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Canadian Science Advisory Secretariat (CSAS)

Research Document 2024/010

Maritimes Region

Assessment of Atlantic Wolffish (*Anarhichas lupus*) Population Trends on the Scotian Shelf

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

[http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca](http://www.dfo-mpo.gc.ca/csas-sccs/csas-sccs@dfo-mpo.gc.ca)



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ISSN 1919-5044

ISBN 978-0-660-69868-7 Cat. No. Fs70-5/2024-010E-PDF

Correct citation for this publication:

Tsitrin, E., Silver, K., and Themelis, D. 2024. Assessment of Atlantic Wolffish (*Anarhichas lupus*) Population Trends on the Scotian Shelf. DFO Can. Sci. Advis. Sec. Res. Doc. 2024/010. iv + 28 p.

Aussi disponible en français :

Tsitrin, E., Silver, K. et Themelis, D. 2024. Évaluation des tendances de la population du loup atlantique (Anarhichas lupus) sur le plateau néo-écossais. Secr. can. des avis sci. du MPO. Doc. de rech. 2024/010. iv + 30 p.

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ABSTRACT

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the status of Atlantic Wolffish (*Anarhichas lupus*) as special concern in 2000. The Atlantic Wolffish was added to Schedule 1 of the *Species at Risk Act* in 2003. COSEWIC re-evaluated the status in 2012 and determined its status to remain as special concern.

As the department responsible for the management of aquatic species at risk, Fisheries and Oceans Canada (DFO) undertook this assessment to examine recent trends in abundance and distribution of the portion of the Atlantic Wolffish population residing on the Scotian Shelf using data from DFO Research Vessel (RV) and industry surveys, commercial landings, at-sea commercial fishing observations and *Species at Risk Act* (SARA) logbooks. Based on the available data, the decrease in abundance of Atlantic Wolffish on the Scotian Shelf reported in the 2012 assessment has persisted over the last decade. Atlantic Wolffish are concentrated on the eastern Scotian Shelf (North Atlantic Fishery Organization [NAFO] Divisions 4VW), the western Scotian Shelf (Division 4X) around Browns Bank and west of German Bank, as well as isolated areas inshore of the 50-fathom line in Divisions 4WX, which have limited sampling. Both immature and mature abundance has declined since 1970. On the northeast peak of Georges Bank (Division 5Z), there is a small aggregation of Atlantic Wolffish that has declined > 90% since 1986, and remains very low today. Although there are no directed fisheries for Atlantic Wolffish in the Maritimes Region, the species is caught as bycatch in other fisheries. Annual landings of wolffish in 5Z and 4VW have been near 4 t since the 1990s; landings in 4X decreased rapidly in the early 2000s, and have remained below 10 t over the past decade. Atlantic Wolffish discards are observed in multiple fisheries; however, estimates of total discards were not determined. The levels of fishing removals from various fisheries are, therefore, not known. The Maritimes Region Ecosystem Summer RV survey has the longest time series and most comprehensive coverage of the Scotian Shelf, making it the primary source to monitor abundance trends and to inform management actions for the species.

INTRODUCTION

Atlantic Wolffish (*Anarhichas lupus*) is a large-bodied, bottom-dwelling fish that is widely distributed on both sides of the North Atlantic and in the Arctic. In Canadian waters, it occurs from the Davis Strait off Baffin Island, the Labrador Sea, through Atlantic Canada to the Gulf of Maine. It is most abundant off northeastern Newfoundland, Labrador Shelf, and southern Grand Banks. It also occurs broadly in the Maritimes Region and is common in the deeper parts of the Gulf of St Lawrence, Scotian Shelf, Bay of Fundy and the Gulf of Maine/Georges Bank (McRuer et al. 2000, Simon et al. 2012). There are two primary areas of concentration on the Scotian Shelf: in the east (North Atlantic Fishery Organization [NAFO] Division 4V) and the west (NAFO Division 4X, primarily Browns Bank) [Figure 1].

In the Maritimes Region, Atlantic Wolffish are managed as part of the multispecies 4VWX groundfish fishery. There are no directed fisheries for Atlantic Wolffish, but it is caught as bycatch in other fisheries, and fishers have been known to make directed sets for Atlantic Wolffish within a trip (Simon et al. 2012). A regulation requiring that all fleets fishing groundfish retain Atlantic Wolffish was changed in 2020 to allow discarding. Bycatch of Atlantic Wolffish is limited to no more than 10% of the total allowable catch of the target species. The mobile gear (< 65 feet, otter trawl) fleet has a cap of 10 t in each of Divisions 4VW and 4X5. The fixed gear (< 45 foot, gillnets and bottom longline) fleets have a total cap of 10 t in 4VWX5.

Commercial landings of Atlantic Wolffish peaked in 4X5Y in the late 1970s at 1,600 t and declined to below 100 t by the 2000s. In 4VW, landings ranged from 400–700 t between 1963 and 1980s, and declined sharply after 1993 with the closure of directed fisheries for Haddock and Cod on the Eastern Scotian Shelf (Simon et al. 2012).

Data from at-sea observer programs are the only source of discard information from fisheries incidentally capturing Atlantic Wolffish while targeting invertebrates (for example, scallop, lobster) because those fisheries are not required to retain Atlantic Wolffish or record their discards in fishing logs (DFO 2020a). Atlantic Wolffish are discarded as bycatch in the Inshore and Offshore Scallop, Jonah Crab and American Lobster fisheries (Gavaris et al. 2010, Sameoto and Glass 2012, Pezzack et al. 2014). They have also been observed discarded in the groundfish bottom longline and otter trawl fisheries (Gavaris et al. 2010, Clark et al. 2015).

Atlantic Wolffish is considered by the Committee on the Status of Endangered Wildlife (COSEWIC) to comprise a single population or designatable unit (DU) in Canadian waters. Although significant regional genetic differences have been observed between individuals collected from the Grand Banks and Scotian Shelf, there is no other evidence to support more than one designatable unit, such as distinct evolutionary lineages, different environments, or spatial disjunctions (COSEWIC 2012).

Atlantic Wolffish was assessed as special concern by COSEWIC because of steep declines in abundance and area of occupancy over much of its range from the 1980s through the mid-1990s (COSEWIC 2000). It was listed under SARA in June 2003. The status of Atlantic Wolffish was re-assessed and confirmed by COSEWIC in 2012 (COSEWIC 2012). Although overall abundance and area of occupancy were found to have increased between the mid-1990s and 2012, the population remains at a low abundance compared to the early 1980s. While there appeared to be some signs of population recovery in other regions of their range, the portion of the population occurring on the Scotian Shelf continued to decline in abundance (Simon et al. 2012, Simpson et al. 2013).

Fisheries and Oceans Canada (DFO) is obliged under SARA to update scientific information on the status of listed species, assess the potential for recovery and identify threats to recovery. As

a species of Special Concern, Section 32 prohibitions do not apply to Atlantic Wolffish and it is managed under the *Fisheries Act*. Trends in the abundance and distribution of the species in the Maritimes Region are monitored by the annual Summer Ecosystem Research Vessel (RV) survey of 4VWX and reported annually in a series of updates on the status of groundfish species (most recently DFO 2020a). A management plan for Atlantic Wolffish was published as part of a National Recovery Plan for the three wolffish (Northern, Spotted and Atlantic) species residing in Canadian waters in 2007 (Kulka et al. 2007) and amended in 2020 (DFO 2020b). An assessment of the entire Atlantic Wolffish population in Canadian waters was undertaken by DFO following the COSEWIC re-assessment (Collins et al. 2015).

This report describes data analyses undertaken in response to a request for scientific advice on recent abundance and distribution trends of the portion of the Atlantic Wolffish population residing on the Scotian Shelf. DFO Science was also asked whether a reliable biomass index could be developed to track population trends over time from data sources other than the 4VWX Summer Ecosystem RV survey, such as other fishery independent surveys conducted by DFO and industry, landings data, commercial fishery observers, and SARA logbooks. This report also documents whether the index could be used to understand population trends and to assess and track fishing mortality over time, and what the data revealed about species distribution patterns, potential drivers of population decline, range shifts, and/or sustained low abundances. The objectives were to: develop a biomass index for the Scotian Shelf portion of the population; examine population trends over time; examine distribution patterns over time; and estimate mortality due to fishing over time.

LIFE HISTORY CHARACTERISTICS

Atlantic Wolffish prefers shallow, coastal waters to depths of 350 m and tolerates a wide range of temperatures from -1 to 10 °C. A non-schooling fish that occurs in low densities, it has been usually observed as solitary individuals or paired during spawning season (Scott and Scott 1988). It lives over hard substrates and complex bottom such as rocks and large stones (Rountree 2002). Atlantic Wolffish is not known to make long migrations, but seasonal, inshore migrations may occur in the spring, when mature fish are found in shallow waters of 0–15 m (McRuer et al. 2000, Simpson et al. 2015).

Size and age of first maturity have not been determined for the Maritimes Region. A length of 53 cm was used in this report to differentiate between immature and mature individuals, consistent with earlier assessments (McRuer et al. 2000, Simon et al. 2012). Simon et al. (2012) examined maturity staging of Atlantic Wolffish ovaries collected during the Summer RV surveys on the Scotian Shelf, but there were too few observations to establish the length at which 50% of individuals become mature. Templeman (1986) noted that females reach sexual maturity at 43 cm off Labrador and at 58 cm in the southern Grand Bank, and suggested that size was related to temperature. Atlantic Wolffish in the Gulf of Maine region is considered mature at lengths of 40–47 cm and 5–6 years of age (Nelson and Ross 1992).

Some recent studies on migration and homing to feeding and spawning grounds have been conducted on Atlantic Wolffish in Newfoundland waters and the Northeastern Atlantic. Tagging experiments by Simpson et al. (2015) in Conception Bay (Newfoundland) found that most individuals were sedentary, with 70% remaining within a 4 km radius for up to two years. Individuals frequently occurred in open water during both daylight and nighttime in spring and summer. Scuba divers observed individuals in dens between July and October (Simpson et al. 2015). Atlantic Wolffish tagged in Icelandic waters were found to have strong homing behaviour and undertook consistent year to year migrations between spawning and feeding grounds (Gunnarsson et al. 2019). Both males and females arrived at the main spawning

ground in the middle of August, with males leaving by February, about two months after the females.

Nearshore habitats with rocky substrates offer important potential denning areas for Atlantic Wolffish by providing foraging, spawning and nursery areas; therefore, habitat degradation is an important consideration in managing this species (Novaczek et al. 2016). Habitats for denning in shallow waters are characterized by a rocky sea floor with large boulders, fissures and crevices (Simpson et al. 2015). High densities of prey (Green Sea Urchin, Blue Mussel, and Rock Crab) provide forage.

Reports of Atlantic Wolffish aggregations in shallow areas of Stellwagen Bank in Massachusetts Bay were investigated by Fairchild et al. (2015). Catch rates of 0.6 to 37.8 fish per hour were recorded at shallow depths of 27–46 m in May and June. The authors concluded that these were feeding aggregations because the fish were mature, in pre-spawning condition, both sexes were equally represented, and 99% of the fish were feeding actively. Their diet was comprised mainly of hard shelled invertebrates (Sea Scallop, hermit crab, Quahaug, gastropods, sea urchins, and Jonah Crab). The habitat was not complex but rather an assemblage of sand and gravel.

METHODS

DFO RESEARCH VESSEL SURVEYS

The Maritimes Region Ecosystem Summer RV Survey has been conducted annually since 1970. The survey follows a stratified random sampling design for sampling fish and invertebrates using a bottom otter trawl. Survey data are used as the primary data source for monitoring trends in species distribution, abundance, and biological condition within the region. Sampling is conducted in NAFO Divisions 4VWX, 5Yb, and the Canadian portion of 5Z; for purposes of this assessment, only areas of the Scotian Shelf (4VWX, Strata 440–495) were analyzed, and data for 2018 and 2021 were not included due to insufficient sampling (Figure 1). From 1970–1981, the survey was conducted by the *A.T. Cameron* using a Yankee 36 Trawl. In 1982, the vessel was replaced by the *MV Lady Hammond* using the Western IIA as the new standard trawl. Although changes to data collection protocols occurred which may affect catchability of Atlantic Wolffish, data were not scaled based on the trawling gear. The survey has been conducted primarily by the Canadian Coast Guard Ship (CCGS) *Alfred Needler* since 1983 using a Western IIA trawl, and the CCGS *Teleost* in its place if mechanical issues occurred. In 2018, sampling was incomplete due to mechanical issues. In 2021, a comparative fishing survey was expected to be conducted by the CCGS *Alfred Needler* and the CCGS *Jacques Cartier* to investigate catchability between the standard Western IIA trawl and the new Northeast Fisheries Science Center Ecosystem Survey Trawl (NEST) trawl. Due to mechanical issues, the CCGS *Alfred Needler* did not conduct any surveys in this time period and data collection was incomplete; exploratory sampling took place instead on the CCGS *Jacques Cartier*.

Since 1986, a survey has been conducted in February/March on Georges Bank (5Ze) following a stratified random design. The CCGS *Alfred Needler* has been the primary survey vessel, using a Western IIA trawl, with the exception of its sister ship the CCGS *Wilfred Templeman* being used in 1993 and 2004. In addition, a comparative survey was completed in 2005 and 2006 between the CCGS *Alfred Needler* and the CCGS *Teleost* to estimate catchability between vessels, and due to mechanical issues with the CCGS *Alfred Needler*, the CCGS *Teleost* conducted the survey in 2016, 2017, 2020, and 2021. The survey concentrates on the Canadian side of the bank (5Zc) with additional sets on the United States of America (USA) side

of Canada's Exclusive Economic Zone (EEZ) that cover the remainder of the bank, and some trips doing sets on the Western Scotian Shelf (4X). Due to consistency of sampling coverage, only data for 5Z1 and 5Z2 were analyzed in this report.

The Spring 4VsW Survey (also referred to as 4VWCOD) was conducted from 1986 to 2010 on the eastern half of the Scotian Shelf (4VW). This survey used a stratification scheme to optimize abundance estimates of Cod. No surveys were conducted in 1998 or 2004, and the 2009 survey was incomplete. The CCGS *Alfred Needler* conducted the survey using the Western IIA trawl in 1986–2003, 2005–2006, and 2010. The CCGS *Wilfred Templeman*, using the same gear, conducted the 2007 survey, and in 2008, the CCGS *Teleost* was the survey vessel.

Other surveys examined in this report include the Spring (1979–1984) and the Spring 4X (2012–2020). The Fall (1978–1984) and Redfish (1982–1988) survey data were described in the previous assessment (Simon et al. 2012). All surveys were primarily conducted by the CCGS *Alfred Needler* or the MV *Lady Hammond*, with the exception of the Spring 4X RV survey using the CCGS *Teleost* in 2016 and 2020. All vessels used the Western IIA trawl gear. The Spring 4X RV survey was not completed in 2013, 2015, 2017, and 2018. Together, the RV surveys provide complete coverage of all divisions in the Maritimes Region, including the shelf break (Redfish survey), using a stratified random design based on depth and geographic area to determine distribution and abundance of species.

Canadian Industry/Science Surveys

The Industry-DFO Halibut Longline survey was implemented in 1998 to provide information on abundance, biomass, exploitation, and species biology for stock assessment purposes. The survey deploys bottom longline gear using a fixed station design aimed at achieving even coverage in the Bay of Fundy, Cape Breton, and Georges Bank. Some variability exists in the sampling effort from year to year (e.g., soak time, number of hooks, etc.) that may affect catchability of other species. Details on this survey are available from Armsworthy et al. (2006).

The 4VsW Sentinel survey initiated in 1995 is a stratified random bottom longline survey conducted by industry participants in September and October to monitor groundfish abundance in 4Vs and 4W in inshore waters and bottom types which cannot be sampled by DFO's trawl surveys. The survey began with a similar coverage to the summer RV survey, with 202 sampling stations, including three inshore strata. In 2004, the survey was reduced to the two western inshore strata as well as four offshore strata thought to be the center of distribution for Haddock. In 2012, the sampling area was further reduced to 18 stations in 4W.

The Maritimes Snow Crab survey began in 1997 using a modified Nephrops Trawl and following a systematic random design. The number of stations has expanded spatially and the density of stations has increased to over 400 stations which are sampled annually in 4Vn, 4Vs, 4W, and the nearshore area of 4X. Distributional data for Atlantic Wolffish are only available since 2004.

The Individual Transferable Quota (ITQ) was a fixed station survey using a bottom trawl that began in 1995 with the purpose of providing abundance indices for groundfish stock assessments. The survey was conducted in early July and covered an average of 181 stations per year in 4X, with the addition of an area inshore of the 50 fathom line. In 2013, the ITQ survey was replaced by the Inshore Lobster Trawl Survey (ILTS) in an effort to improve knowledge of lobster stock characteristics. The new survey used the same gear as the ITQ survey in 2013–2015, but the number of sampled stations was reduced; in subsequent years the survey has moved towards a more standardized sampling protocol using a NEST trawl. For the purpose of this report, the surveys are presented together, but visual aids are used to indicate when the change occurred. A description of the new survey design is provided by Denton (2020).

Data Analysis

Estimates of trawlable biomass and abundance were calculated by extrapolating RV survey catch per tow to the total number of trawlable units in a survey area, and scaled by survey area. Similar scaling was used for length frequencies. These estimates should be considered with care, particularly over the last ten years, given the low number of Atlantic Wolffish in recent survey catches. Trawlable estimates of biomass and abundance from industry surveys were not calculated, so average catches are presented instead, standardized by the sampling effort where possible.

Data from Canada's At-Sea Observer Program within the Maritimes Region were examined from 1978 to 2021 to determine which commercial fisheries catch Atlantic Wolffish and the proportion of individuals kept (landed) to released (discarded). Only those sets that reported Atlantic Wolffish were examined therefore the amount is an underestimate. Commercial landings of Atlantic Wolffish (or catfish) were obtained from the Maritimes Fisheries Information System (MARFIS) database, and are examined from 2000. The names catfish or wolffish were used interchangeably for all species of wolffish until 2006, therefore the commercial landings data may include Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*). Most are assumed to be Atlantic Wolffish based on known distributions of the three species from DFO RV surveys in this area. Fishing logs (catch estimates recorded during commercial fishing) and SARA logs (records of interactions with SARA listed species during commercial fishing) were examined for evidence of wolffish discards.

RESULTS

OVERVIEW OF CANADIAN RV SURVEYS

Maritimes Summer Ecosystem Research Vessel (RV) Survey of the Scotian Shelf (Divisions 4VWX)

A total of 8,998 sets were completed by the Maritimes Summer Ecosystem Research Vessel Survey between 1970–2021 in strata 440–495, of which 1,566 captured Atlantic Wolffish (Table 1). Composite distribution patterns determined two primary areas where these fish were caught: the eastern Scotian Shelf (4V) and the western Scotian Shelf (4X) (Figure 3). The distribution maps from 2011–2021 showed similar results, but catch decreased and distribution was more confined around Browns Bank and along Eastern Cape Breton. Distributional data were examined separately for immature (1–53 cm) and mature (> 53 cm) individuals. Abundance of immature individuals followed the same pattern compared to mature individuals, and appeared to show a greater abundance on the western Scotian Shelf (4X); mature individuals were mostly absent in 4VW (Figure 4). The survey predominantly catches individuals < 60 cm (Figure 5).

Overall abundance of Atlantic Wolffish on the Scotian Shelf has decreased since 2010. Abundance of immature individuals peaked in the late 1990s–early 2000s, although with high interannual variability, and has declined since 2010 (Figure 6). Abundance of mature individuals exhibited a smaller peak in the late 1990s, followed by rapid decline. Total stratified biomass on the Scotian Shelf was generally stable in the 1970s and 1980s, but has declined consistently since that period: 62% from 1970 to 2000, 69% from 2000 to 2010, and 23% from 2010 to 2021, which corresponds to an overall decrease of 91% (Figure 7). Area occupied declined 36% from 1970 to 2010, and 85% from 2010 to 2021 – an overall decline of 73.8% for 1970–2021.

Spring surveys have been conducted in 4VWX from 1979 to 1987, 1986 to 2010, and from 2008 to 2020. These surveys do not offer enough consistent coverage to provide meaningful indices

of abundance and biomass, but allow for comparisons of seasonal distribution with the Maritimes Summer Ecosystem RV Survey. In the 1980s, catches of Atlantic Wolffish in the spring survey followed a similar distribution seen in the summer, with areas of concentration around Browns Bank in 4X, and Banquereau Bank in 4Vs (Figure 8). This pattern remained consistent in 4Vs and 4W during 1986–2010 spring sampling (Figure 9). Catches in 4X have been low over the last twelve years of spring sampling, with catches occurring East of Browns Bank, and some in the Bay of Fundy (Figure 10).

Maritimes Winter Ecosystem Research Vessel (RV) Survey of Georges Bank (Division 5Ze)

The Maritimes Winter Ecosystem RV survey has been conducted annually on Georges Bank since 1987, with a total of 2,993 sets completed, of which 147 captured Atlantic Wolffish. Due to the consistency of sampling and data available, estimates of abundance and biomass are limited to the Canadian side of Georges Bank (Strata 5Z1 and 5Z2). In these strata, 1,408 sets were completed, and 99 of those sets captured Atlantic Wolffish.

From 1987–2010, Atlantic Wolffish were primarily concentrated in 5Z2 and in USA waters along Cape Cod (Figure 11). The distribution maps from 2011–2021 showed catches decreasing in 5Z2, and almost none being caught outside of that area. It should be noted that the period from 1988 to 1991 had a greater number of stations sampled compared to other years, with an annual average of 126 vs 78 respectively. Strata outside of Canada's EEZ were also rarely sampled after 2010. Immature fish have previously been caught along the northern edge of the strata boundary, while mature fish were also present in USA waters (Figure 12). In the last decade, catches of both size classes have greatly decreased, and occur almost exclusively in strata 5Z1 and 5Z2. The survey predominantly catches larger fish (Figure 13).

Abundance of mature Atlantic Wolffish in 5Z1 and 5Z2 has been variable from 1987 to the early 2000s, with peaks in 1988 and 1996 (Figure 14). Catches on immature individuals have also been inconsistent, resulting in highly variable estimates of abundance at the start of the time series. Data collected after 2010 showed a steep decline for both size classes, with catches nearing zero in areas where fish were seen previously caught.

Stratified biomass has been decreasing since the early 1990s, and has remained consistently near zero since the late 2000s (Figure 15). This corresponds to a 99.9% decrease in biomass over the survey period, most of which occurred from 1987 to 2010. This decline was also found with the area of occupancy, which showed a 98% decline from 1987 to 2021. No Atlantic Wolffish were caught in 2009, 2010, 2013, 2015, and 2019.

CANADIAN INDUSTRY SURVEYS

Industry-DFO Halibut Longline Survey (Divisions 4VWX)

A total of 4,757 sets from the fixed station portion of the Industry-DFO Halibut Longline survey were examined, with 489 sets reporting Atlantic Wolffish. Presence of this species in sets was highly variable across years. The distribution pattern of catches was similar to the summer RV series, with primary areas of concentration in 4X, 4Vs and 4Vn, and a scattered presence in 4W (Figure 16). Mean catch per 1,000 hooks over the entire survey period was 15 ± 27 kg. Catches have been variable throughout the series, with differences as high as 78% between consecutive years (Figure 17). Average annual catch over the last decade appears higher than in 2000–2010; however, the total annual catch is consistently around 300 kg per year.

Sentinel Longline Survey (Divisions 4VsW)

Atlantic Wolffish were present in 295 out of 2,973 sets of the 4VsW Sentinel survey. The number of sets made in this survey has decreased from 44 sets in 1996 to 6 in 2021. The period from 2004 to 2013 saw an average of only 3.5 sets a year, with most sets occurring inshore, where wolffish presence was highest. The distribution of Atlantic Wolffish in this survey was concentrated in shallower inshore strata and north of Banquereau Bank (Figure 18). Catches decreased 65% from 1995 to 2010, and have plateaued around 1 kg (Figure 19). Total annual catch decreased from 107 kg per year before 2010 to 8 kg per year in the last decade.

Maritimes Snow Crab Fixed Survey (Divisions 4VWX)

Of the 8,895 sets examined since 2004 from the fixed station portion of the Maritimes Snow Crab survey, only 496 sets reported Atlantic Wolffish. The species was broadly distributed throughout 4Vn and the northern half of 4Vs, with scattered presence throughout 4W and 4X (Figure 20). Sampling effort was reduced in 2020 to 43 stations, and in 2021 to 137 stations, compared to a previous average of 342 stations/year; however, catches were comparable to the preceding three years (Figure 21). The average catch per tow in this survey is very low (< 1kg), but size composition of catches are not known. Total annual catches were consistently around 20 kg/y up to 2020.

ITQ/ILTS Survey (Division 4X)

A total of 3,005 sets have been completed as part of the ITQ survey, with Atlantic Wolffish occurring in 250 of the sets. Since 2013, 1,309 sets have been completed by the ILTS, of which 22 recorded the species. Atlantic Wolffish were distributed throughout 4X, with the highest concentration at the northwest peak of Browns Bank (Figure 22). The ILTS samples closer inshore, but where stations overlapped, distribution was comparable between the two surveys. Catches in the ITQ survey decreased 75% by 2010, and have remained low in the ILTS (Figure 23). Total annual catch was around 15 kg/y until 2003, and 4.5 kg/y since that period.

CANADIAN COMMERCIAL LANDINGS

Commercial landings of Atlantic Wolffish (also reported as catfish) are presented beginning in year 2001. Historical catches are available from Simon et al. (2012). The largest proportion of landings come from 4X, where they are primarily concentrated on the western edge of Browns Bank – the same area found to have the highest presence of Atlantic Wolffish in DFO summer and spring RV surveys (Figure 24). Landings in 4X decreased rapidly in the early 2000s, and have remained below 10 t over the past decade; landings from 4VW and 5Z have been near zero since before 2000 (Figure 25).

Mobile gear accounted for the largest proportion of landed Atlantic Wolffish (Table 2), followed by bottom longline. Landings by both gear types have declined to a few tons in recent years. Table 3 shows interactions between fisheries and three species of wolffish (Atlantic, Northern and Spotted) as recorded in SARA logs. These logs were implemented in 2006 but only recently have been digitized and entered into an accessible database. As expected, Atlantic Wolffish form only a small proportion of the records, since fisheries are not required to record them. The proportion of records of Northern and Spotted wolffishes are surprising, particularly the observations of these species in relatively shallow, coastal fisheries targeting Sea Scallop and Lobster (Table 4). Northern and Spotted wolffishes are more northern, deeper dwelling species that are uncommon on the Scotian Shelf (Scott and Scott 1988, Simon et al. 2012); therefore, those records may be mis-identified Atlantic Wolffish. Going forward, quality control of the data

from SARA logs would enhance their values; for example, some verification that trips recording thousands of kg of Northern Wolffish are not transcription errors or mis-identifications.

Similar to reported commercial landings, observations of Atlantic Wolffish during observed commercial fishing activities have decreased since 2000, with an average estimated caught weight of 1.56 t per year over the last decade (Figure 26). The percentage of observed Atlantic Wolffish caught and discarded has been around 39% of total since 2001 (Table 5). This estimate is based only on catches that had observer coverage, and therefore does not account for the total effort of a fishery. The percent of observer coverage for commercial fisheries catching Atlantic Wolffish in Canadian waters is not known. Atlantic Wolffish are consistently caught in groundfish (includes Cod, Pollock, Haddock and Silver Hake), redfish and Halibut fisheries, as well as invertebrate fisheries such as shrimp, Scallop and Lobster (Table 6). These data indicate that Atlantic Wolffish are encountered during commercial fishing operations, and that landings are not an accurate reflection of the impact of fishing activities on the population. The contribution of discards to estimates of fishing mortality on Atlantic Wolffish is an important source of uncertainty.

DISCUSSION AND CONCLUSIONS

Atlantic Wolffish was assessed as a species of Special Concern by COSEWIC. This status was confirmed after a re-evaluation in 2012. This report provides an update for the portion of the Atlantic Wolffish population residing on the Scotian Shelf. We examined DFO RV and industry surveys, including observer and commercial landings data in NAFO areas 4VWX (Strata 440–495) and 5Ze. Analysis of the data suggests that the species has become less widely distributed since the last assessment.

The composite distribution patterns from both survey and fishery data on the Scotian Shelf revealed two primary areas where Atlantic Wolffish concentrated: the eastern side of the shelf (4V) and the western side, primarily near Browns Bank (4X). Abundance of both immature (1–53 cm) and mature (> 53cm) size classes has decreased > 90% since the start of the Summer RV survey series, but immature individuals still occur throughout 4X and 4V, with limited presence in 4W, while mature individuals are mostly only found in 4X. Declines in abundance and distribution were also observed on Georges Bank, where Atlantic Wolffish presence has remained near zero over the last decade. They continue to be caught in longline and mobile gear industry surveys; however, catches are generally low. There is little evidence for seasonal changes in distribution between the summer and winter/spring months, although winter/spring sampling has been very limited over the past 10 years. Given all the examined data sources, abundance of Atlantic Wolffish on the Scotian Shelf remains low. The eastern and western parts of the Scotian Shelf are primary areas of concentration for both size classes, while distribution between these regions has largely collapsed.

Atlantic Wolffish were found inshore of the 50-mile line in 4X and 4W. Currently, only the Lobster survey (ILTS) in 4X and the Spring survey in 4VsW conduct sampling so close inshore. Both surveys have a limited number of stations, and occur at different times of year in different areas. Biological information (e.g., lengths, individual weights) from these surveys would complement the data collected during the summer RV survey by providing more information on individuals occurring in shallower, coastal regions, which may represent areas of important habitat.

Although there are no directed fisheries for Atlantic Wolffish in the Maritime Region, the species is landed as bycatch in other fisheries. Annual landings have been on the decline since the 1980s. Since 2010, the average annual catch reported in commercial landings has averaged 4 t per year. An estimate of fishing mortality for Atlantic Wolffish cannot at this time be provided,

because estimates of total discards have not been quantified. Mortality due to fishing has declined, based on declining commercial landings and observations by at-sea observers; however, population abundance has also continued to decline. Given the uncertainties around discard rates, survival rates of discards, and observer coverage, these data are not sufficient to provide an estimate of the impacts of fishing on the population. Any future assessment should consider the uncertainty related to fisheries monitoring and survivability of discards from the various gears encountered.

Currently, the DFO Summer RV Survey in 4VWX provides the best source of information to monitor trends in population abundance and distribution. This is the longest-running continuous time series available for this area, and covers all the areas on the Scotian Shelf that Atlantic Wolffish are still seen to occupy. Data from other sources are largely congruent with survey findings. Conversion factors should be developed if necessary to account for the adoption of a new survey vessel and trawl in 2021. Presently, all abundance and biomass estimates constitute relative indices, because the catchability of Atlantic Wolffish by survey gear is not known. Future work may require that an appropriate indicator for species reference points be developed for Atlantic Wolffish to help quantify the observed changes in population abundance, and to inform recommended actions.

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TABLES

Table 1. DFO Research Vessel and Industry-Science surveys examined for Atlantic Wolffish records in Maritimes Region.

Category	Identifier	NAFO Area	Years	Gear	Total Sets Observed	Sets Containing Atlantic Wolffish
Research Vessel Surveys	Summer	4VWX	1970–2021	Trawl	8,998	1,566
	Spring 4VsW	4VsW	1986–2010	Trawl	2,024	220
	Spring 4X	4X	2008–2021	Trawl	330	26
	Spring	4VWX	1979–1984	Trawl	792	172
	Georges	5Ze	1987–2021	Trawl	2,993	147
Industry Surveys	Halibut	4VWX	1998–2021	Longline	4,757	489
	Sentinel	4VsW	1995–2021	Longline	2,973	295
	Snow Crab	4VWX	2004–2021	Trawl	8,895	496
	ITQ	4X	1995–2013	Trawl	3,005	250
	ILTS	4X	2013–2021	Trawl	1,309	22

Table 2. Total landings (t) of Atlantic Wolffish by fishery in NAFO Divisions 4VWX5Z (2001–2021). (- indicates no data).

Year	Mobile Gear (Otter trawl)	Seine	Gillnet	Bottom Longline	Handline	Total
2001	61.1	< 0.1	0.2	50.0	1.5	112.9
2002	130.0	< 0.1	0.2	40.6	2.5	173.3
2003	99.9	< 0.1	0.1	46.9	0.8	147.7
2004	85.8	< 0.1	0.1	34.8	3.9	124.6
2005	73.3	< 0.1	0.0	31.9	0.4	105.7
2006	44.8	< 0.1	0.1	23.9	0.2	69.0
2007	22.8	< 0.1	< 0.1	31.1	< 0.1	54.0
2008	4.2	-	< 0.1	17.9	0.1	22.3
2009	2.6	-	< 0.1	8.3	< 0.1	10.9
2010	3.7	-	< 0.1	6.6	< 0.1	10.3
2011	3.7	-	< 0.1	2.5	-	6.3
2012	2.9	-	-	2.5	-	5.4
2013	1.6	-	< 0.1	3.2	< 0.1	4.8
2014	1.7	-	-	1.4	-	3.1
2015	1.1	-	-	2.4	< 0.1	3.5
2016	2.2	-	0.1	1.1	-	3.4
2017	1.2	-	0.2	2.4	-	3.9
2018	1.3	-	0.1	1.4	-	2.8
2019	1.3	-	< 0.1	1.6	-	2.9
2020	1.3	-	-	2.8	-	4.1
2021	1.7	-	0.1	2.8	-	4.6
Grand Total	548.3	0.1	1.3	316.2	9.6	875.5

Table 3. Interactions by wolffish species (kg) as recorded in Species at Risk Act logs from fishing locations in NAFO Divisions 4VWX. (- indicates no data).

Years	Northern Wolffish	Spotted Wolffish	Atlantic Wolffish	Unspecified Wolffishes	Total (kg)
2006	1,491	117	137	-	1,746
2007	38,644*	7,283	67	-	45,994
2008	3,809	361	489	10	4,669
2009	4,752	3,602	2	-	8,355
2010	1,047	498	16	-	1,561
2011	615	503	144	7	1,269
2012	535	262	-	352	1,150
2013	1,576	328	20	-	1,924
2014	1,512	353	129	1	1,994
2015	415	406	28	5	854
2016	903	100	250	-	1,253
2017	539	205	-	1	744
2018	550	93	-	-	643
2019	1,059	235	-	-	1,295
2020	2,293	738	-	-	3,031
2021	3,738	564	-	-	4,301
Total (kg)	63,480	15,647	1,282	374	80,783

*A single trip in 4VW recorded 34,500 kg.

Table 4. Interactions by fishery with wolffishes (kg) as recorded in Species at Risk Act logs from fishing locations in NAFO Divisions 4VWX. (- indicates no data).

Years	Snow Crab	Groundfish	Lobster	Sea Scallop	Tuna	Total (kg)
2006	-	1,746	-	-	-	1,746
2007	-	45,7671*	-	-	227	45,994
2008	-	4,669	-	-	-	4,669
2009	-	8,355	-	-	-	8,355
2010	-	1,561	0	-	-	1,561
2011	-	1,102	167	-	-	1,269
2012	-	1,116	34	-	-	1,150
2013	-	1,876	48	-	< 1	1,924
2014	< 1	1,977	17	-	-	1,994
2015	-	837	18	-	-	854
2016	-	1,241	12	-	-	1,253
2017	26	624	92	< 1	-	744
2018	-	521	102	20	-	643
2019	68	1,202	20	5	-	1,295
2020	16	2,893	105	18	-	3,031
2021	32	4,194	76	-	-	4,301
Total (kg)	142	78,482	689	43	227	80,783

*A single trip in 4VW recorded 34,500 kg.

Table 5. Total kept and discarded annual catch (kg) of Atlantic Wolffish as recorded by at-sea observers during commercial fishing activities in NAFO Divisions 4VWX from 1978–2021.

Year	Discarded catch (kg)	Kept catch (kg)	Percent discarded
1978	294	135	31
1979	211	43	17
1980	4,394	381	8
1981	6,830	1,706	20
1982	9,606	2,305	19
1983	6,388	5,993	48
1984	5,712	3,741	40
1985	12,258	9,546	44
1986	4,289	2,096	33
1987	5,306	507	9
1988	3,363	1,284	28
1989	2,661	3,369	56
1990	7,917	3,322	30
1991	4,312	1,094	20
1992	4,036	1,300	24
1993	5,837	4,023	41
1994	1,488	78	5
1995	713	102	13
1996	1,451	31	2
1997	1,654	47	3
1998	12,932	721	5
1999	3,162	158	5
2000	5,003	233	4
2001	1,067	162	13
2002	2,113	146	6
2003	584	164	22
2004	2,178	270	11
2005	2,011	284	12
2006	175	107	38
2007	541	30	5
2008	165	114	41
2009	198	64	24
2010	422	325	44
2011	129	809	86
2012	196	161	45
2013	26	103	80
2014	19	18	49
2015	31	68	69
2016	137	156	53
2017	341	100	23
2018	239	103	30
2019	22	48	69
2020	8	55	87
2021	85	20	19

Table 6. Total catch (kg) of Atlantic Wolffish recorded by at-sea observers during commercial fishing activities categorized by fishery from locations in NAFO Divisions 4VWX. Percent discarded in fisheries targeting fish species are shown in brackets; 100% discards in all invertebrate fisheries. (- indicates no data).

Year	Groundfish	Halibut	Redfish	Lobster	Scallop	Sea Cucumber	Shrimp	Snow Crab
1978	429 (31)	-	-	-	-	-	-	-
1979	254 (17)	-	-	-	-	-	-	-
1980	4,775 (8)	-	-	-	-	-	-	-
1981	8,461 (20)	-	55 (9)	-	-	-	-	-
1982	11,876 (19)	-	5 (100)	-	-	-	30	-
1983	11,971 (49)	-	410 (21)	-	-	-	-	-
1984	8,037 (46)	-	1,416 (3)	-	-	-	-	-
1985	21,072 (45)	-	732 (22)	-	-	-	-	-
1986	5,752 (34)	-	633 (20)	-	-	-	-	-
1987	4,881 (9)	-	932 (9)	-	-	-	-	-
1988	4,386 (28)	-	252 (16)	8	-	-	-	-
1989	5,357 (62)	-	653 (2)	5	15	-	-	-
1990	9,728 (30)	-	1,511 (24)	-	-	-	-	-
1991	3,946 (17)	-	1,407 (28)	-	-	-	53	-
1992	4,525 (23)	-	810 (34)	-	-	-	1	-
1993	9,302 (43)	-	558 (1)	-	-	-	-	-
1994	983 (3)	-	583 (8)	-	-	-	-	-
1995	376 (23)	50 (0)	385 (3)	-	4	-	-	-
1996	1,245 (2)	8 (0)	166 (0)	-	10	-	-	-
1997	108 (6)	711 (0)	243 (11)	-	-	-	-	14
1998	11,766 (0)	3 (0)	437 (0)	-	-	-	-	-
1999	810 (0)	118 (24)	267 (6)	-	-	-	-	-
2000	3,571 (1)	276 (3)	103 (0)	-	-	-	-	18
2001	582 (0)	77 (61)	236 (20)	20	1	-	-	30
2002	83 (0)	443 (6)	1,439 (2)	-	-	-	-	89
2003	278 (17)	206 (56)	250 (0)	-	-	-	-	1
2004	2,095 (3)	-	39 (0)	35	128	-	-	12
2005	1,937 (1)	273 (90)	38 (0)	12	4	-	3	-
2006	173 (24)	37 (89)	34 (26)	11	3	-	-	5
2007	533 (2)	16 (75)	15 (0)	-	-	-	-	-
2008	112 (0)	8 (100)	12 (0)	30	1	-	-	3
2009	147 (4)	54 (54)	5 (0)	22	3	-	2	8
2010	305 (10)	318 (70)	36 (0)	-	13	-	1	10
2011	98 (63)	211 (94)	19 (0)	6	11	4	-	-
2012	170 (23)	48 (75)	53 (0)	12	42	-	-	3
2013	38 (55)	3 (100)	9 (22)	28	12	-	-	17
2014	29 (45)	3 (0)	-	1	-	-	-	-
2015	26 (0)	35 (100)	8 (38)	3	1	-	-	8
2016	103 (23)	163 (64)	-	5	10	-	1	6
2017	306 (1)	58 (36)	12 (83)	-	23	2	-	21
2018	243 (9)	39 (82)	-	17	3	-	1	-
2019	21 (0)	27 (96)	-	7	14	-	-	1
2020	12 (33)	10 (100)	-	-	2	-	-	-
2021	92 (8)	-	10 (100)	3	-	-	-	-

FIGURES

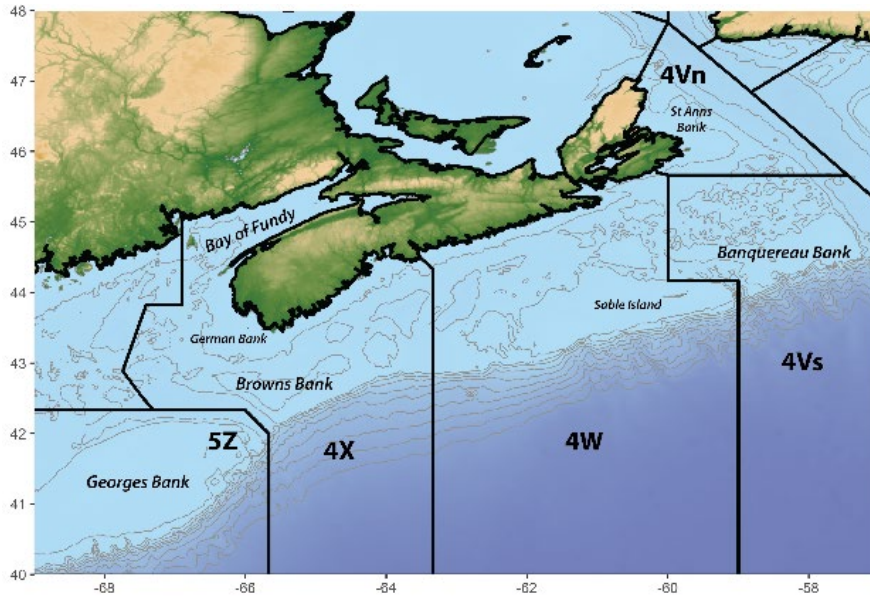


Figure 1. Location of NAFO Divisions and fishing banks in the DFO Maritimes Region.

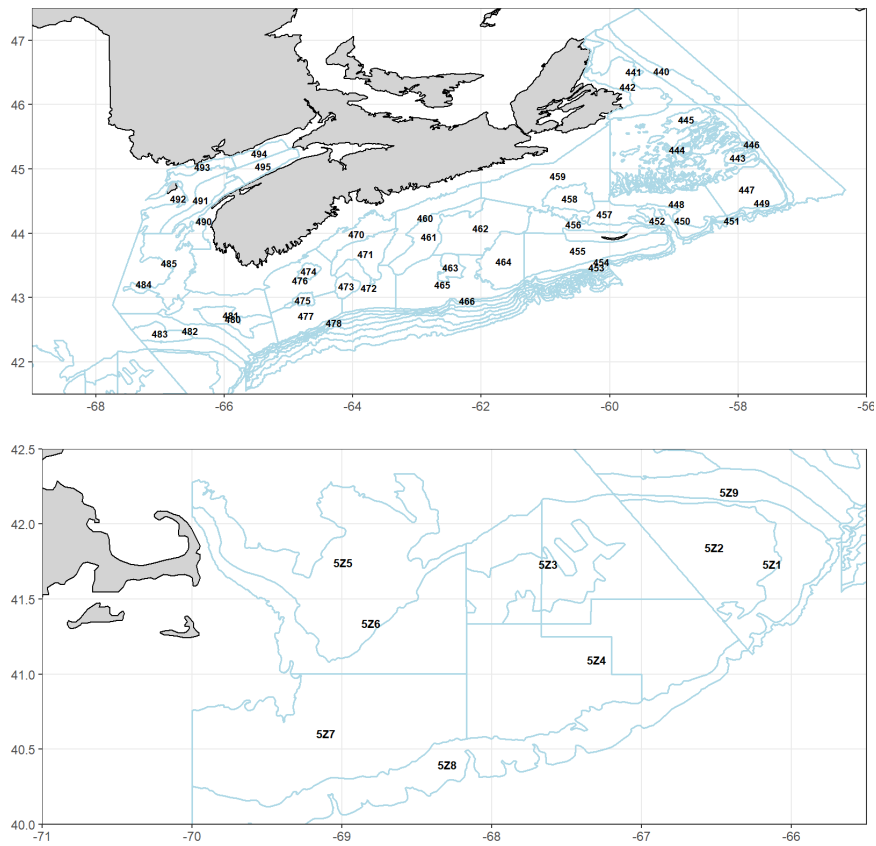


Figure 2. Survey strata used during the 4VWX Summer RV survey (top panel) and the winter Georges Bank survey (bottom panel).

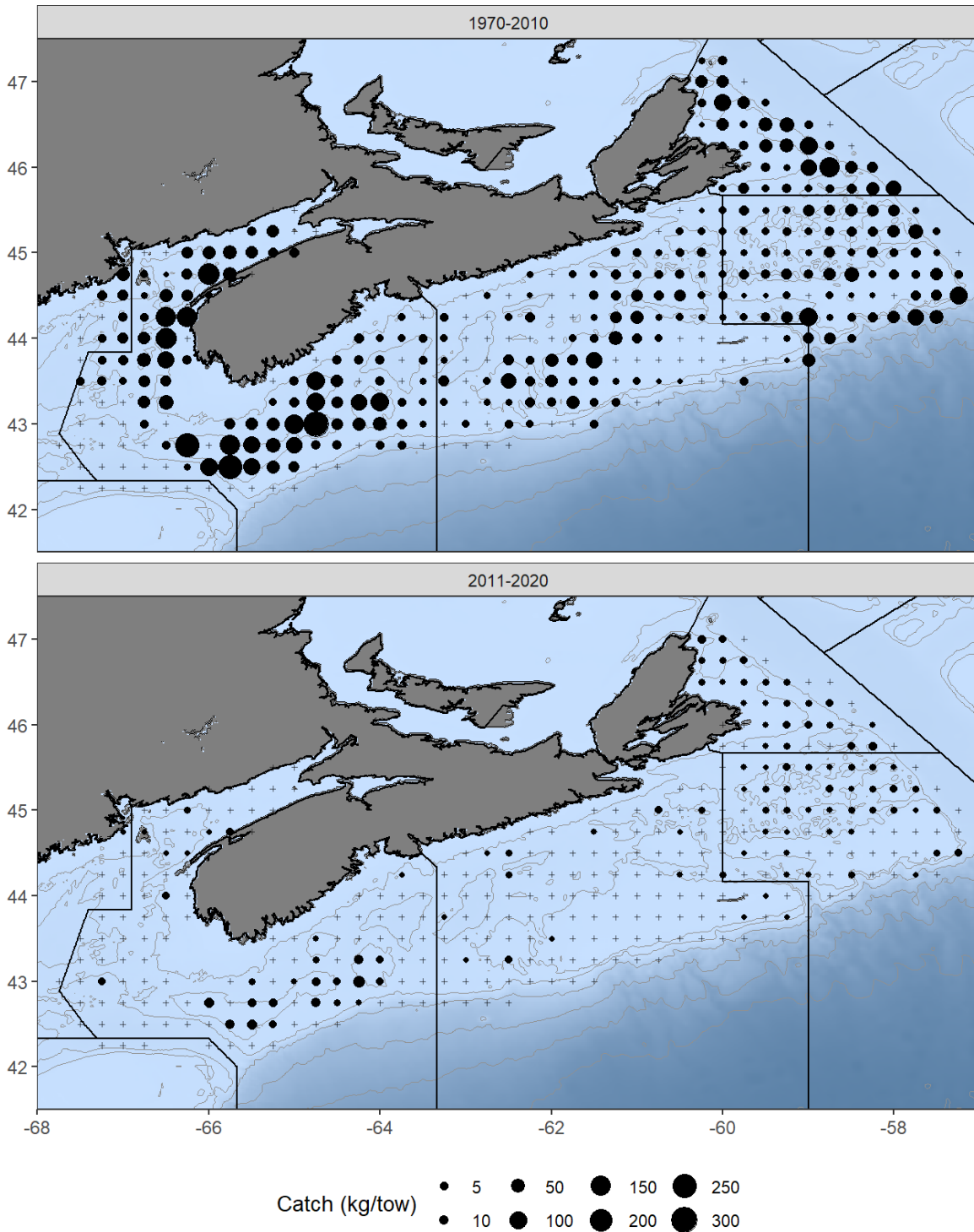


Figure 3. Distribution of Atlantic Wolffish catches in the 4VWX Summer RV survey on the Scotian Shelf, 1970–2020. (+) indicate zero catches.

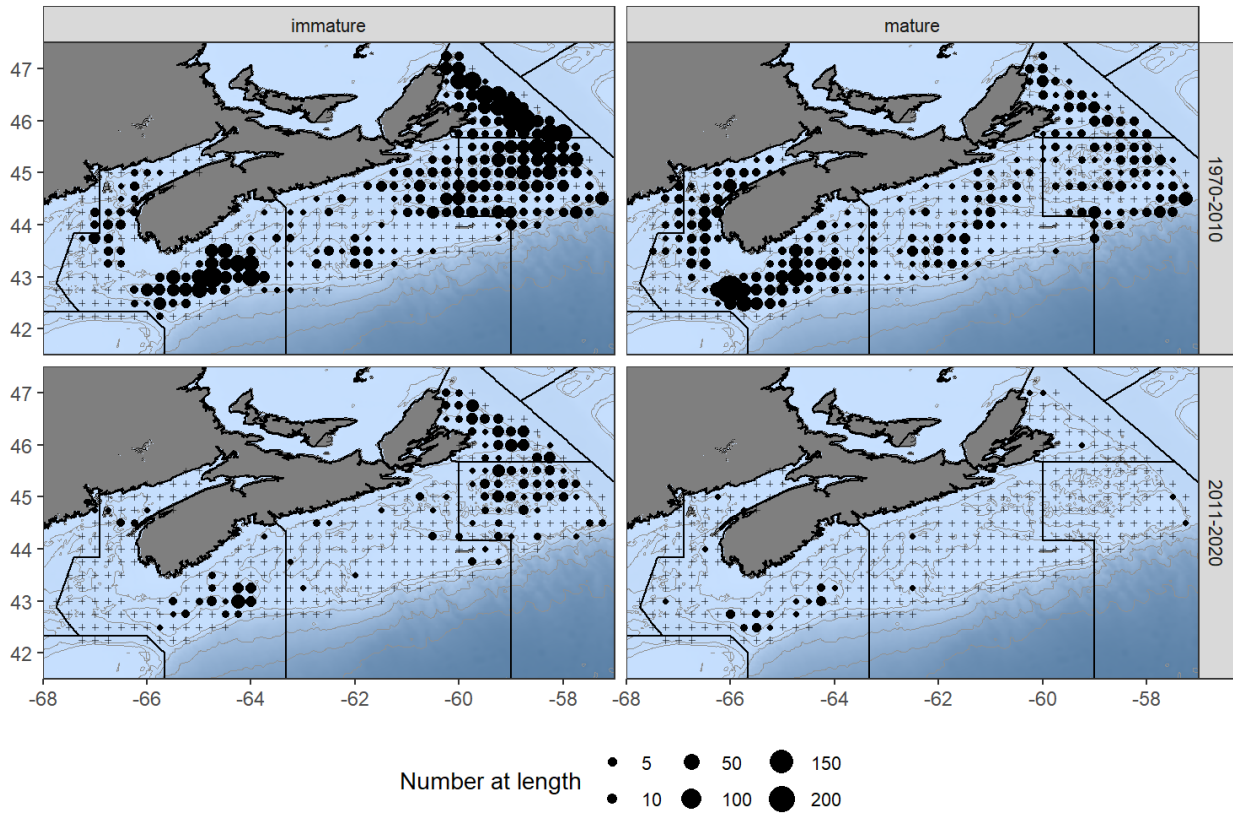


Figure 4. Distribution of immature (1–53 cm) and mature (> 53 cm) Atlantic Wolffish from 1970–2010 (top panels), and 2011–2020 (bottom panels) in the 4VWX Summer RV survey, summed by 15 minute aggregation. (+) indicate zero catches.

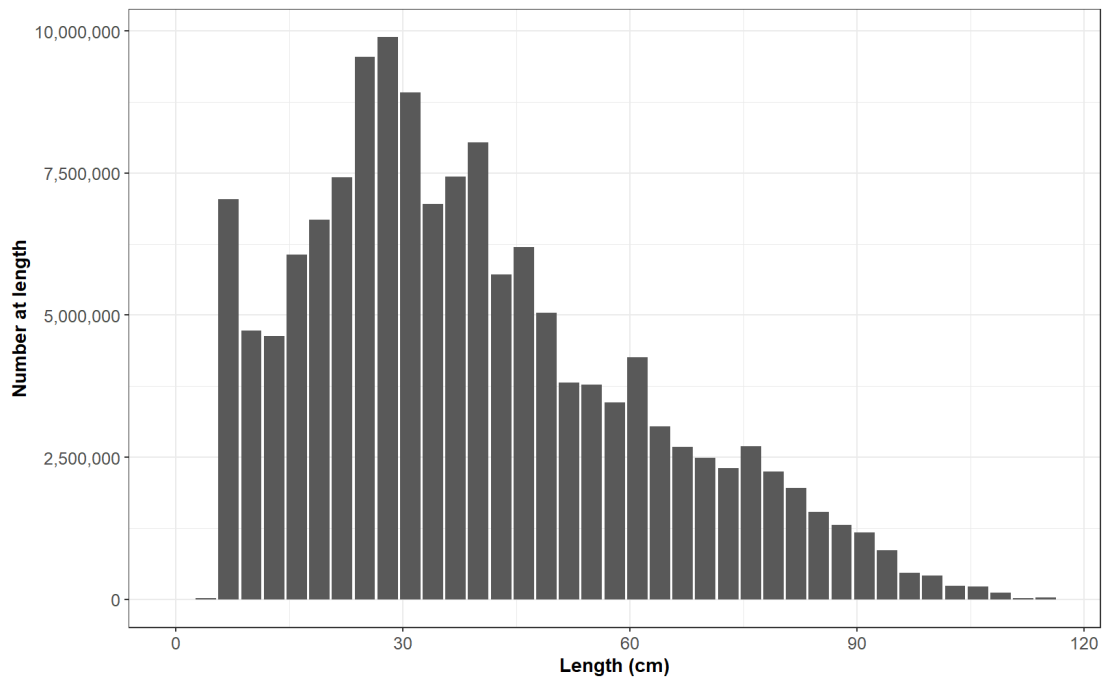


Figure 5. Length frequency distribution of Atlantic Wolffish in the 4VWX Summer RV survey 1970–2020.

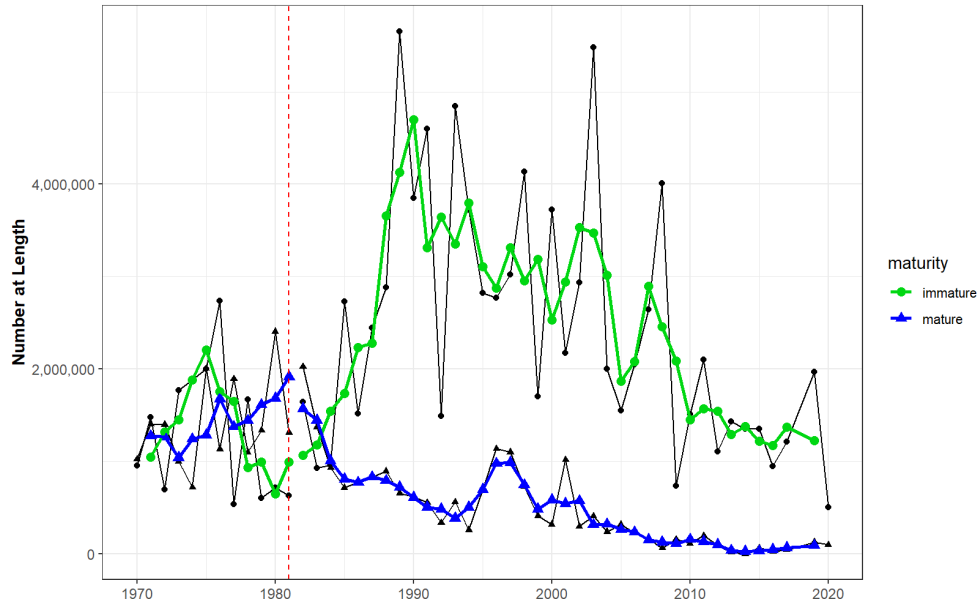


Figure 6. Stratified three-year geometric mean abundance of immature (1–53 cm) (green circles) and mature (> 53 cm) (blue triangles) Atlantic Wolffish in Divisions 4VW and 4X in the 4VWX Summer RV survey (gaps and dashed line indicate change in vessel and gear after 1981). Black lines and symbols are annual values.

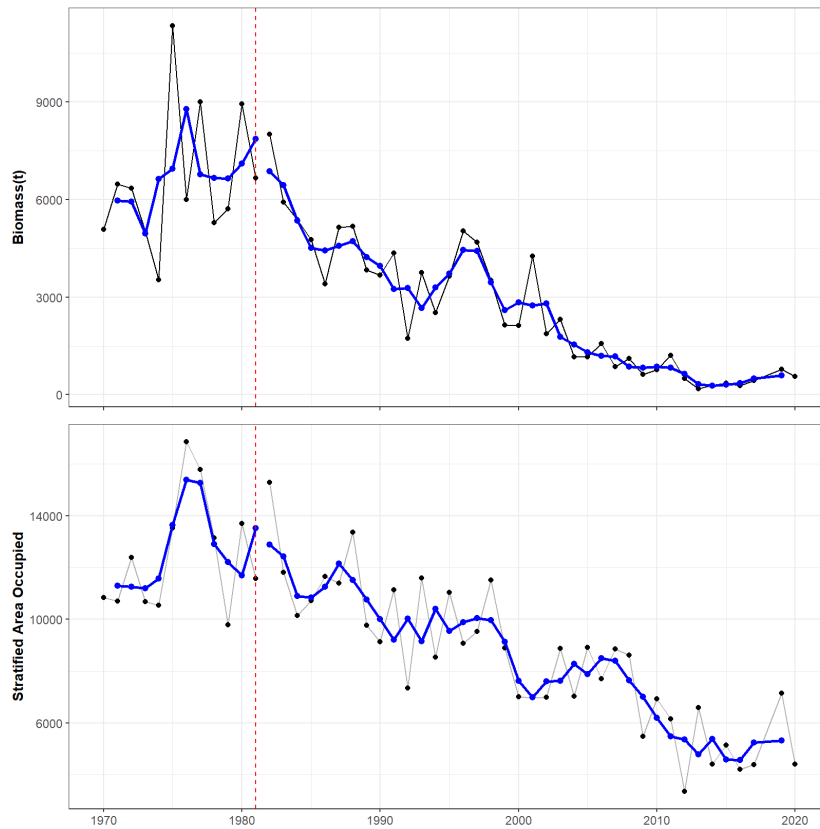


Figure 7. Three-year geometric mean (blue line) of total stratified biomass and area occupied by Atlantic Wolffish in Divisions 4VWX in the 4VWX Summer RV survey (gaps and dashed line indicate change in vessel and gear after 1981).

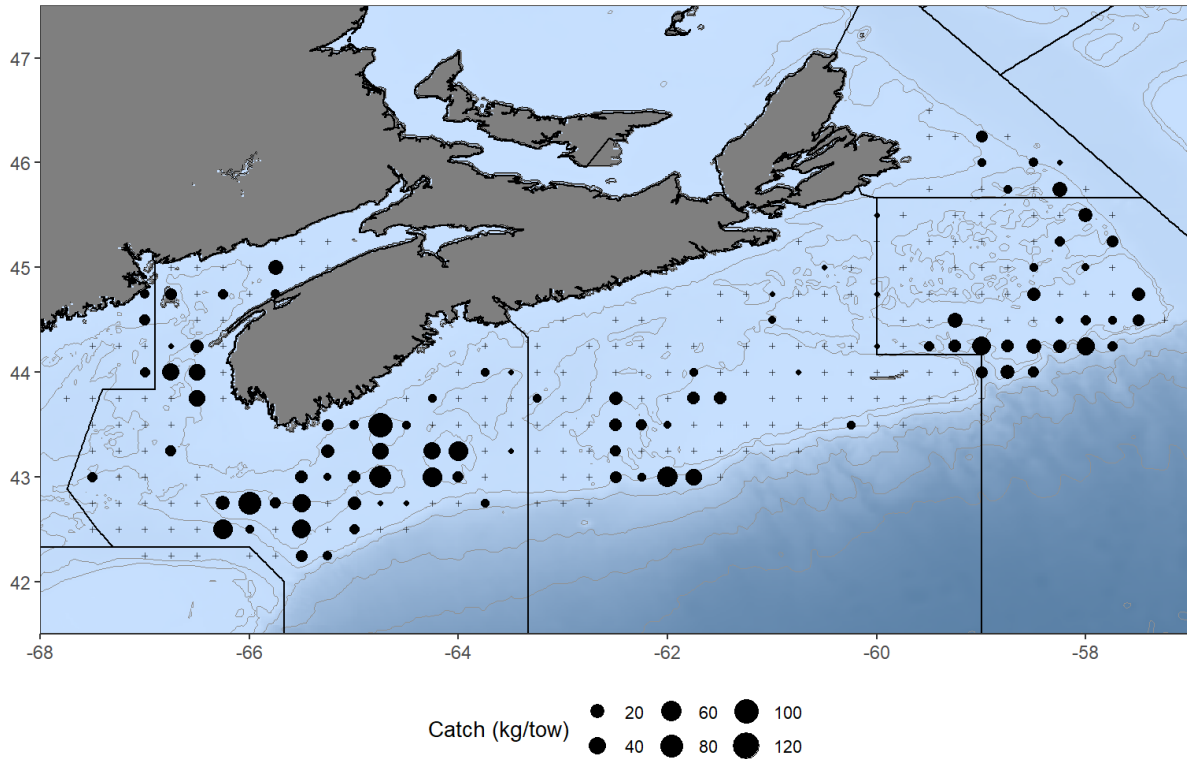


Figure 8. Distribution of Atlantic Wolffish catches in the 1979–1987 Spring RV survey in Divisions 4VWX, summed by 15 minute aggregation. (+) indicate zero catches.

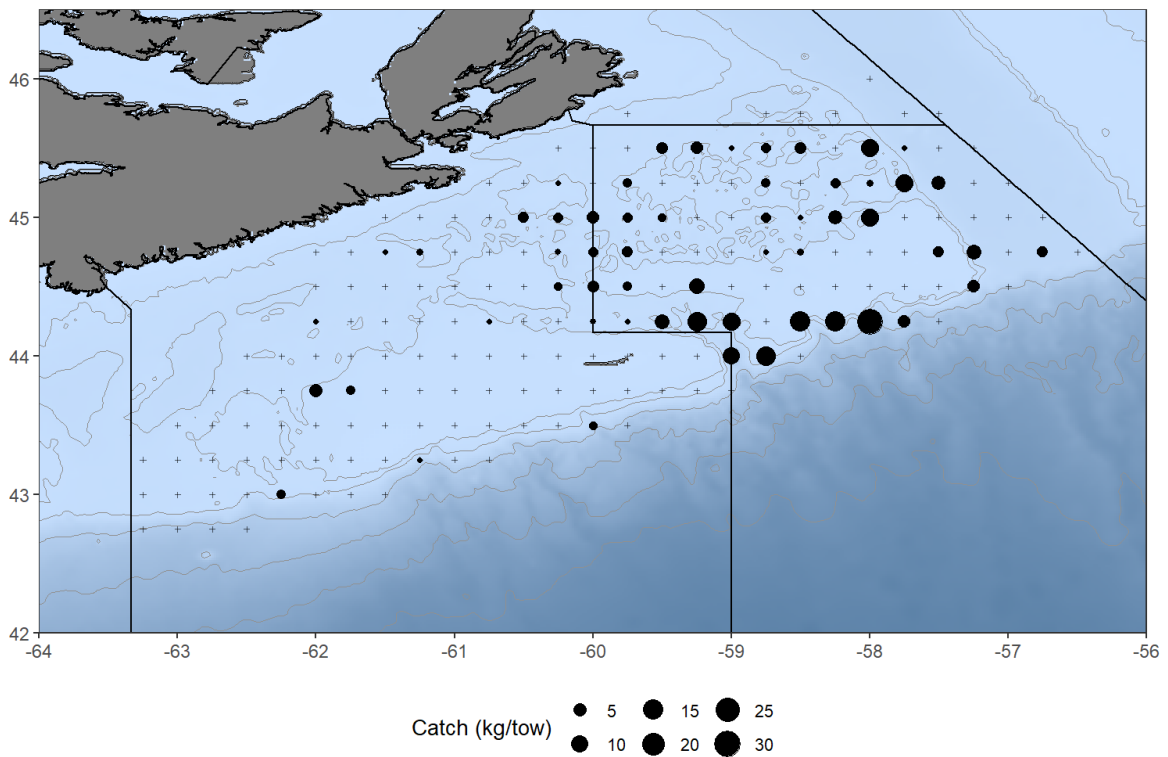


Figure 9. Distribution of Atlantic Wolffish catches in the 1986–2010 Spring RV survey in Divisions 4VSW, summed by 15 minute aggregation. (+) indicate zero catches.

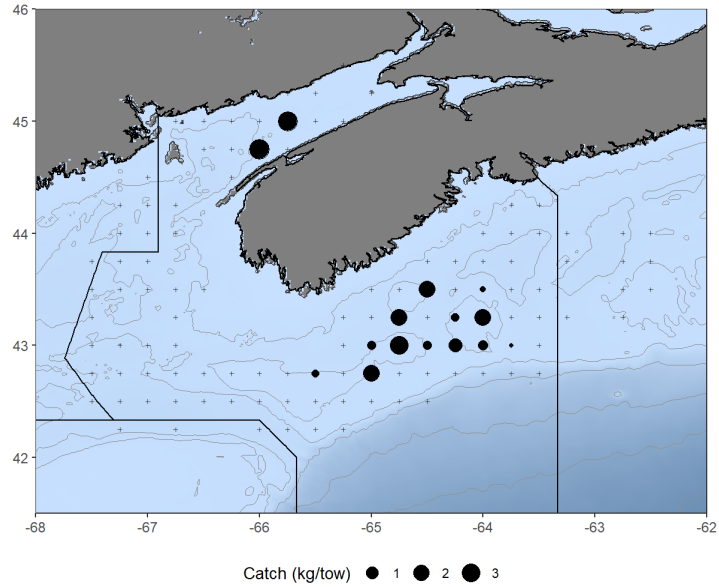


Figure 10. Distribution of Atlantic Wolffish catches in the 2008–2021 Spring RV survey in Division 4X, summed by 15 minute aggregation. (+) indicate zero catches.

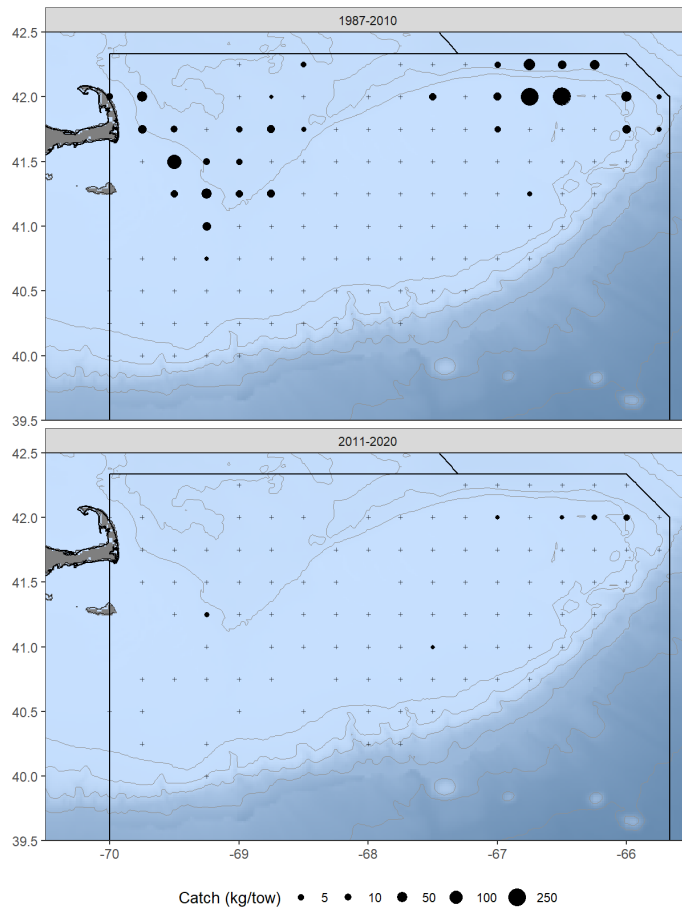


Figure 11. Distribution of Atlantic Wolffish catches in the Winter/Spring RV survey on Georges Bank, 1987–2020. (+) indicate zero catches.

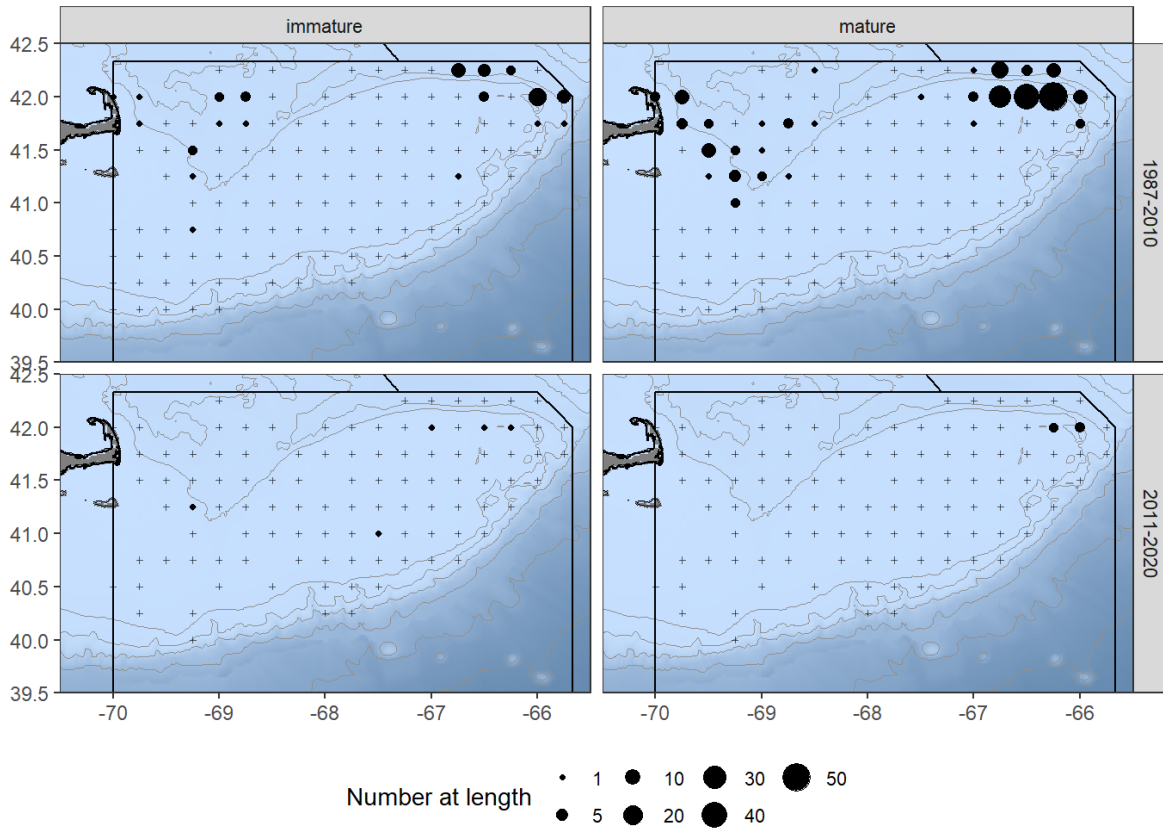


Figure 12. Distribution of immature (1–53 cm)(left panels) and mature (> 53 cm)(right panels) Atlantic Wolffish from 1987–2010 (top panels), and 2011–2021 (bottom panels) in the Georges Bank survey, summed by 15 minute aggregation. (+) indicate zero catches.

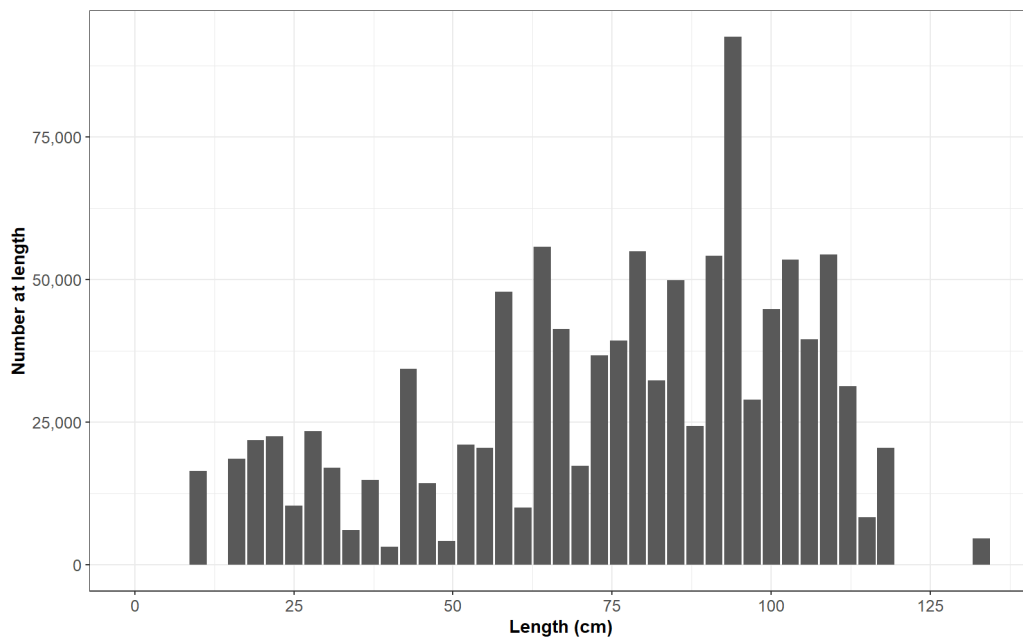


Figure 13. Length frequency distribution of Atlantic Wolffish in the Georges Bank RV surveys from 1987–2010.

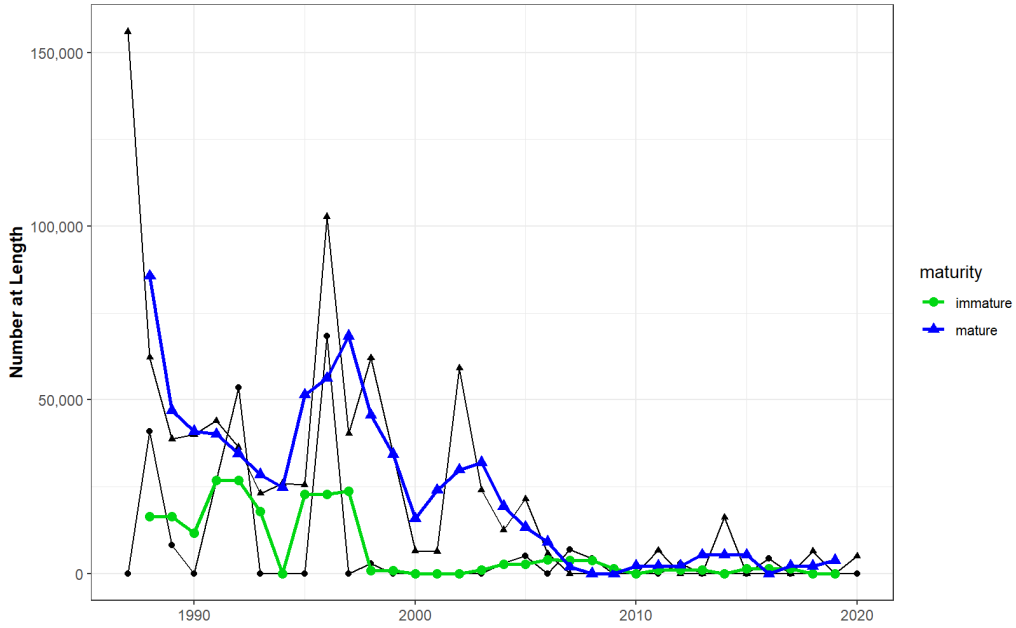


Figure 14. Three-year geometric mean stratified abundance of immature (1–53 cm) (green circle) and mature (> 53 cm) (blue triangle) Atlantic Wolffish in the Georges Bank RV survey. Black lines and symbols are annual values.

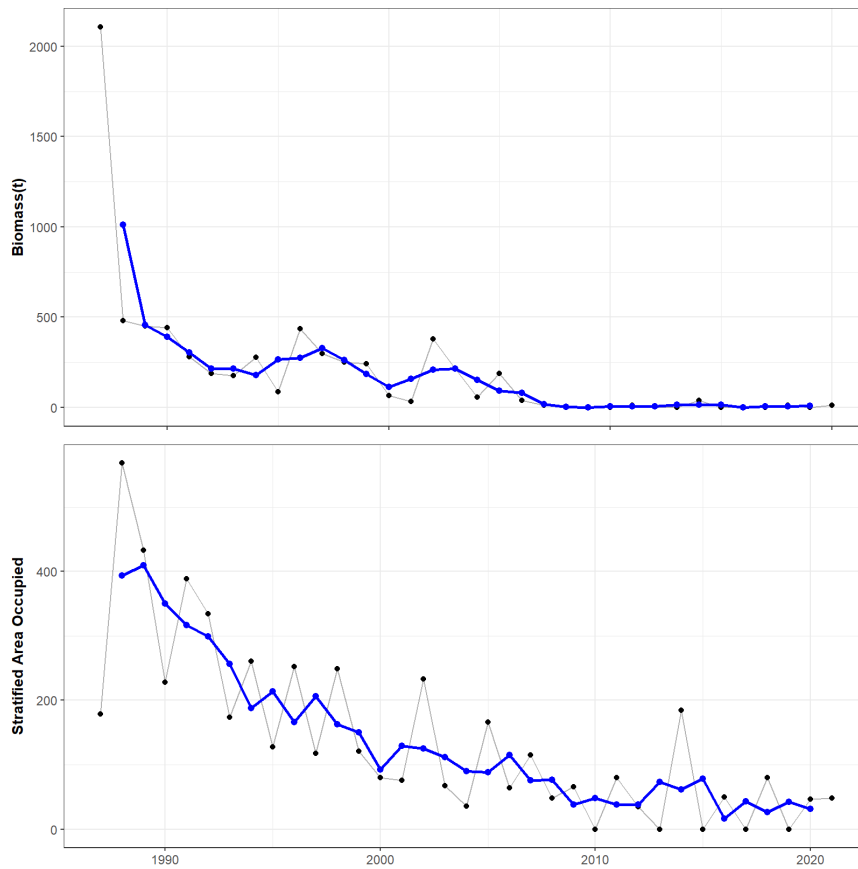


Figure 15. Stratified biomass (top panel) and area occupied (bottom panel) of Atlantic Wolffish in the Georges Bank RV survey with three-year running means (blue lines).

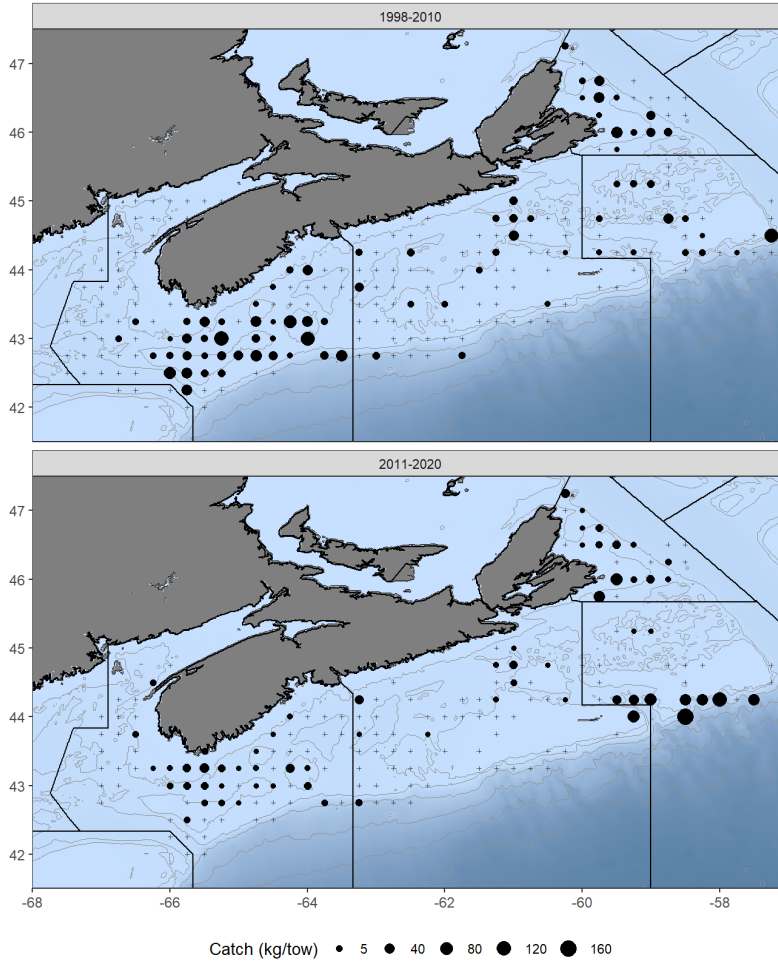


Figure 16. Distribution of Atlantic Wolffish catches in the Industry-DFO Halibut Longline survey on the Scotian Shelf (Divisions 4VWX), 1998–2010 (top panel) and 2011–2021 (bottom panel), summed by 15 minute aggregation. (+) indicate zero catches.

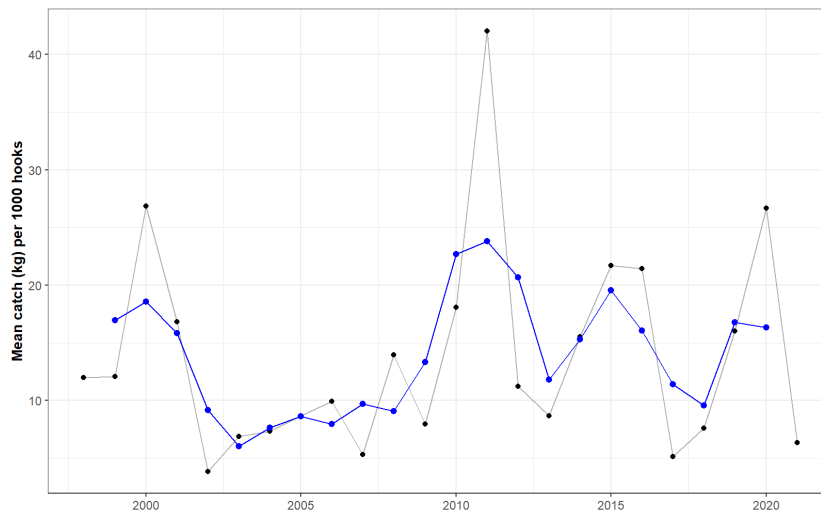


Figure 17. Mean catch per 1,000 hooks of Atlantic Wolffish in the Industry-DFO Halibut Longline survey from 1998–2021.

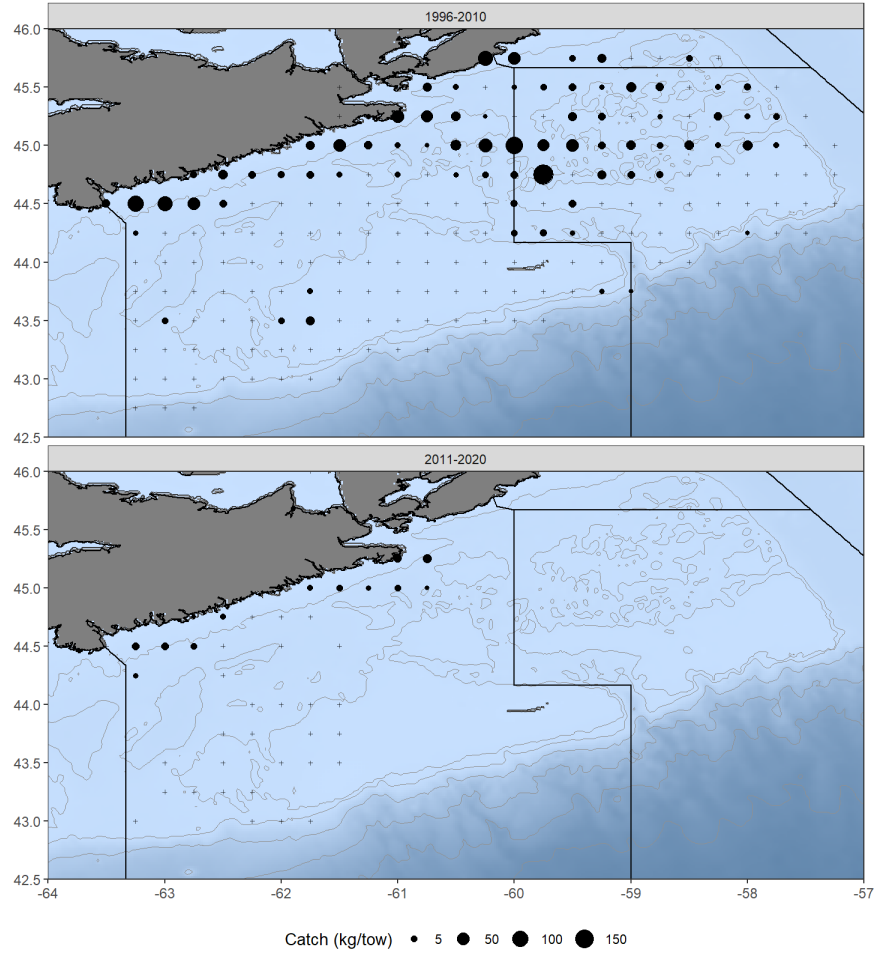


Figure 18. Distribution of Atlantic Wolffish catches in 4VSW Sentinel Longline survey, 1996–2020, summed by 15 minute aggregation. (+) indicate zero catches.

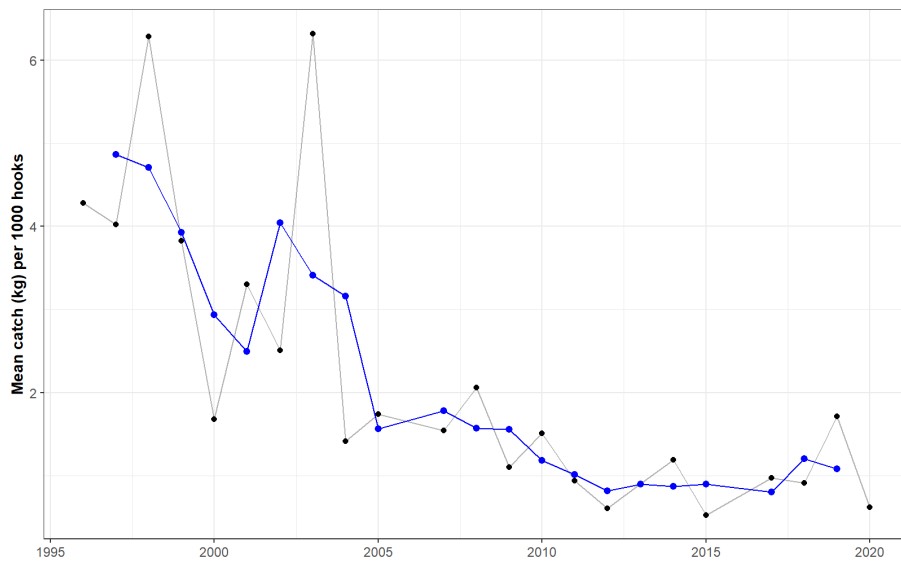


Figure 19. Mean catch per 1,000 hooks of Atlantic Wolffish in the 4VSW Sentinel Longline survey from 1996–2020.

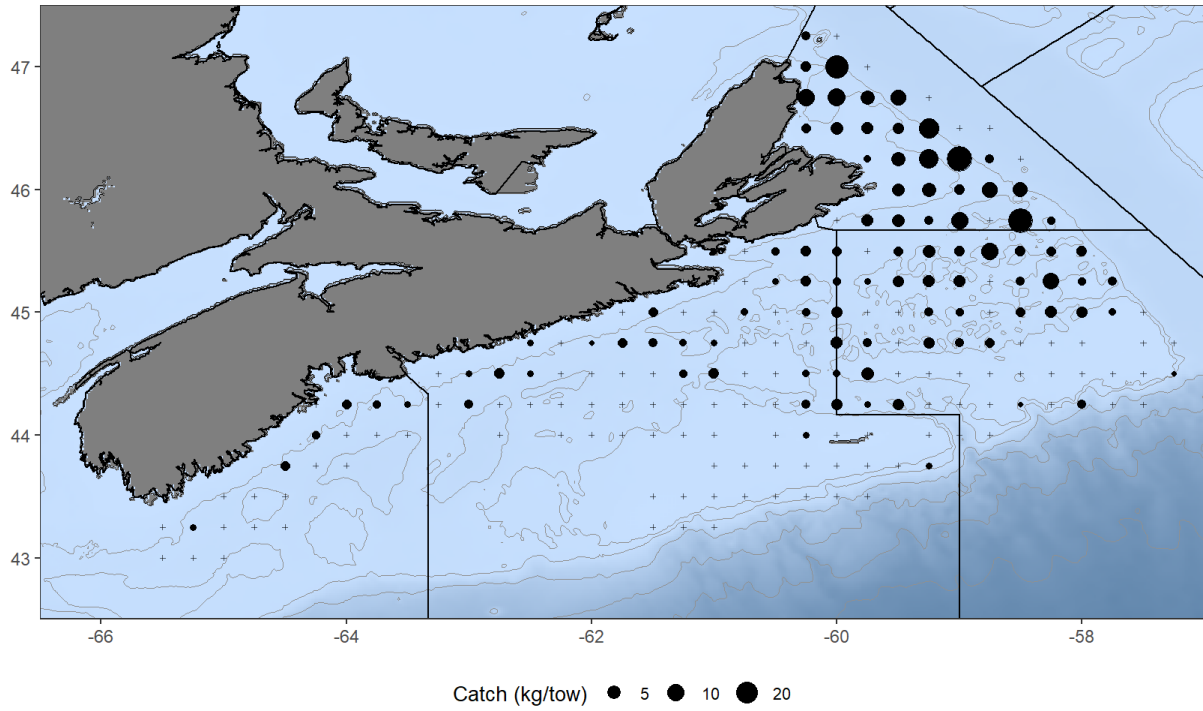


Figure 20. Distribution of Atlantic Wolffish catches in the Maritimes Snow Crab survey (Divisions 4VWX), 2004–2021, summed by 15 minute aggregation. (+) indicate zero catches.

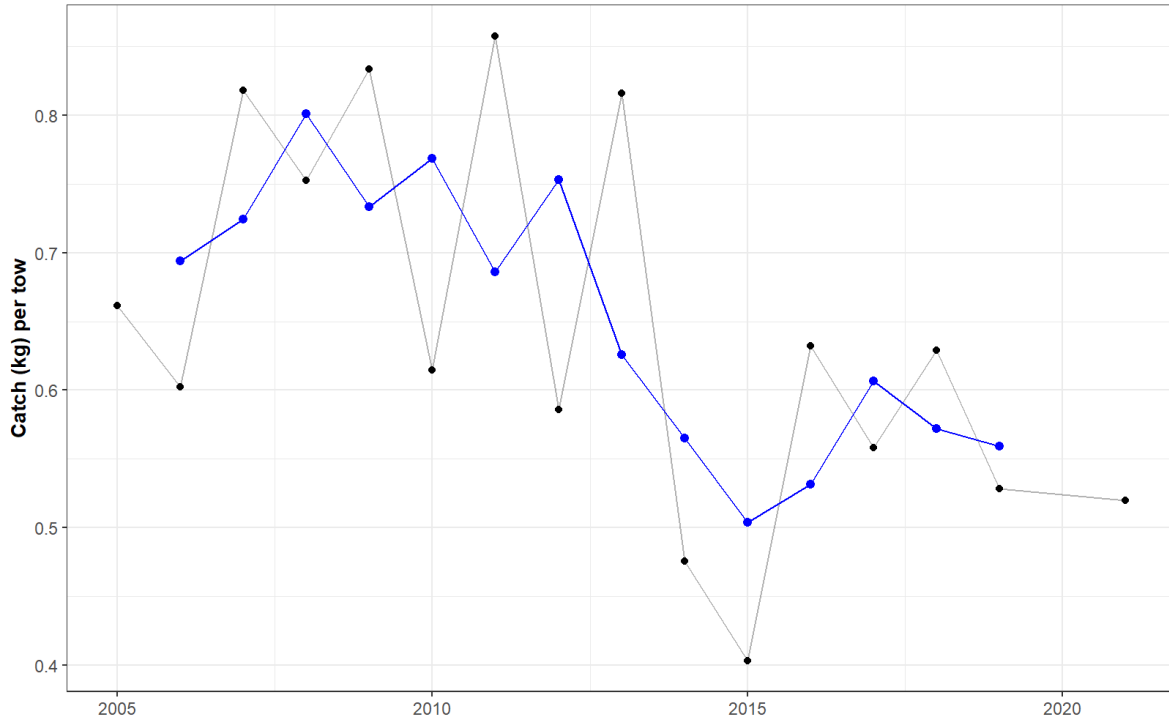


Figure 21. Mean catch (kg) per tow of Atlantic Wolffish in the Maritimes Snow Crab survey from 2004–2021.

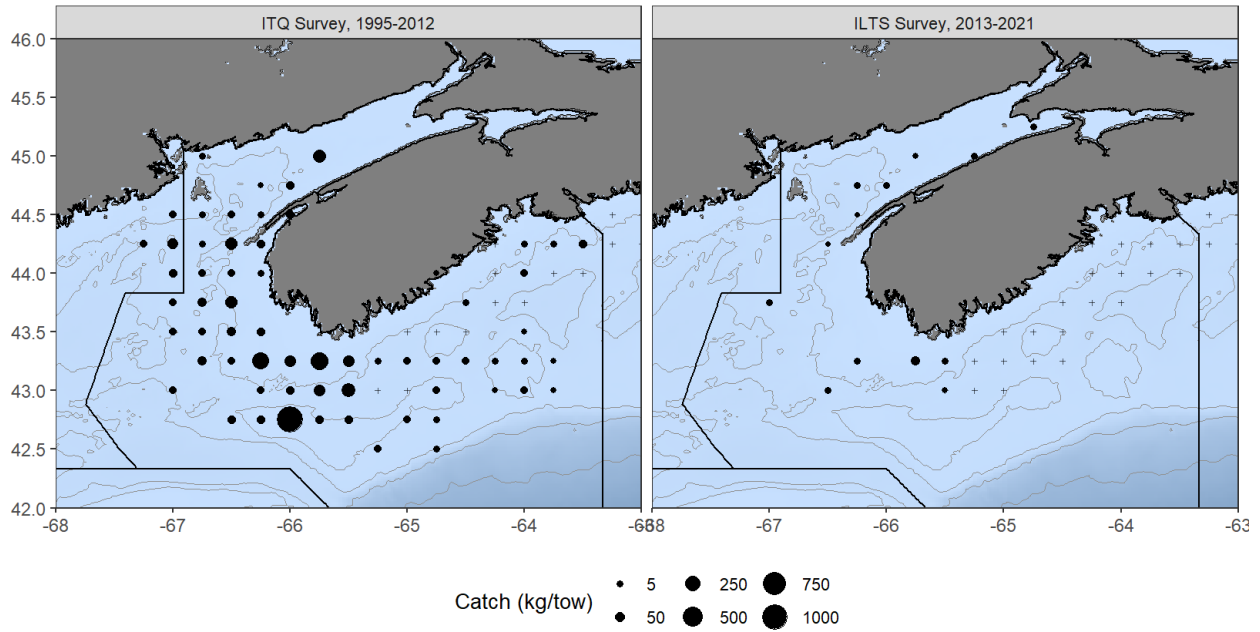


Figure 22. Distribution of Atlantic Wolffish catches in the ITQ (left panel) and ILTS (right panel) surveys (Division 4X), 1995–2021, summed by 15 minute aggregation. (+) indicate zero catches.

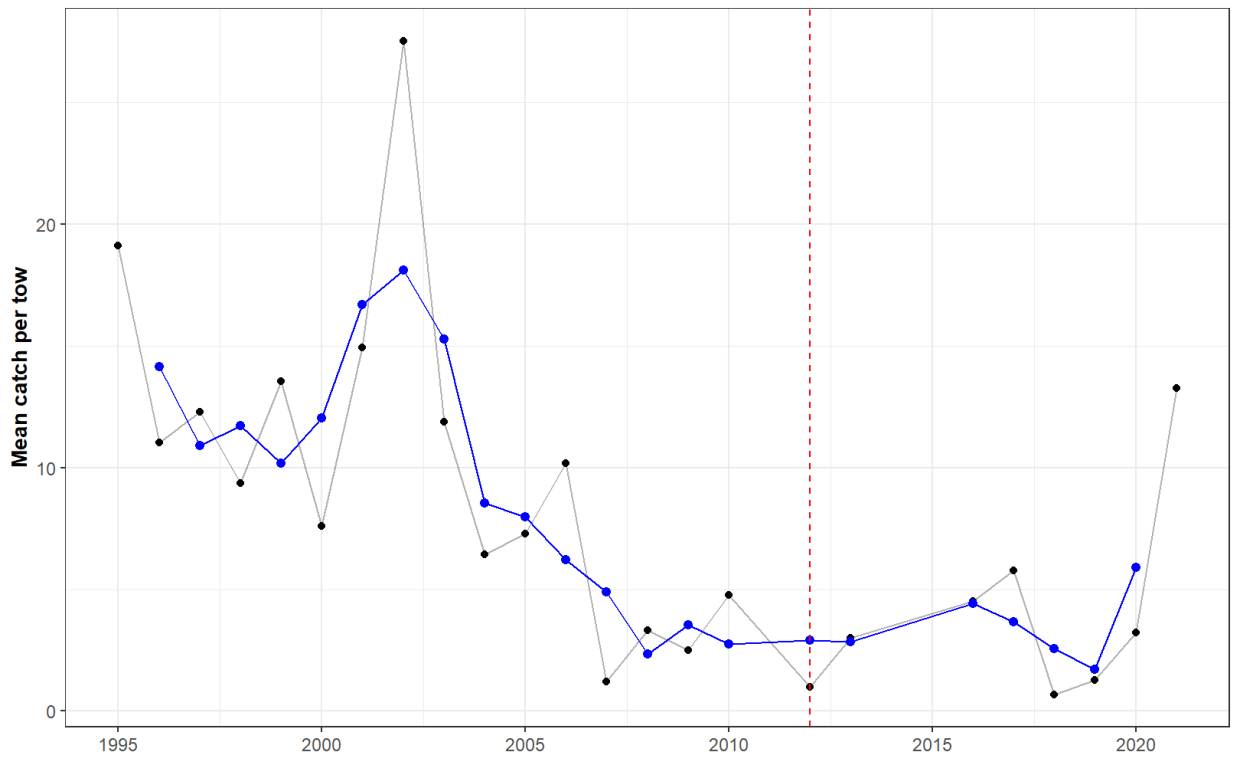


Figure 23. Mean catch per tow of Atlantic Wolffish in the ITQ and ILTS surveys from 1995–2021. Red line indicates the final year of the ITQ survey.

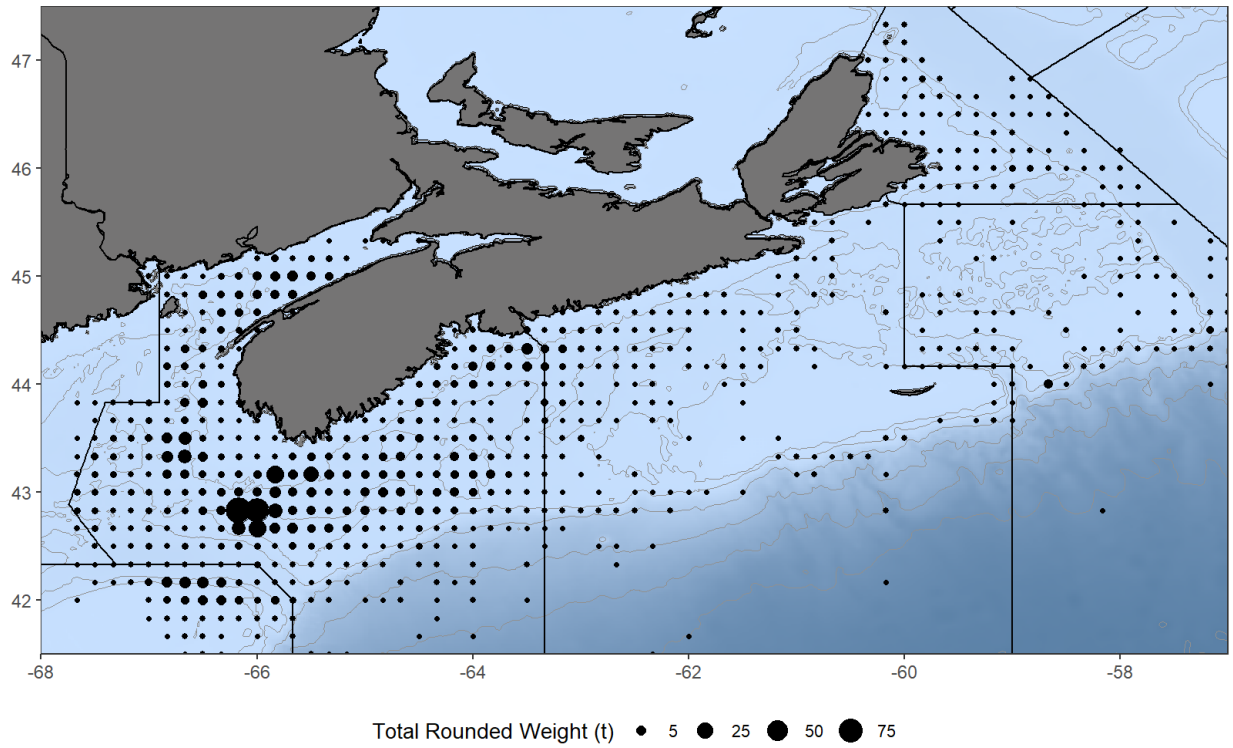


Figure 24. Distribution of reported commercial landings (t) of wolffish from Divisions 4VW, 4X and 5Z (2001–2021).

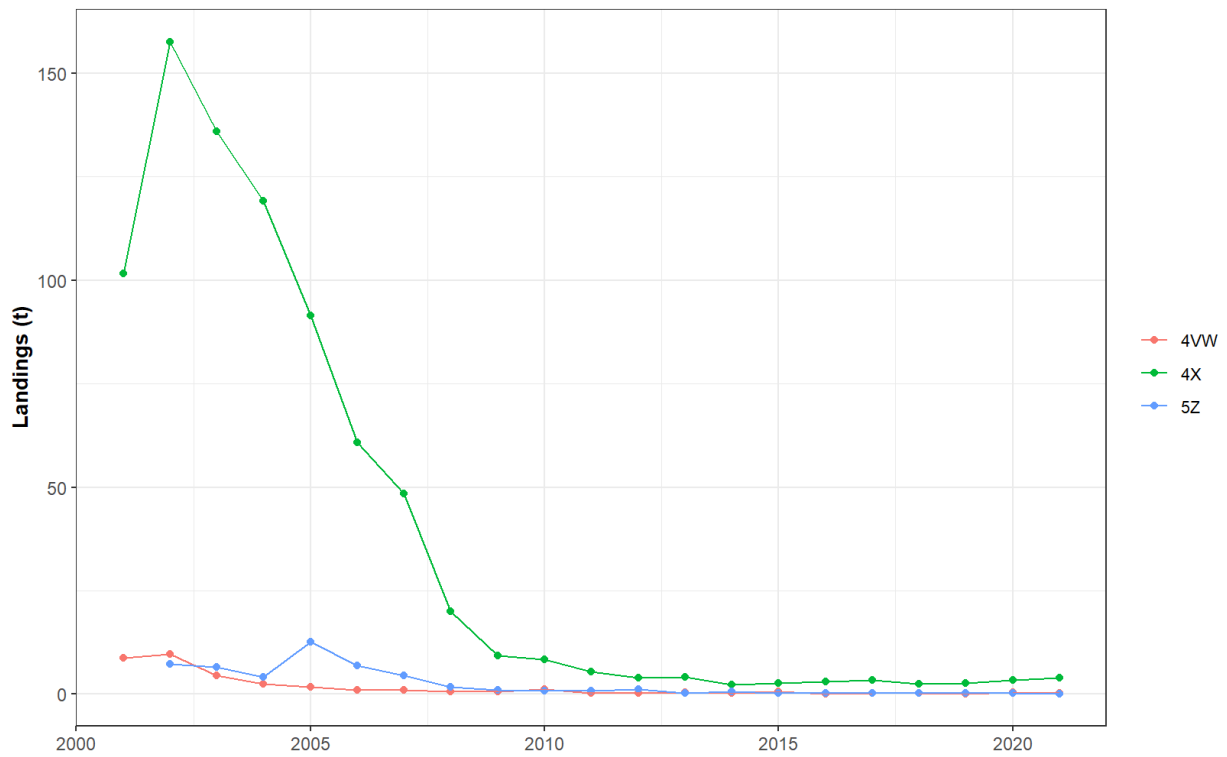


Figure 25. Commercial landings of wolffish (t) from Divisions 4VW, 4X and 5Z (2001–2021).

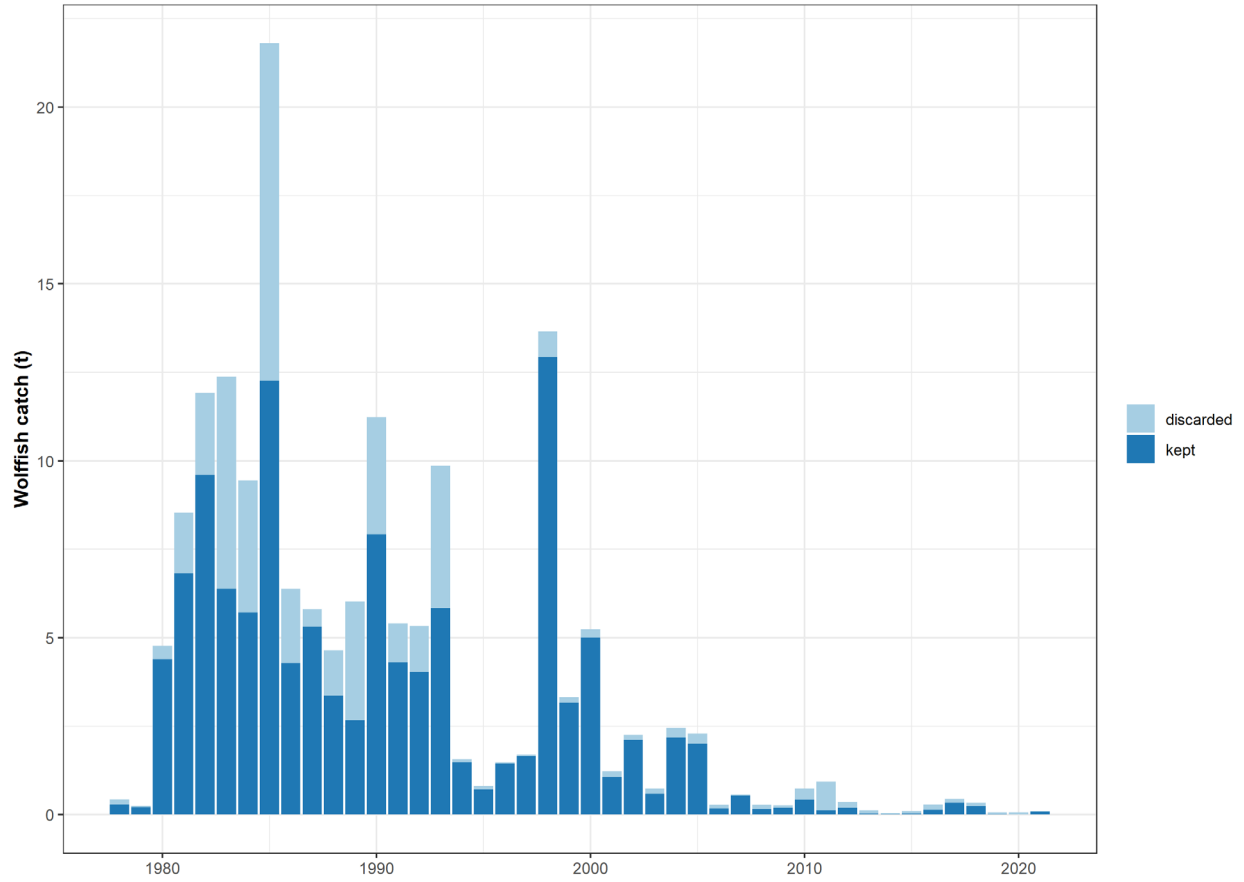


Figure 26. Annual total Atlantic Wolffish catches (t) observed during at-sea commercial fishing reported as discarded and kept in NAFO Divisions 4VXW and 5Z.