanthogorgia armata*	1	<1	1
8328	Anthomastus Grandiflorus	*Anthomastus grandiflorus*	1	<1	2
8354	Sergia	*Sergia*	1	<1	1

Table 3. Summary of vertebrate catch from the deep sets (strata 501 and 502) during the 2011 summer RV survey.

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
169	Viperfish	*Chauliodus sloani*	5	<1	28
221	Black Dogfish	*Centroscyllium fabricii*	5	63	187
594	Smoothhead,Agassiz's	*Alepocephalus agassizii*	5	17	137
602	Gray's Cutthroat Eel	*Synaphobranchus kaupi*	5	11	225
716	Straightline Dragonfish	*Borostomias antarcticus*	5	<1	7
983	Apristurus	*Apristurus*	5	8	18
31	Turbot,Greenland Halibut	*Reinhardtius hippoglossoides*	4	62	60
138	Mirror Lanternfish	*Lampadena speculigera*	4	<1	8
157	Glacier Lanternfish	*Benthosema glaciale*	4	<1	266
159	Boa Dragonfish	*Stomias boa*	4	<1	41
247	Longnose Chimera	*Harriotta raleighana*	4	9	18
248	Knifenose Chimera	*Rhinochimaera atlantica*	4	27	12
410	Marlin-Spike Grenadier	*Nezumia bairdii*	4	2	85
414	Roundnose Grenadier	*Coryphaenoides rupestris*	4	220	920
601	Snubnose Eel, Slime Eel	*Simenchelys parasitica*	4	1	32
613	Stout Sawpalate	*Serrivomer beani*	4	<1	26
795	Beans Blueback	*Scopelogadus beanii*	4	<1	18
52	Northern Wolffish	*Anarhichas denticulatus*	3	3	3
113	Blue Antimora/Hake	*Antimora rostrata*	3	2	31
146	Lampanyctus Macdonaldi	*Lampanyctus macdonaldi*	3	<1	53
176	Goitre Blacksmelt	*Bathylagus euryops*	3	<1	9
223	Portuguese Shark	*Centroscymnus coelolepis*	3	65	42
224	Rough Sagre	*Etmopterus princeps*	3	26	51
252	Lampanyctus	*Lampanyctus*	3	<1	15
588	Scopelosaurus Lepidus	*Scopelosaurus lepidus*	3	<1	5
604	Snipe Eel	*Nemichthys scolopaceus*	3	<1	8
612	Derichthys Serpentinus	*Derichthys serpentinus*	3	<1	4
712	White Barracudina	*Notolepis rissoi*	3	1	8
740	Spiny Eel	*Notacanthus chemnitzii*	3	1	3
909	Chiasmodon	*Chiasmodon*	3	<1	5

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
1264	Ghost Catshark	*Apristurus manis*	3	9	11
158	Muller's Pearlsides	*Maurolicus muelleri*	2	<1	51
180	Spotted Lanternfish	*Myctophum punctatum*	2	<1	19
227	Notoscopelus	*Notoscopelus*	2	<1	3
307	Polar Sculpin	*Cottunculus microps*	2	1	2
411	Roughhead Grenadier	*Macrourus berglax*	2	2	3
607	Duckbill Oceanic Eel	*Nessorhamphus ingolfianus*	2	<1	3
617	Common Wolf Eel	*Lycenchelys paxillus*	2	<1	2
646	Atlantic Soft Pout	*Melanostigma atlanticum*	2	<1	7
724	Bairds Smoothead	*Alepocephalus bairdii*	2	3	5
725	Atlantic Gymnast	*Xenodermichthys copei*	2	<1	13
755	Anglemouth	*Cyclothone*	2	<1	53
1030	Aldrovandia Affinis	*Aldrovandia affinis*	2	<1	9
39	Black Swallower	*Chiasmodon niger*	1	<1	1
163	Lanternfish,Horned	*Ceratoscopelus maderensis*	1	<1	3
194	Moras	*Moridae*	1	<1	6
287	Notoscopelus Bolini	*Notoscopelus bolini*	1	<1	1
308	Pallid Sculpin	*Cottunculus thompsoni*	1	1	2
356	Rondeletia Loricata	*Rondeletia loricata*	1	<1	1
511	Blacksnout Seasnail	*Paraliparis copei*	1	<1	2
700	Atlantic Silver Hatchfish	*Argyropelecus aculeatus*	1	<1	1
710	Longnose Lancetfish	*Alepisaurus ferox*	1	2	1
711	Short Barracudina	*Paralepis atlantica*	1	<1	2
774	Ogrefish	*Anoplogaster cornuta*	1	<1	1
805	Tonguefish	*Symphurus*	1	<1	2
816	Tongue Fish	*Symphurus diomedeanus*	1	<1	6
862	Dicrolene Introniger	*Dicrolene introniger*	1	<1	2
863	Bathypterois Quadrifilis	*Bathypterois quadrifilis*	1	<1	2
1010	Halosaurus Guentheri	*Halosaurus guentheri*	1	<1	1
1024	Ilyophis	*Ilyophis*	1	<1	1
1039	Bathypterois Longipes	*Bathypterois longipes*	1	<1	1
1054	Duckbill Barracudina	*Paralepis atlantica kroyer*	1	<1	3

Table 4. Summary of invertebrate catch from the deep sets (strata 501 and 502) during the 2011 summer RV survey.

Species Code	Common Name	Scientific Name	Sets Occupied	Total Weight (kg)	Total Number
8353	Acanthephyra Pelagica	*Acanthephyra pelagica*	5	1	529
8500	Jellyfishes	*Scyphozoa*	4	2	6
2220	Shrimp	*Pasiphaea tarda*	3	<1	24
2532	Red Deepsea Crab	*Chaceon quinquedens*	3	4	60
4511	Short-Fin Squid	*Illex illecebrosus*	3	<1	5
2415	Pontophilus Norvegicus	*Pontophilus norvegicus*	2	<1	4
2559	Hermit Crabs	*Paguridae*	2	<1	28
4500	Cephalopoda	*Cephalopoda*	2	1	2
8145	Blind Lobster	*Polycheles sculptus*	2	<1	3
8300	Sea Anemone	*Anthozoa*	2	1	2
8354	Sergia	*Sergia*	2	<1	3
1283	Sergia Robusta	*Sergia robusta*	1	<1	5
2100	Shrimps	*Decapoda*	1	<1	28
2223	Sergestes Arcticus	*Sergestes arcticus*	1	<1	60
2319	Lebbeus Groenlandicus	*Lebbeus groenlandicus*	1	<1	2
2420	Sabinea	*Sabinea*	1	<1	1
2611	Meganyctiphanes Norvegica	*Meganyctiphanes norvegica*	1	<1	493
2771	Gnathophausia	*Gnathophausia*	1	<1	4
4514	Squid	*Loliginidae,ommastrephidae*	1	2	1
4527	Stauroteuthidae	*Stauroteuthidae*	1	<1	2
4574	Histioteuthidae	*Histioteuthidae*	1	<1	1
5100	Sea Spider	*Pycnogonida*	1	<1	1
6116	Pseudarchaster	*Pseudarchaster*	1	<1	1
8332	Coral (NS)	*Anthozoa*	1	<1	1

Table 5. Summary of vertebrate catch from the Georges Bank sets (strata 5Z1 and 5Z9) during the 2011 summer RV survey.

Species Code	Common Name	Scientific Name	Sets occupied	Total Weight(kg)	Total Number	Age Samples
10	Cod(Atlantic)	*Gadus morhua*	8	77	104	
11	Haddock	*Melanogrammus aeglefinus*	12	630	655	
12	White Hake	*Urophycis tenuis*	4	10	7	6
13	Squirrel Or Red Hake	*Urophycis chuss*	3	6	22	
14	Silver Hake	*Merluccius bilinearis*	6	34	280	
15	Cusk	*Brosme brosme*	1	1	1	1
16	Pollock	*Pollachius virens*	10	676	369	85
23	Redfish Unseparated	*Sebastes*	7	11	95	
30	Halibut(Atlantic)	*Hippoglossus hippoglossus*	1	1	1	1
40	American Plaice	*Hippoglossoides platessoides*	4	3	13	
41	Witch Flounder	*Glyptocephalus cynoglossus*	3	3	7	
44	Gulf Stream Flounder	*Citharichthys arctifrons*	2	<1	3	
50	Striped Atlantic Wolffish	*Anarhichas lupus*	2	<1	2	
60	Herring(Atlantic)	*Clupea harengus*	3	5	39	
61	Shad American	*Alosa sapidissima*	1	<1	1	
62	Alewife	*Alosa pseudoharengus*	4	1	6	
70	Mackerel(Atlantic)	*Scomber scombrus*	2	1	2	
123	Rosefish(Black Belly)	*Helicolenus dactylopterus*	6	6	73	
135	Hygophum Hygomi	*Hygophum hygomi*	1	0	1	
142	Fourspot Flounder	*Hippoglossina oblonga*	3	2	7	
143	Brill/Windowpane	*Scophthalmus aquosus*	1	<1	1	
156	Short-Nose Greeneye	*Chlorophthalmus agassizi*	1	<1	12	
158	Muller's Pearlsides	*Maurolicus muelleri*	2	<1	11	
160	Argentine(Atlantic)	*Argentina silus*	2	2	5	
200	Barndoor Skate	*Dipturus laevis*	2	23	5	
201	Thorny Skate	*Amblyraja radiata*	6	5	7	
202	Smooth Skate	*Malacoraja senta*	2	3	10	
203	Little Skate	*Leucoraja erinacea*	3	5	13	
204	Winter Skate	*Leucoraja ocellata*	5	21	27	

Species Code	Common Name	Scientific Name	Sets occupied	Total Weight(kg)	Total Number	Age Samples
220	Spiny Dogfish	*Squalus acanthias*	1	<1	1	
241	Northern Hagfish	*Myxine glutinosa*	2	<1	6	
300	Longhorn Sculpin	*Myoxocephalus octodecemspinosus*	3	<1	3	
320	Sea Raven	*Hemitripterus americanus*	1	2	1	
340	Alligatorfish	*Aspidophoroides monopterygius*	2	<1	2	
400	Monkfish,Goosefish,Angler	*Lophius americanus*	2	4	2	
640	Ocean Pout(Common)	*Macrozoarces americanus*	2	<1	6	
701	Butterfish	*Peprilus triacanthus*	2	<1	2	
720	Atlantic Saury,Needlefish	*Scomberesox saurus*	1	<1	1	

Table 6. Summary of invertebrate catch from the Georges Bank sets (strata 5Z1 and 5Z9) during the summer RV survey.

Species Code	Common Name	Scientific Name	Sets occupied	Total Weight (kg)	Total Number
2212	Pandalus Montagui	*Pandalus montagui*	4	<1	433
2221	Pasiphaea Multidentata	*Pasiphaea multidentata*	1	<1	6
2419	Sabinea Sarsi	*Sabinea sarsi*	2	<1	19
2511	Jonah Crab	*Cancer borealis*	5	4	26
2521	Hyas Coarctatus	*Hyas coarctatus*	1	<1	3
2523	Northern Stone Crab	*Lithodes maja*	1	<1	1
2527	Toad Crab	*Hyas araneus*	5	<1	17
2550	American Lobster	*Homarus americanus*	12	86	89
2555	Munida Iris	*Munida iris*	1	<1	0
2559	Hermit Crabs	*Paguridae*	2	<1	3
2600	Krill Shrimp	*Euphausiacea*	1	<1	0
3100	Bristle Worms	*Polychaeta*	1	<1	1
4321	Sea Scallop	*Placopecten magellanicus*	5	42	360
4511	Short-Fin Squid	*Illex illecebrosus*	7	7	117
4512	Longfin Squid, Longfin Inshore Squid	*Loligo pealeii*	2	<1	10
4521	Octopus	*Octopoda*	3	<1	3
6100	Asteroidea	*Asteroidea*	1	<1	2
6101	Ceremaster Granularis	*Ceremaster granularis*	2	<1	2

Species Code	Common Name	Scientific Name	Sets occupied	Total Weight (kg)	Total Number
6102	Porania Pulvilis	*Porania pulvilis*	6	1	25
6109	Asterias Forbesi	*Asterias forbesi*	3	<1	10
6111	Asterias Rubens	*Asterias rubens*	1	<1	1
6116	Pseudarchaster	*Pseudarchaster*	1	<1	1
6117	Hippasteria Phrygiana	*Hippasteria phrygiana*	2	<1	3
6120	Henrica	*Henrica*	7	<1	44
6123	Spiny Sunstar	*Crossaster papposus*	4	1	18
6134	Slender Armed Sea Star	*Leptasterias tenera*	2	<1	12
6411	Sea Urchin (Green)	*Strongylocentrotus droebachiensis*	2	<1	2
8300	Sea Anemone	*Anthozoa*	5	1	6
8347	Psilaster Andromeda	*Psilaster andromeda*	2	<1	4
8600	Sponges	*Porifera*	7	4	31

Table 7. Special samples collected during the 2011 summer RV survey.

Organism Requested	Details of Request
Skate Purses	All
Little Skate	Kept live
Sea Urchins	Strongylocentrotus droebachensis and S. pallidus – depths >70 m
Atlantic halibut	Maturity staging
Large Shark species	Fork length, total length, sex, photograph
Deepwater Shark species	Frozen Whole
American Plaice (4VsW)	500 – otoliths and maturity

Table 8. Index of individual species summaries and associated figures.

Species	Summary Page	Figure Page
Atlantic Cod (*Gadus morhua*)	6	31
Haddock (*Melanogrammus aeglefinus*)	7	35
White Hake (*Urophycis tenuis*)	7	39
Silver Hake (*Merluccius bilinearis*)	7	43
Pollock (*Pollachius virens*)	7	46
Redfish (*Sebastes*)	7	49
Atlantic Halibut (*Hippoglossus hippoglossus*)	8	52
Winter Flounder (*Pseudopleuronectes americanus*)	8	54
Witch Flounder (*Glyptocephalus cynoglossus*)	8	57
American Plaice (*Hippoglossoides platessoides*)	8	60
Yellowtail Flounder (*Limanda ferruginea*)	8	62
Spiny Dogfish (*Squalus acanthias*)	9	64
Winter Skate (*Leucoraja ocellata*)	9	66
Thorny Skate (*Amblyraja radiata*)	9	68
Greenland Halibut (*Reinhardtius hippoglossoides*)	9	70
Atlantic Herring (*Clupea harengus*)	9	72
Argentine (*Argentina silus*)	9	74
Northern Sandlance (*Ammodytes dubius*)	9	75
Cusk (*Brosme brosme*)	9	76
Atlantic Wolffish (*Anarhichas lupus*)	9	76
Monkfish (*Lophius americanus*)	9	77
Red Hake (*Urophycis chuss*)	9	77
Blackbelly Rosefish (*Helicolenus dactylopterus*)	10	78
Ocean Pout (*Macrozoarces americanus*)	10	78
Northern Hagfish (*Myxine glutinosa*)	10	79
American Lobster (*Homarus americanus*)	10	80
Short-fin Squid (*Illex illecebrosus*)	10	82
Sea Scallop (*Placopecten magellanicus*)	10	84
Snow Crab (*Chionoecetes opilio*)	10	86
Pink Shrimp (*Pandalus montagui*)	10	88
Northern Shrimp (*Pandalus borealis*)	10	89
Orange Footed Sea Cucumber (*Cucumaria frondosa*)	10	90

Table 9. Comparison of 2011 biomass estimate (mt) with 2010 estimate, short-term 5 year average (2005-2009), medium-term 15 year average (1995-2009), and the long-term survey average (1970-2009 for 4X and 4VW).

Stock/Region	2011	2010	Short-term Avg	Medium-term Avg	Long-term Avg
4VW Cod	32,000	41,491	30,795	19,767	70,264
4X5Y Cod (4X East)	2,091	1,835	3,218	4,665	8,428
4X5Y Cod (4X West)	1,684	1,203	4,974	10,809	13,412
4VW Haddock	28,763	48,339	79,642	63,526	61,237
4X5Y Haddock (4X East)	34,974	26,834	39,149	34,799	34,830
4X5Y Haddock (4X West)	12,900	18,702	14,209	22,799	22,354
4VW White Hake	4,850	5,507	5,668	6,026	10,406
4X5Y White Hake (4X East)	1,738	1,748	1,555	1,602	2,759
4X5Y White Hake (4X West)	7,626	12,587	11,304	11,865	16,435
4VW Silver Hake	43,366	29,024	15,570	18,783	*23,885
4X5Y Silver Hake (4X East)	8,151	8,764	4,979	5,888	*10,077
4X5Y Silver Hake (4X West)	3,638	61,940	2,281	4,229	*4,122
4VW Pollock	26,624	4,429	13,840	8,918	16,528
4X5Y Pollock (4X East)	129,074	13,378	10,927	8,945	17,596
4X5Y Pollock (4X West)	5,715	5,826	54,781	29,496	25,924
4VW Redfish	144,992	117,253	54,537	42,443	64,950
4X5Y Redfish (4X East)	80,816	43,251	118,934	67,730	44,800
4X5Y Redfish (4X West)	44,025	28,642	62,765	31,960	22,556
4VW American Plaice	9,600	12,038	18,576	17,144	24,923
4VW Witch Flounder	5,119	3,955	5,730	3,805	3,931
4X5Y Witch Flounder (4X East)	225	241	453	659	675
4X5Y Witch Flounder (4X West)	263	2,084	867	892	1,210
4VW Yellowtail Flounder	11,615	10,197	11,827	10,073	13,782
4X5Y Winter Flounder (4X East)	1,152	404	598	1,058	560
4X5Y Winter Flounder (4X West)	2,438	12,580	4,422	3,403	2,669
Atlantic Halibut in 4VWX	6,777	8,277	5,719	3,388	3,088
4VW Atlantic Wolffish	483	415	598	1004	2,084
4X Atlantic Wolffish	638	348	465	1,389	2,236
4VW Monkfish	1,178	681	1,228	1,504	3,399
4X Monkfish	732	236	1,009	1,457	2,379

*Silver hake long-term average is for 1982-2009

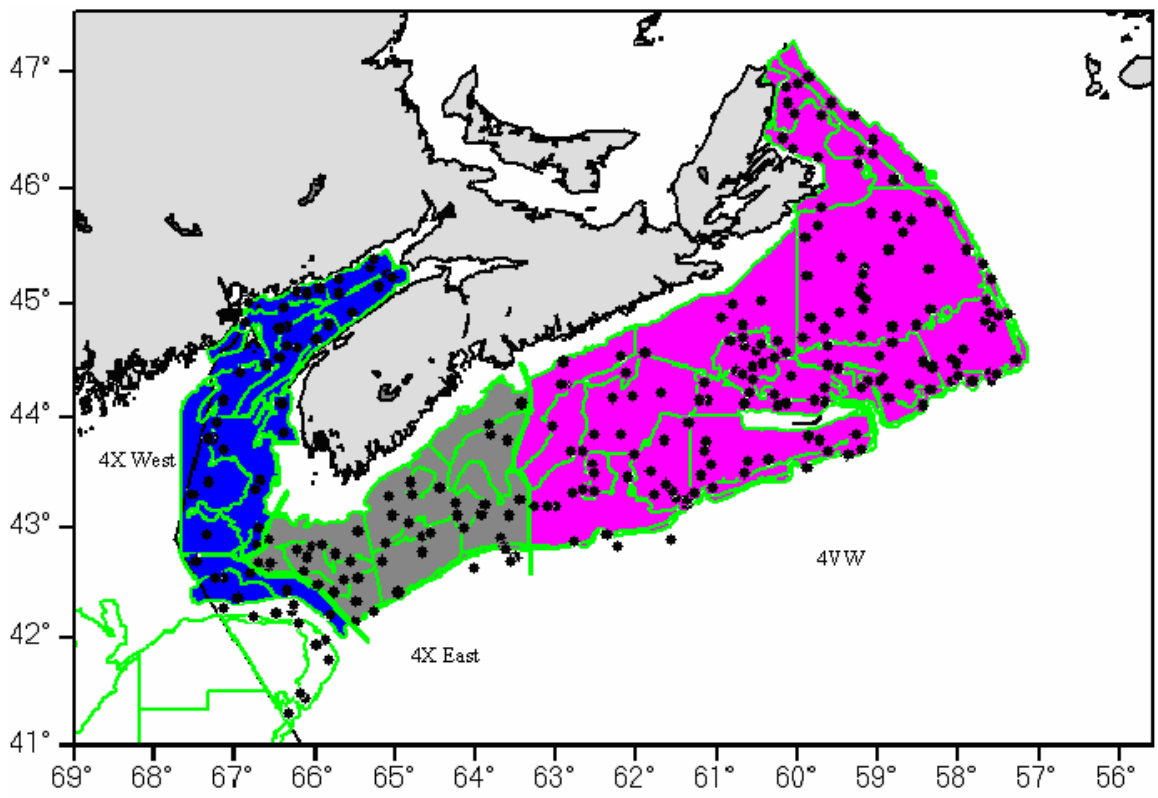


Figure 1. 2011 Summer Research Vessel Survey station distribution. Geographic areas (strata) used in calculating catch for 4VW, 4X East and 4X West are indicated.

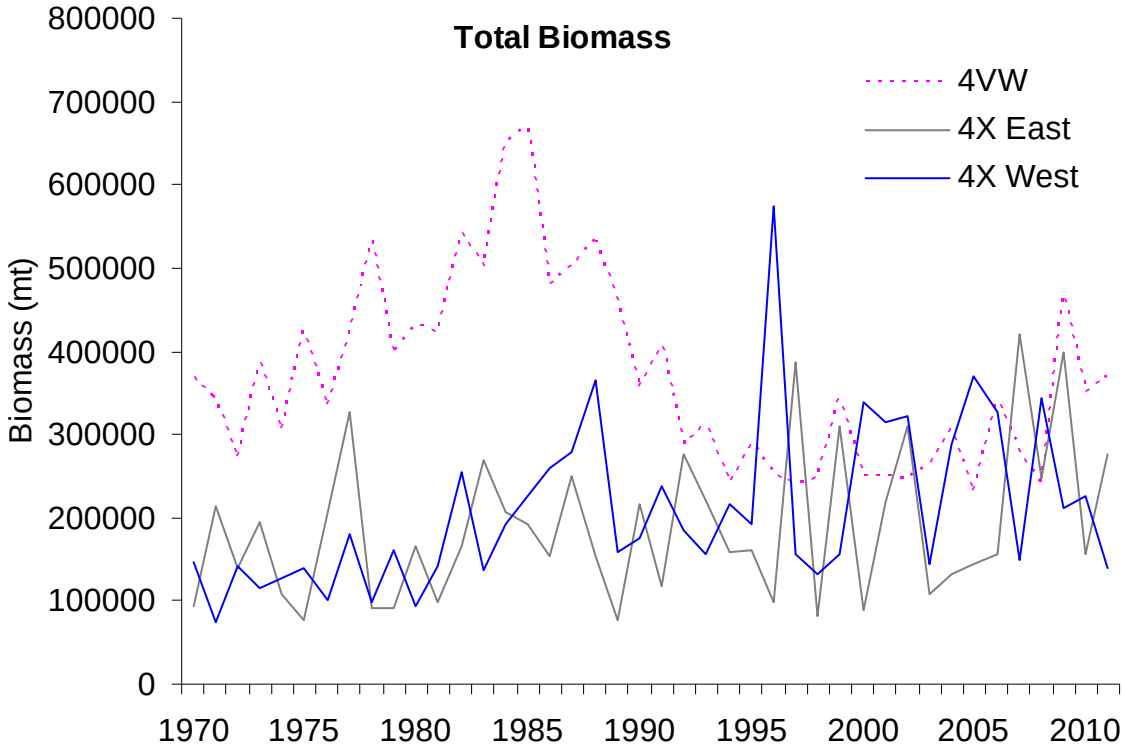


Figure 2. Total biomass estimate for all species (vertebrates, lobster and squid) combined by NAFO Division/geographic region from the summer RV survey, 1970-2011.

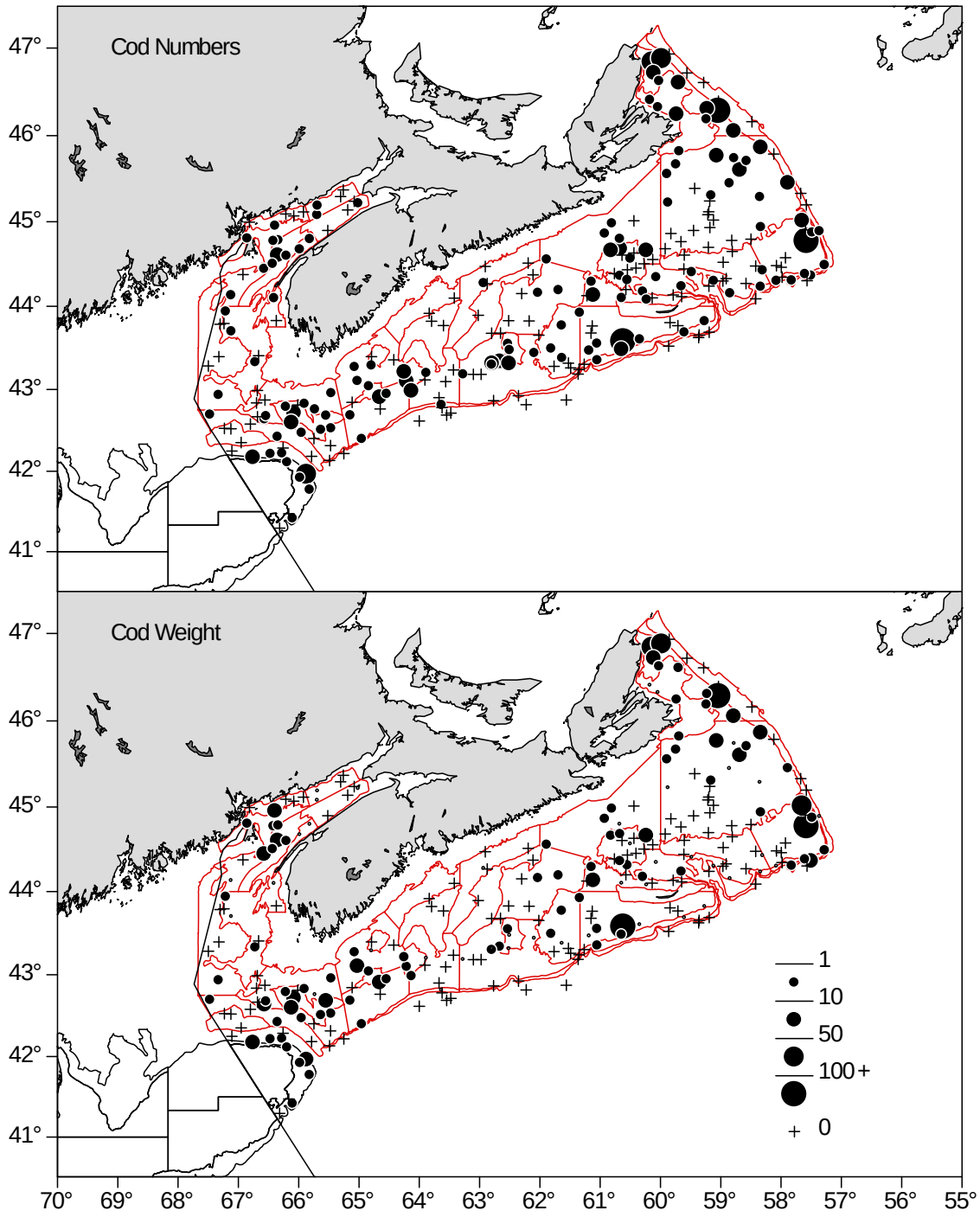


Figure 3. Distribution of cod catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

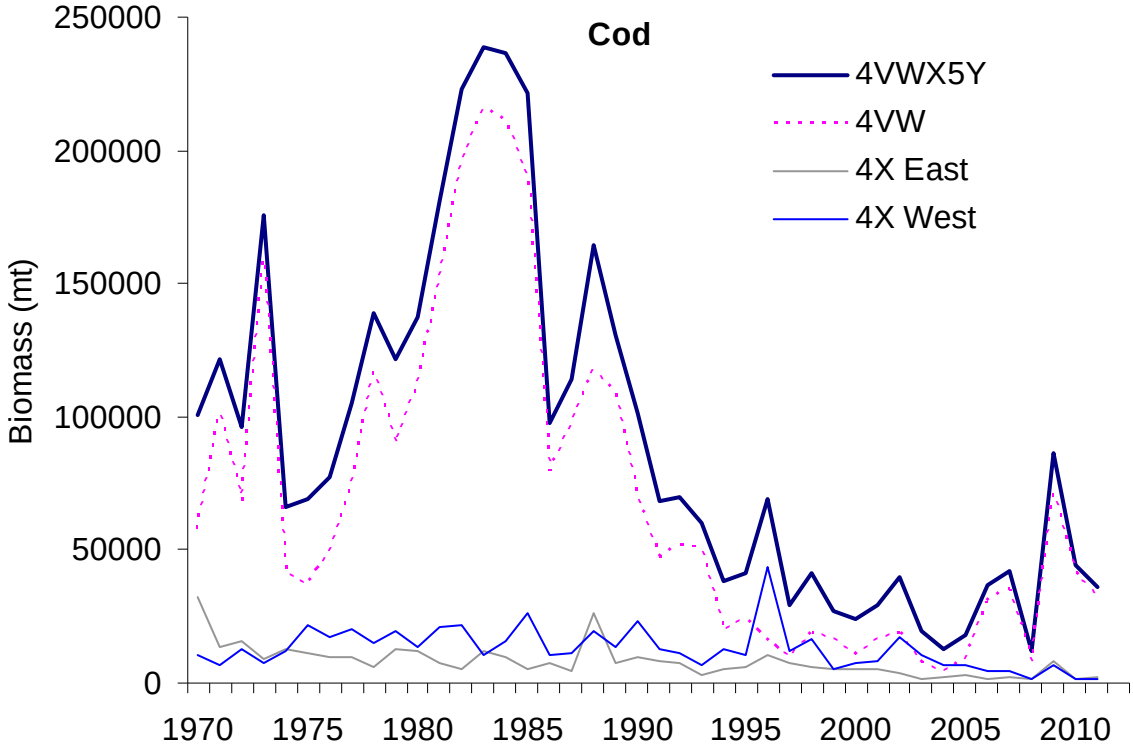


Figure 4. Total biomass estimates for cod in 4VWX5Y from the summer RV survey.

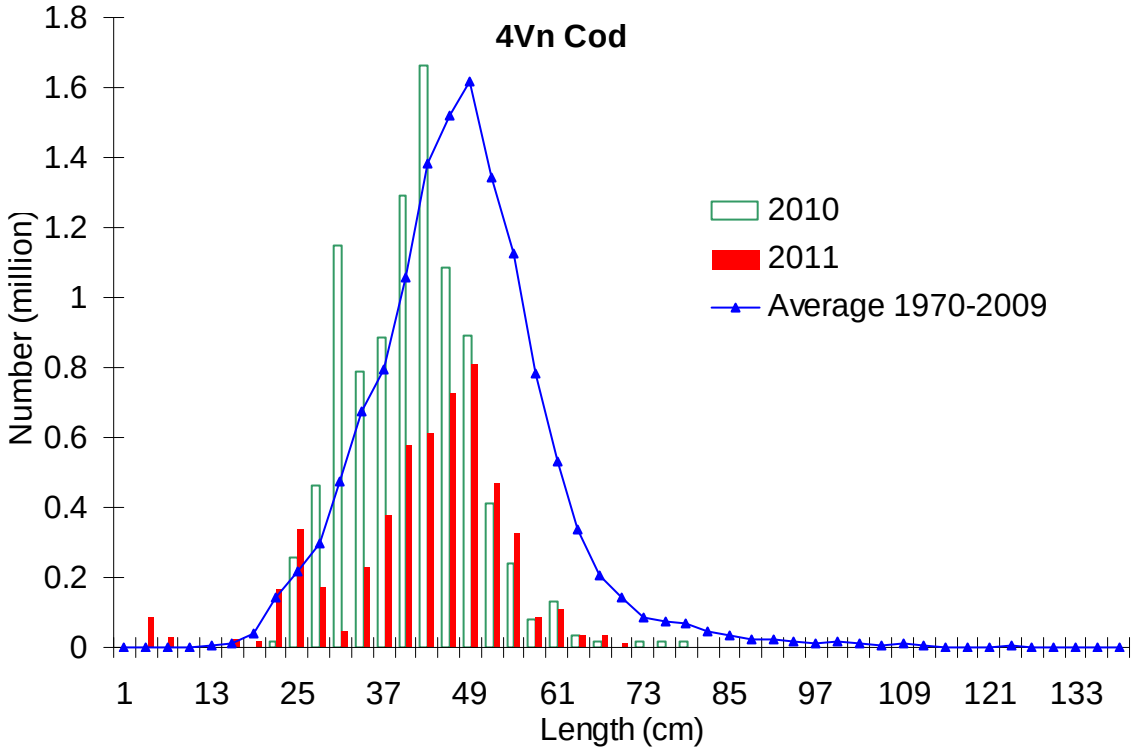


Figure 5. Length stratified total number (millions) of cod in 4Vn in 2010 and 2011 compared to the average for 1970-2009.

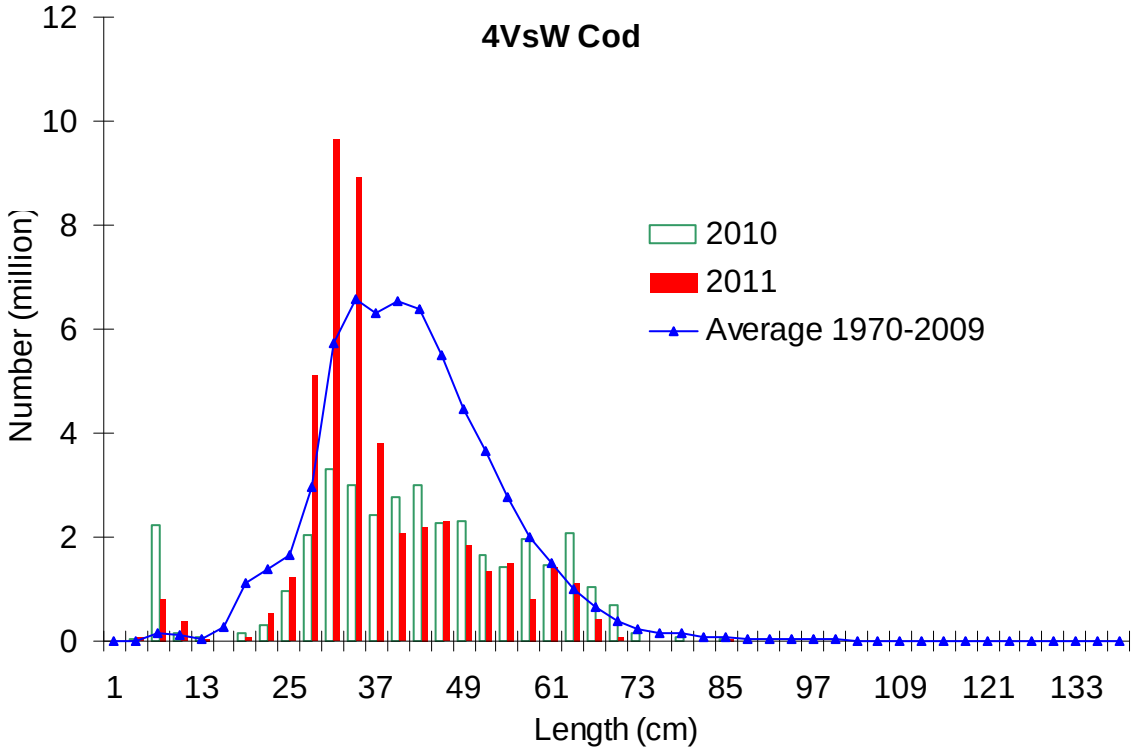


Figure 6. Length stratified total number (millions) of cod in 4VsW in 2010 and 2011 compared to the average for 1970-2009.

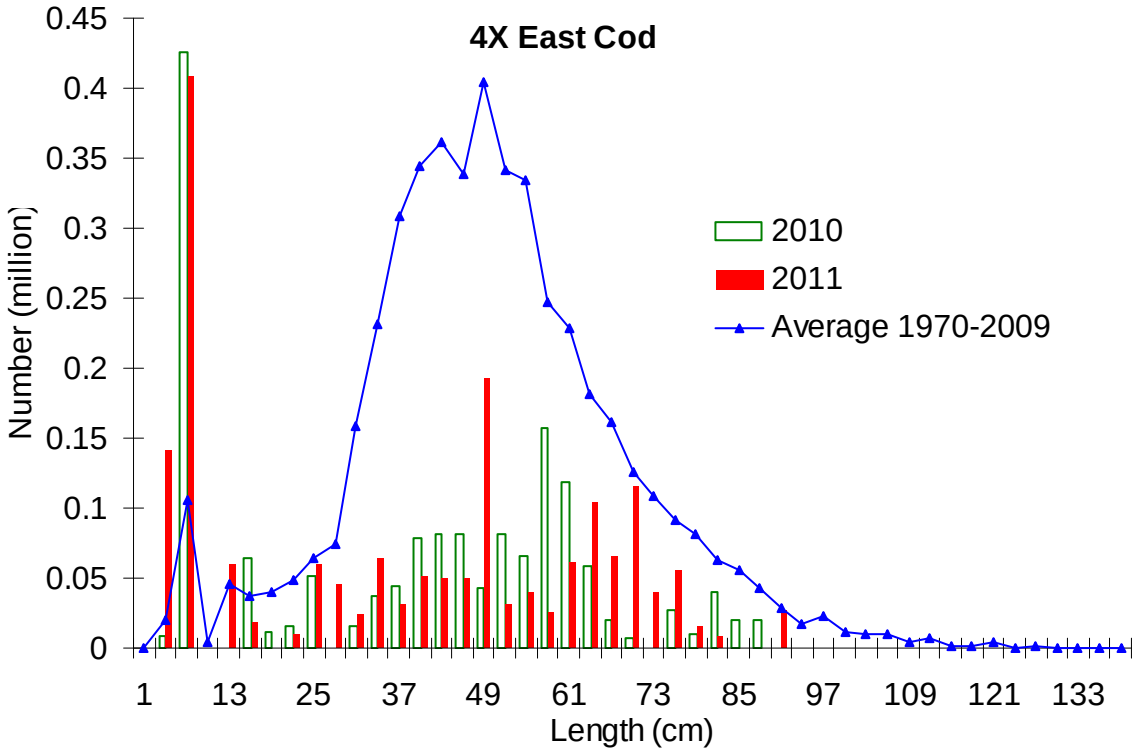


Figure 7. Length stratified total number (millions) of cod in 4X East in 2010 and 2011 compared to the average for 1970-2009.

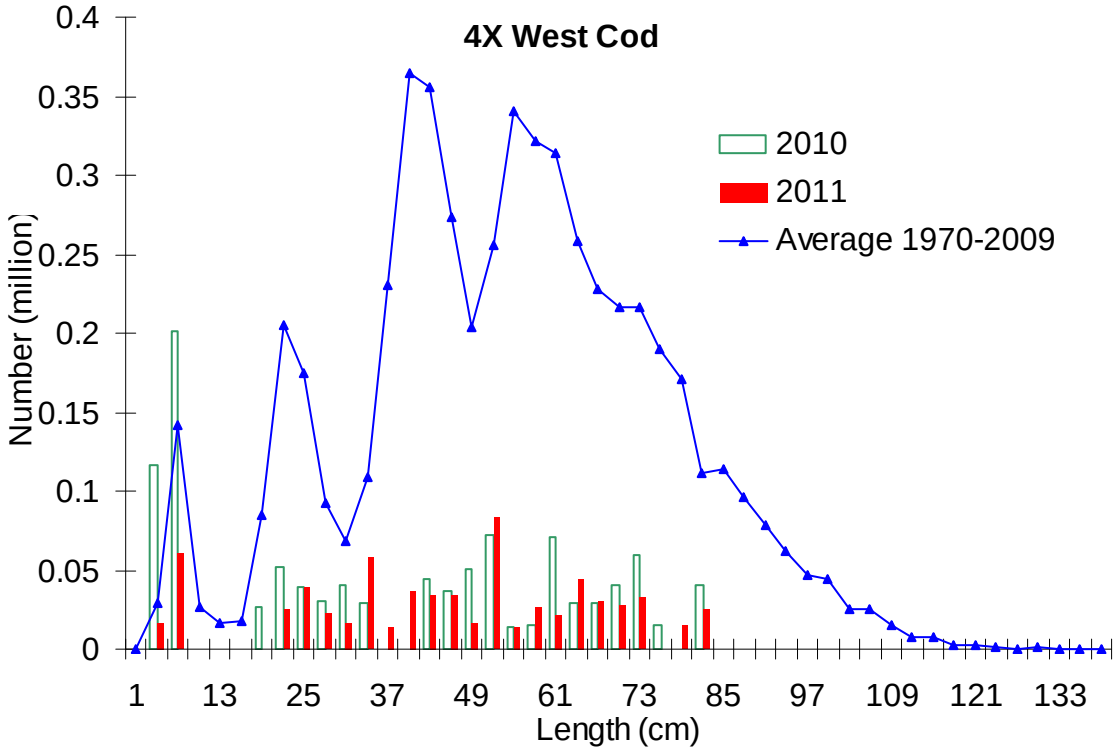


Figure 8. Length stratified total number (millions) of cod in 4X West in 2010 and 2011 compared to the average for 1970-2009.

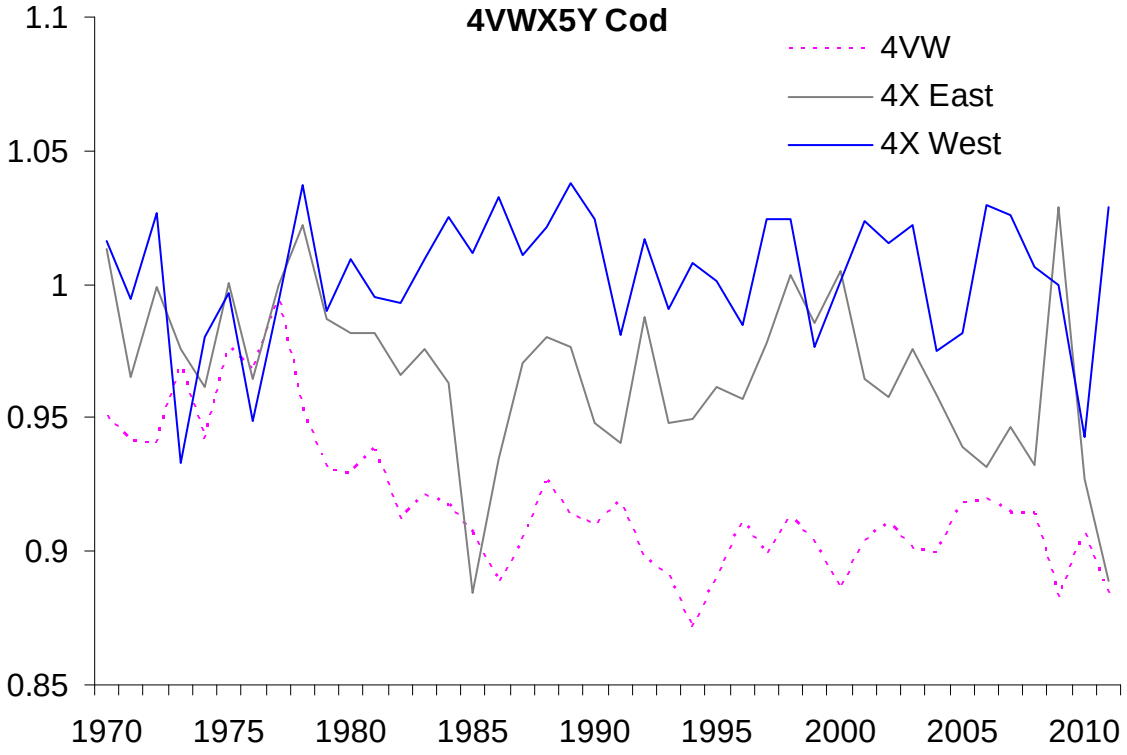


Figure 9. Condition factor (Fulton's K) for cod in 4VWX5Y from the summer RV survey.

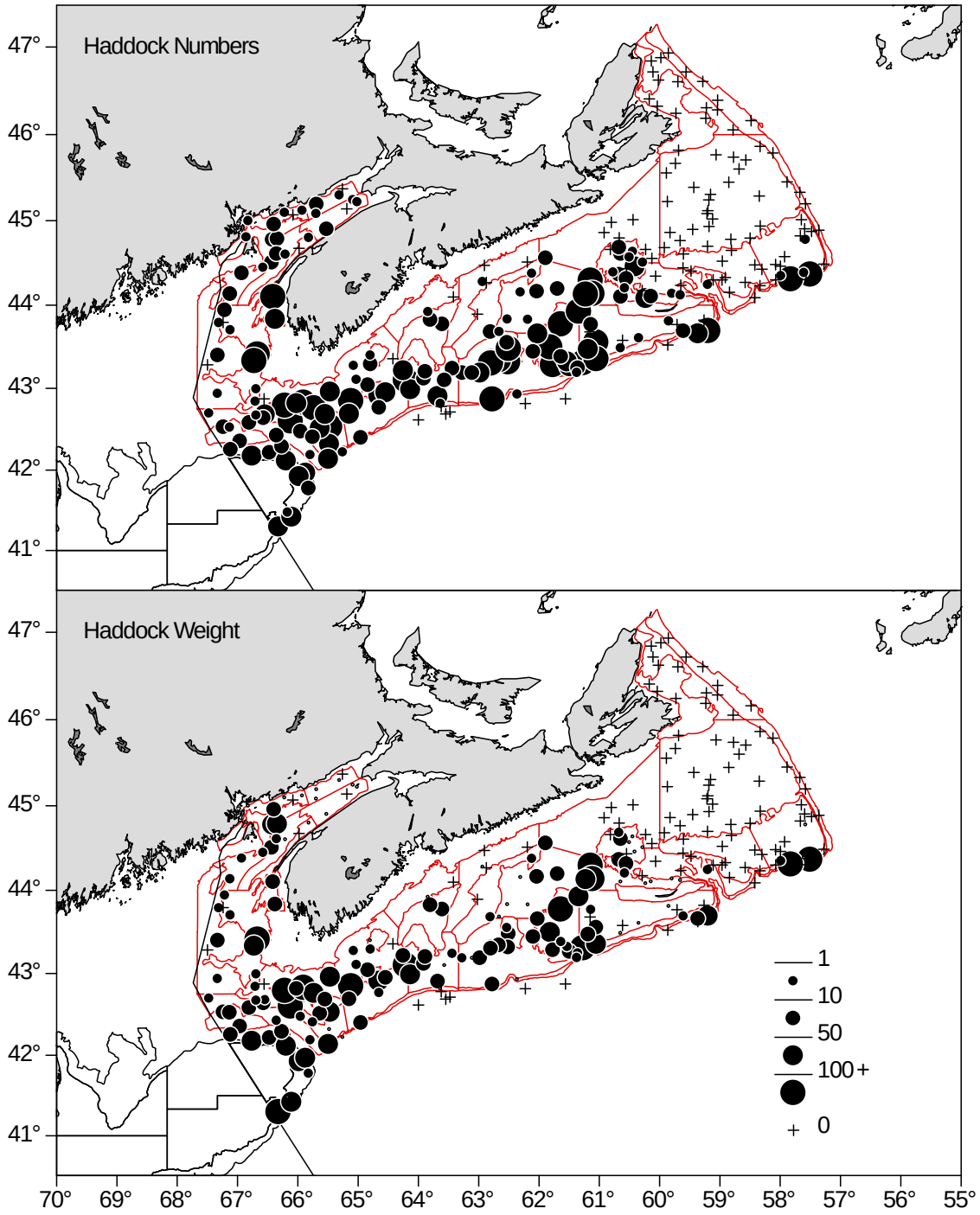


Figure 10. Distribution of haddock catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

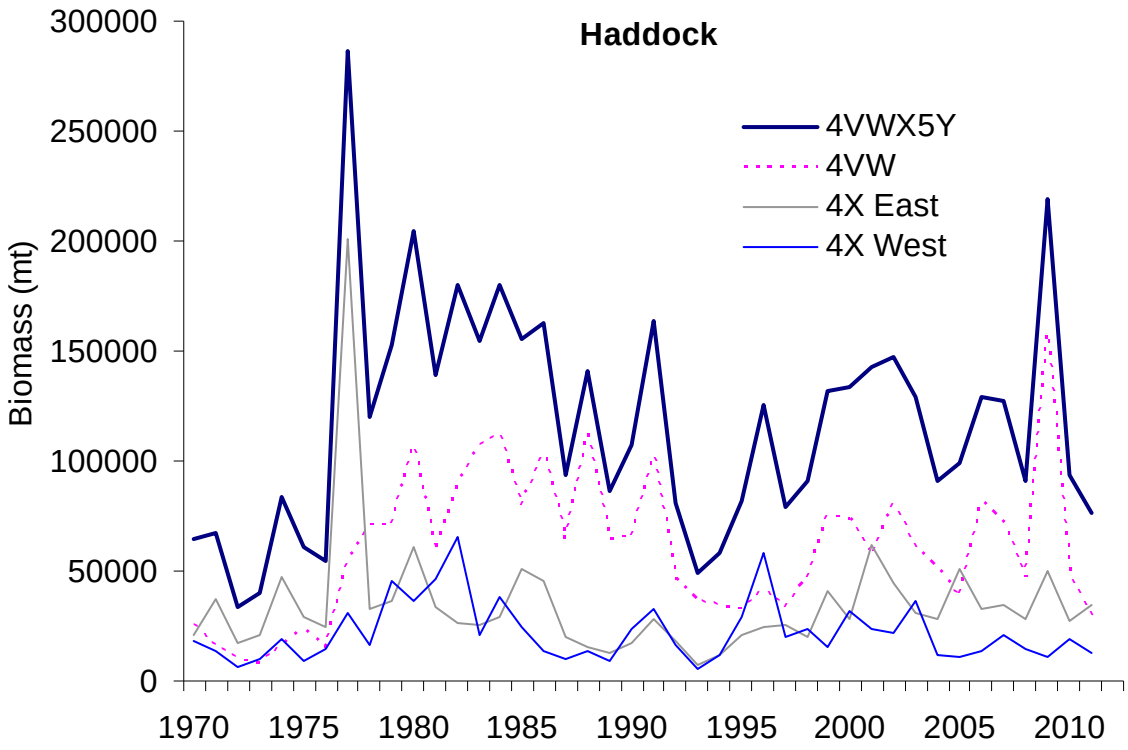


Figure 11. Total biomass estimates for haddock in 4VWX5Y from the summer RV survey.

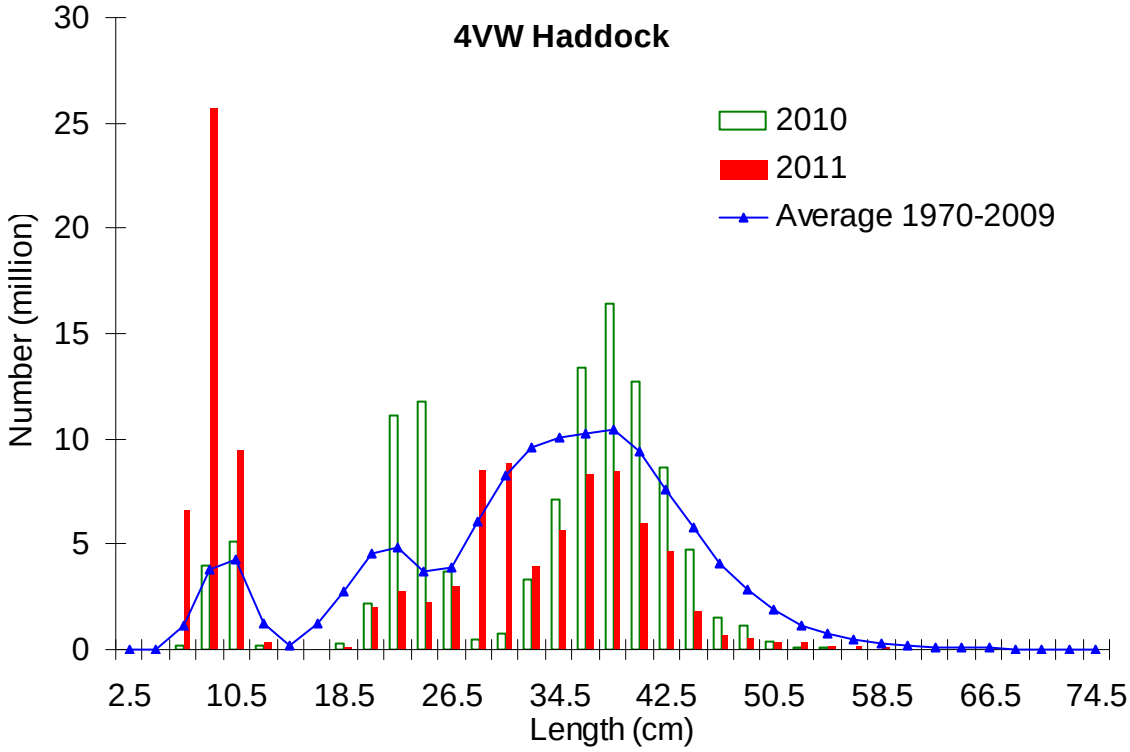


Figure 12. Length stratified total number (millions) of haddock in 4VW in 2010 and 2011 compared to the average for 1970-2009.

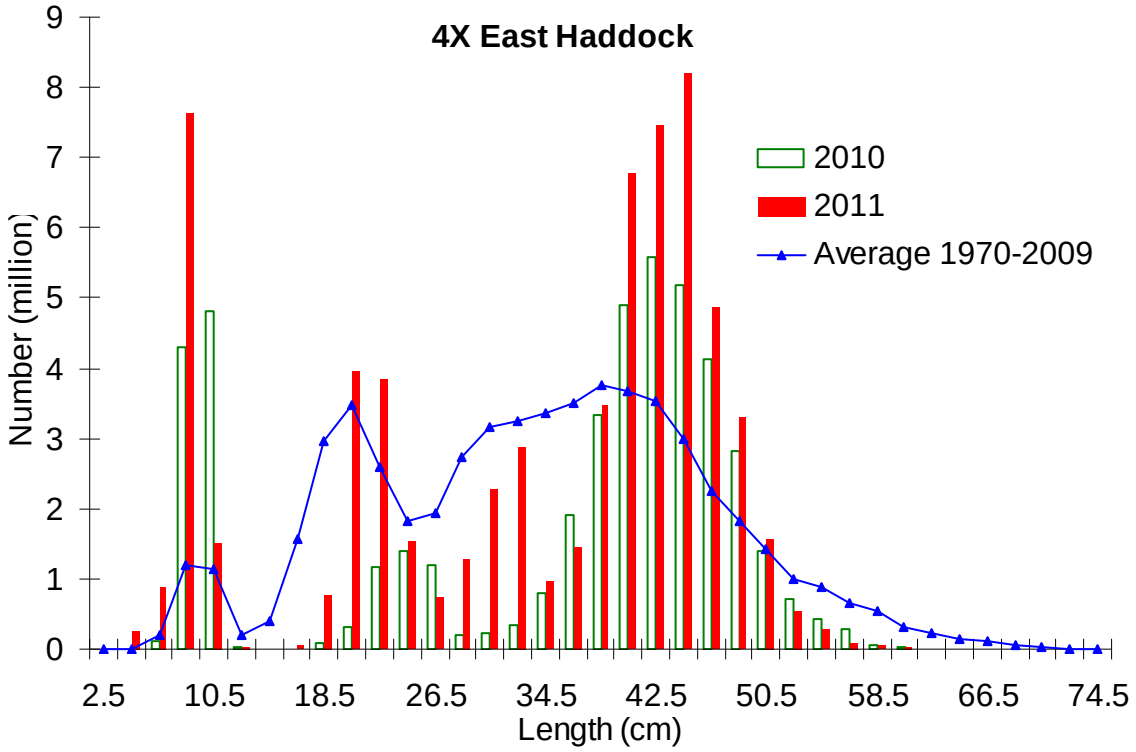


Figure 13. Length stratified total number (millions) of haddock in 4X East in 2010 and 2011 compared to the average for 1970-2009.

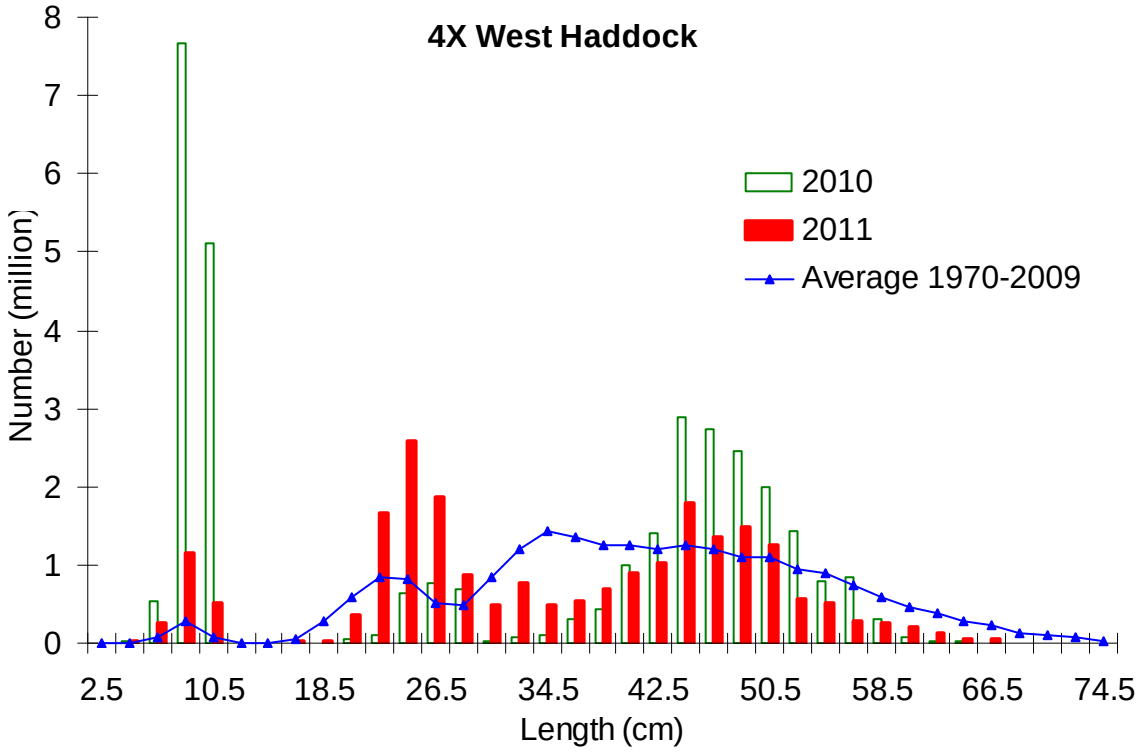


Figure 14. Length stratified total number (millions) of haddock in 4X West in 2010 and 2011 compared to the average for 1970-2009.

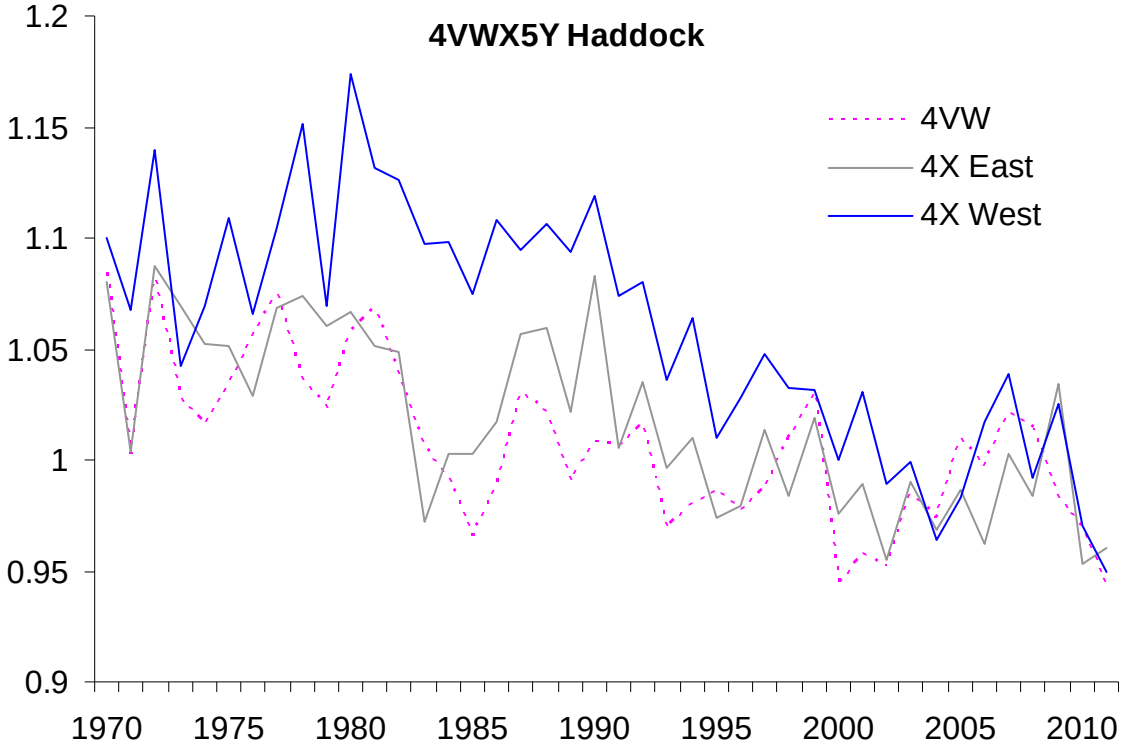


Figure 15. Condition factor (Fulton's K) for haddock in 4VWX5Y from the summer RV survey.

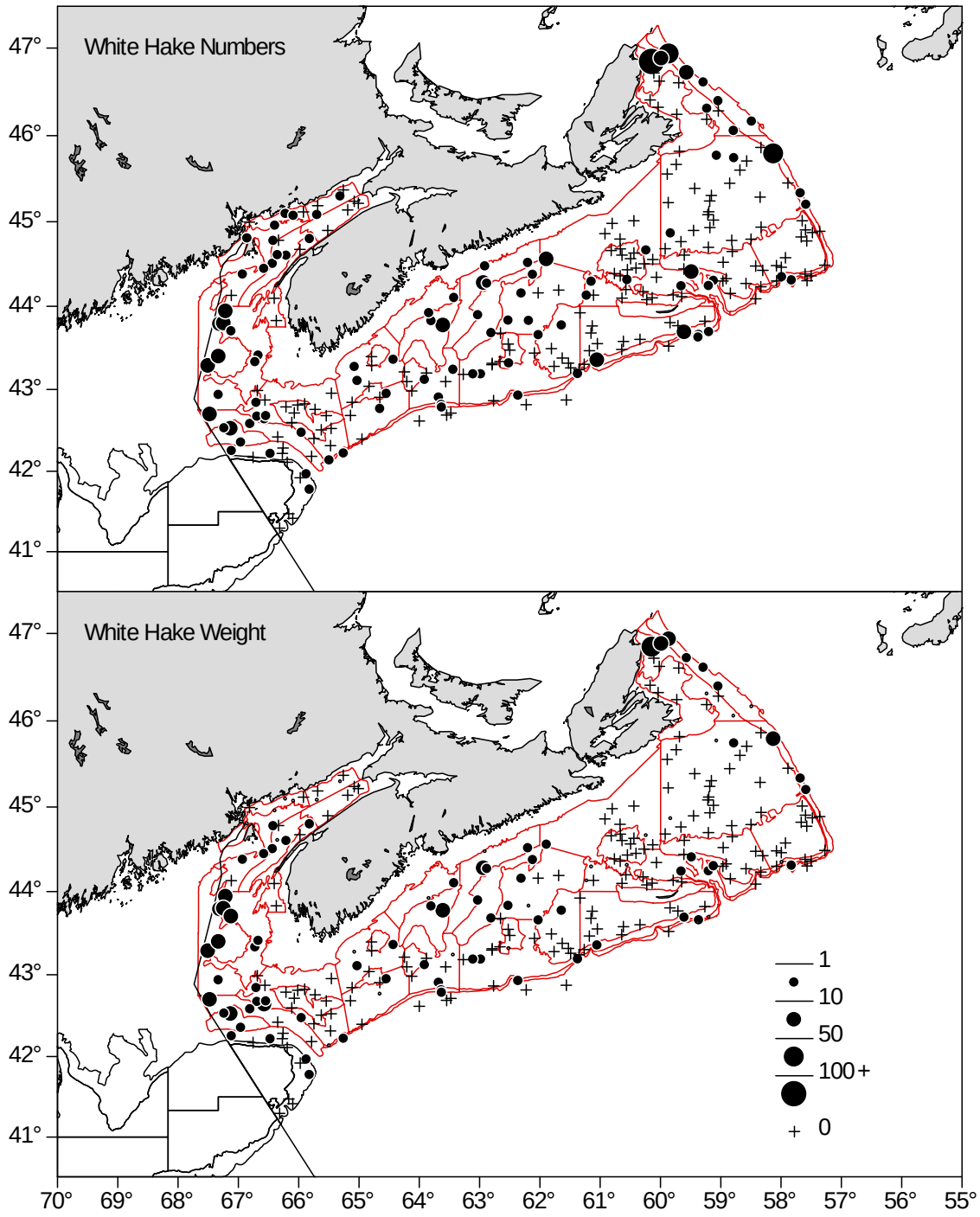


Figure 16. Distribution of white hake catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

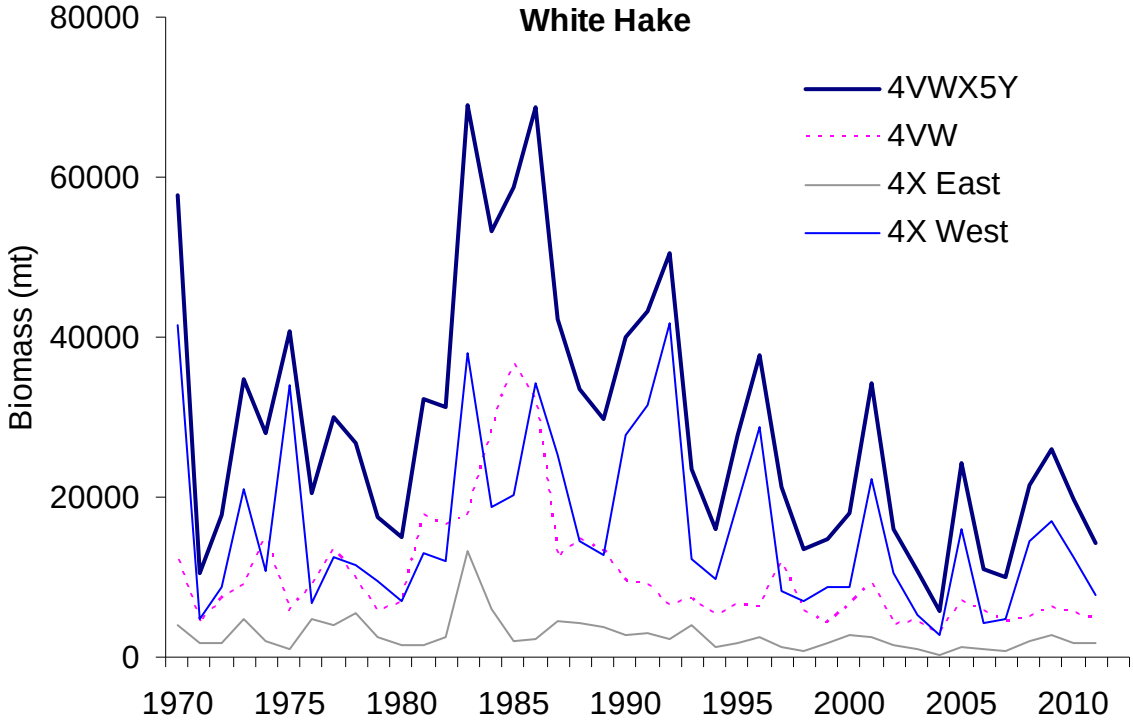


Figure 17. Total biomass estimates for white hake in 4VWX5Y from the summer RV survey.

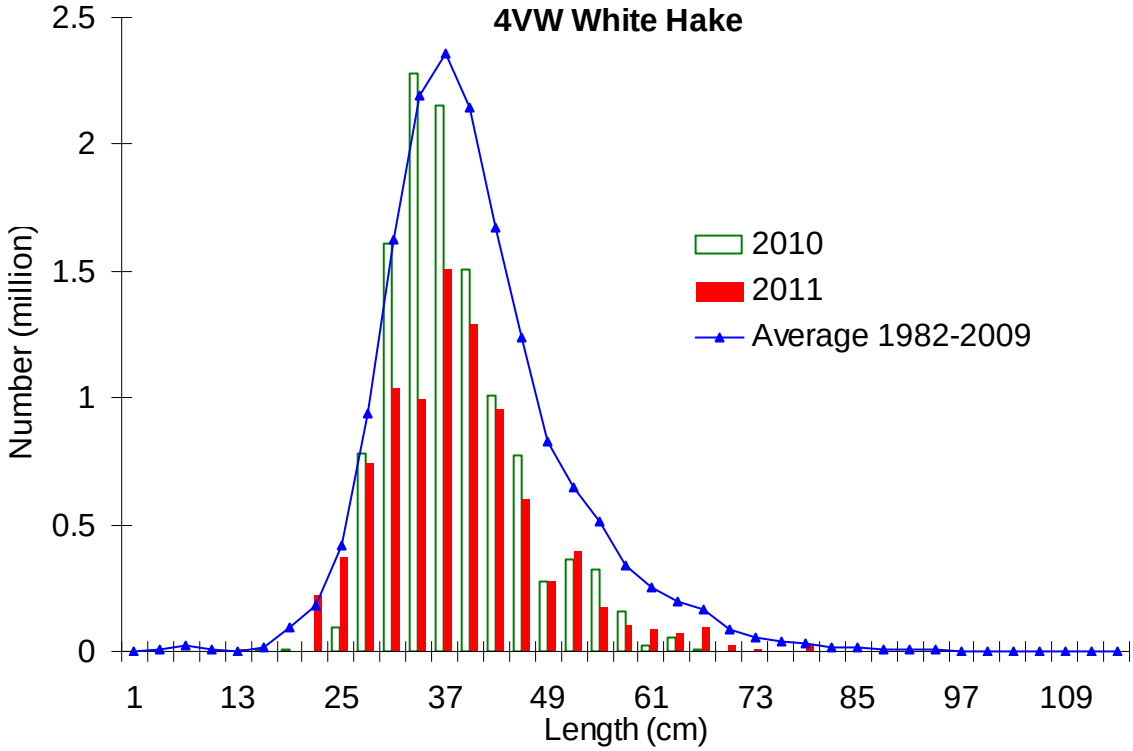


Figure 18. Length stratified total number (millions) of white hake in 4VW in 2010 and 2011 compared to the average for 1970-2009.

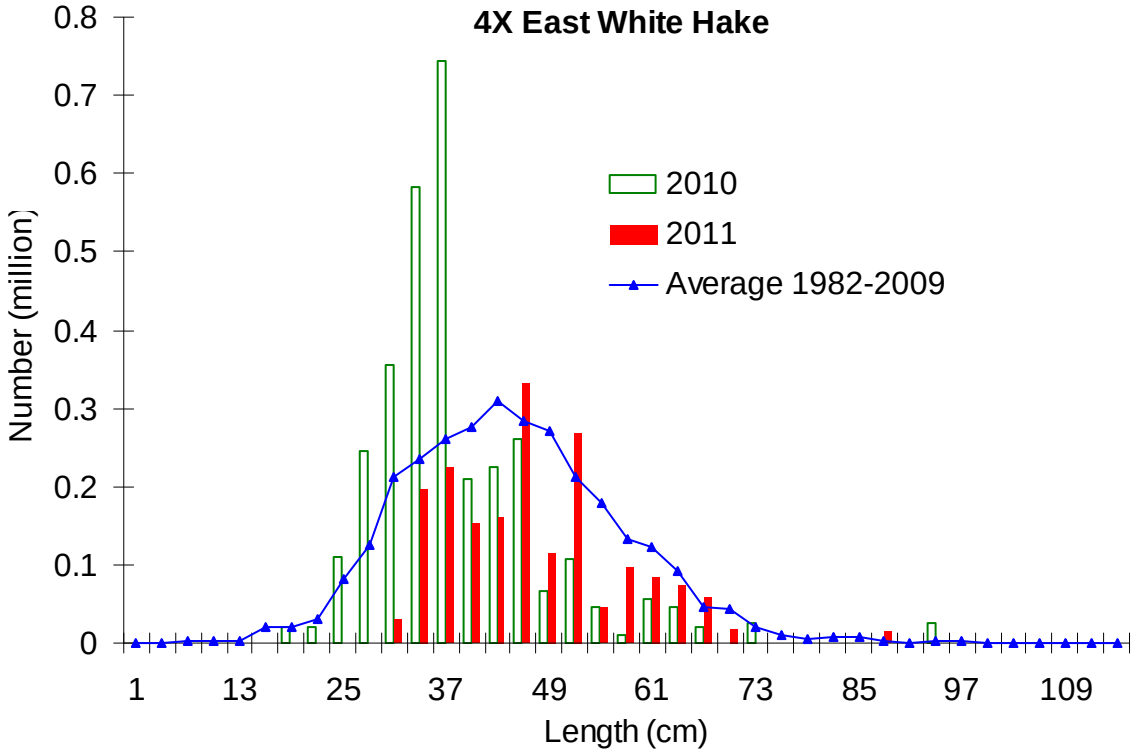


Figure 19. Length stratified total number (millions) of white hake in 4X East in 2010 and 2011 compared to the average for 1970-2009.

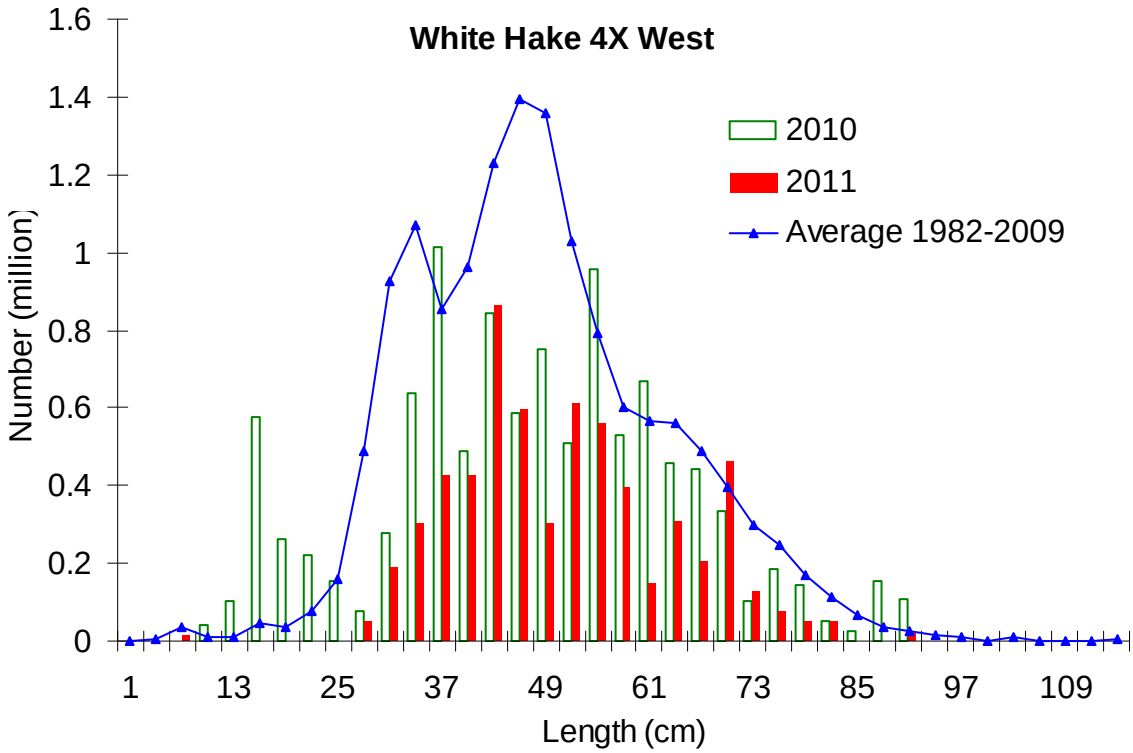


Figure 20. Length stratified total number (millions) of white hake in 4X West in 2010 and 2011 compared to the average for 1970-2009.

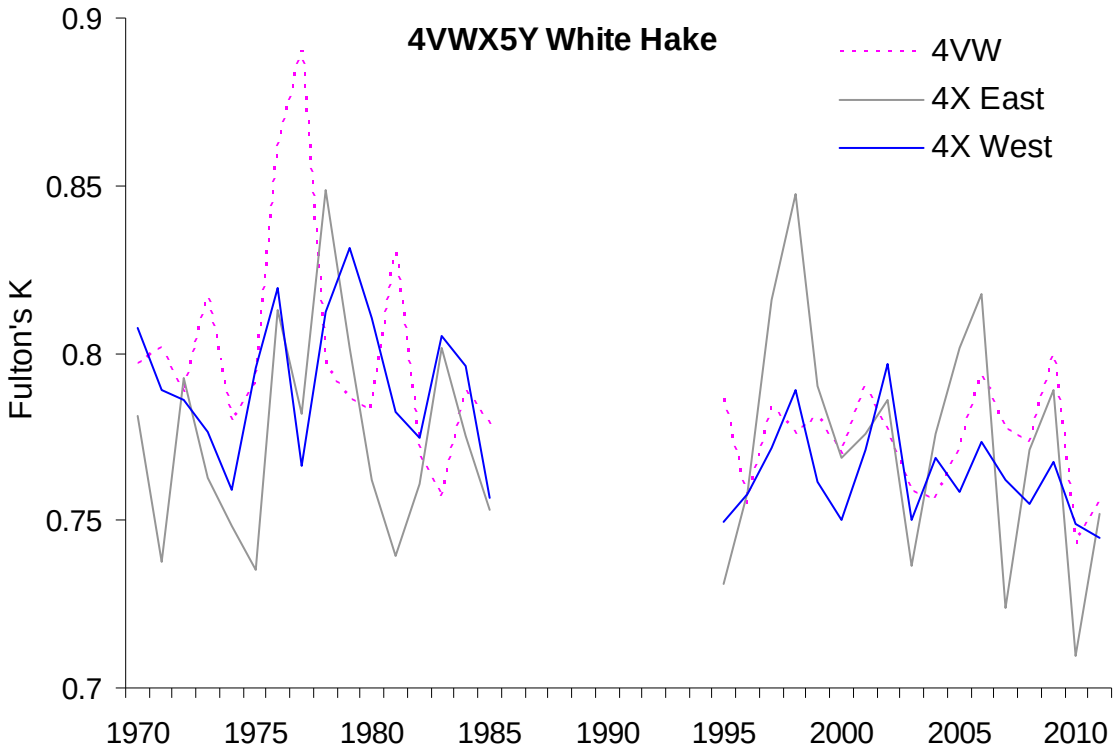


Figure 21. Condition factor (Fulton's K) for white hake in 4VWX5Y from the summer RV survey.

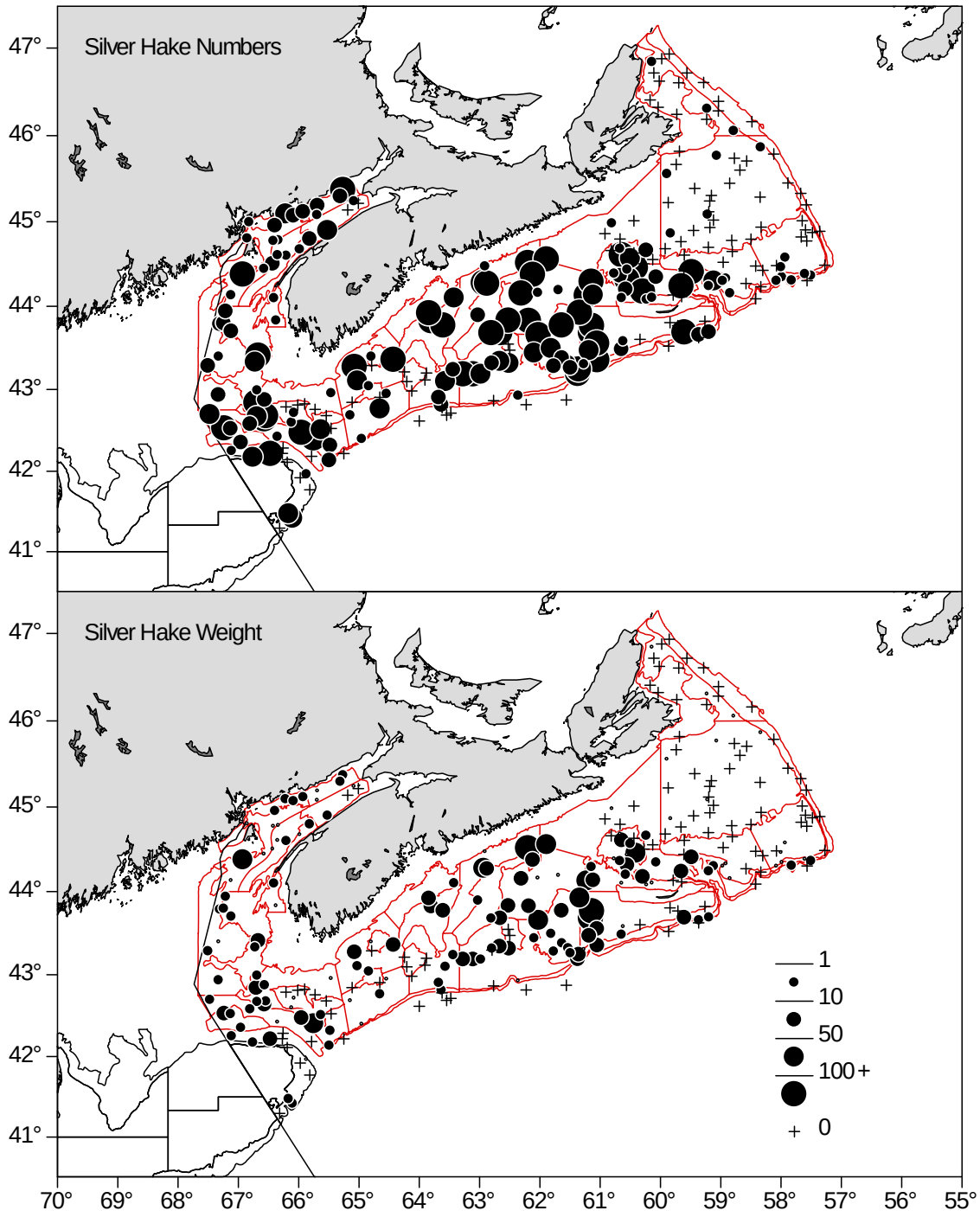


Figure 22. Distribution of silver hake catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

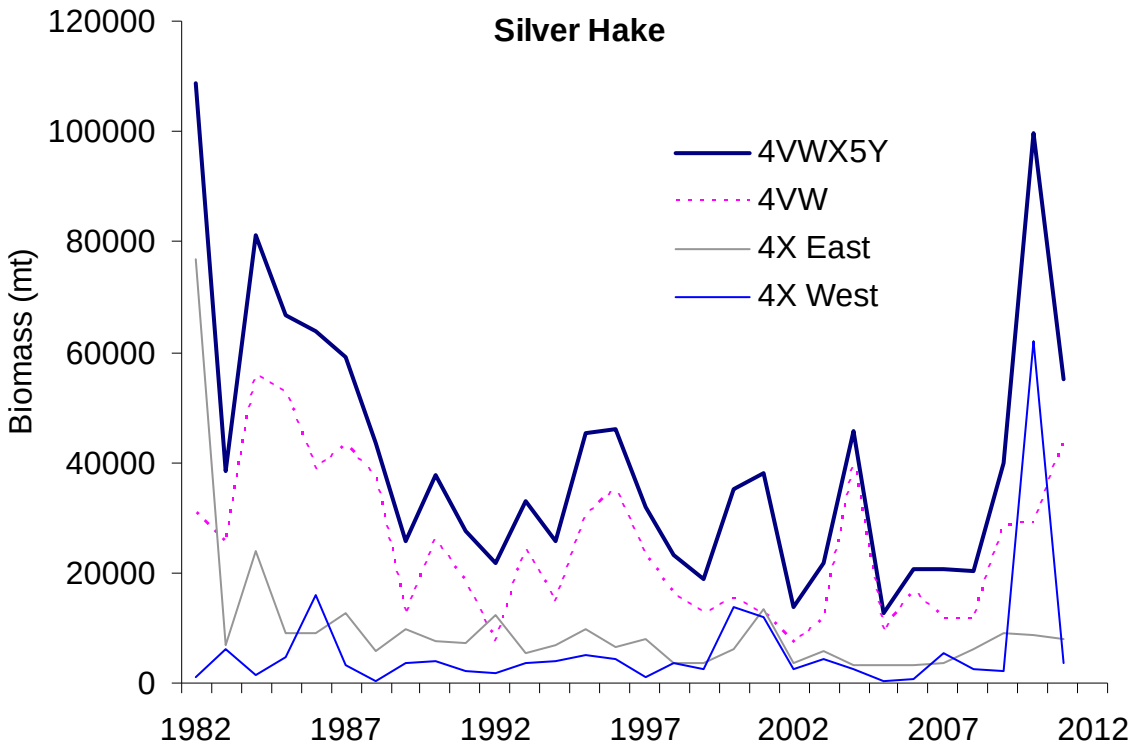


Figure 23. Total biomass estimates for silver hake in 4VWX5Y from the summer RV survey.

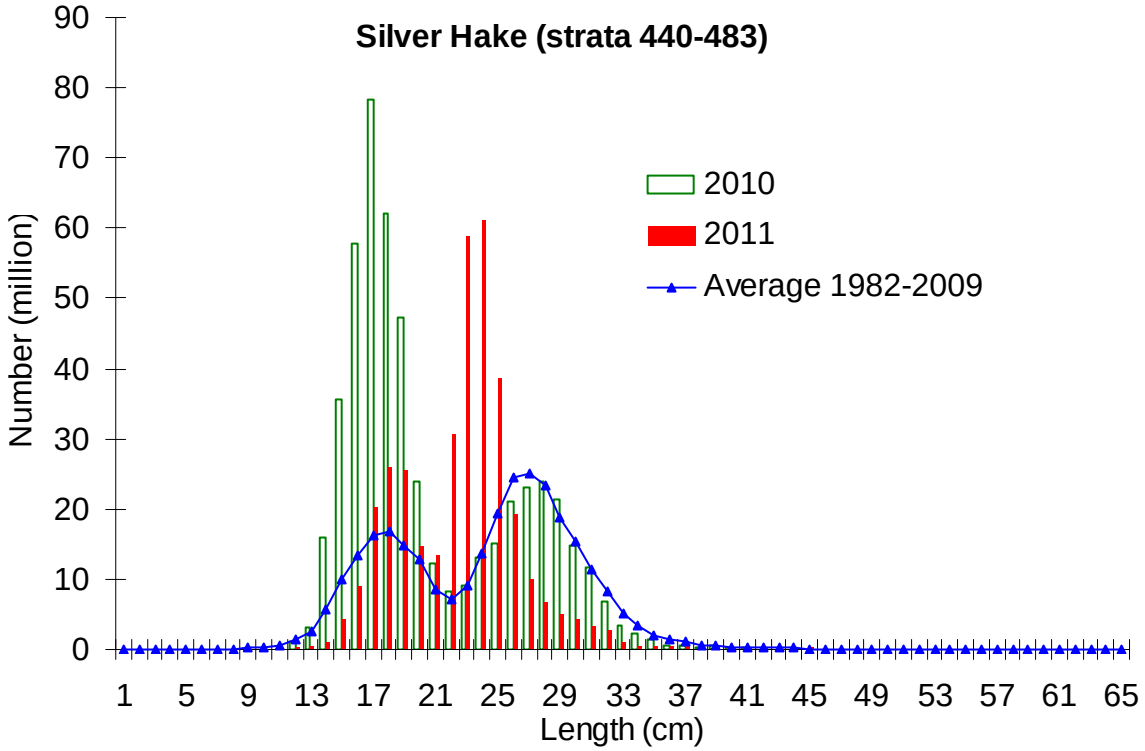


Figure 24. Length stratified total number (millions) of silver hake in strata 440-483 in 2010 and 2011 compared to the average for 1970-2009.

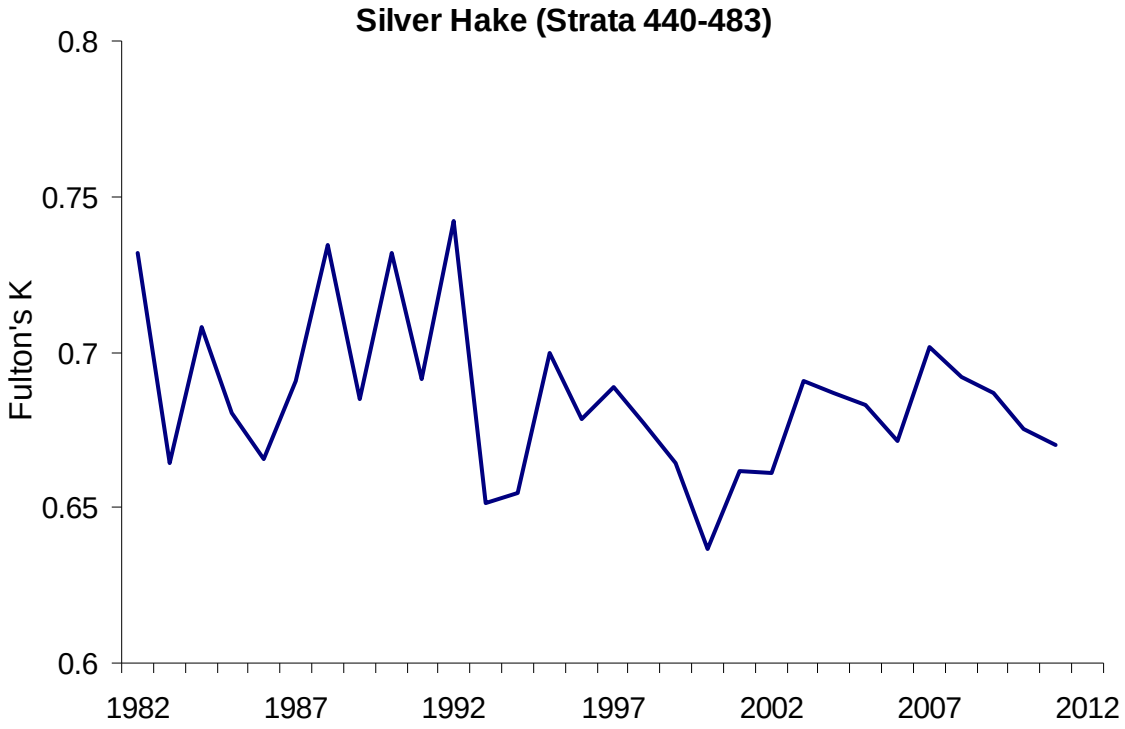


Figure 25. Condition factor (Fulton's K) for silver hake in strata 440-483 from the summer RV survey.

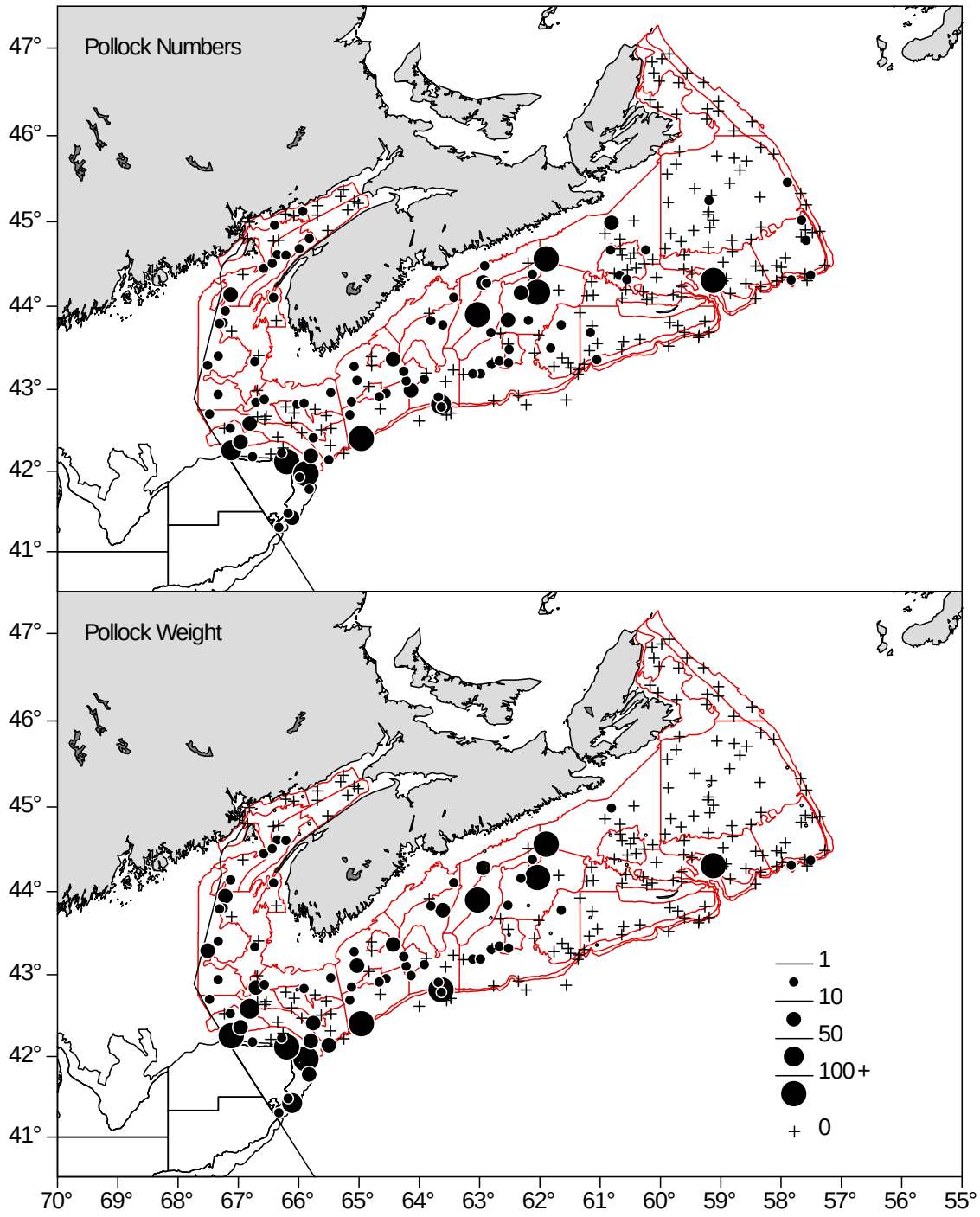


Figure 26. Distribution of pollock catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

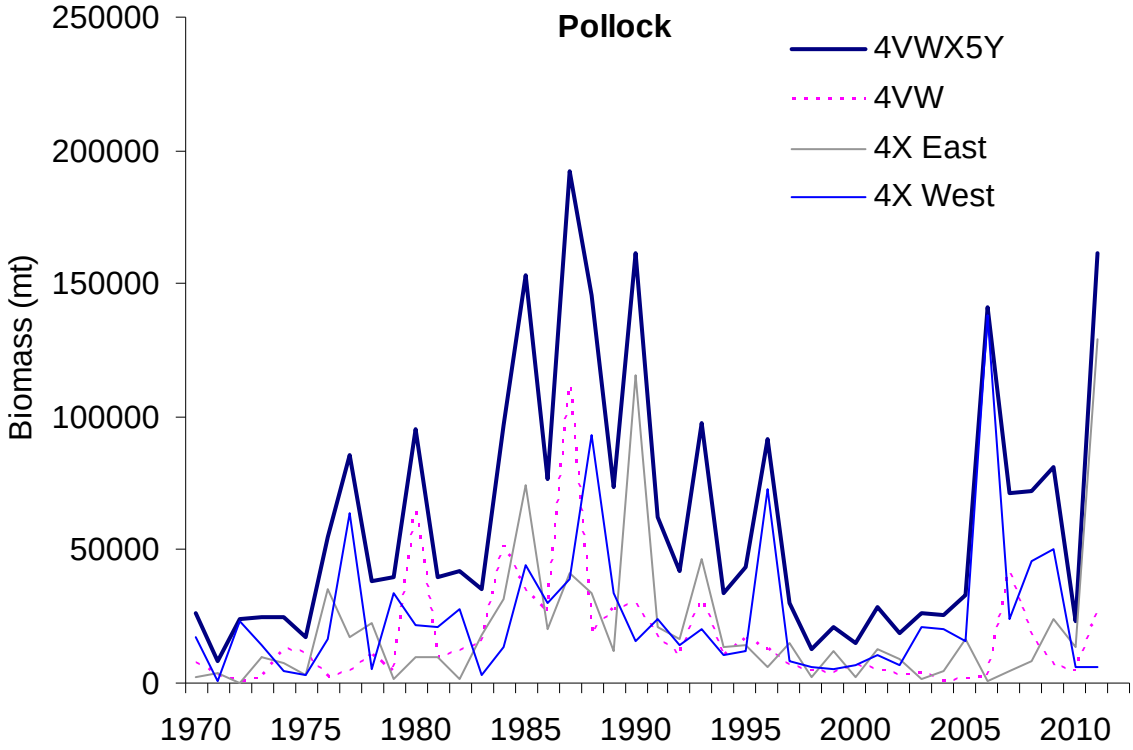


Figure 27. Total biomass estimates for pollock in 4VWX5Y from the summer RV survey.

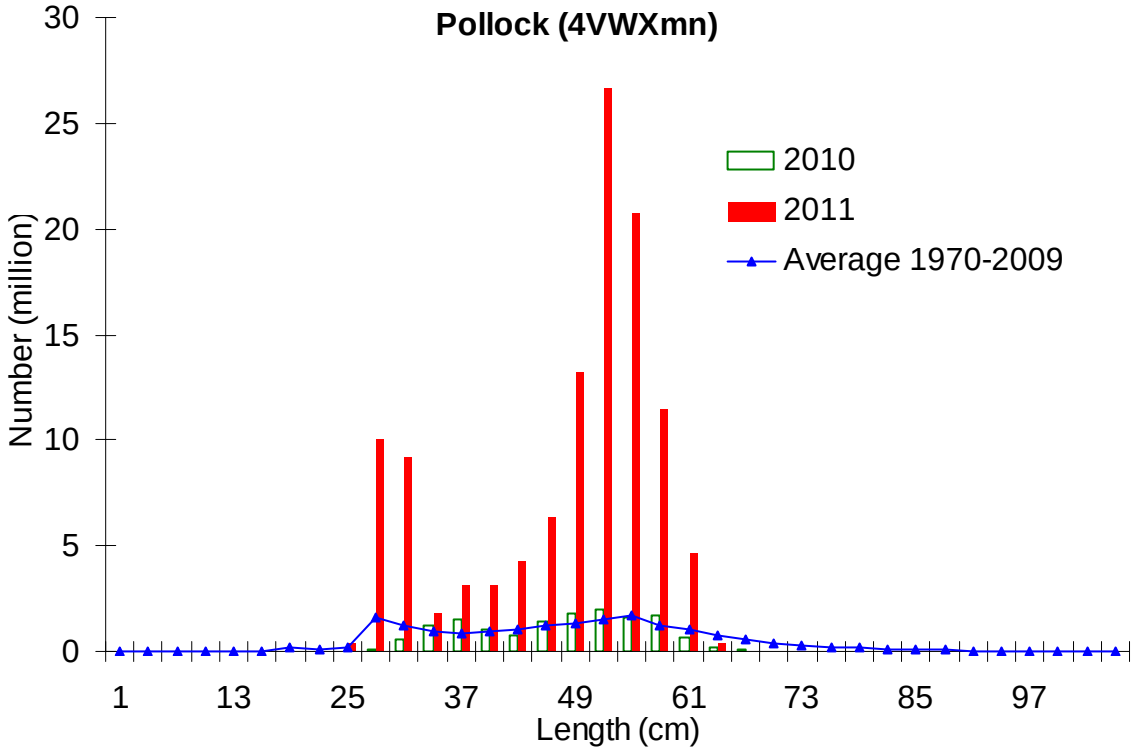


Figure 28. Length stratified total number (millions) of pollock in the Eastern component in 2010 and 2011 compared to the average for 1970-2009.

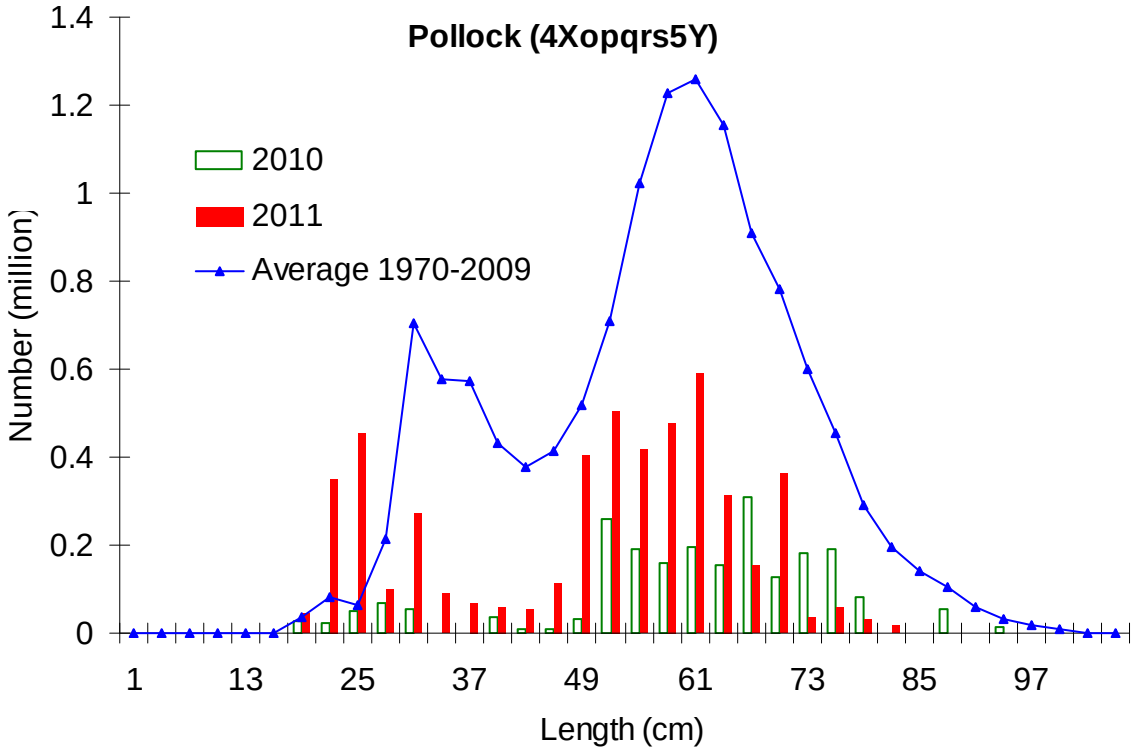


Figure 29. Length stratified total number (millions) of pollock in the Western component in 2010 and 2011 compared to the average for 1970-2009.

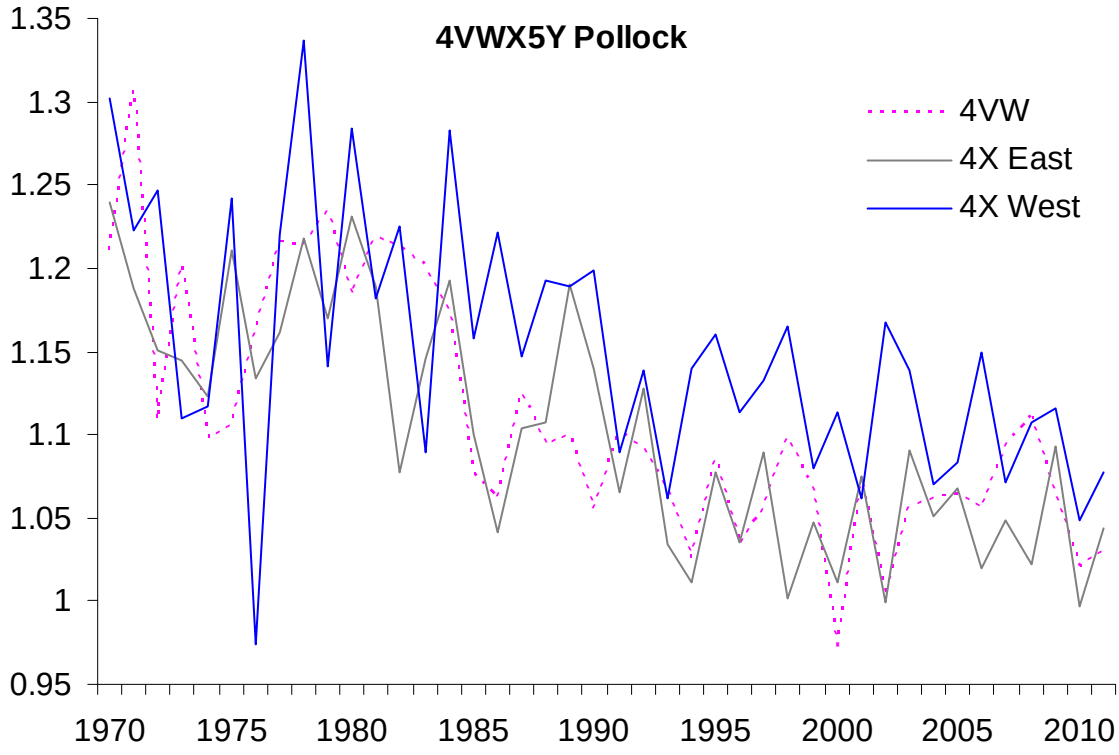


Figure 30. Condition factor (Fulton's K) for pollock in 4VWX5Y from the summer RV survey.

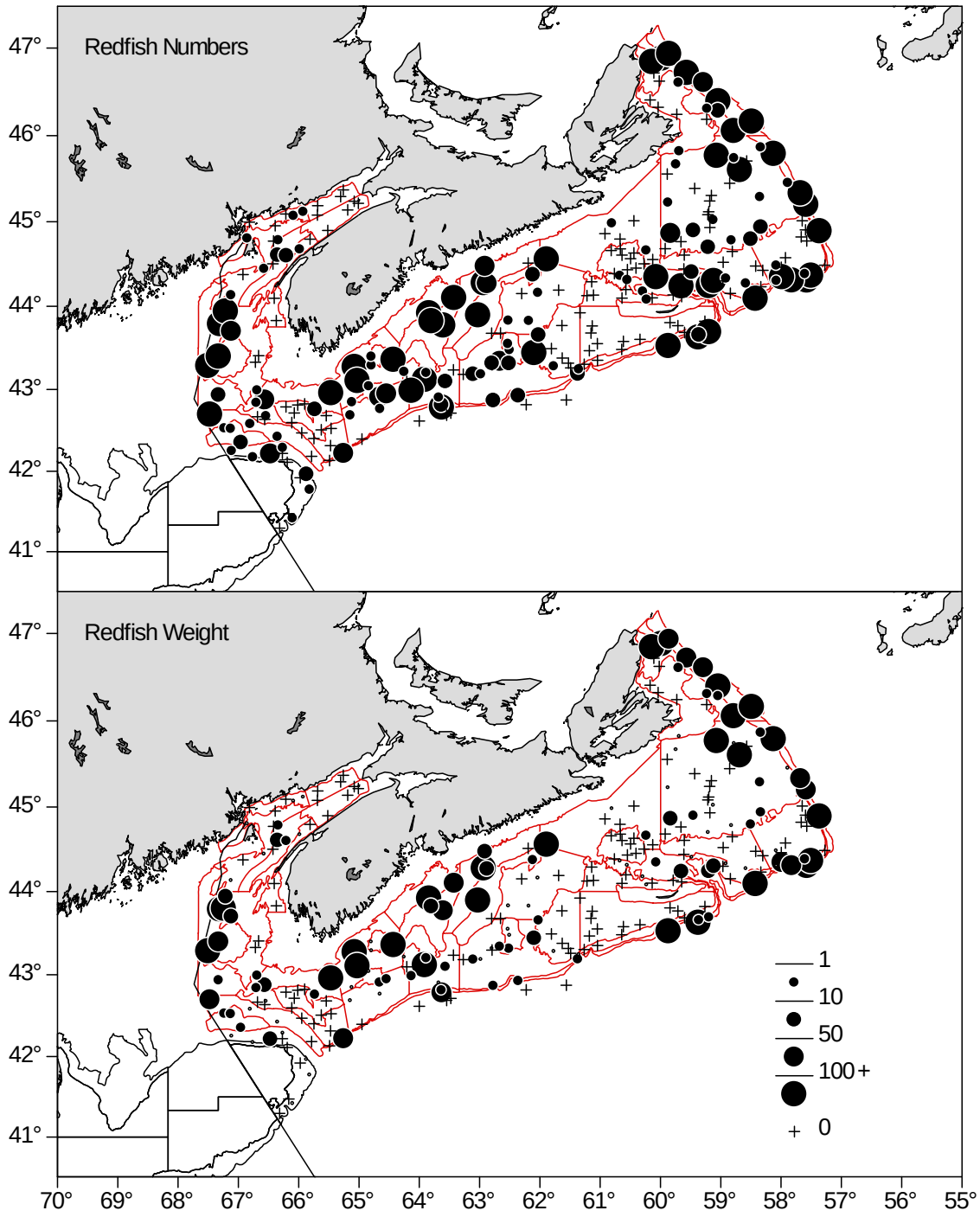


Figure 31. Distribution of redfish catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

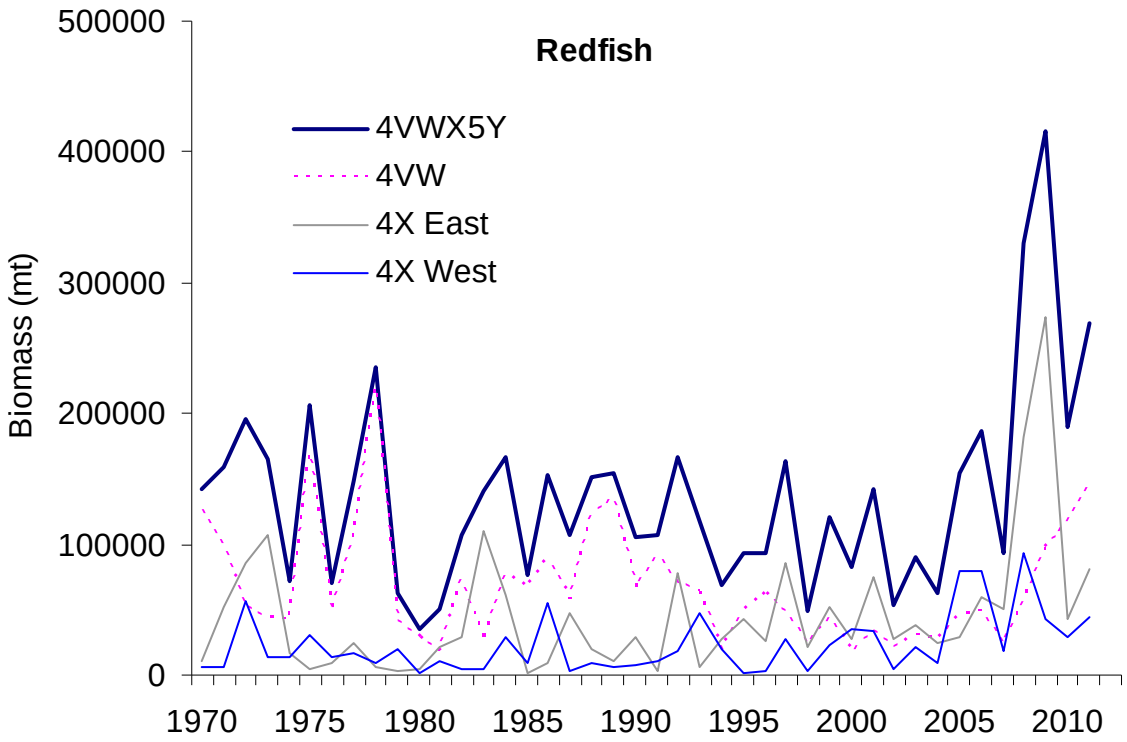


Figure 32. Total biomass estimates for redfish in 4VWX5Y from the summer RV survey.

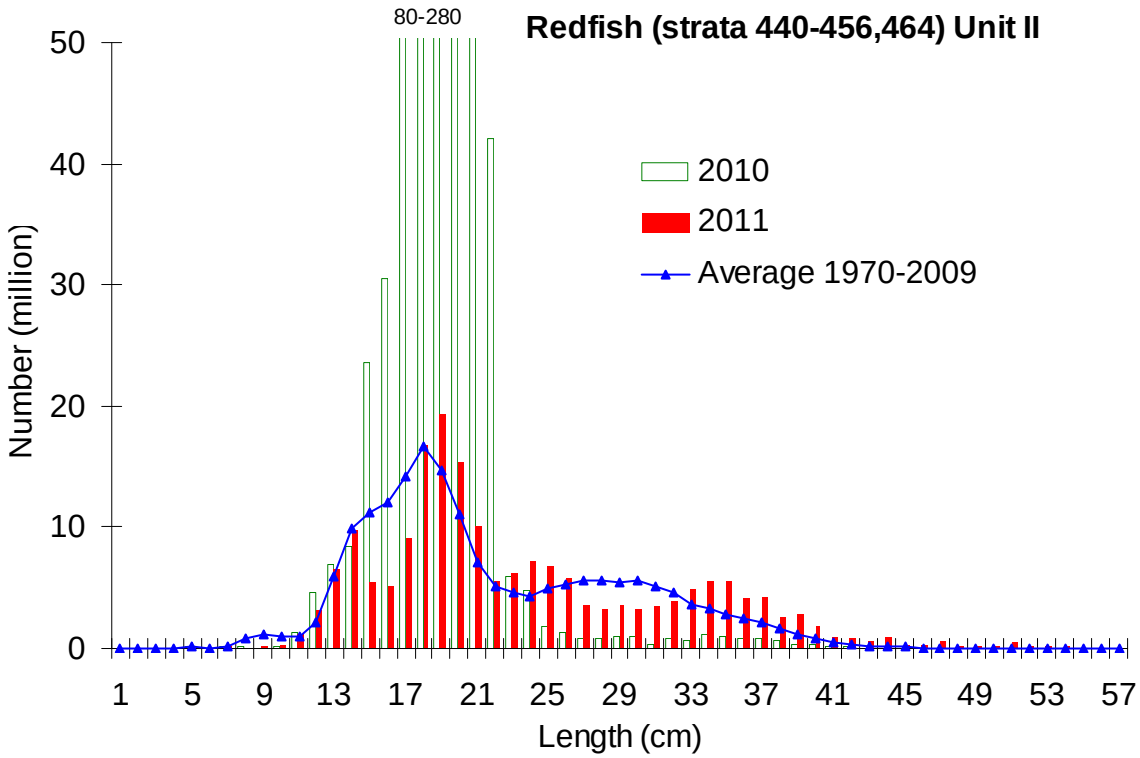


Figure 33. Length stratified total number (millions) of redfish in Unit II in 2010 and 2011 compared to the average for 1970-2009.

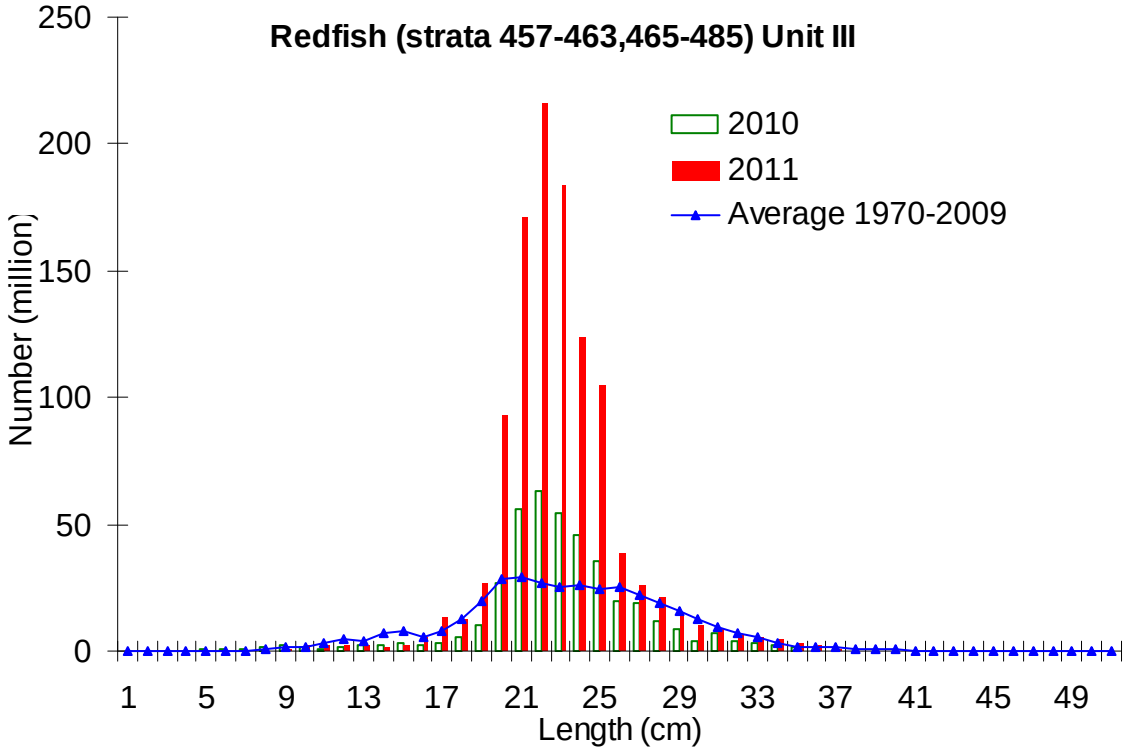


Figure 34. Length stratified total number (millions) of redfish in Unit III in 2010 and 2011 compared to the average for 1970-2009.

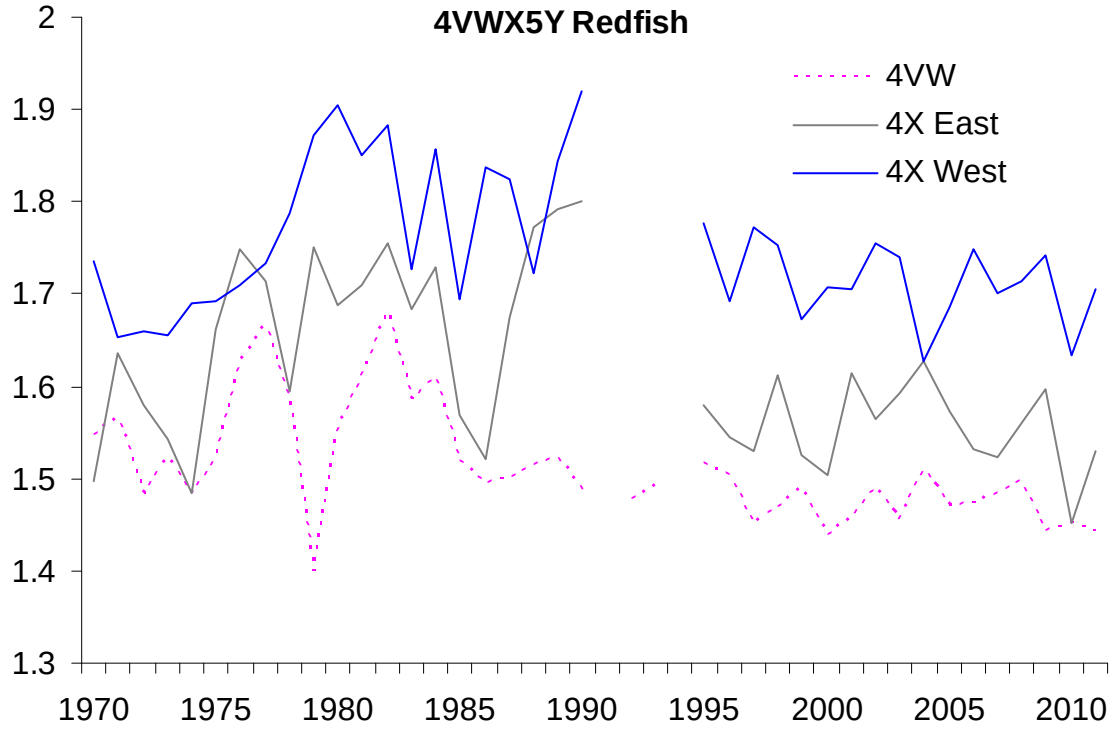


Figure 35. Condition factor (Fulton's K) for redfish in 4VWX5Y from the summer RV survey.

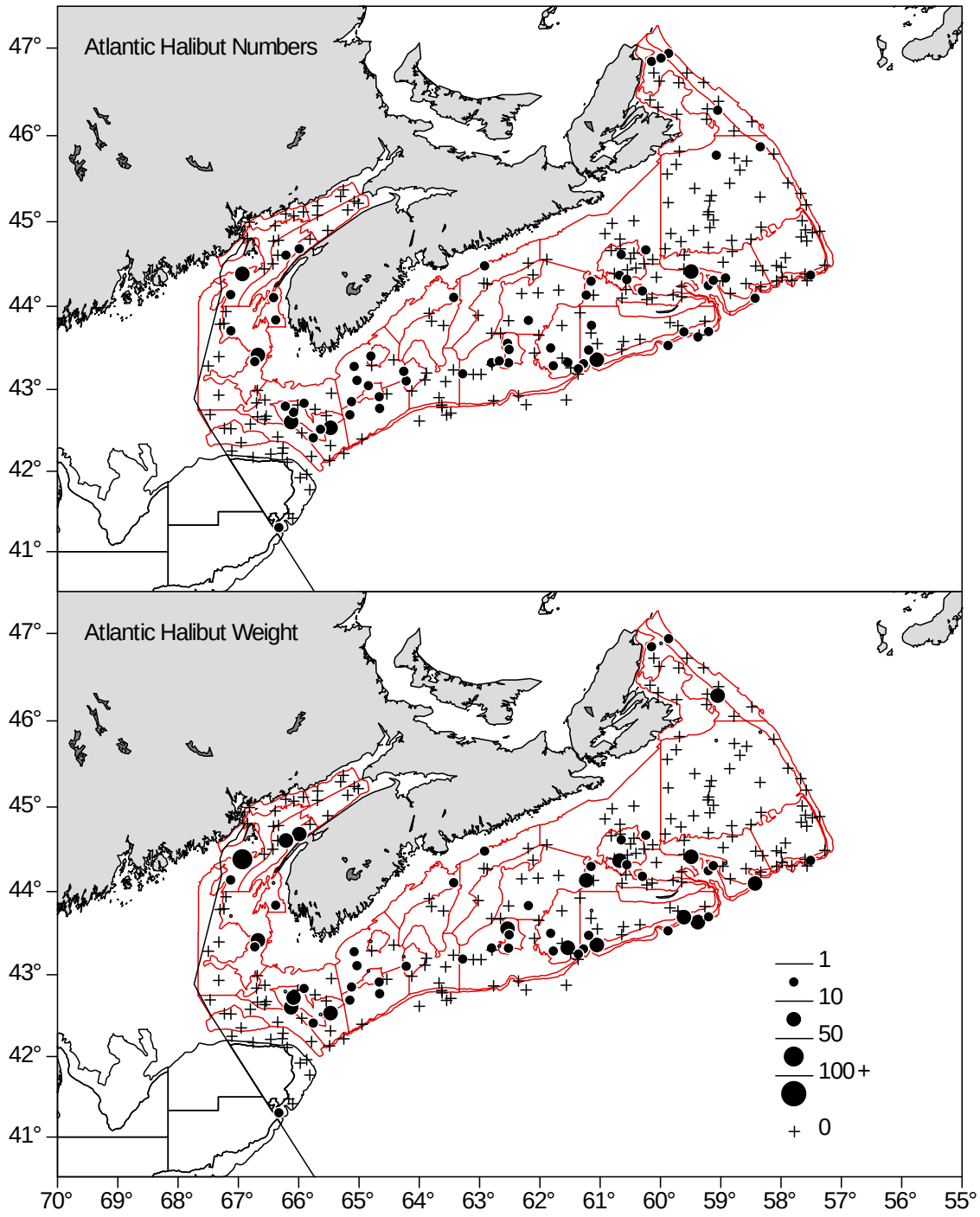


Figure 36. Distribution of Atlantic halibut catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

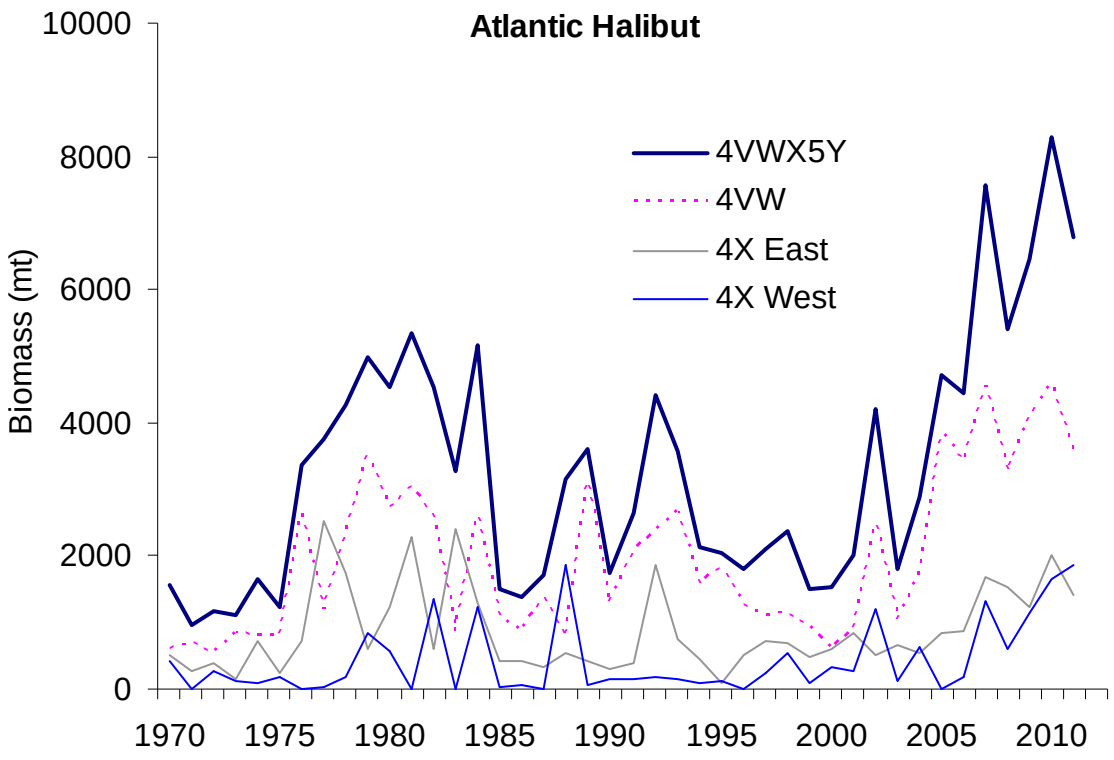


Figure 37. Total biomass estimates for Atlantic halibut in 4VWX5Y from the summer RV survey.

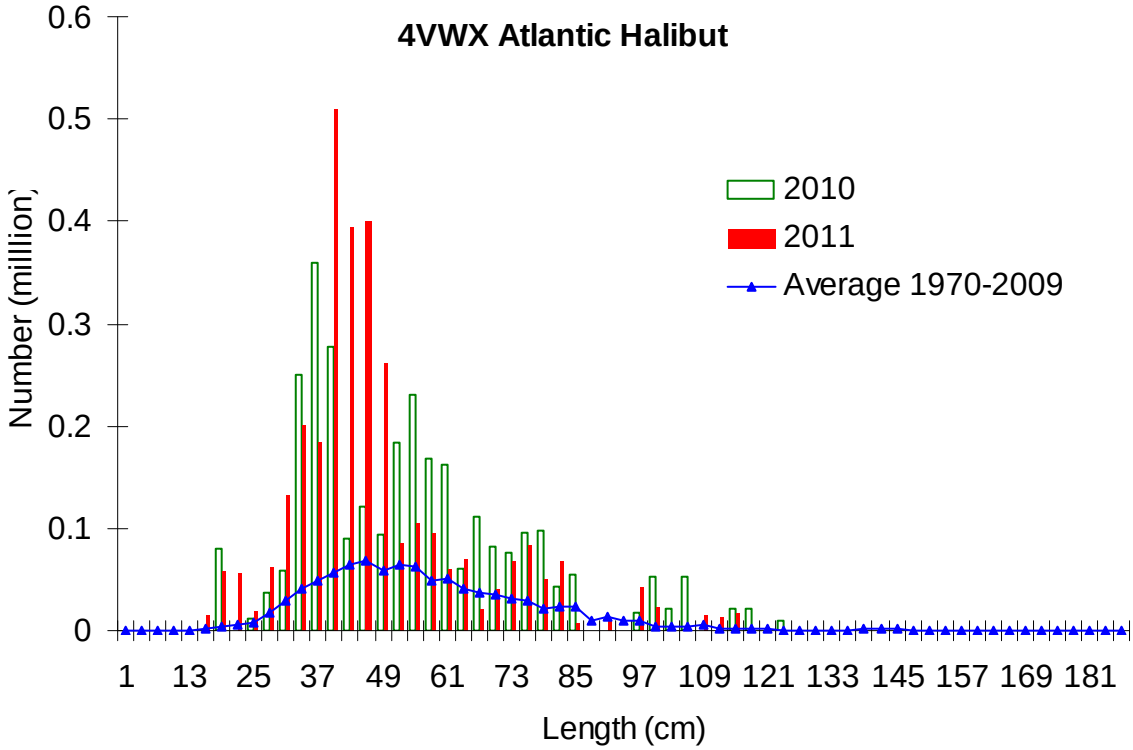


Figure 38. Length stratified total number (millions) of Atlantic halibut in 4VWX5Y in 2010 and 2011 compared to the average for 1970-2009.

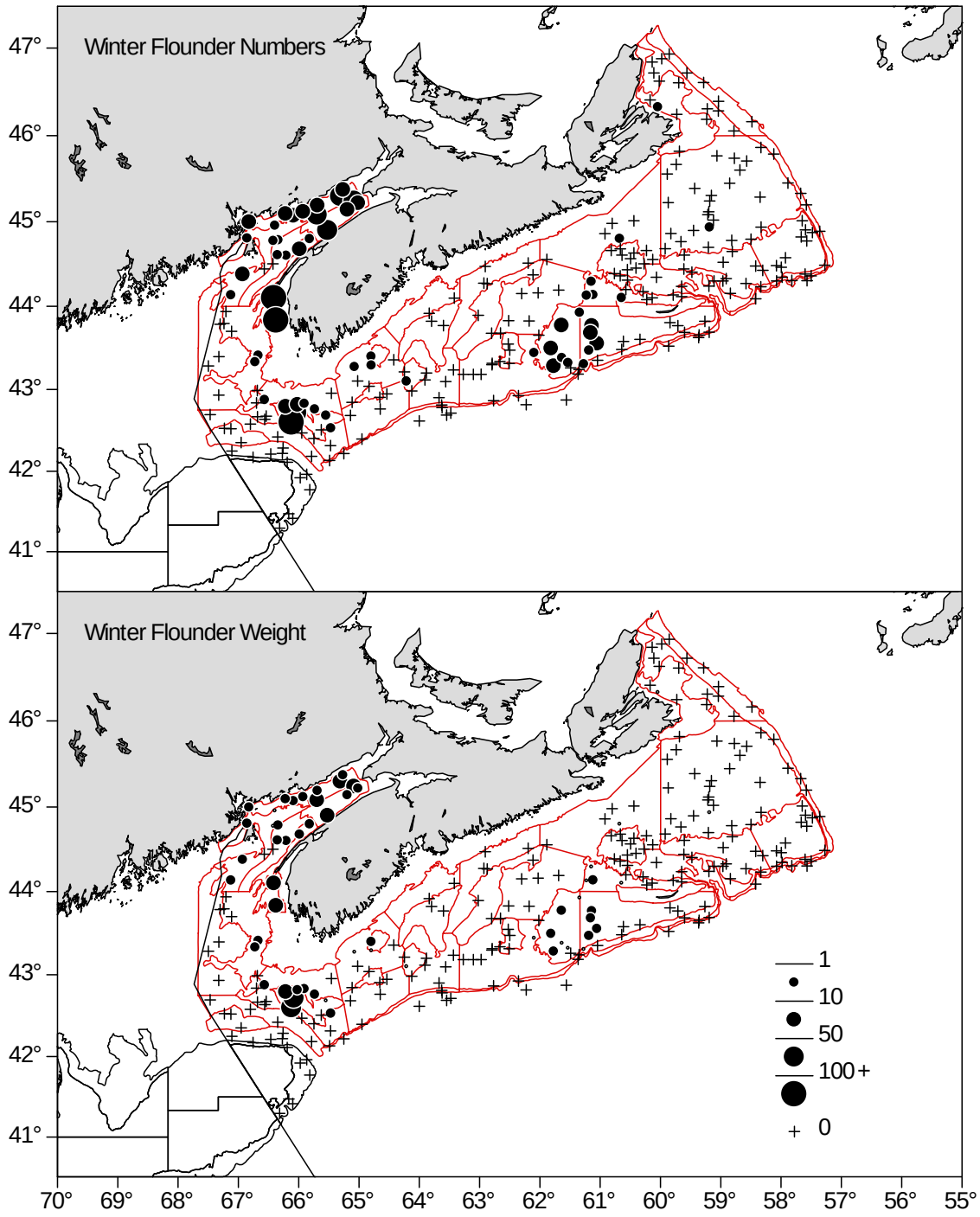


Figure 39. Distribution of winter flounder catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

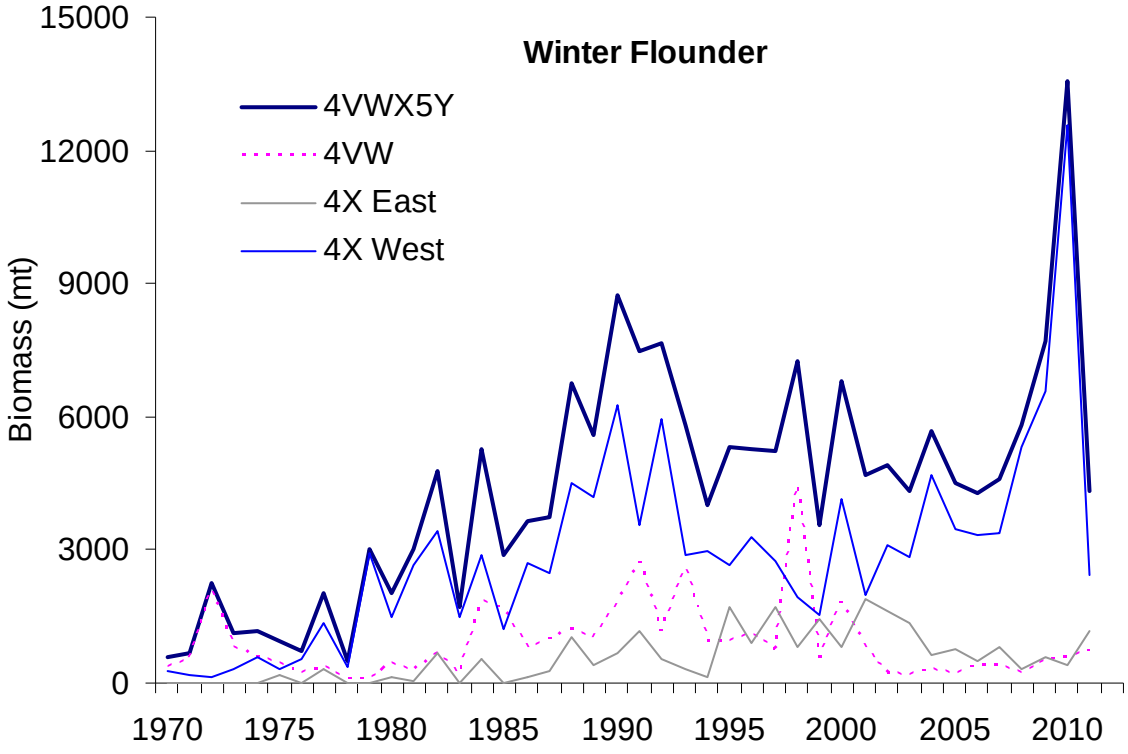


Figure 40. Total biomass estimates for winter flounder in 4VWX5Y from the summer RV survey.

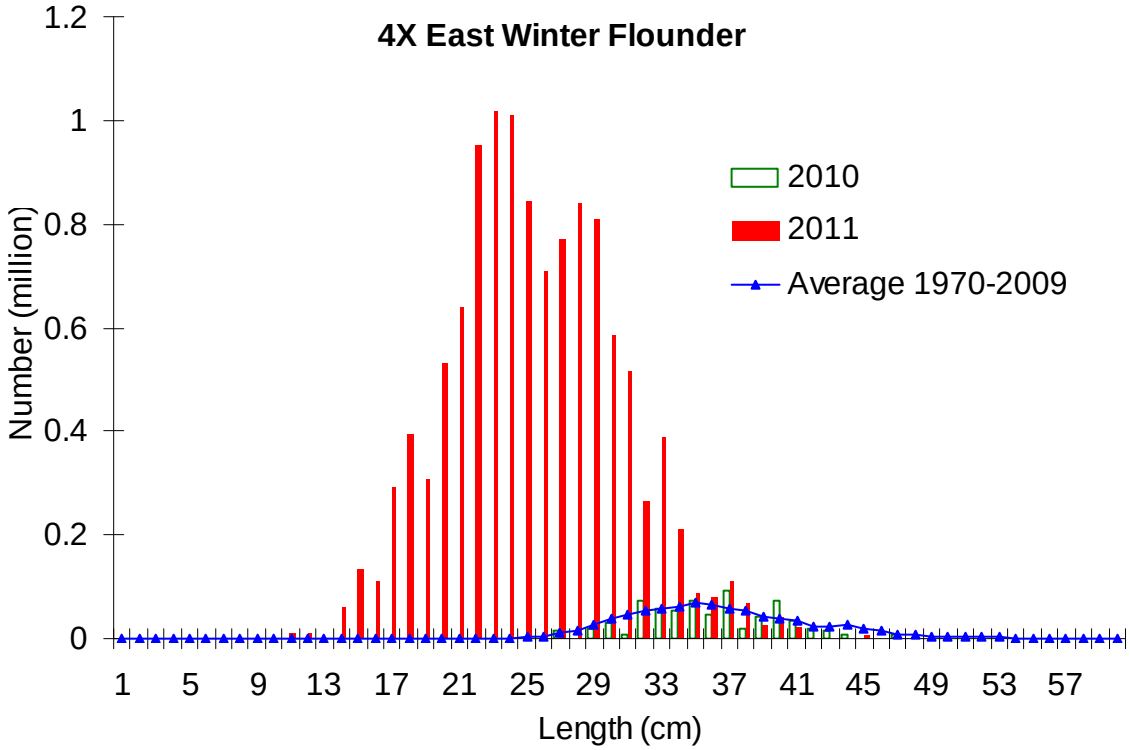


Figure 41. Length stratified total number (millions) of winter flounder in 4X East in 2010 and 2011 compared to the average for 1970-2009.

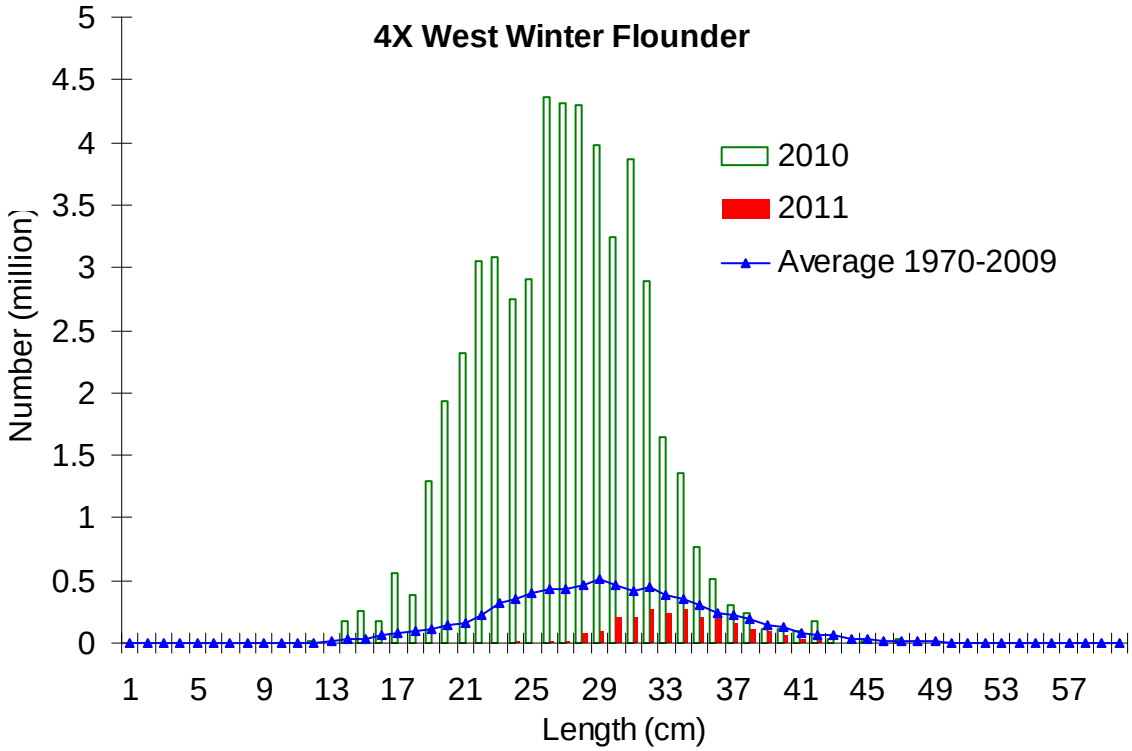


Figure 42. Length stratified total number (millions) of winter flounder in 4X West in 2010 and 2011 compared to the average for 1970-2009.

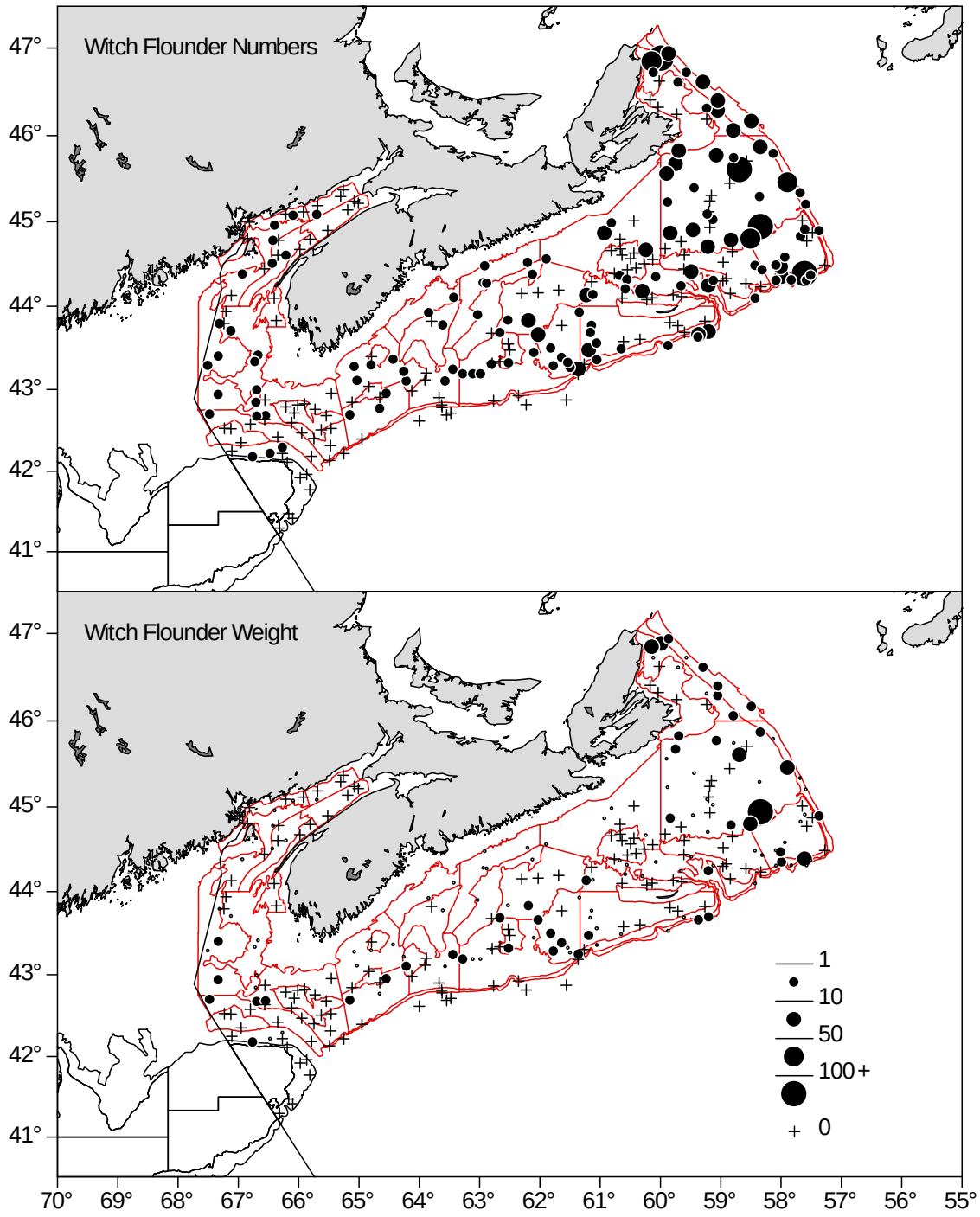


Figure 43. Distribution of witch flounder catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

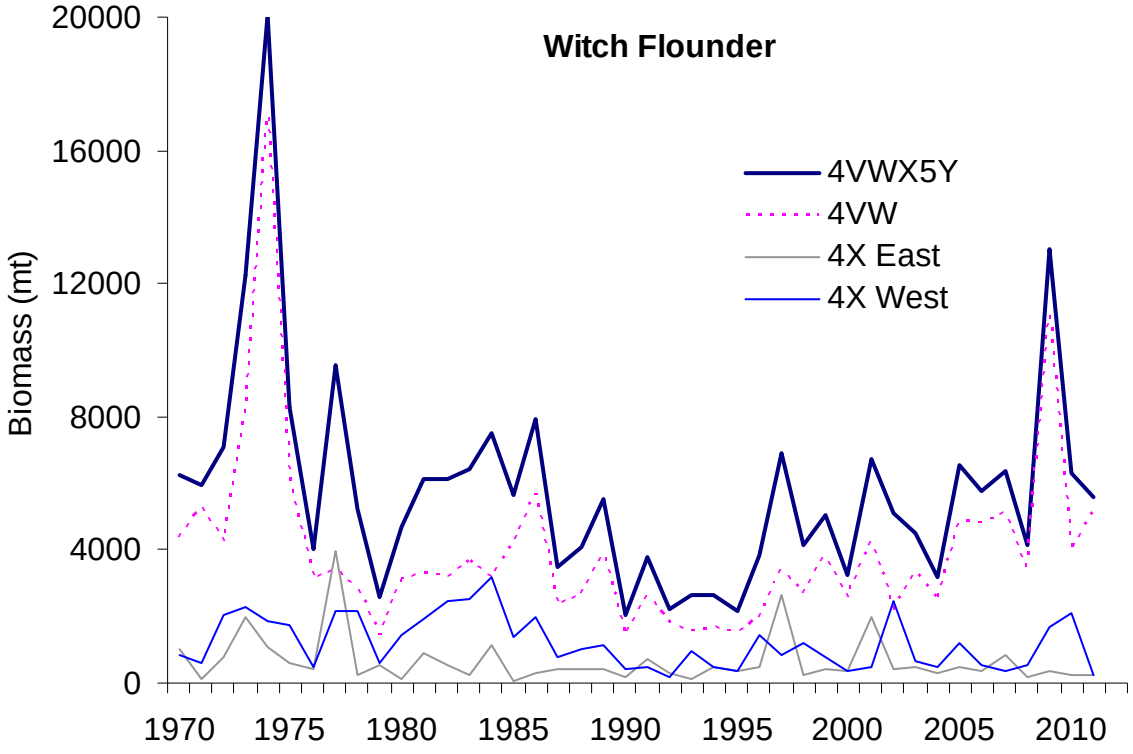


Figure 44. Total biomass estimates for witch flounder in 4VWX5Y from the summer RV survey.

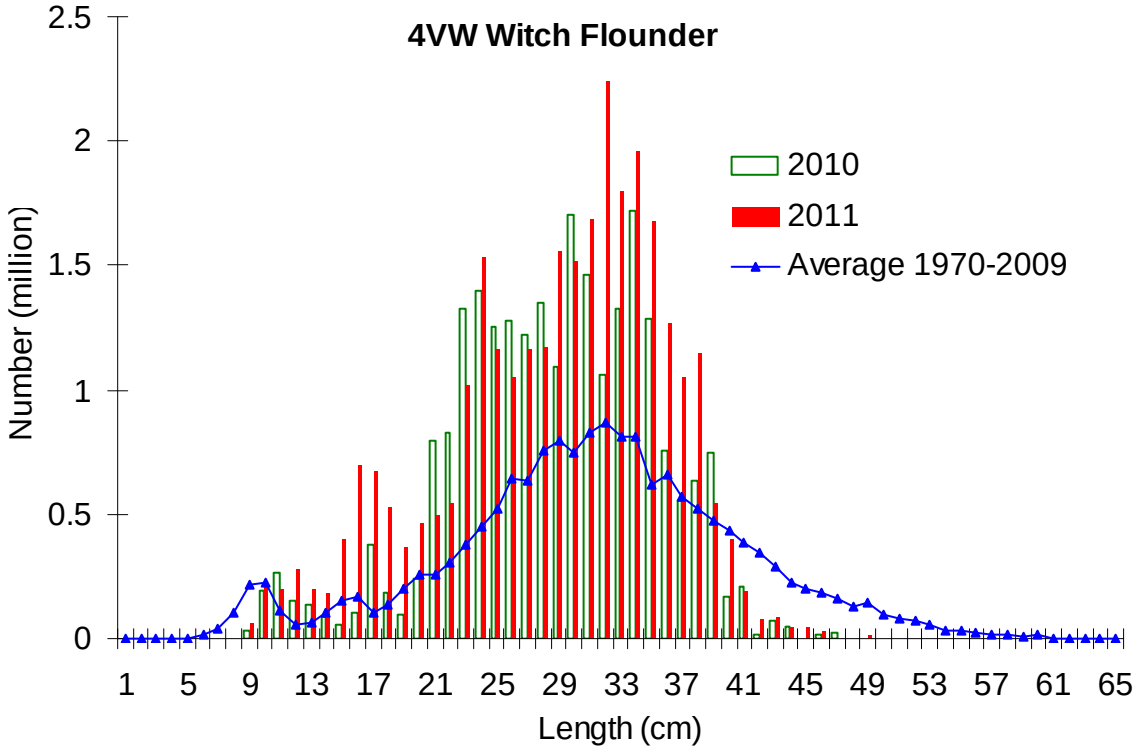


Figure 45. Length stratified total number (millions) of witch flounder in 4VW in 2010 and 2011 compared to the average for 1970-2009.

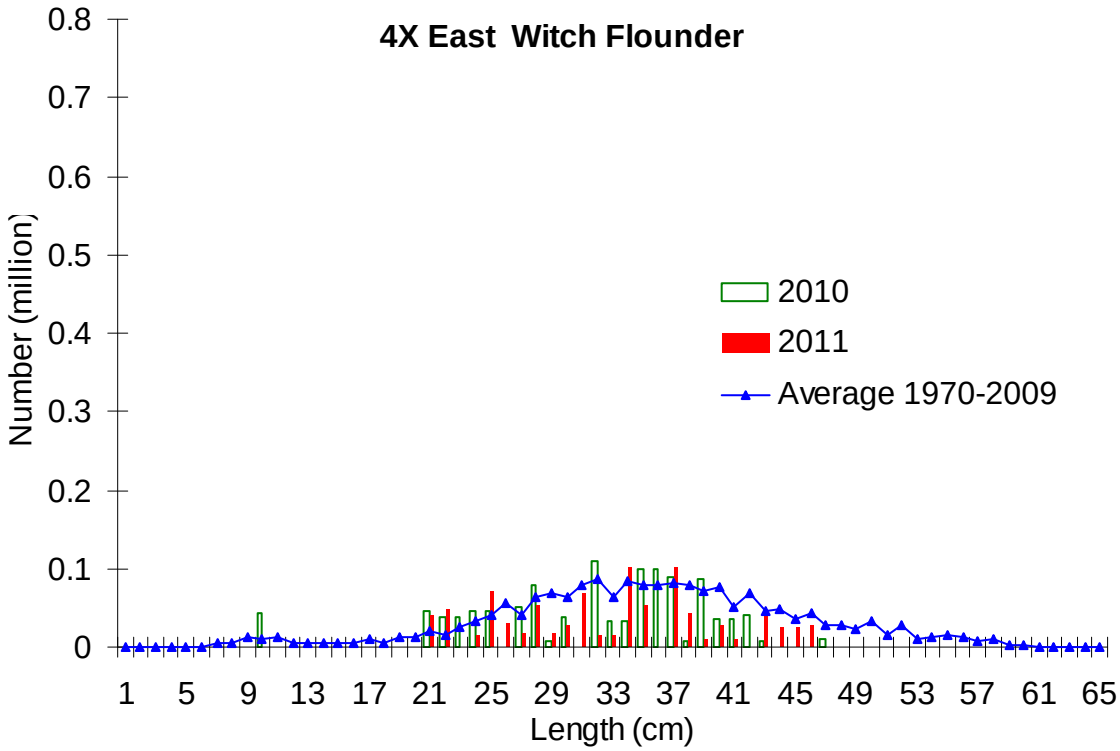


Figure 46. Length stratified total number (millions) of witch flounder in 4X East in 2010 and 2011 compared to the average for 1970-2009.

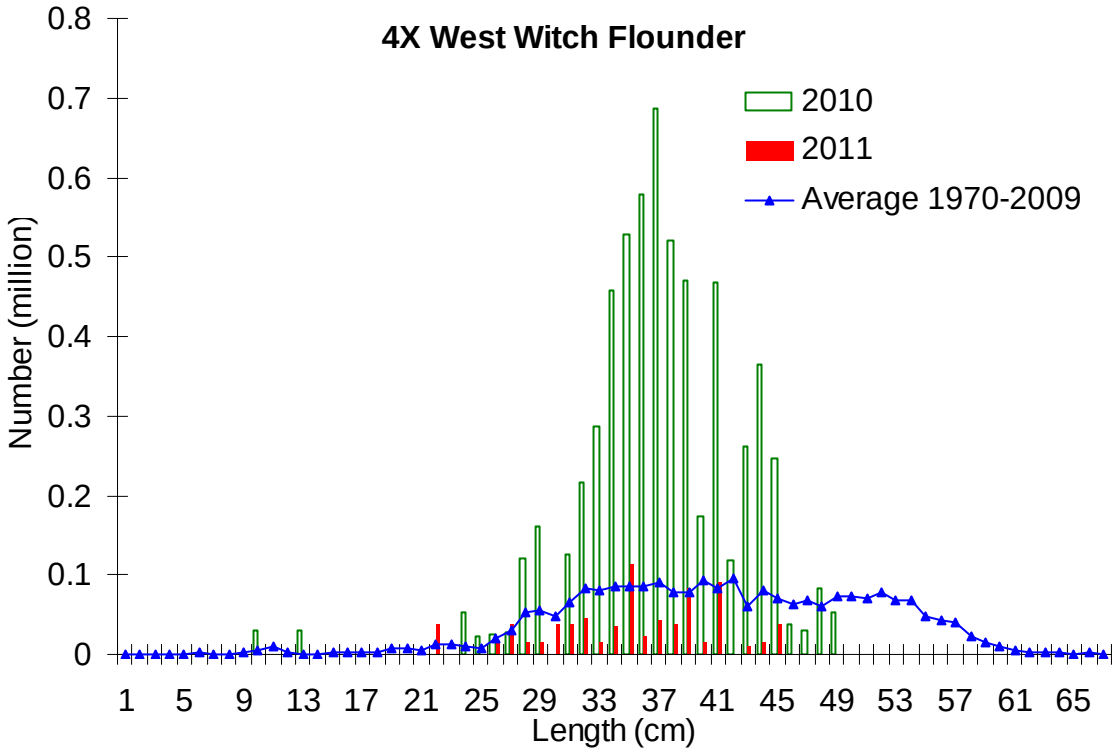


Figure 47. Length stratified total number (millions) of witch flounder in 4X West in 2010 and 2011 compared to the average for 1970-2009.

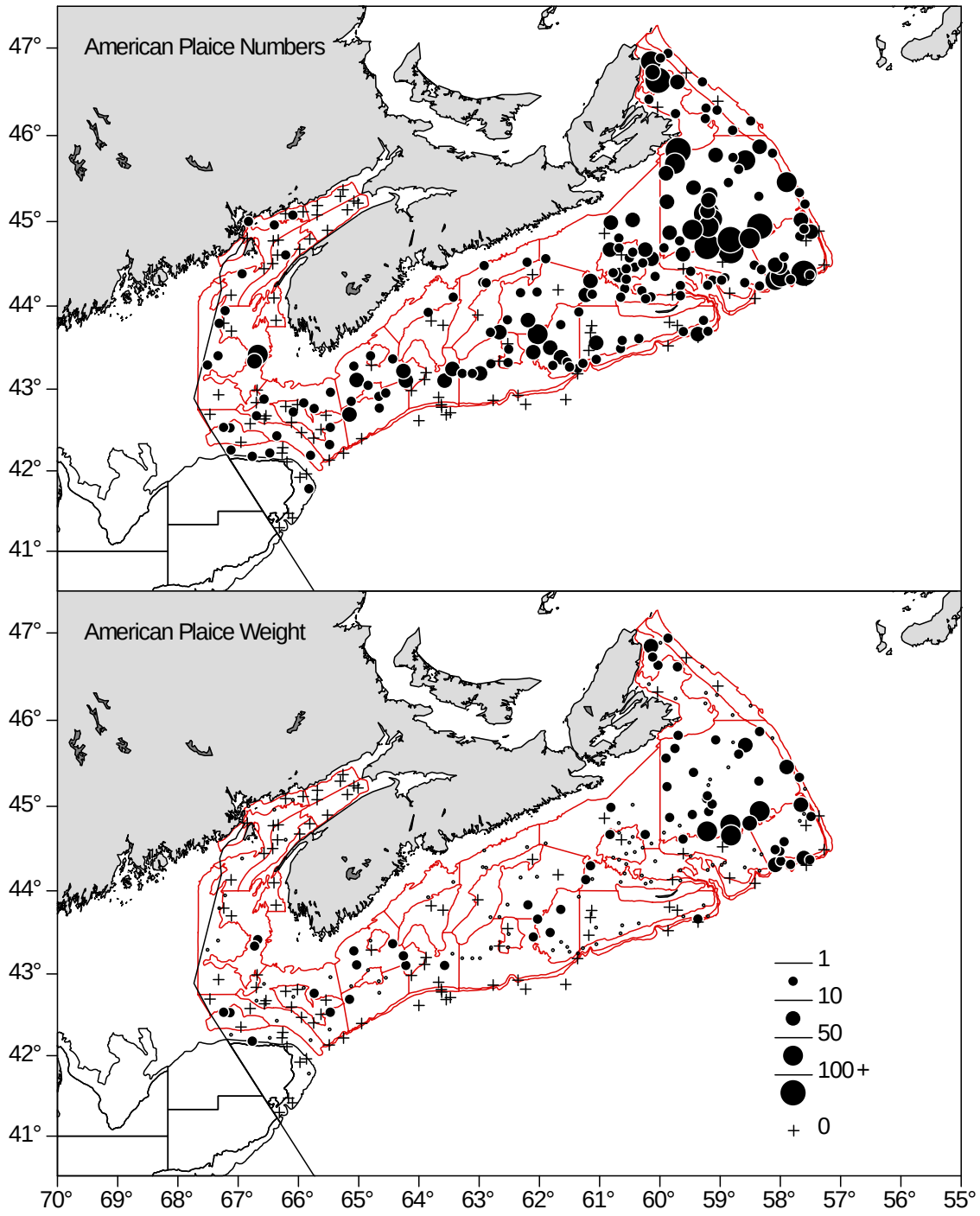


Figure 48. Distribution of American plaice catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

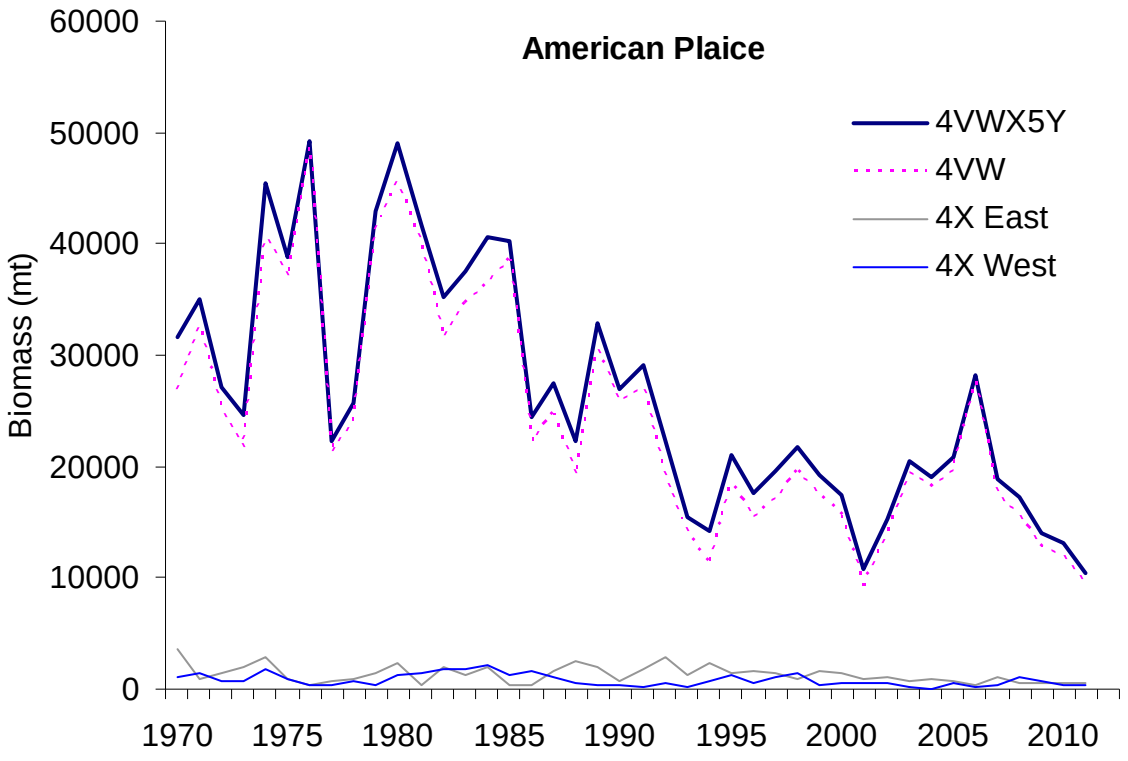


Figure 49. Total biomass estimates for American plaice in 4VWX5Y from the summer RV survey.

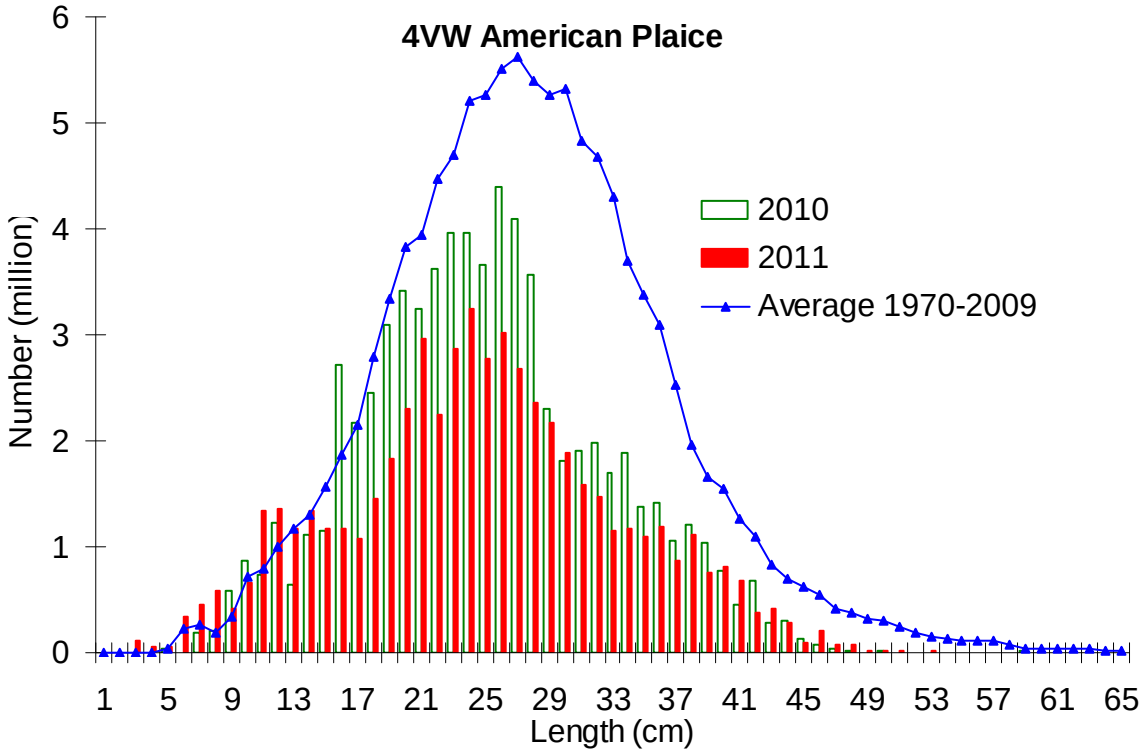


Figure 50. Length stratified total number (millions) of American plaice in 4VW in 2010 and 2011 compared to the average for 1970-2009.

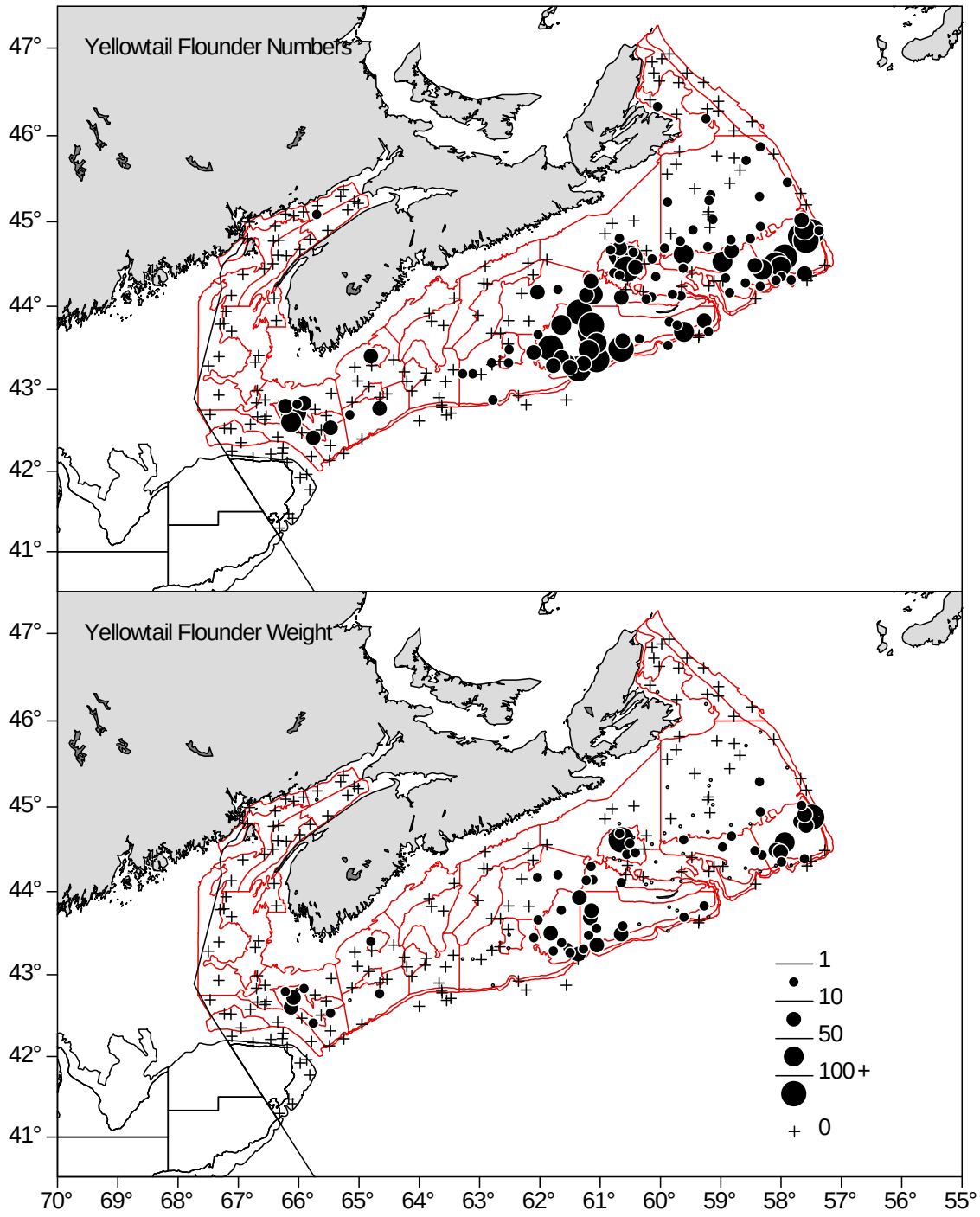


Figure 51. Distribution of yellowtail flounder catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

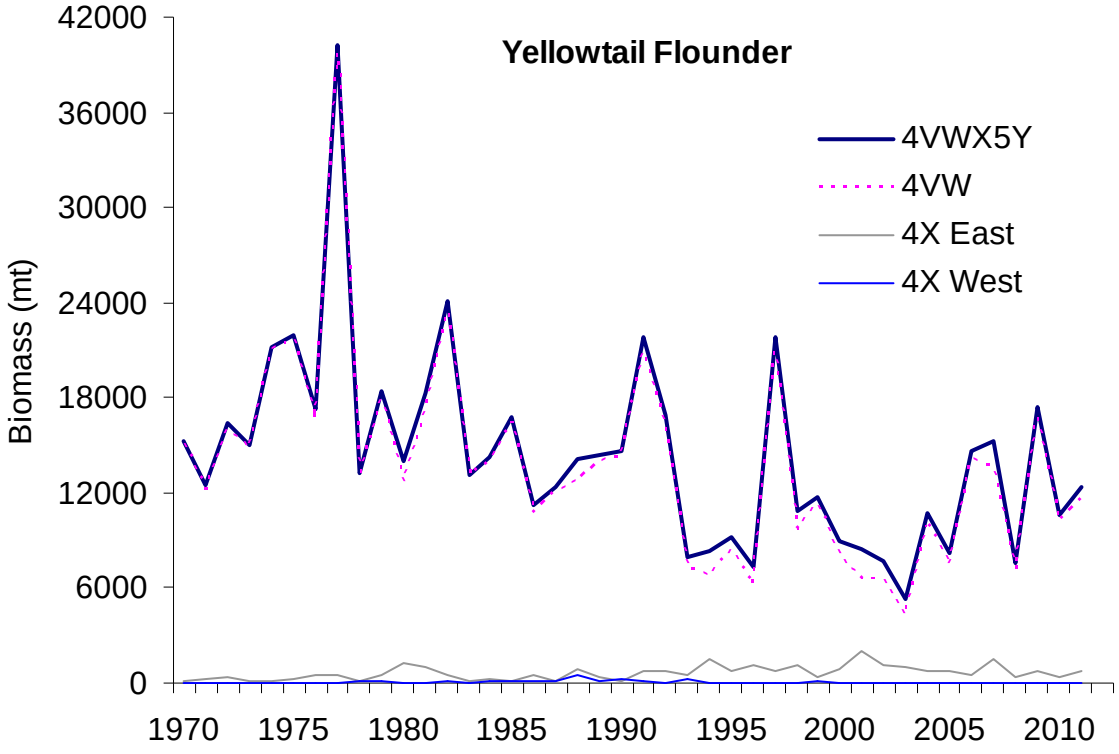


Figure 52. Total biomass estimates for yellowtail flounder in 4VWX5Y from the summer RV survey.

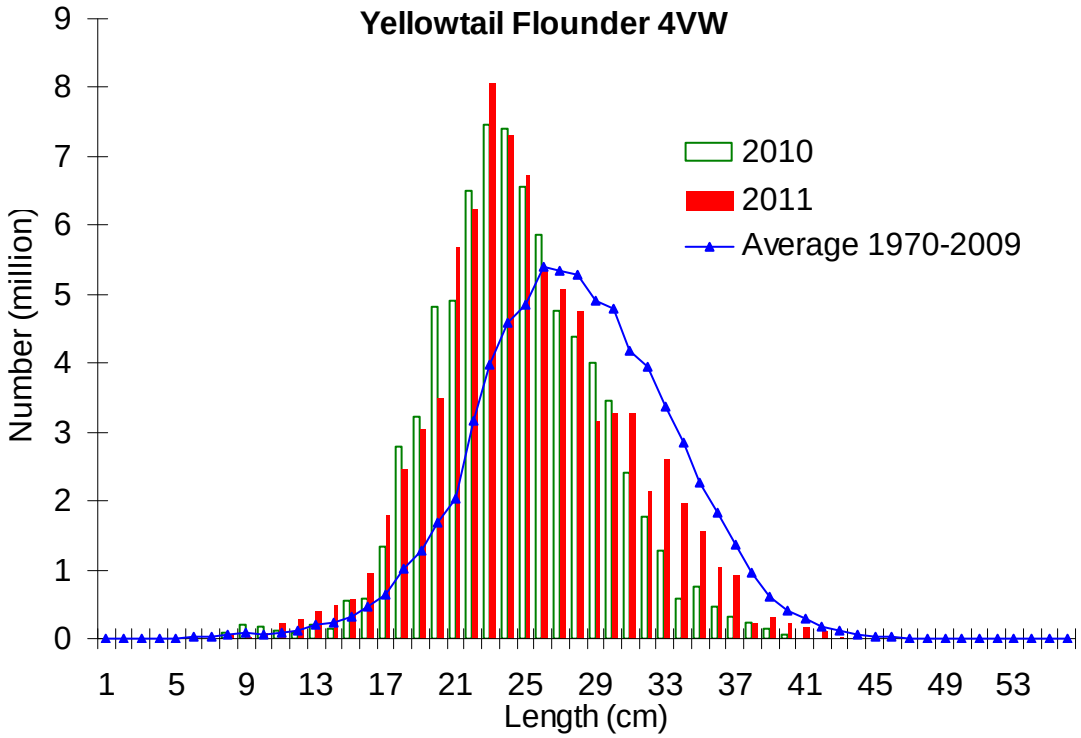


Figure 53. Length stratified total number (millions) of yellowtail flounder in 4VW in 2010 and 2011 compared to the average for 1970-2009.

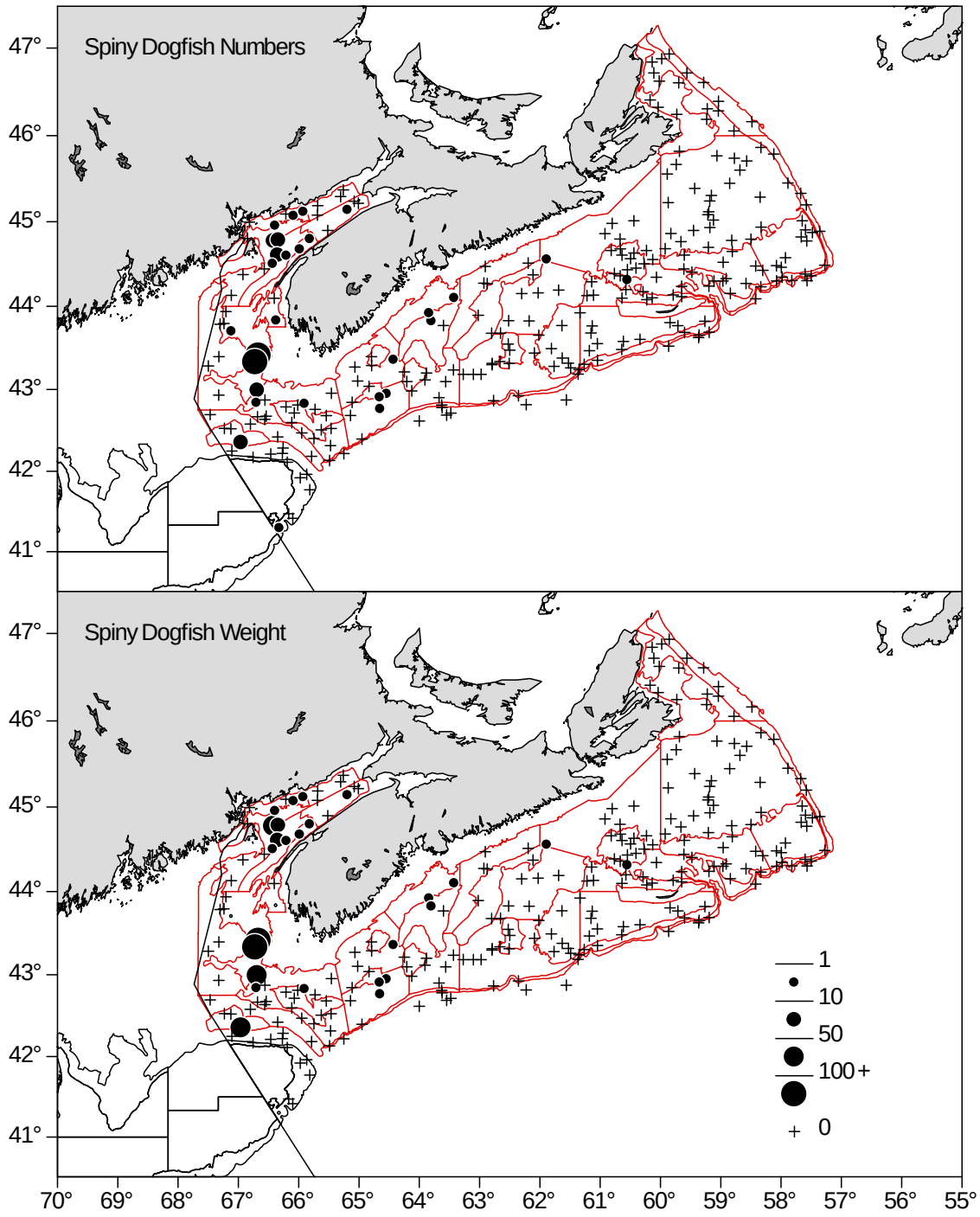


Figure 54. Distribution of spiny dogfish catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

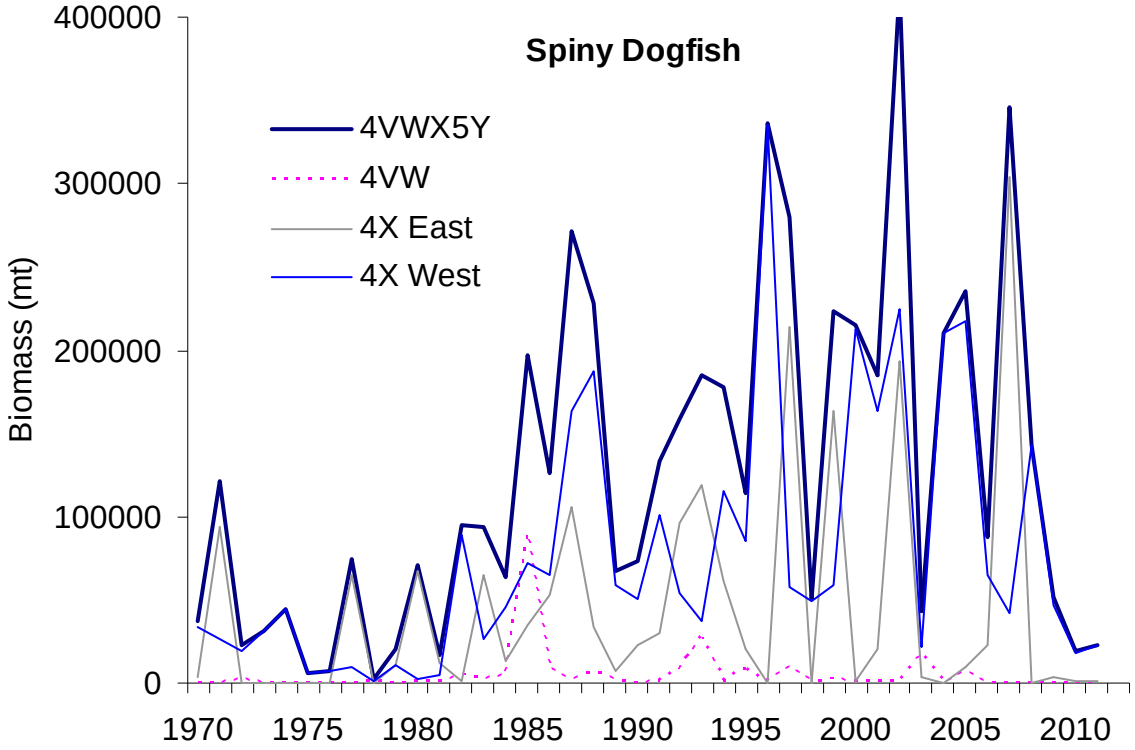


Figure 55. Total biomass estimates for spiny dogfish in 4VWX5Y from the summer RV survey.

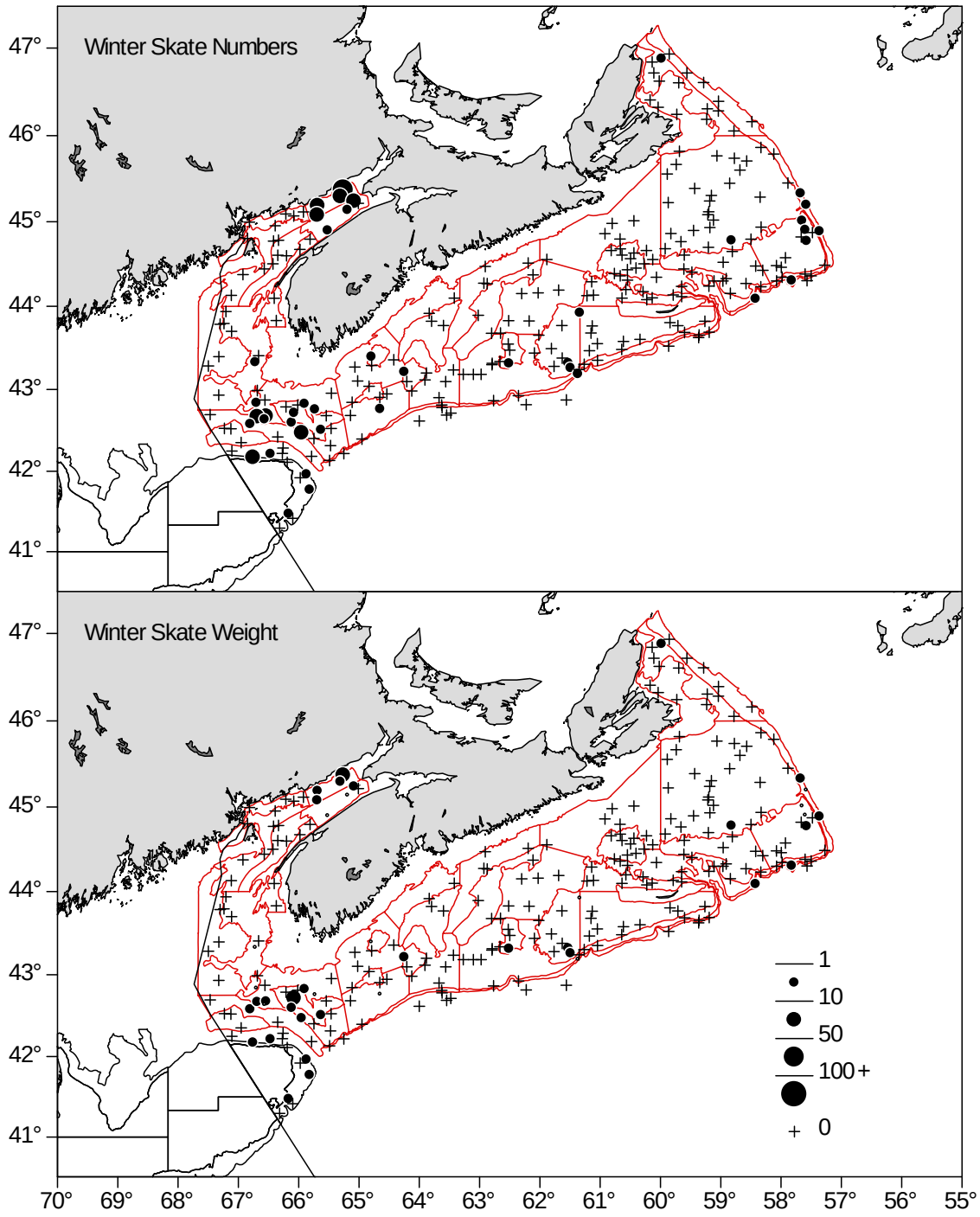


Figure 56. Distribution of winter skate catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

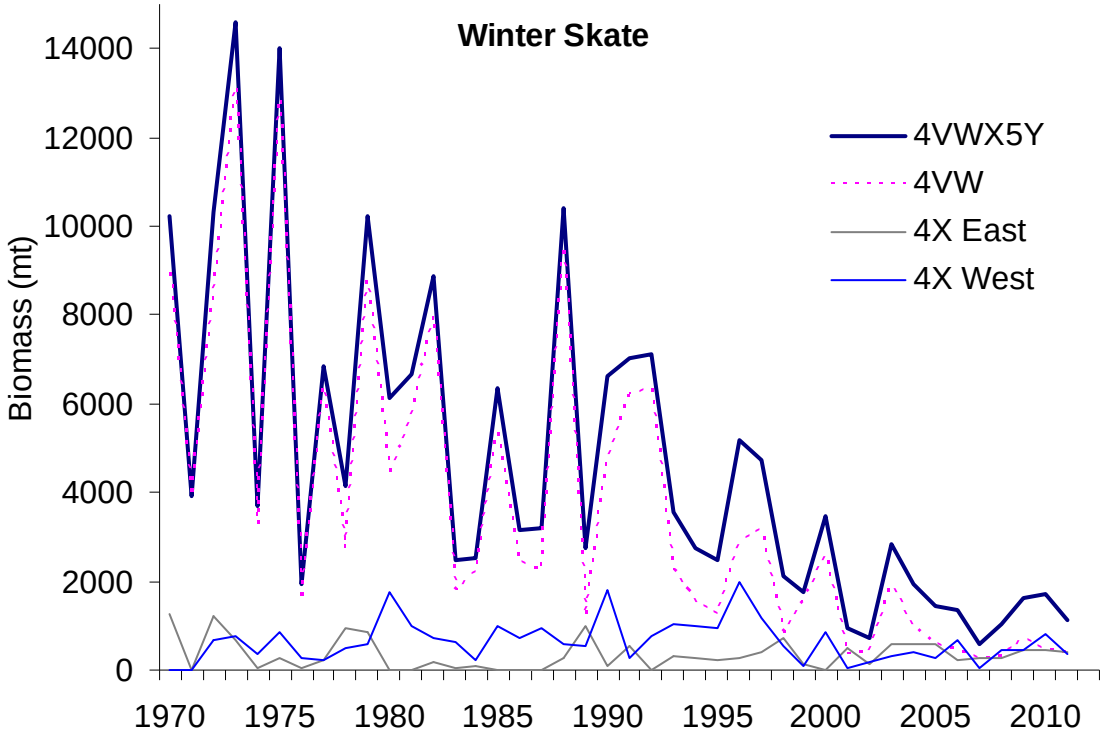


Figure 57. Total biomass estimates for winter skate in 4VWX5Y from the summer RV survey.

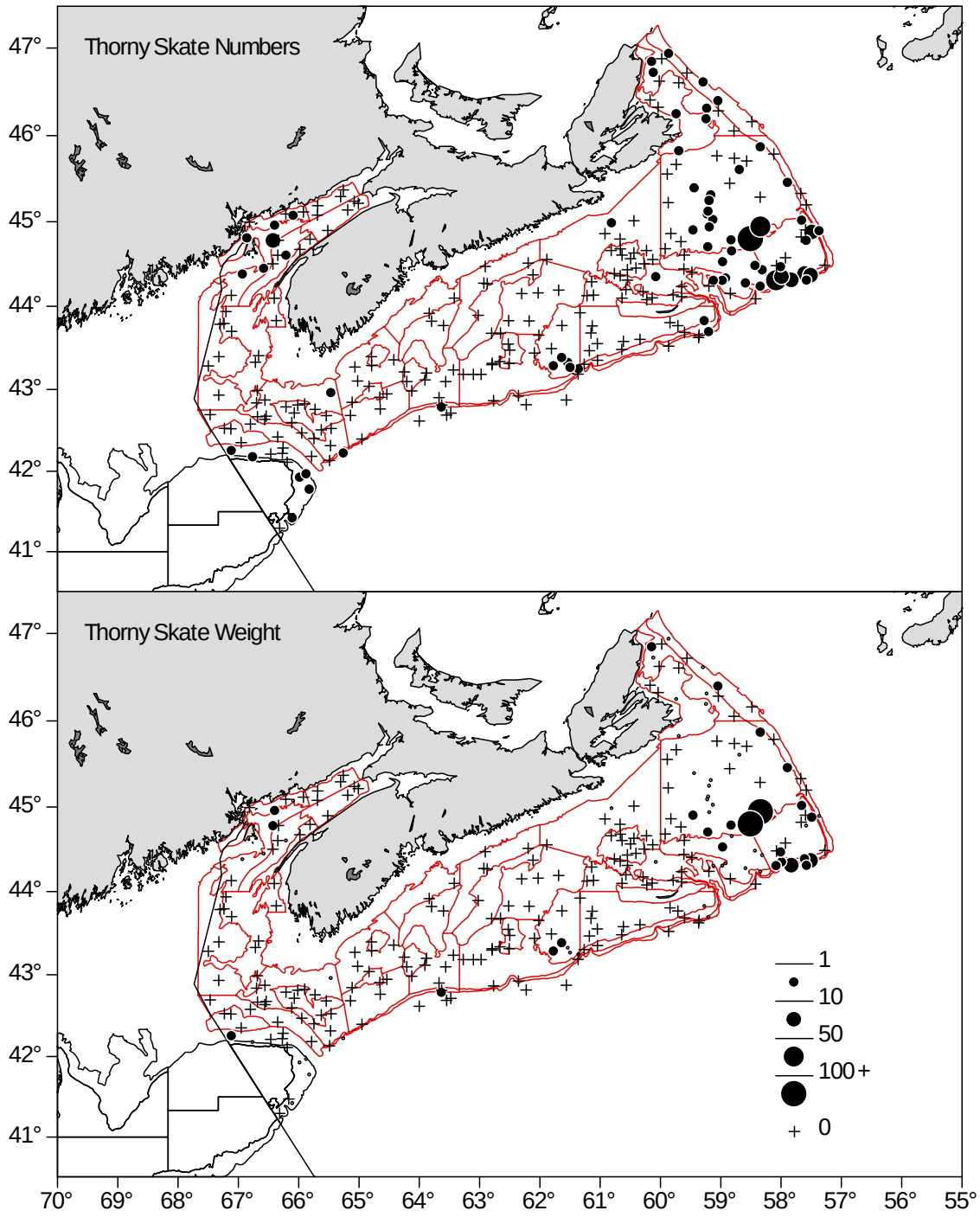


Figure 58. Distribution of thorny skate catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

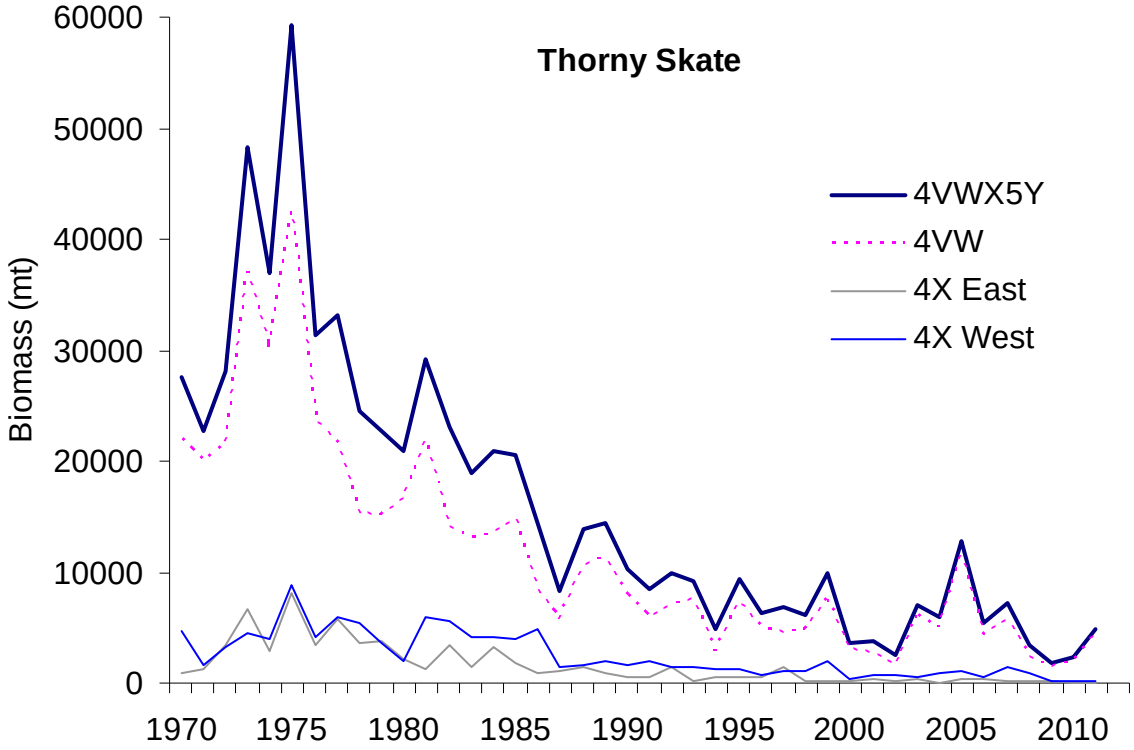


Figure 59. Total biomass estimates for thorny skate in 4VWX5Y from the summer RV survey.

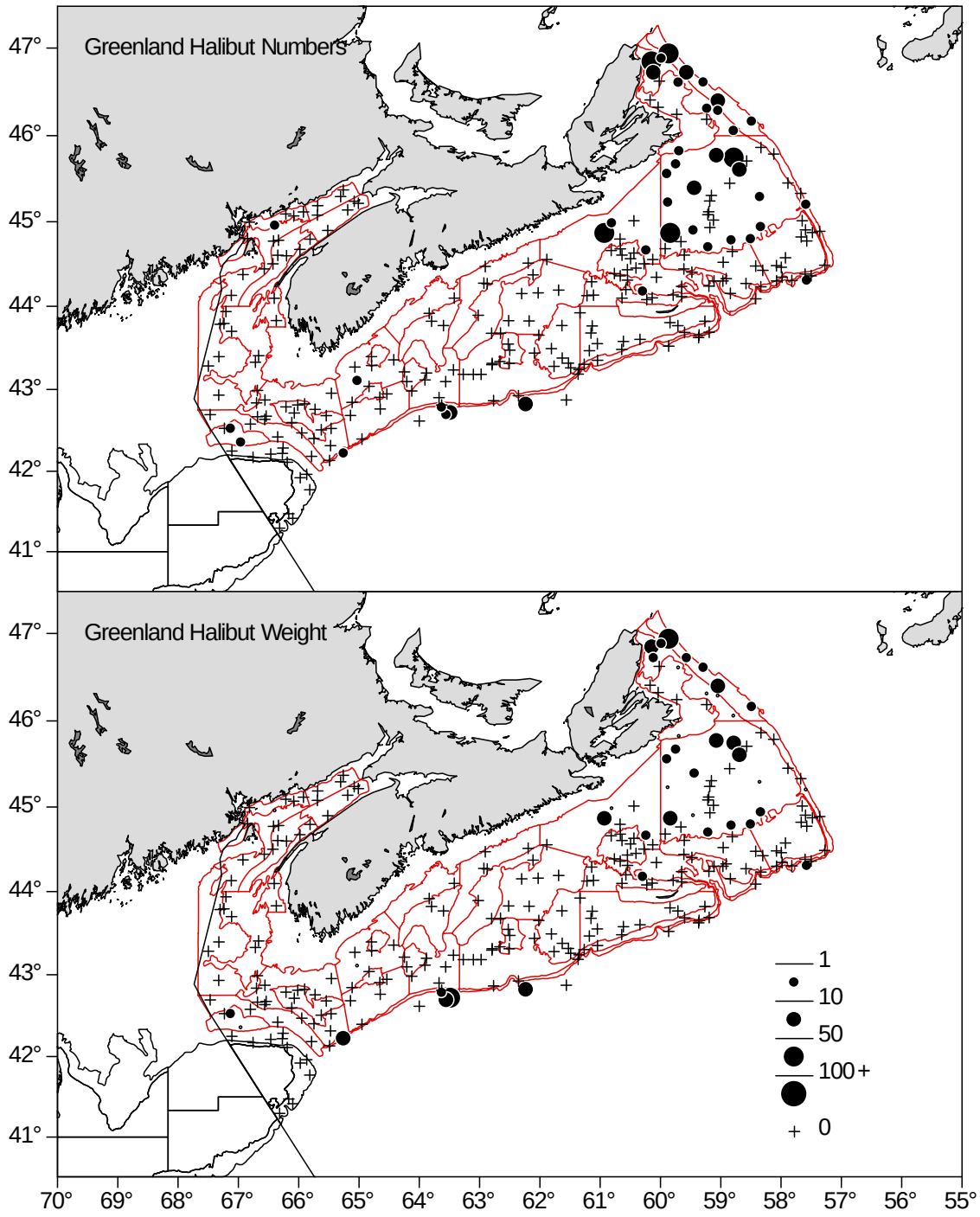


Figure 60. Distribution of Greenland halibut catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

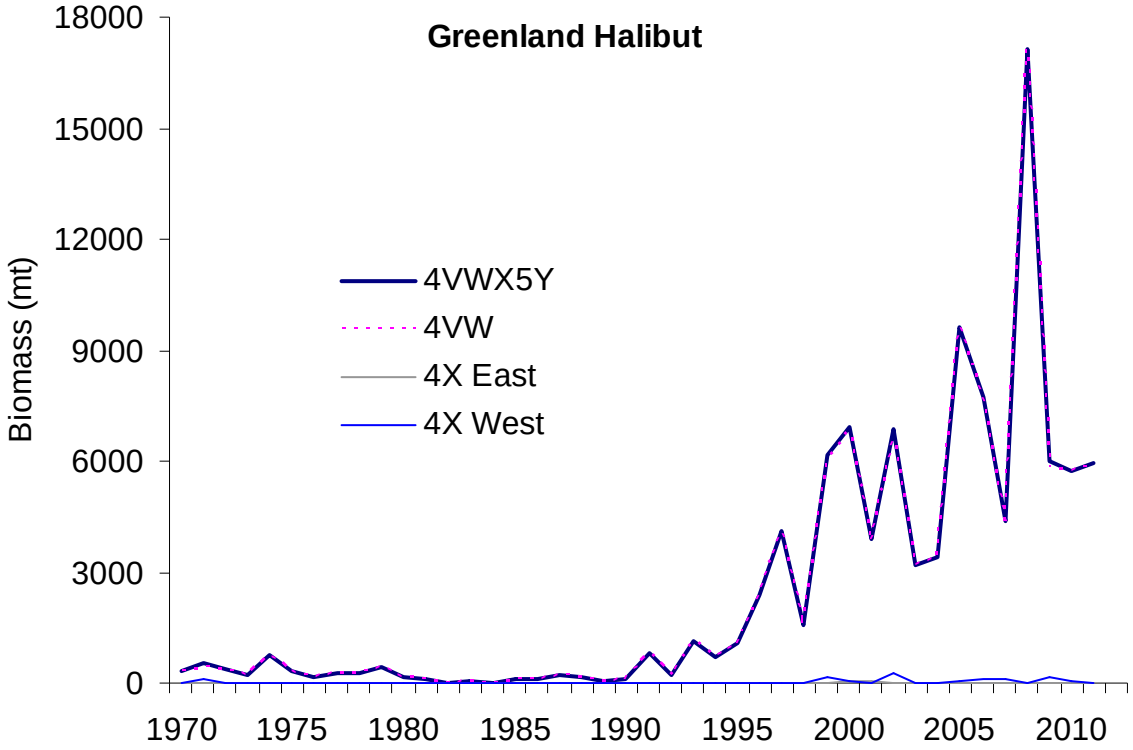


Figure 61. Total biomass estimates for Greenland halibut in 4VWX5Y from the summer RV survey.

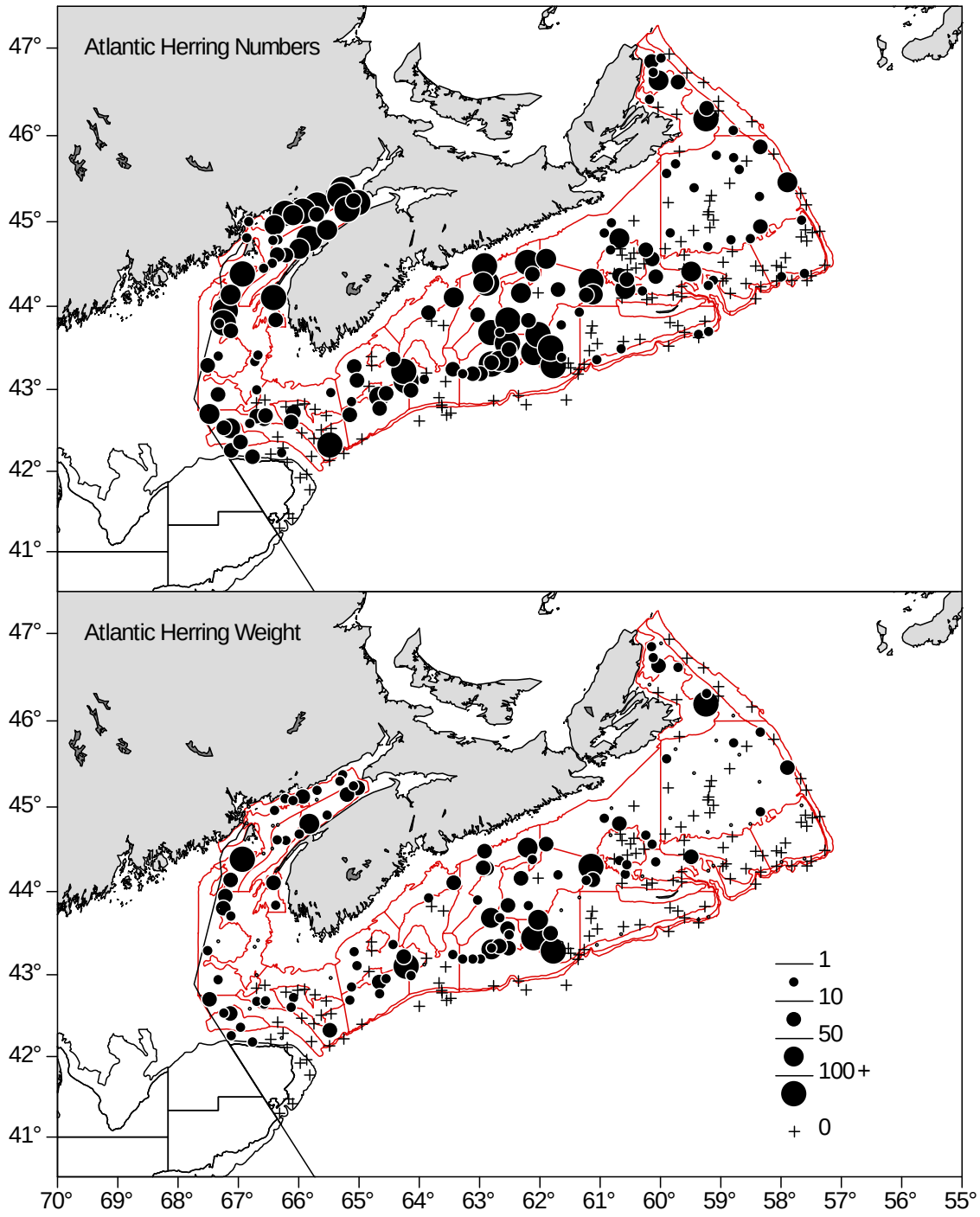


Figure 62. Distribution of Atlantic herring catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

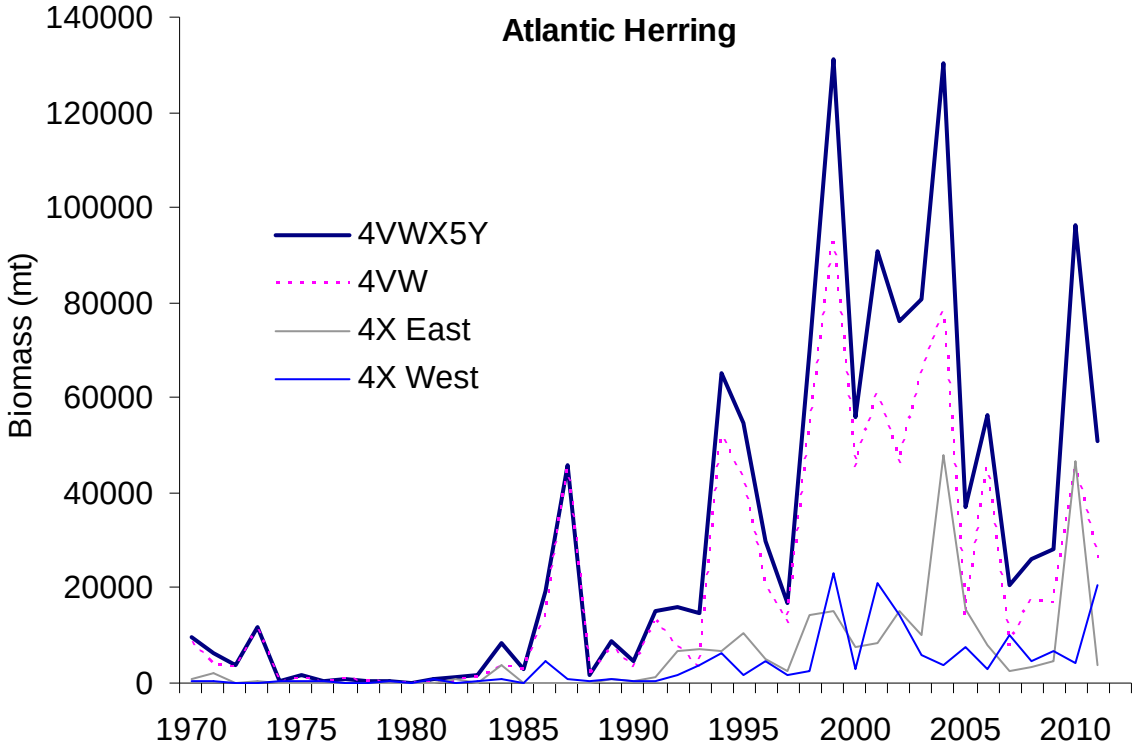


Figure 63. Total biomass estimates for Atlantic herring in 4VWX5Y from the summer RV survey.

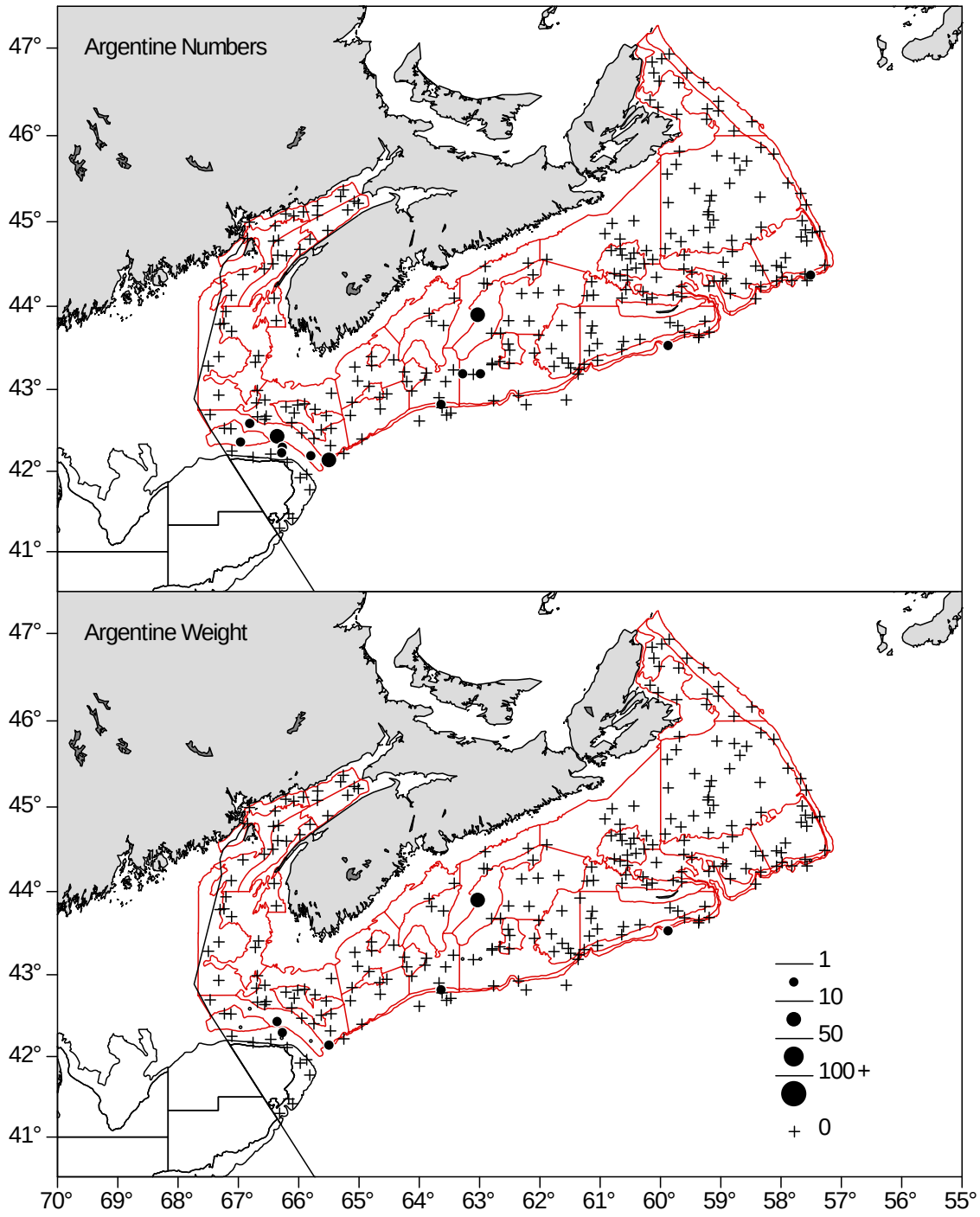


Figure 64. Distribution of argentine catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

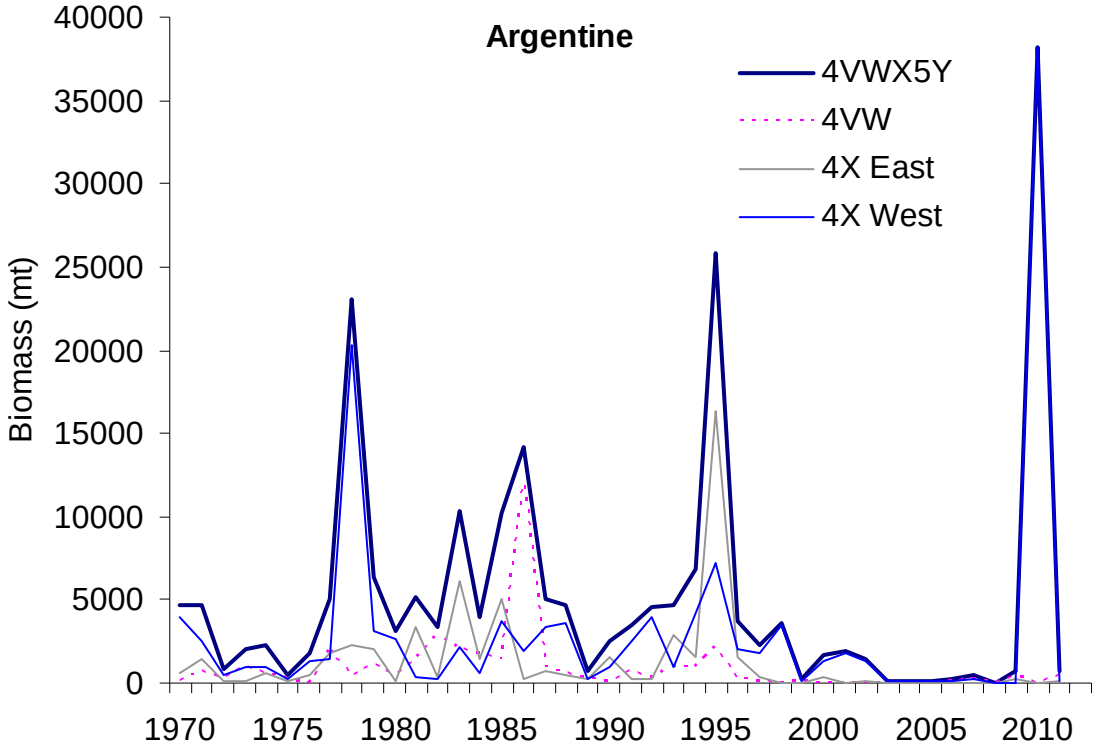


Figure 65. Total biomass estimates for argentine in 4VWX5Y from the summer RV survey.

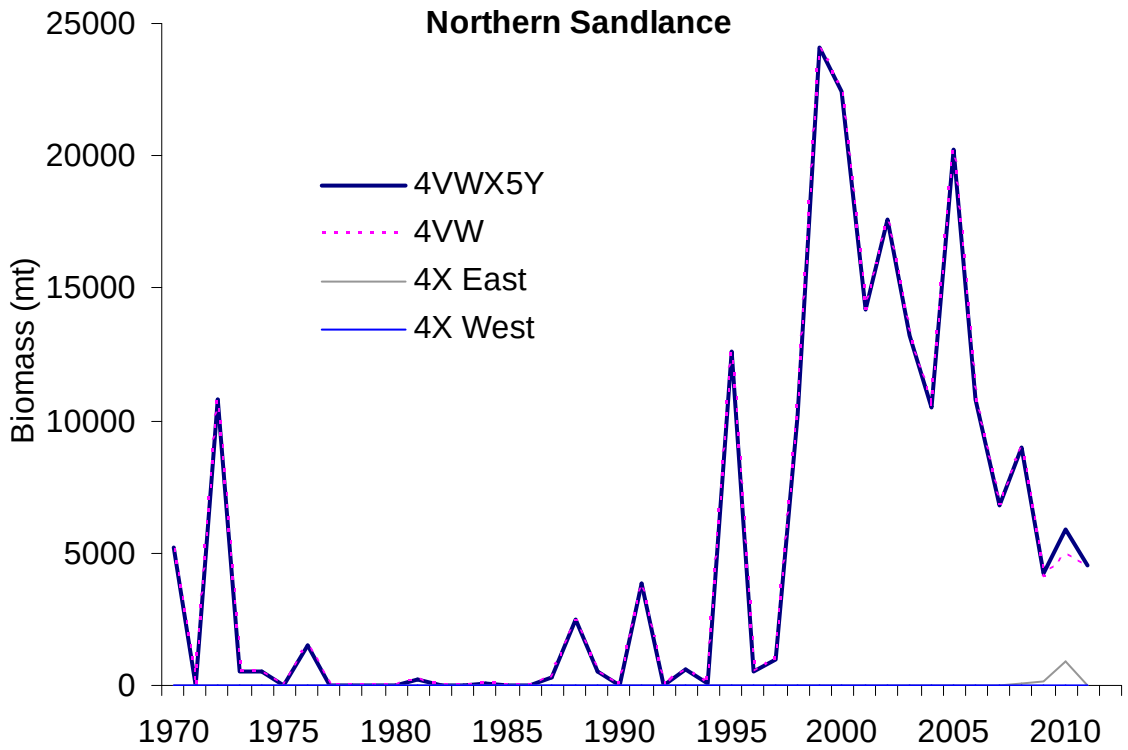


Figure 66. Total biomass estimates for northern sandlance in 4VWX5Y from the summer RV survey.

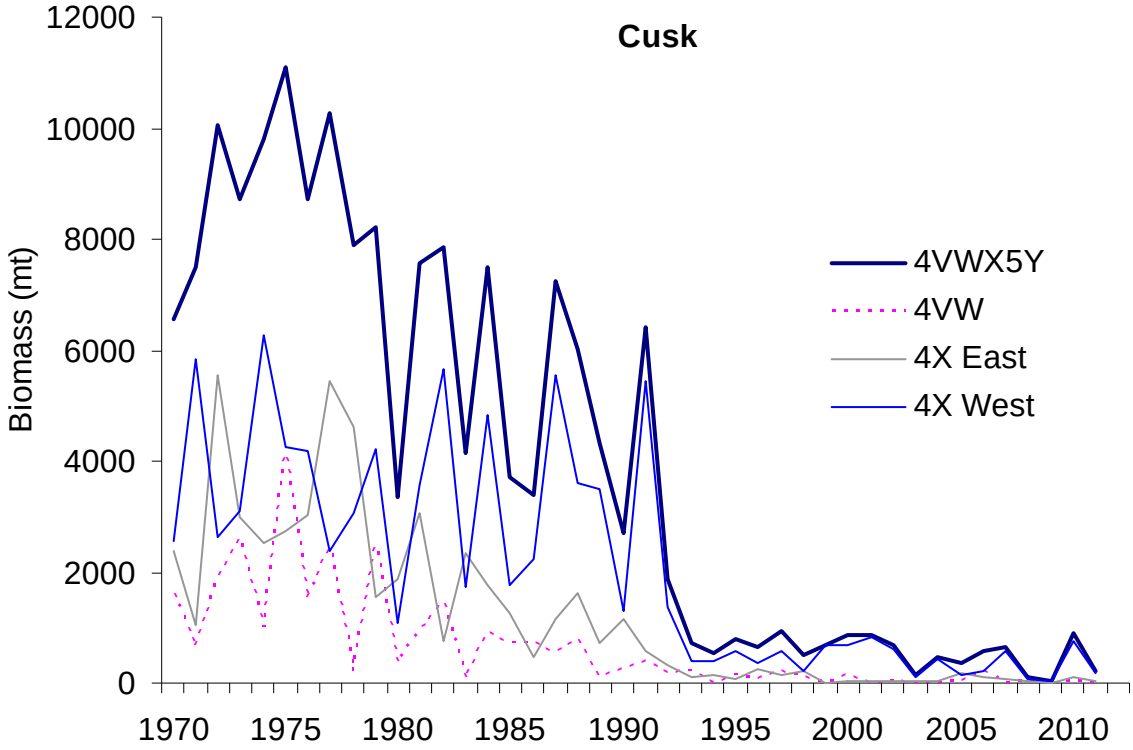


Figure 67. Total biomass estimates for cusk in 4VWX5Y from the summer RV survey.

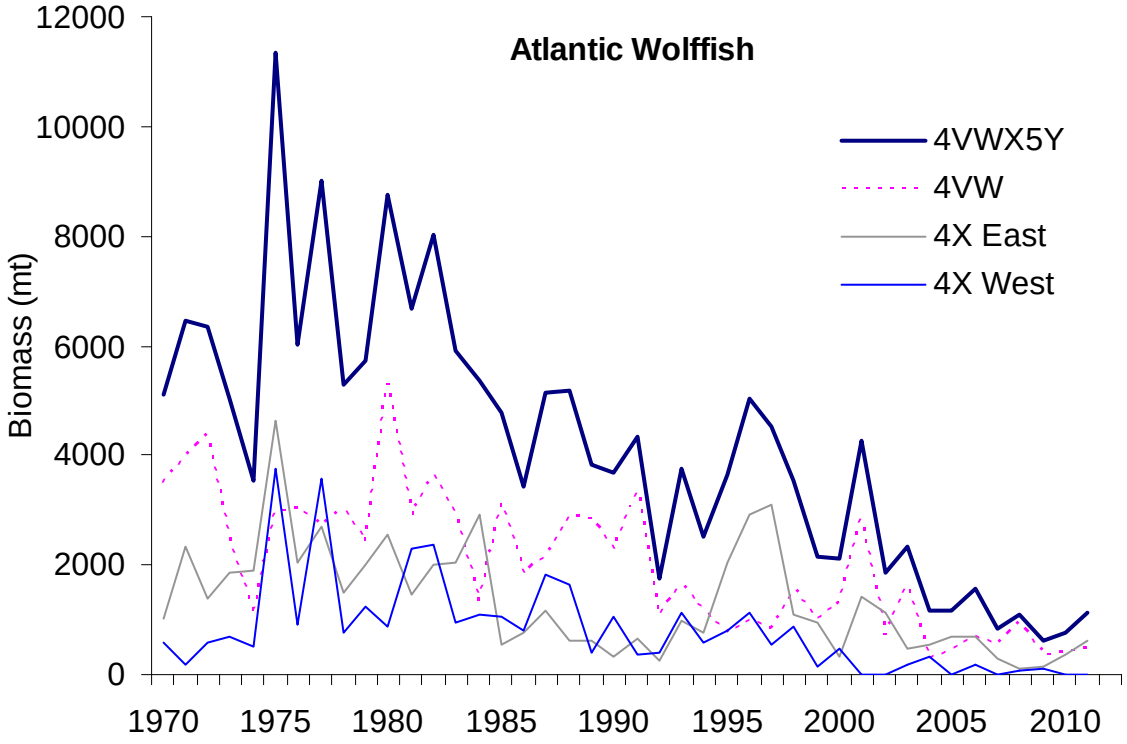


Figure 68. Total biomass estimates for Atlantic wolffish in 4VWX5Y from the summer RV survey.

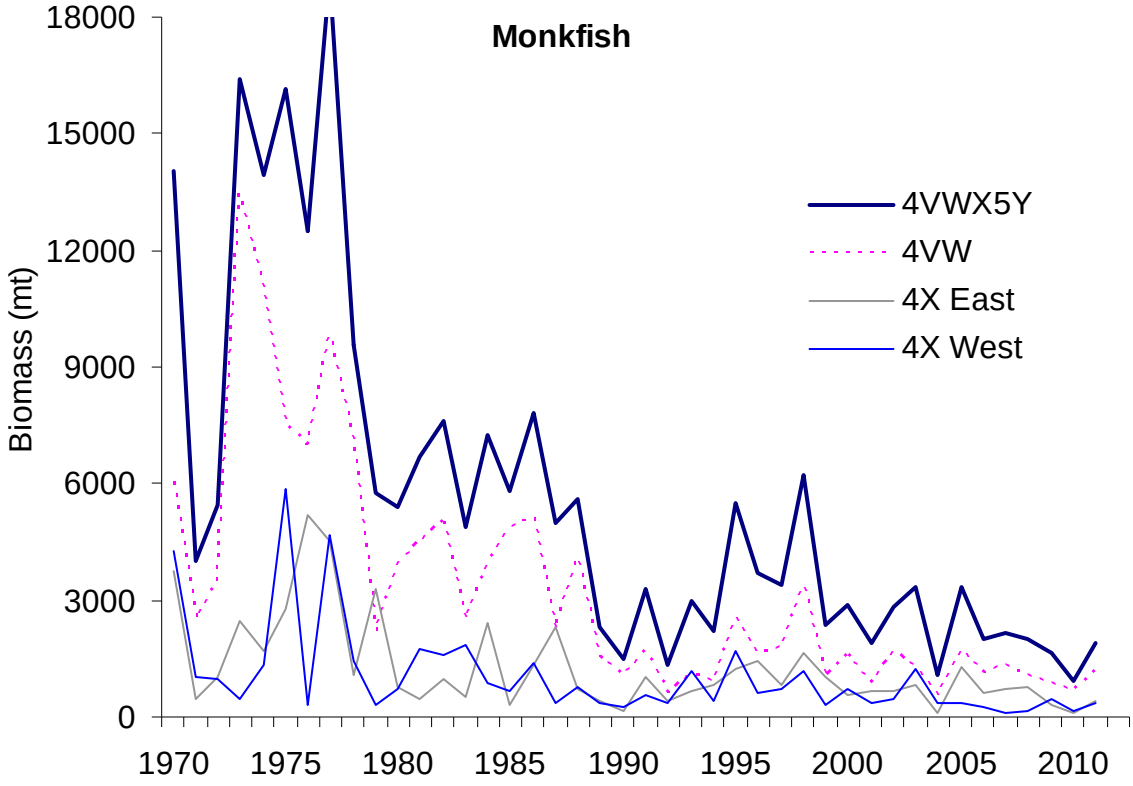


Figure 69. Total biomass estimates for monkfish in 4VWX5Y from the summer RV survey.

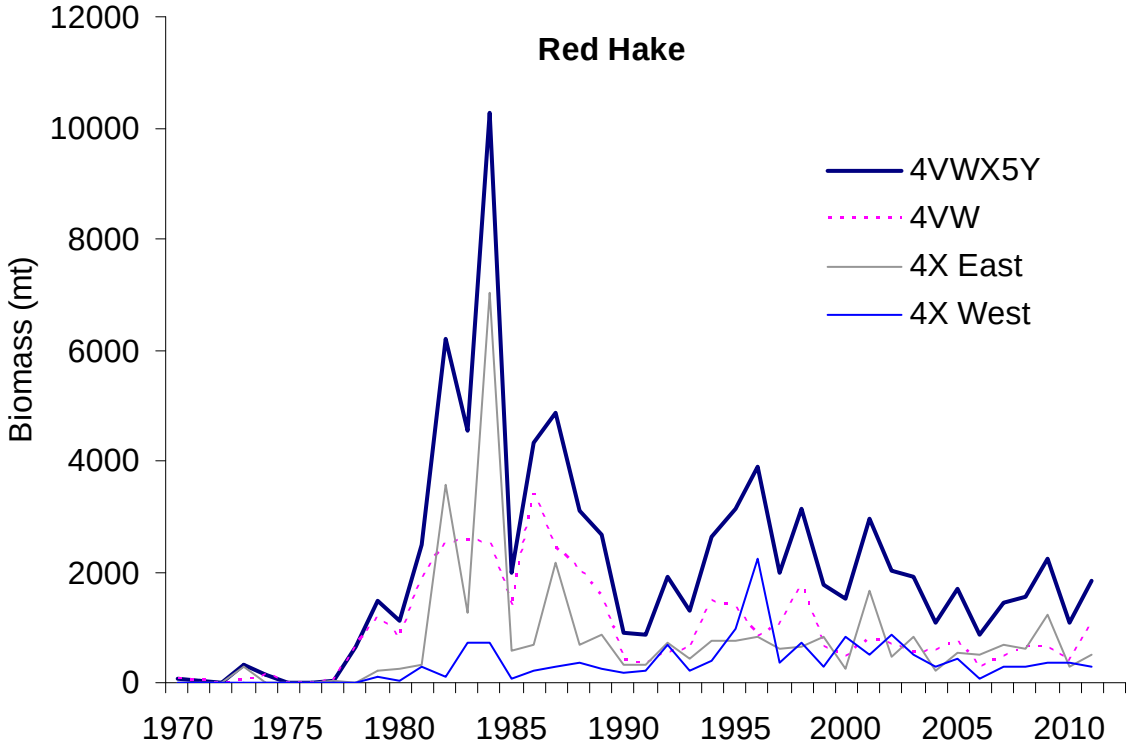


Figure 70. Total biomass estimates for red hake in 4VWX5Y from the summer RV survey.

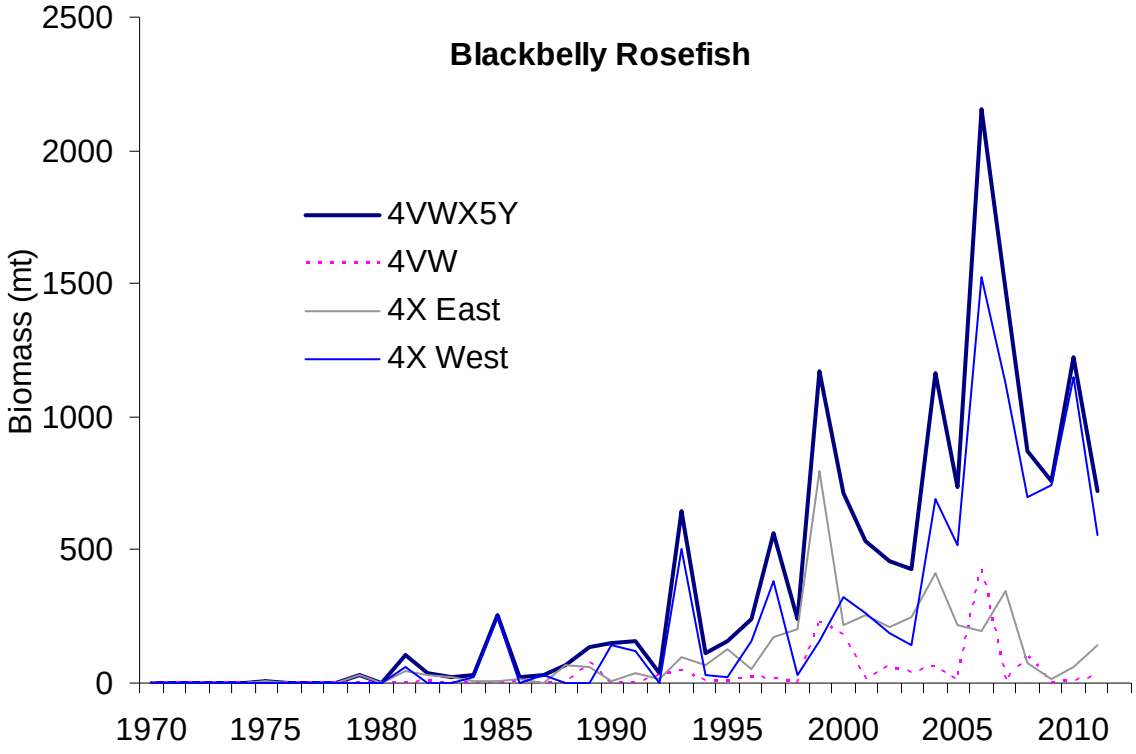


Figure 71. Total biomass estimates for blackbelly rosefish in 4VWX5Y from the summer RV survey.

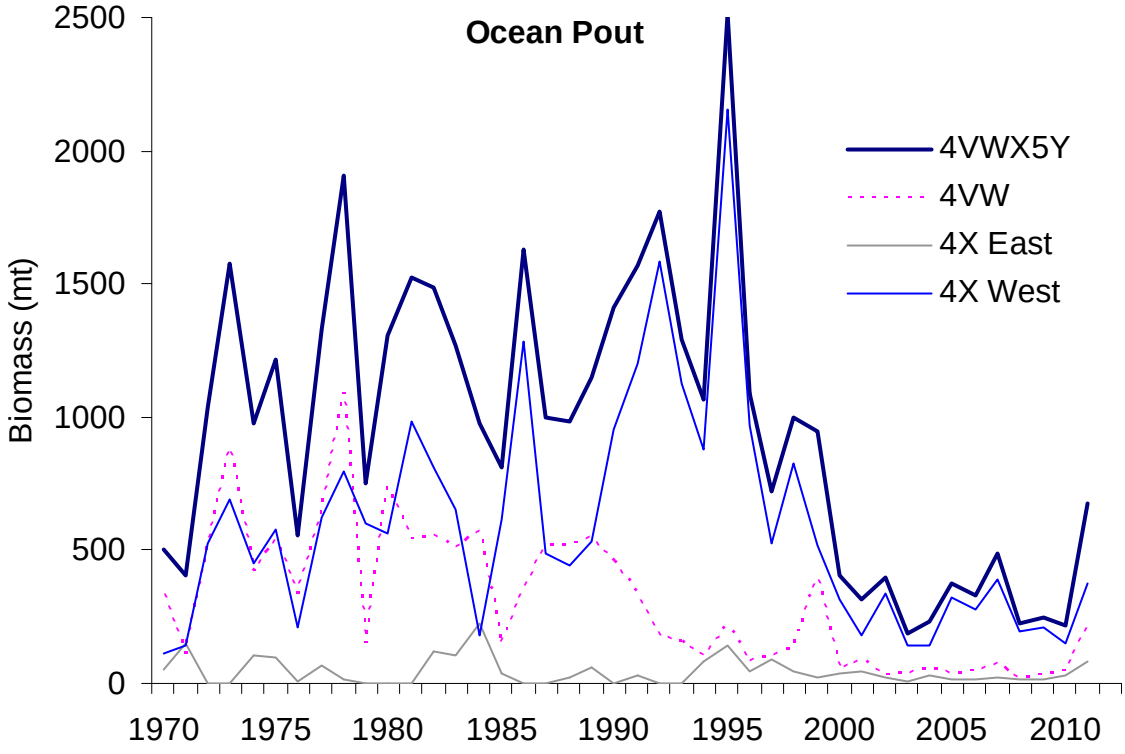


Figure 72. Total biomass estimates for ocean pout in 4VWX5Y from the summer RV survey.

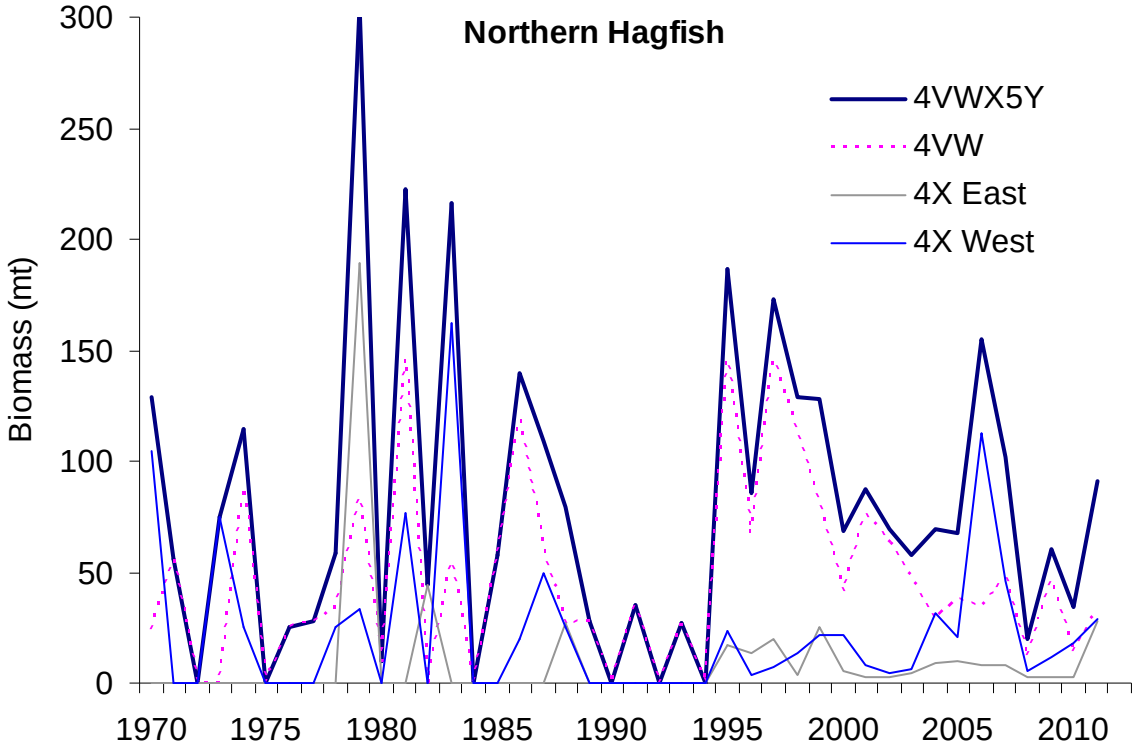


Figure 73. Total biomass estimates for northern hagfish in 4VWX5Y from the summer RV survey.

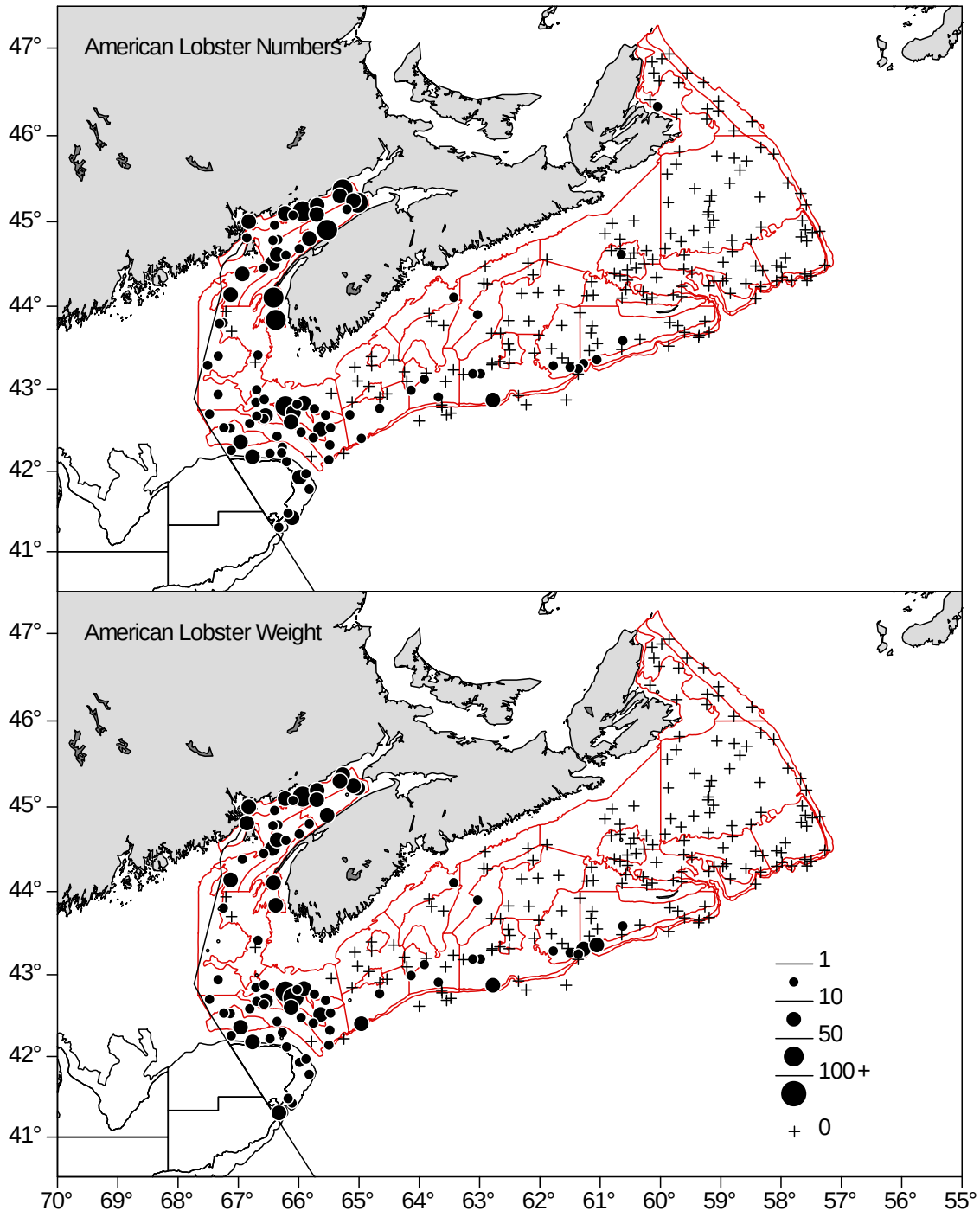


Figure 74. Distribution of American lobster catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

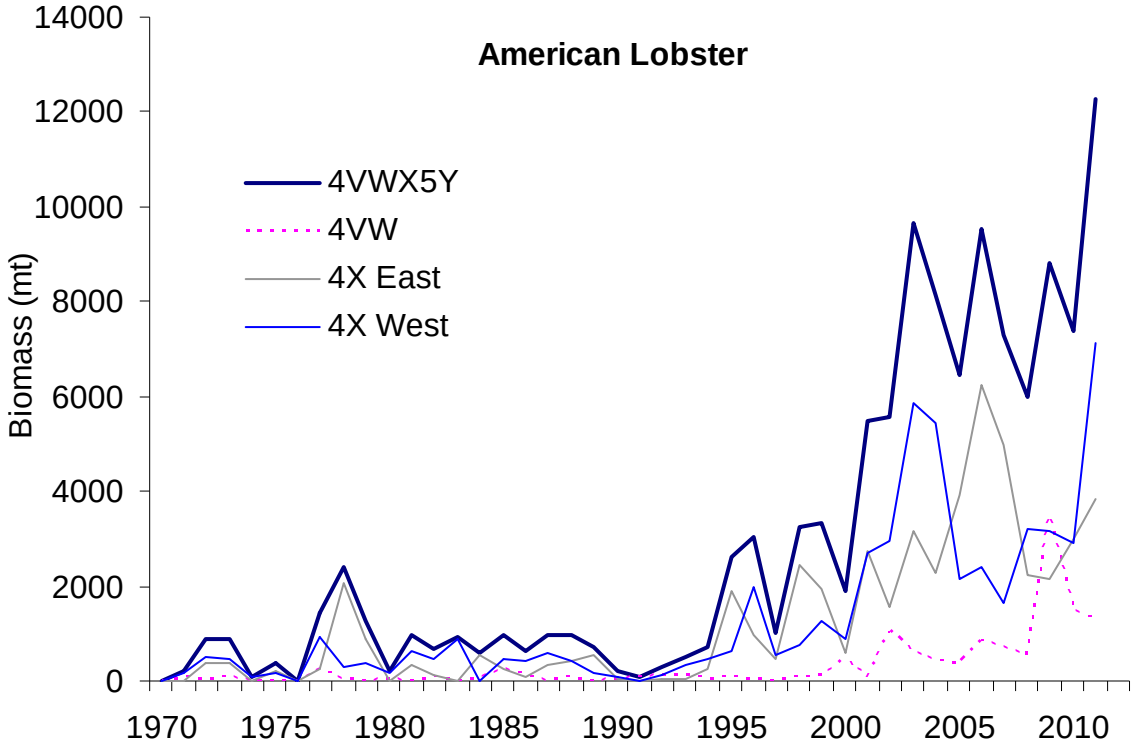


Figure 75. Total biomass estimates for American lobster in 4VWX5Y from the summer RV survey.

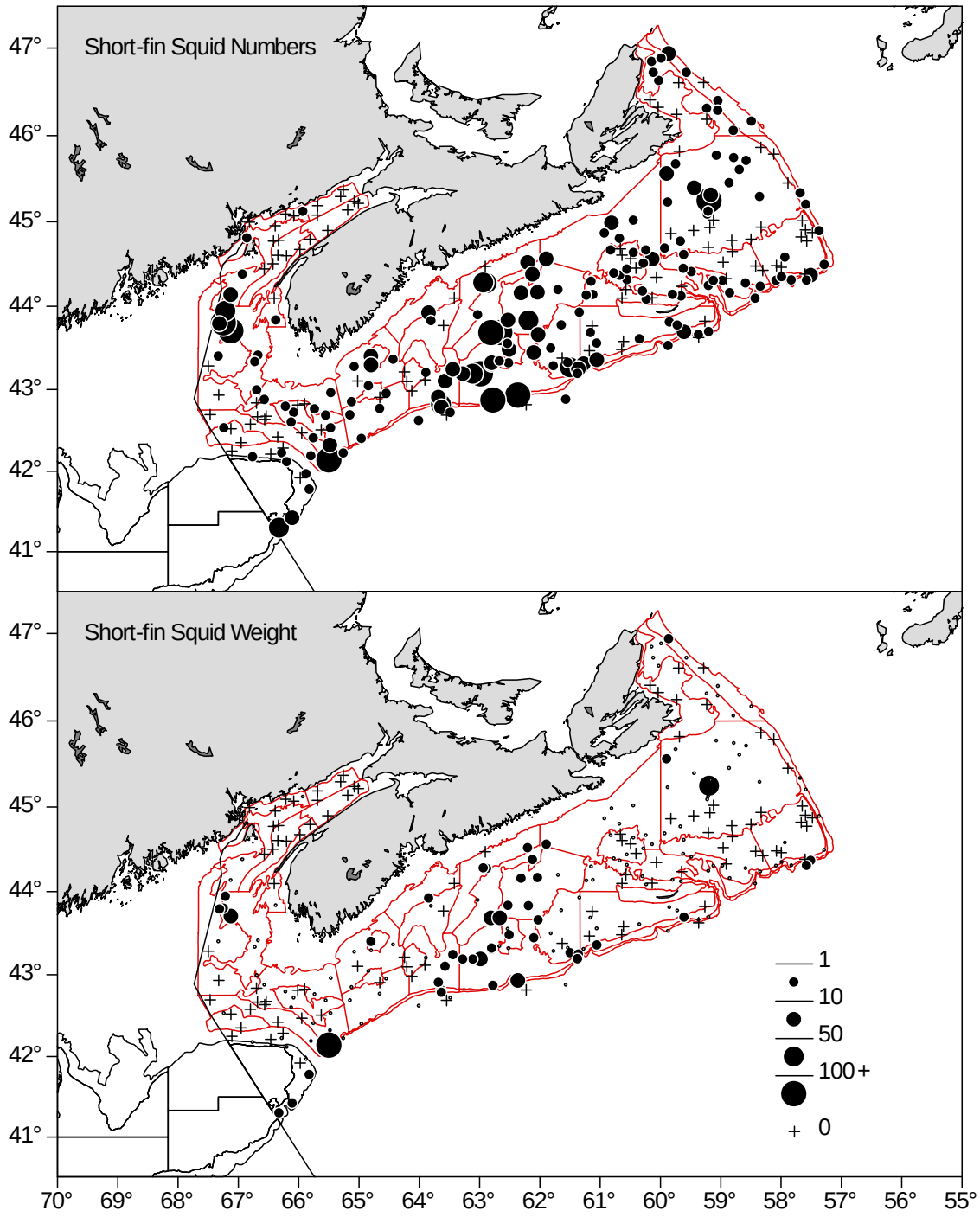


Figure 76. Distribution of short-fin squid catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

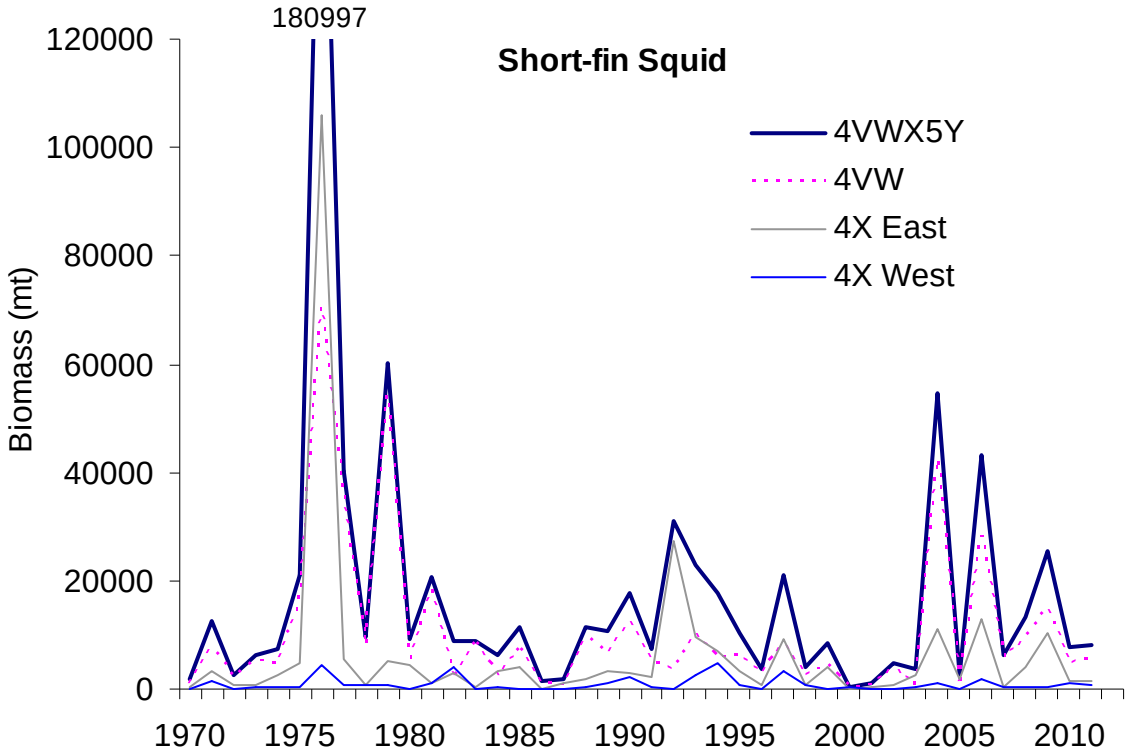


Figure 77. Total biomass estimates for short-fin squid in 4VWX5Y from the summer RV survey.

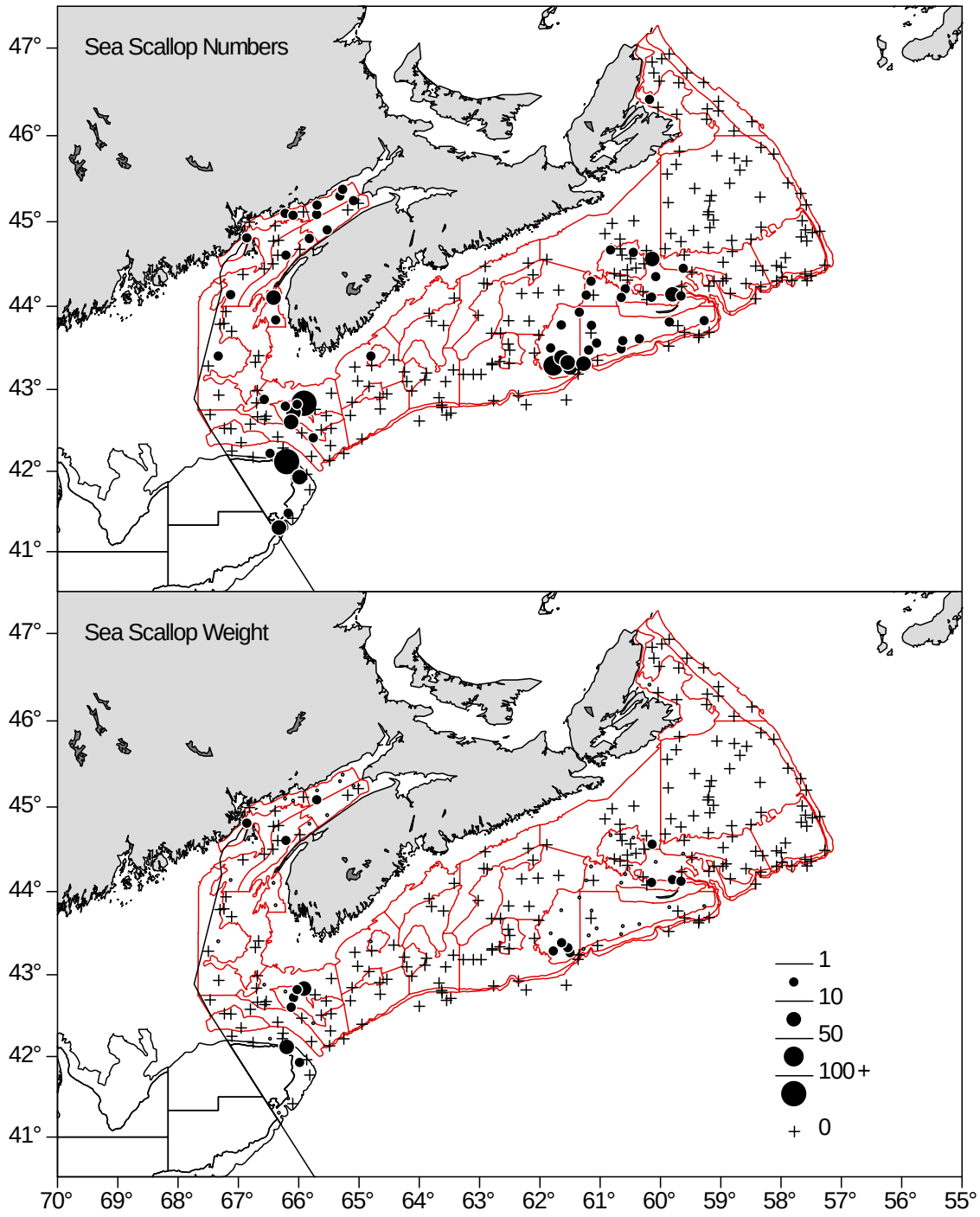


Figure 78. Distribution of sea scallop catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

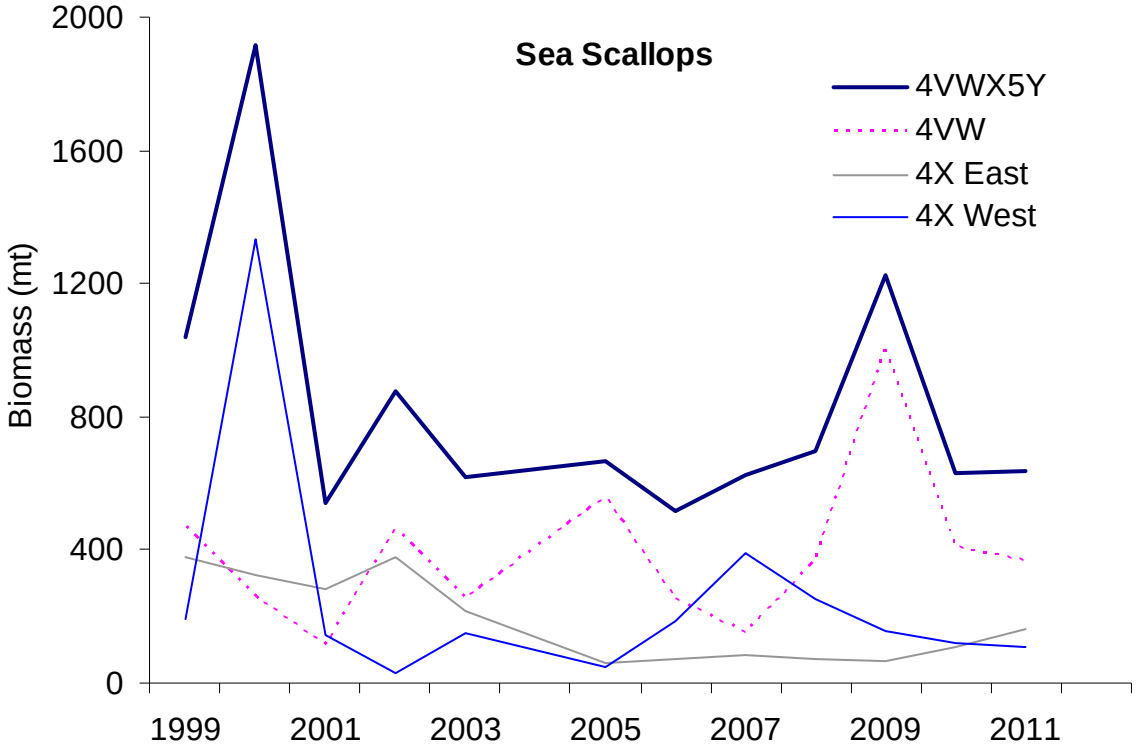


Figure 79. Total biomass estimates for sea scallop in 4VWX5Y from the summer RV survey.

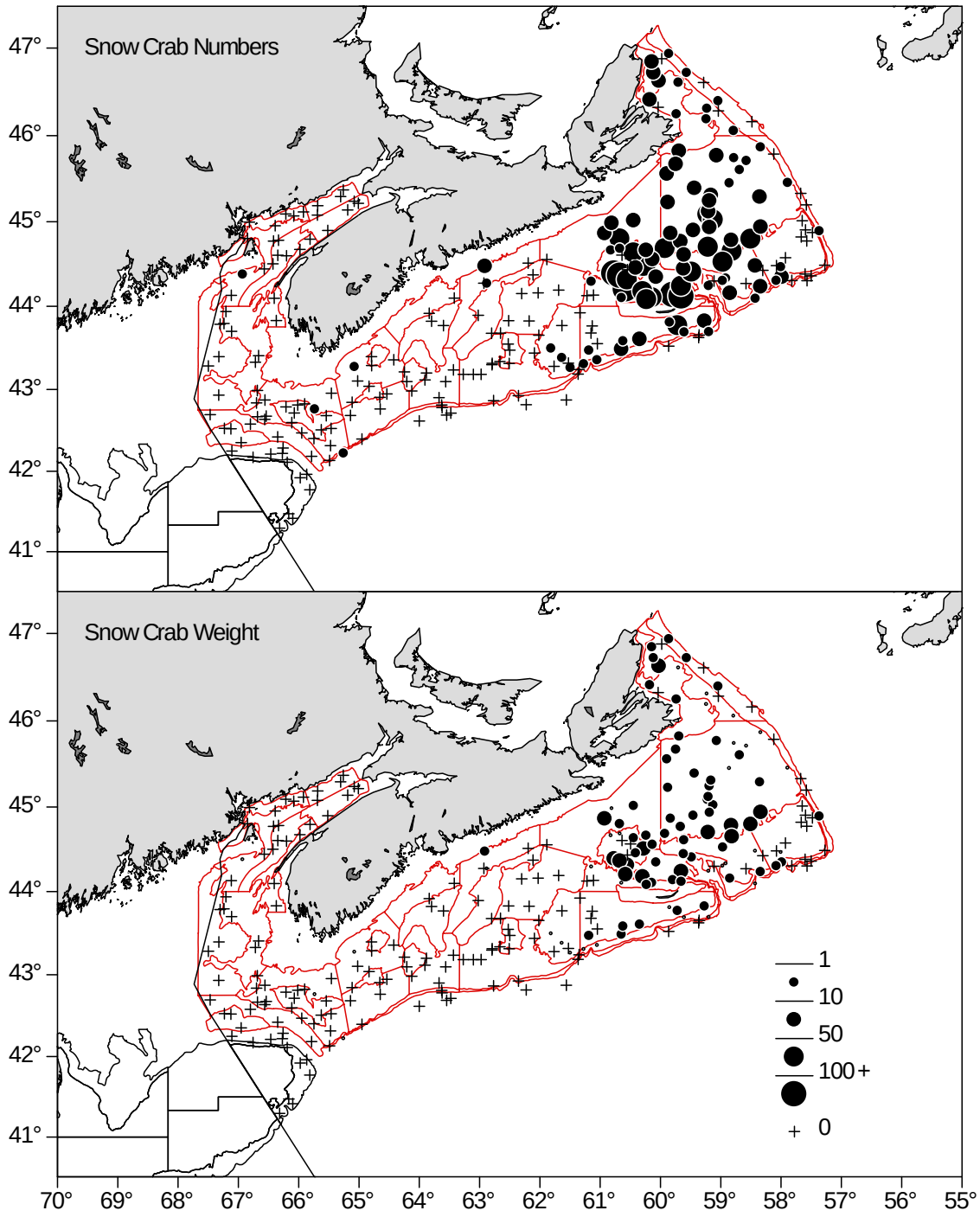


Figure 80. Distribution of snow crab catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

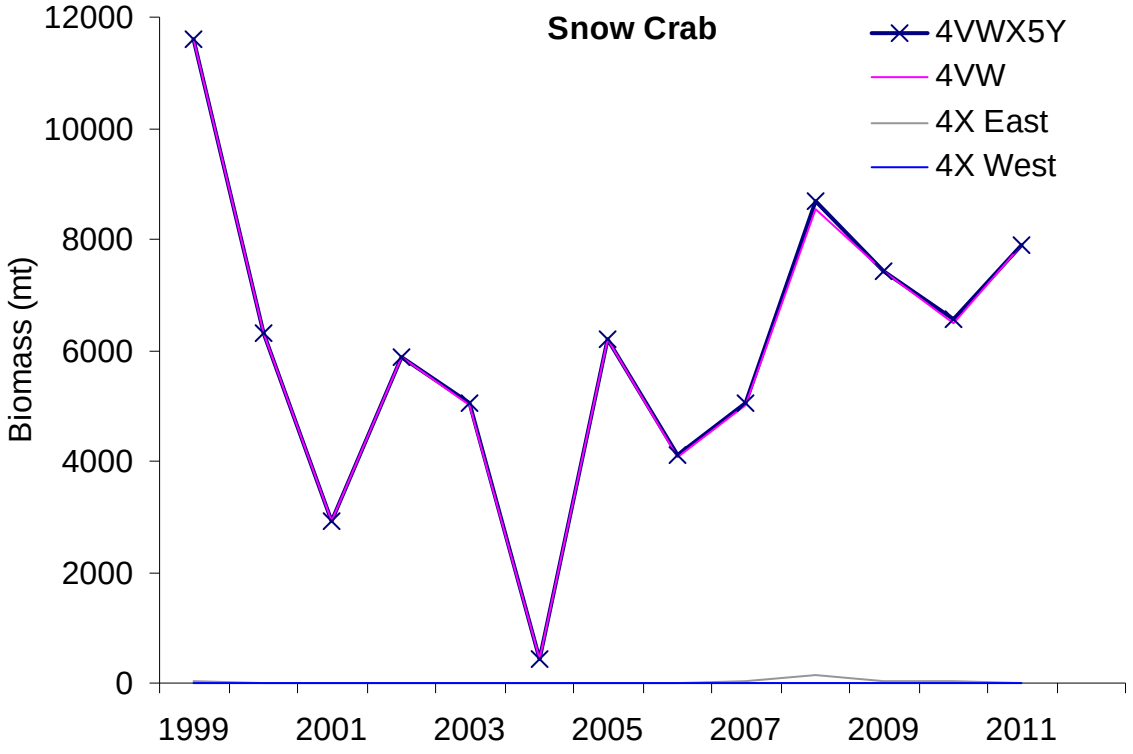


Figure 81. Total biomass estimates for snow crab in 4VWX5Y from the summer RV survey.

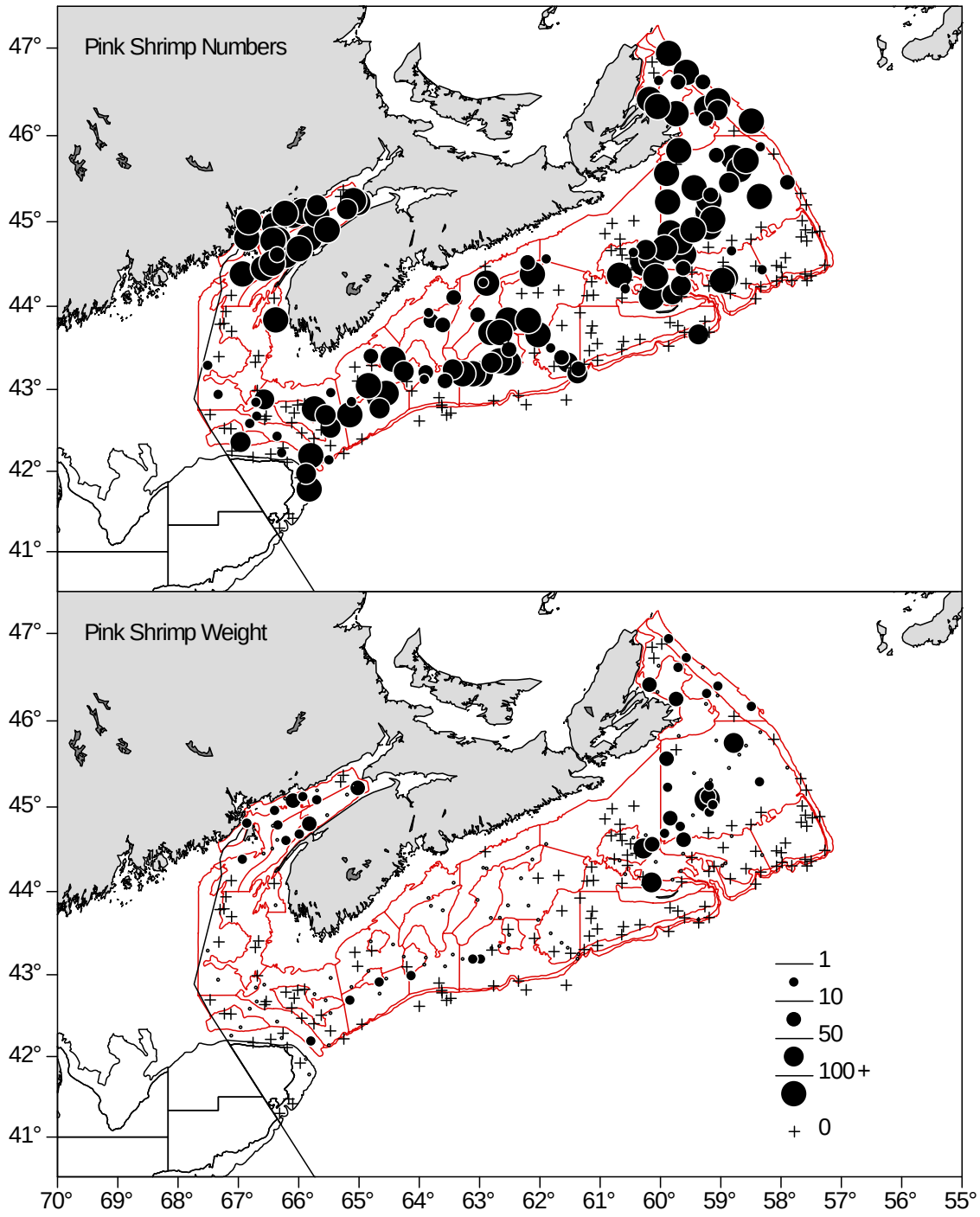


Figure 82. Distribution of pink shrimp catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

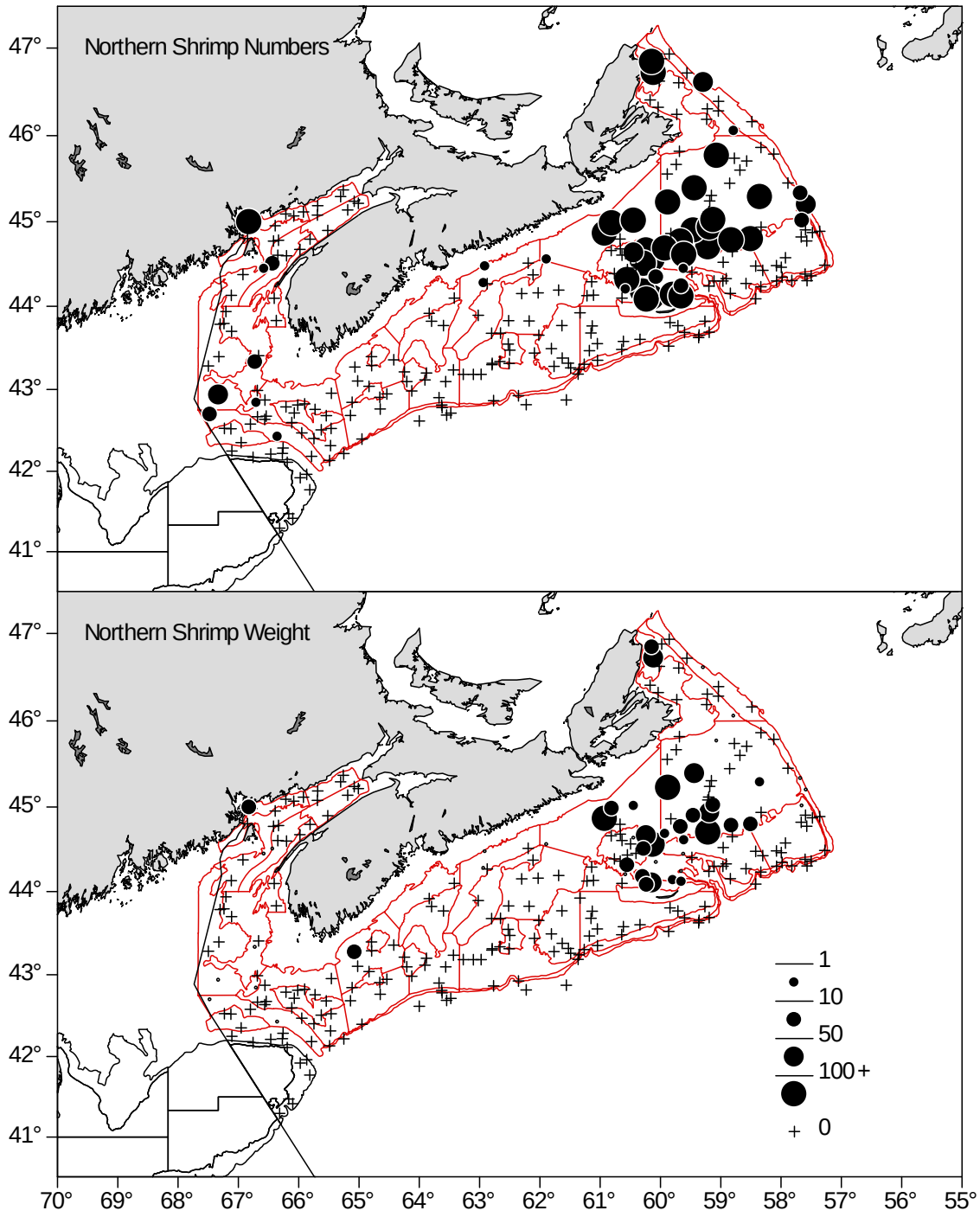


Figure 83. Distribution of northern shrimp catches (top panel: number per tow; lower panel: kg/tow) during the 2011 summer RV survey (scale represents both weight (kg) and numbers).

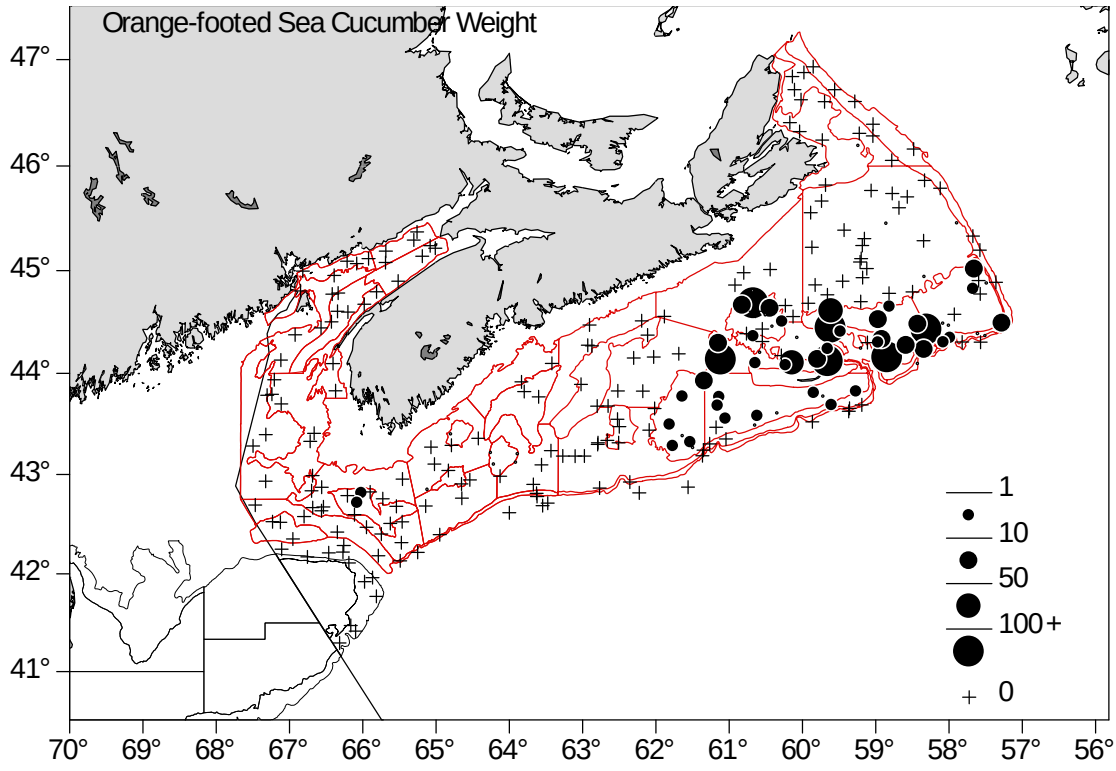


Figure 84. Distribution of orange-footed sea cucumber catches during the 2011 summer RV survey (scale represents weight in kg).

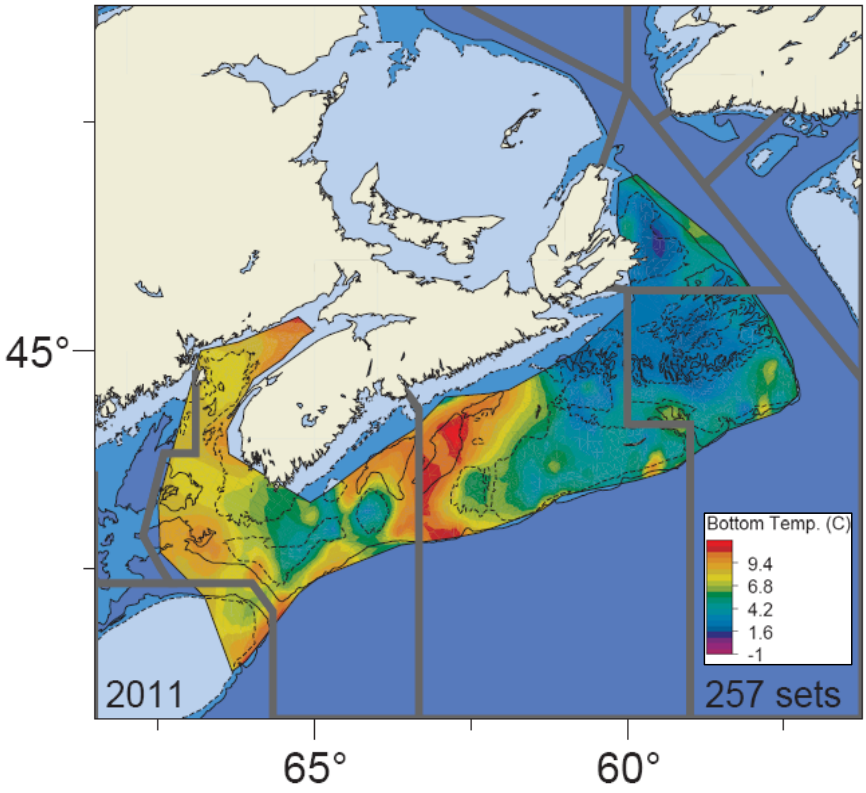


Figure 85. Bottom temperature distribution from the 2011 summer RV survey.

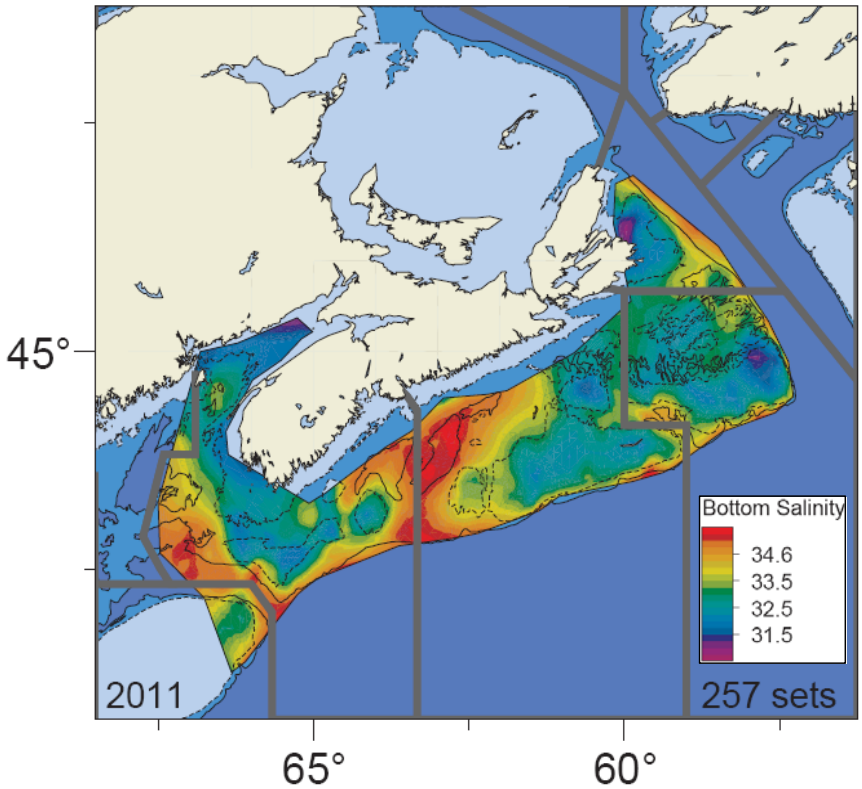


Figure 86. Bottom salinity distribution from the 2011 summer RV survey.

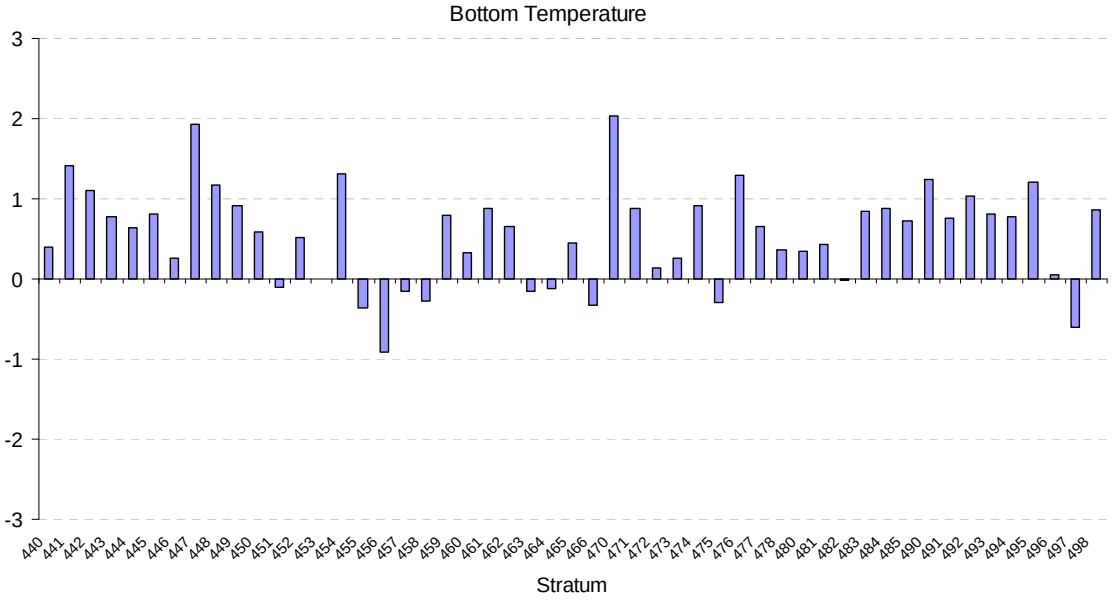


Figure 87. Bottom temperature anomaly plot from the 2011 summer RV survey, calculated as the difference between the average bottom temperature by stratum in 2011 and the average bottom temperature by stratum for the entire survey time series (1970-2010).

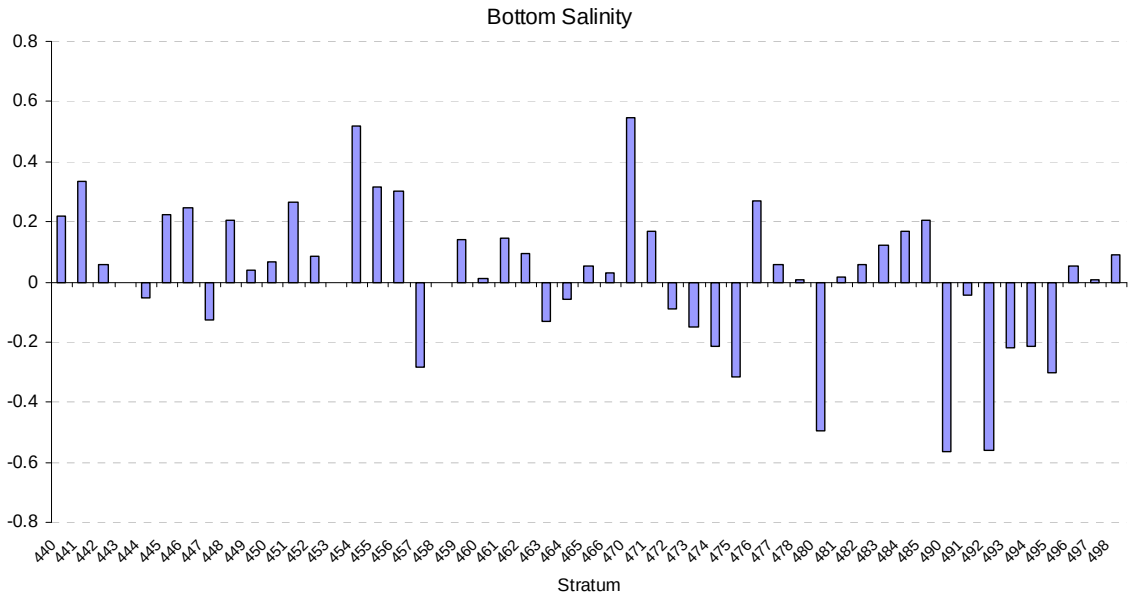
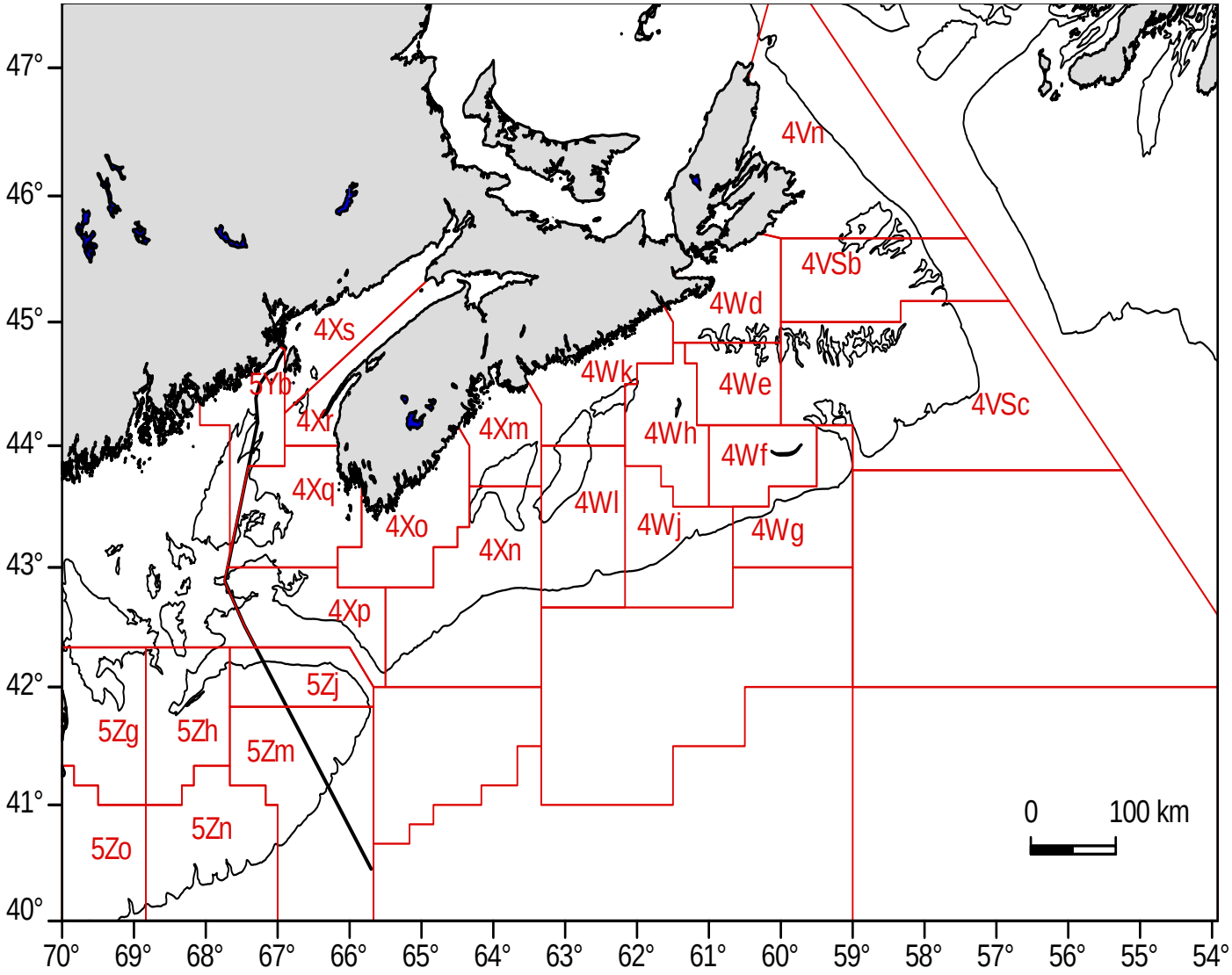
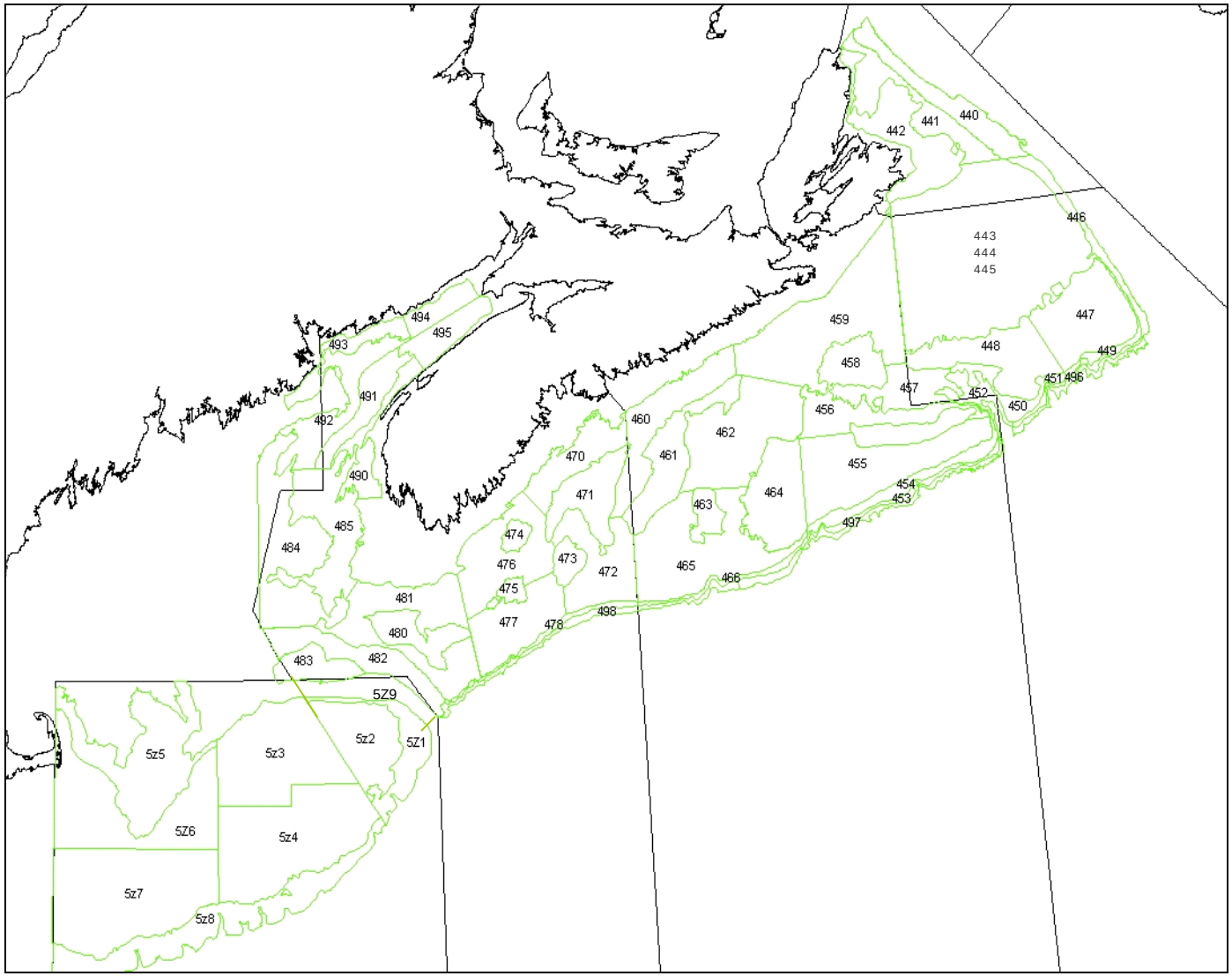


Figure 88. Bottom salinity anomaly plot from the 2011 summer RV survey, calculated as the difference between the average bottom salinity by stratum in 2011 and the average bottom salinity by stratum for the entire survey time series (1970-2010).

Appendix A. NAFO divisions 4VWX5YZ and subunits.



Appendix B. Summer RV survey strata and Georges Bank RV survey strata.



Appendix C. Banks and basins on the Scotian Shelf and Bay of Fundy.