



## ASSESSMENT OF ATLANTIC WOLFFISH POPULATION TRENDS IN THE MARITIMES REGION



Atlantic Wolffish (Credit: Fisheries and Oceans  
Canada)

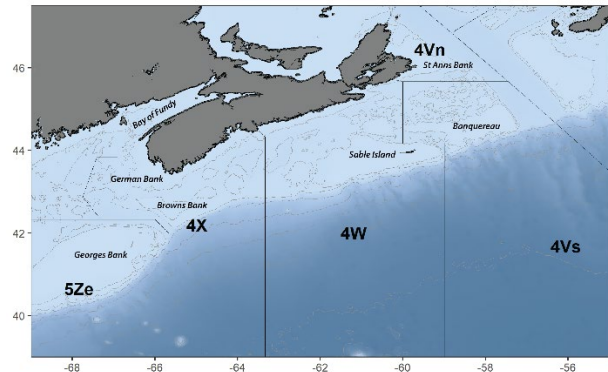


Figure 1. Map showing Scotian Shelf and NAFO  
Divisions 4VnX5Z.

### Context:

Atlantic Wolffish (*Anarhichas lupus*) (listed as a species of Special Concern under the Species at Risk Act [SARA]) underwent steep declines in both abundance and area of occupancy over much of its range from the 1980s until the mid-1990s. Research Vessel (RV) surveys (North Atlantic Fisheries Organization [NAFO] Divisions 4X and 4VW) suggest that abundance continued to decline on the Scotian Shelf in the 2000s and remains at low levels (Simon et al. 2012). However, numerous factors make it difficult to confidently assess trends within the population. The population has not been assessed for several years, and other data sources (such as other surveys, landings and observer data) exist that could provide information on the current status of Atlantic Wolffish.

This peer review process sought to answer the following questions: (a) Given the data sources available (e.g., Fisheries Observer data, SARA logbooks, other Fisheries and Oceans Canada [DFO] surveys, industry data), is it possible to develop a reliable biomass index for the Scotian Shelf portion of the population? (b) Can the index be used to understand population trends over time, and to assess and track fishing mortality over time? (c) What does the data reveal about species distribution patterns, potential drivers of population decline, range shifts, and/or sustained low abundances?

This Science Advisory Report is from the February 9–10, 2022, Maritimes Regional peer review of the Assessment of Atlantic Wolffish population trends in the Maritimes Region. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

## SUMMARY

- Atlantic Wolffish was assessed as Special Concern by the Committee on the Status of Endangered Wildlife (COSEWIC) in 2000 and listed under the *Species at Risk Act* (SARA) in 2003 because of steep declines in abundance and area of occupancy over much of its range from the 1980s through the mid-1990s.
- Its status was re-assessed and confirmed by COSEWIC in 2012. No signs of population recovery were observed for the portion of the population occurring on the Scotian Shelf where abundance continued to decline.
- Data analyses were undertaken to examine recent trends in abundance and distribution of the portion of the Atlantic Wolffish population residing on the Scotian Shelf using data from Fisheries and Oceans Canada (DFO) research vessel and industry surveys, commercial landings, at-sea commercial fishing observations, and SARA logbooks.
- The Maritimes Region Ecosystem Summer Research Vessel (RV) survey has the longest time series and most comprehensive coverage of the Scotian Shelf. Other RV and fishing industry surveys overlap the Summer RV survey geographically and provide short time series for other seasons, depths, and gear types.
- Overall abundance of Atlantic Wolffish on the Scotian Shelf has decreased. Abundance of immature individuals peaked in the late 1990s–early 2000s, and has declined since 2010. Abundance of mature individuals has been declining since the 1980s.
- Total stratified biomass decreased 62% from 1970 to 2000, 69% from 2000 to 2010, and 23% from 2010 to 2021, an overall decrease of 91% over the survey period. Stratified area occupied declined 36% from 1970 to 2010, and 85% from 2010 to 2021 – an overall decline of 74%.
- Commercial fishery 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.
- While Atlantic Wolffish discards are observed in multiple fisheries, estimates of total discards were not determined. The contribution of discards to estimates of fishing mortality on Atlantic Wolffish from various fisheries has not been assessed.
- Given the data sources available, abundance of Atlantic Wolffish on the Scotian Shelf remains low.
- 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.

## INTRODUCTION

Atlantic Wolffish (*Anarhichus 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 prefers shallow, coastal waters to depths of 350 m and tolerates a wide range of temperatures from  $-1$  to  $10^{\circ}\text{C}$ . A non-schooling species that lives over hard substrates, it 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.

Although Atlantic Wolffish occur broadly in the Maritimes Region, DFO Ecosystem Summer Research Vessel Surveys (herein referred to as the Summer RV survey[s]) indicate there are two primary areas of concentration on the Scotian Shelf: in the east (NAFO Division 4V) and the west (Division 4X, primarily Browns Bank). Since the start of the Summer RV survey series in 1970, the abundance of both immature and mature individuals in areas 4VW and 4X has declined (Simon et al. 2012). 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. Landings 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 the early 1980s, and declined sharply until 1993 when all directed fishing for Haddock and Cod was ended (Simon et al. 2012).

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. It was assessed as Special Concern by COSEWIC in 2000 and listed under the *Species at Risk Act* (SARA) in 2003 because of steep declines in abundance and area of occupancy over much of its range from the 1980s through the mid-1990s. Its status was re-assessed and confirmed by COSEWIC in 2012 (COSEWIC 2012). Although overall abundance and area of occupancy were found to have increased, 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).

This report describes data analyses undertaken 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 and industry surveys, commercial landings, at-sea commercial fishing observations, and SARA logbooks. The objectives were to develop a reliable biomass index to track population trends over time, examine population abundance and distribution patterns, and estimate mortality due to fishing over time.

## METHODS

Fishery independent surveys of the Scotian Shelf and Georges Bank are conducted annually by DFO using Canadian Coast Guard vessels, or in collaboration with fishing industry vessels (Table 1). The Summer RV survey has the longest time series and the most comprehensive coverage of the Scotian Shelf area, sampling 4VWX since 1970. Depths of 35–450 m are sampled by bottom trawl using a stratified random design. The survey vessel and gear changed in 1982, but no conversion factors have been calculated for Atlantic Wolffish. Other research vessel and fishing industry surveys overlap the Summer RV survey geographically and provide short time series for other seasons, depths, and gear types: February and March (Georges Bank, Spring 4X, Spring 4VsW); shallower depths (Individual Transferrable Quota [ITQ], Inshore Lobster, 4VsW Sentinel); additional sampling of 4VW (Snow Crab) and bottom longline gear (Halibut and 4VsW Sentinel).

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. Industry survey catch estimates were calculated as averages per tow, standardized by the sampling effort where possible. A length of 50% maturity at 53 cm was used to distinguish immature from mature individuals, consistent with earlier assessments (Simon et al. 2012, McRuer et al. 2000).

At-sea observations of commercial fisheries within the Maritimes Region were examined from 1978 to 2021. Only those sets that reported catching Atlantic Wolffish were examined. Landings

of wolffish (also recorded as catfish) were obtained from the Maritimes Fisheries Information System (MARFIS) database and were examined from 2000. These common names were used interchangeably for all species of wolffish until 2006, and may include Northern Wolffish and Spotted Wolffish. Most are assumed to be Atlantic Wolffish based on known distributions of the three species from DFO RV surveys in this area.

*Table 1. Surveys examined for Atlantic Wolffish records in the Maritimes Region. Georges refer to Georges Bank Winter Research Vessel Surveys, ITQ = Individual Transferrable Quota surveys.*

Category	Identifier	NAFO Divisions	Years	Gear	Total Sets observed	Sets Containing Atlantic Wolffish
Research Vessel (RV) 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
	Lobster	4X	2013–2021	Trawl	1,309	22

## ASSESSMENT

### Canadian Research Vessel surveys

The Summer RV surveys sampled 8,998 sets between 1970–2021, of which 1,566 (17%) captured Atlantic Wolffish. Composite distribution patterns determined two primary areas where Atlantic Wolffish were caught: the eastern Scotian Shelf (4V) and the western Scotian Shelf (4X), particularly around Brown’s Bank. Since 2011, species catch decreased and distribution was more confined in these areas (Figure 2). 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 2).

Overall abundance of Atlantic Wolffish on the Scotian Shelf has continued to decrease since the previous assessment to the end of 2010 (Simon et al. 2012). Abundance of immature individuals in 4VW peaked in the late 1990s–early 2000s, although with high interannual variability, and has declined since 2010 (Figure 3). Abundance of mature individuals has been declining since the 1980s. Abundance of both size classes in 4X was comparable between the 1970s and 1990s, and it has subsequently decreased to near zero since 2000. Total stratified biomass on the Scotian Shelf was generally stable in the 1970s and 1980s for both size classes, but it 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% over the survey time series (Figure 4) This pattern was consistent in both 4VW and 4X. Stratified area occupied declined 36% from 1970 to 2010, and 85% from 2010 to 2021 – an overall decline of 74% (Figure 5).

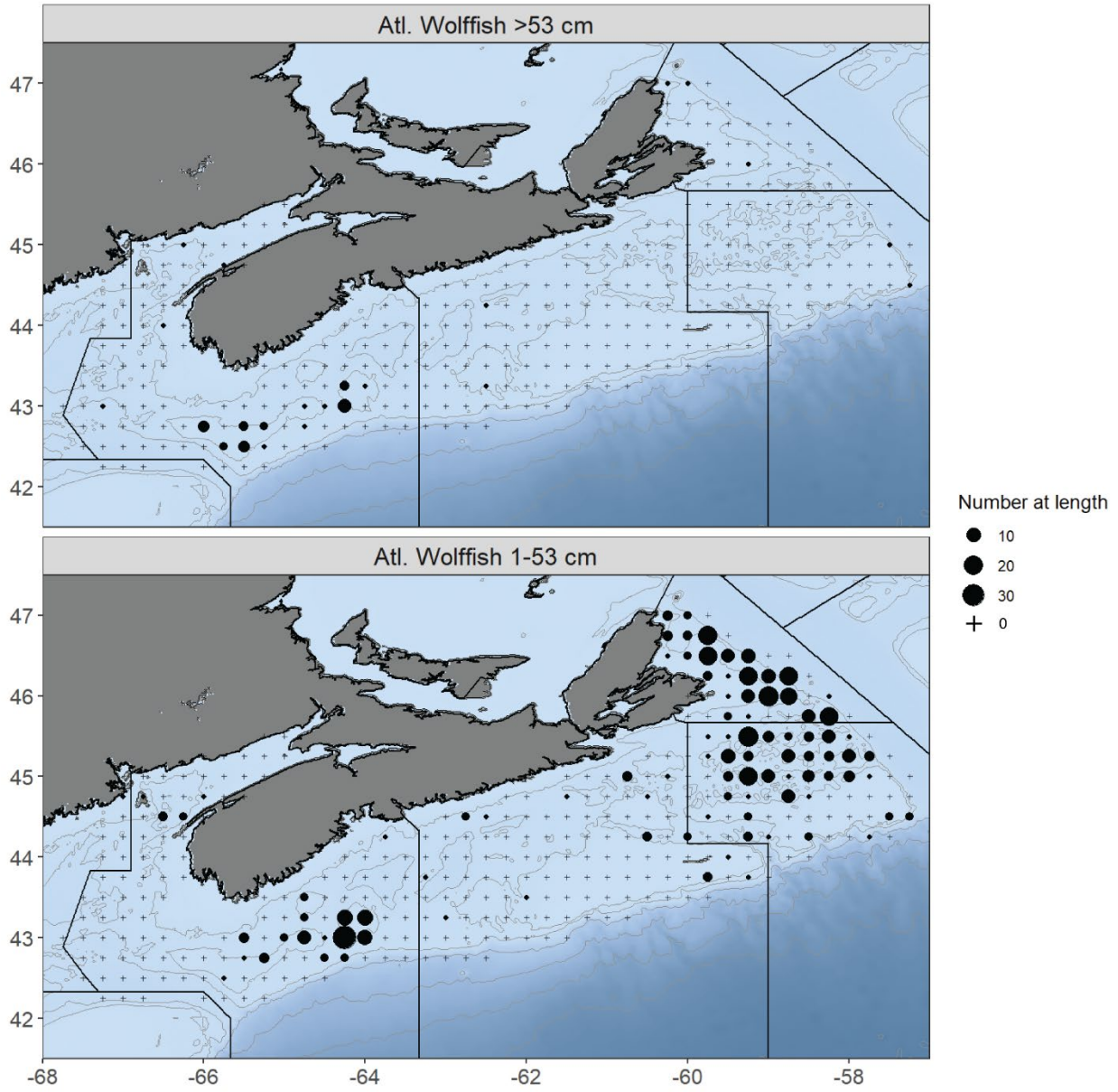


Figure 2. Distribution of mature (> 53 cm, top panel) and immature (1–53 cm, lower panel) Atlantic Wolffish in the DFO Summer Research Vessel surveys (2011–2021).

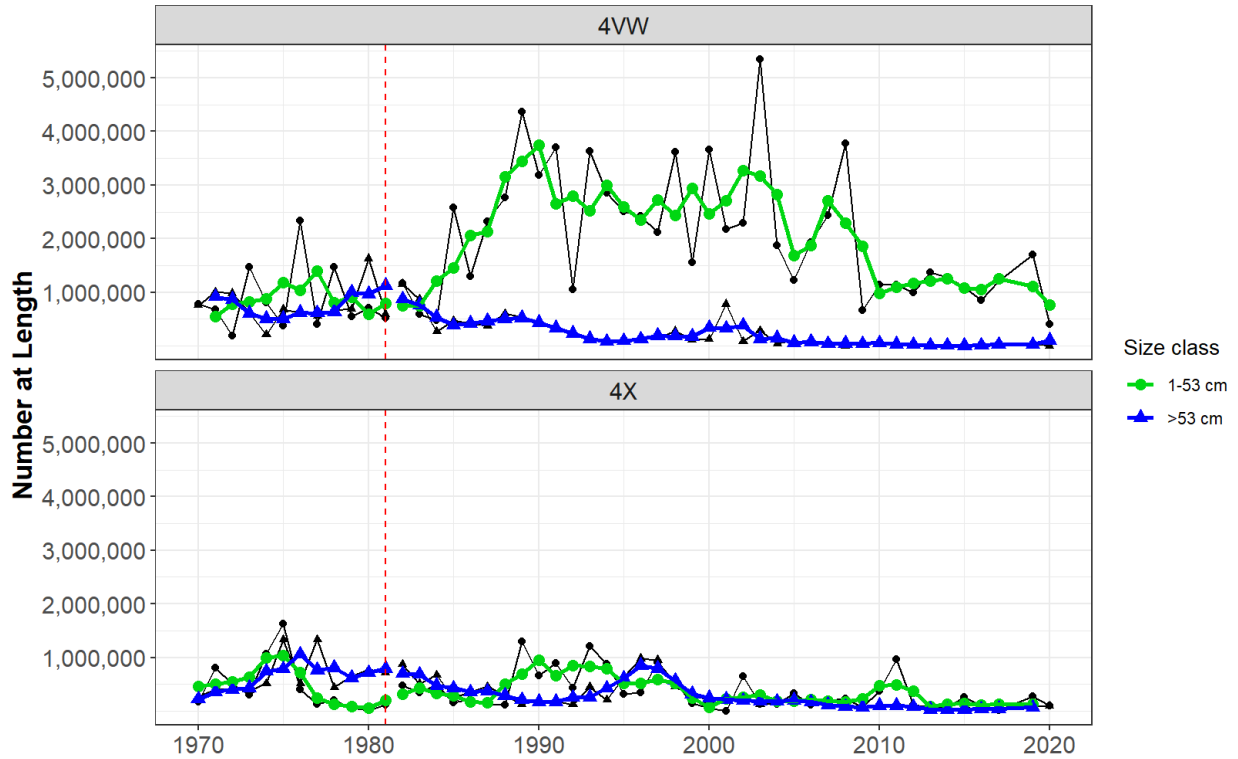


Figure 3. Stratified 3-year geometric mean abundance of immature (1–53 cm) (green triangle) and mature (> 53 cm) (blue circle) Atlantic Wolffish in 4VW (top panel) and 4X (bottom panel) in the DFO Summer Research Vessel surveys (gaps and dashed line indicate change in vessel and gear after 1981). Black lines and symbols are annual values.

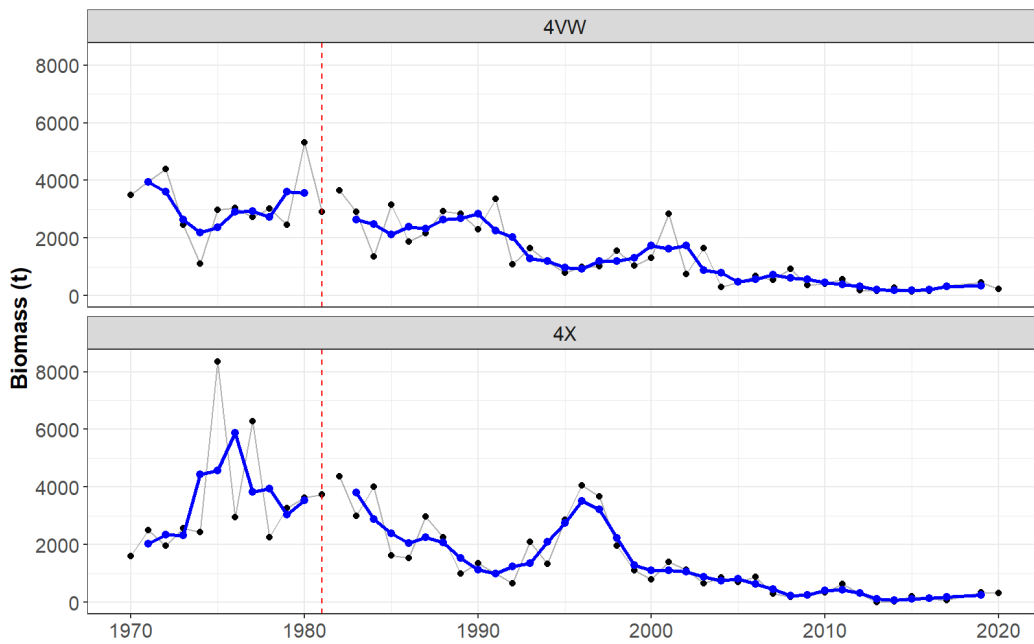


Figure 4. Stratified 3-year geometric mean (blue line) and annual (black line) biomass (t) of Atlantic Wolffish in 4VW (top panel) and 4X (lower panel) in the DFO Summer Research Vessel surveys (gap and dashed line indicate change in vessel and gear after 1981).

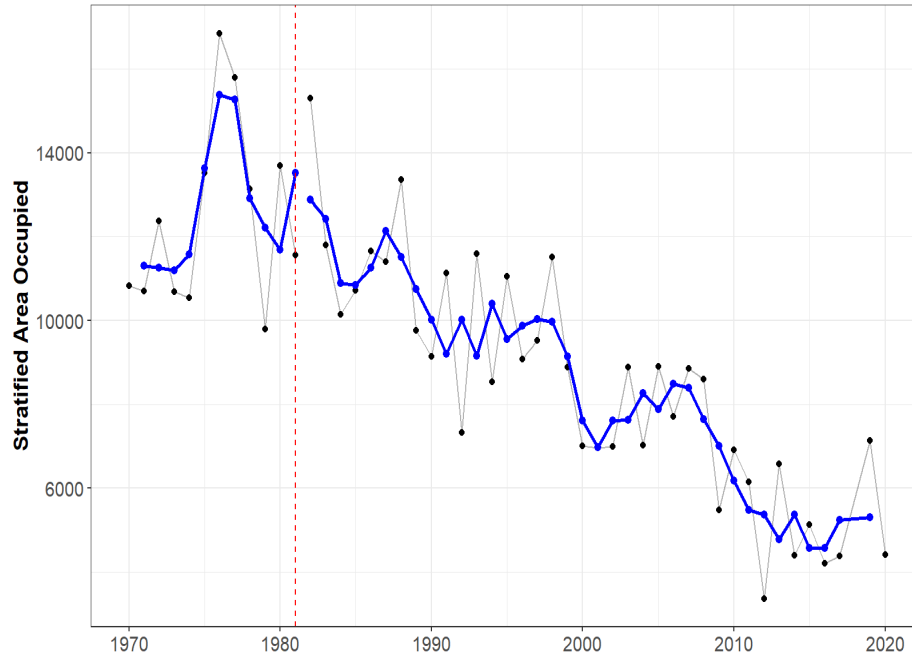


Figure 5. The 3-year geometric mean (blue line) and annual (black line) stratified area occupied by Atlantic Wolffish in 4VWX in the DFO Summer Research Vessel surveys (gap and dashed line indicate change in vessel and gear after 1981).

The three spring survey series have not consistently provided complete coverage in 4VWX and cannot be used as indices of abundance. These surveys do, however, allow for comparisons of the seasonal distribution of Atlantic Wolffish to the Summer RV survey. Overall, distribution patterns did not differ between the seasons for any of the surveys.

Analysis of the Winter RV survey on Georges Bank was limited to the Canadian side (Strata 5Z1–2), which are the only strata consistently sampled for the survey time series. A total of 99 out of 1,408 sets (7%) reported Atlantic Wolffish (Figure 6). Stratified biomass has been decreasing since the early 1990s, and it has remained consistently near zero since the late 2000s (Figure 7). 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 was caught in 2010, 2013, 2015, and 2019.

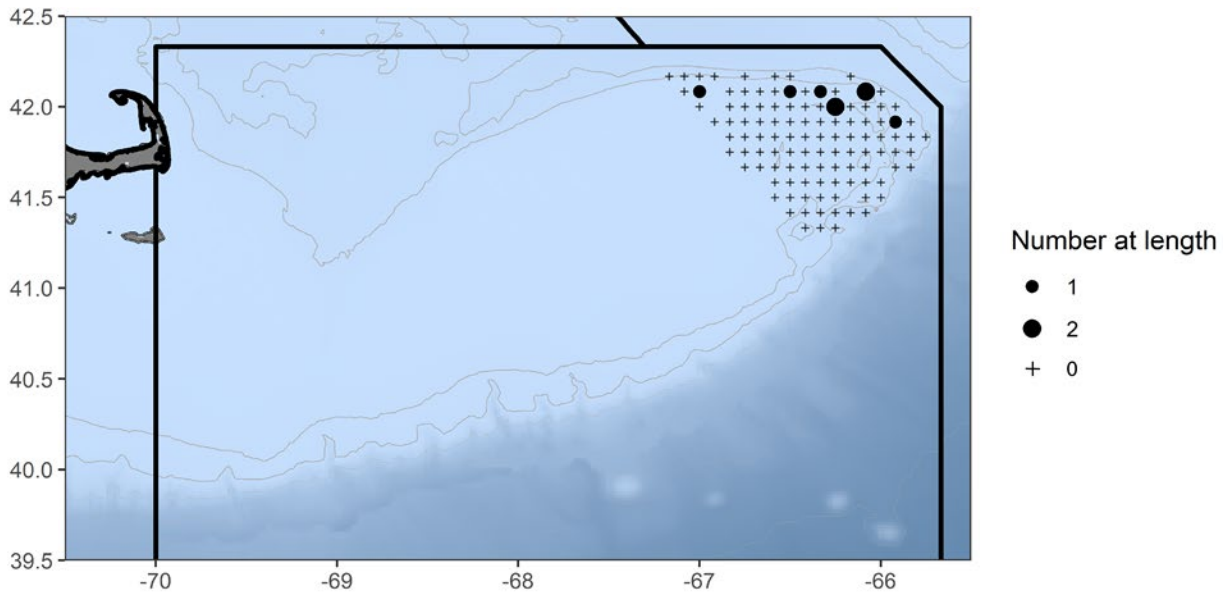


Figure 6. Distribution of Atlantic Wolffish in the Georges Bank Winter Research Vessel surveys. Data shown for Strata 5Z1 and 5Z2 only, 2011–2021.

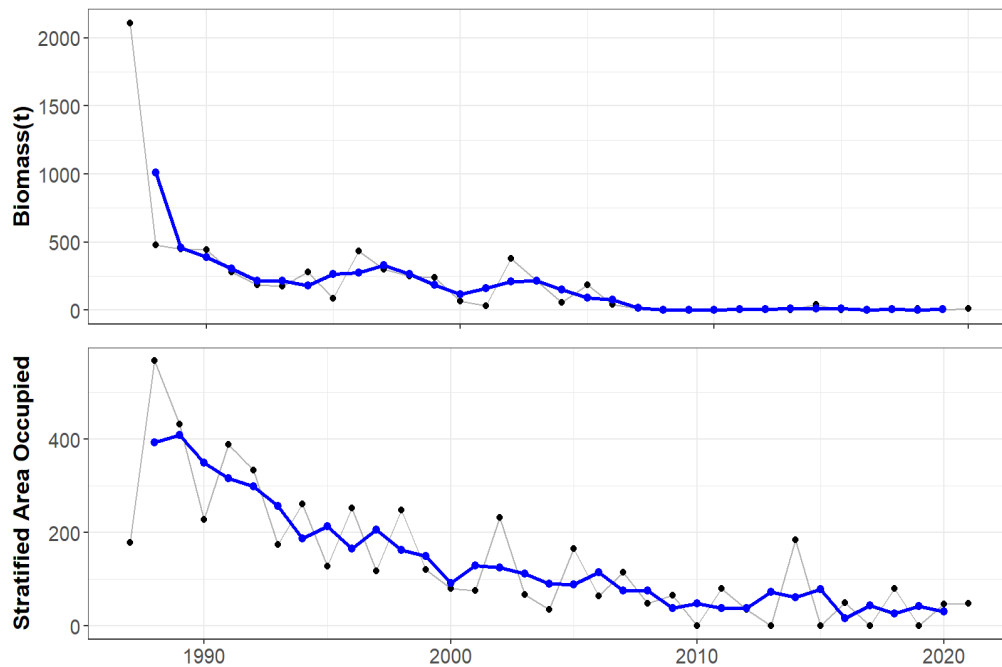


Figure 7. The 3-year geometric mean (blue line) and annual (black line) values for stratified biomass (top panel) and area occupied (bottom panel) of Atlantic Wolffish in Strata 5Z1 and 5Z2 of the Georges Bank Winter Research Vessel surveys, 1986–2021.

### Industry Surveys

Atlantic Wolffish occurrence was low in most industry surveys (10% or less of sets sampled), and the patterns of geographic distribution and declining abundance did not differ from the Summer RV survey. In the Halibut longline survey, the mean catch per 1,000 hooks was highly variable between years, with no discernable long-term pattern. The distribution of catches



showed the same areas of concentration near Browns Bank and the edge of the shelf in 4V. The 4VsW Sentinel longline survey consistently catches Atlantic Wolffish, but its coverage has been reduced to six stations in the inshore portion of 4W since 2011. In the Snow Crab trawl survey, only 6% of sampled stations contained Atlantic Wolffish, and average annual catch per tow has decreased since 2012. Atlantic Wolffish were broadly distributed through 4Vn and the northern part of 4Vs; survey coverage was limited in 4WX, with catches occurring near shore. The percent of sets catching Atlantic Wolffish in the ITQ survey declined from 8% to 1.7% when the switch to the Lobster survey was initiated. Average catch per tow has been below 10 kg since 2005.

### Commercial Fishing Landings and at-sea observations

The largest portion of commercial fishery landings come from 4X, where Atlantic Wolffish are primarily concentrated on the western edge of Brown's Bank – the same area found to have the highest presence of Atlantic Wolffish in DFO Summer and Spring RV surveys. Landings in 4X decreased rapidly in the early 2000s, and they have remained below 10 t over the past decade (Figure 8). Landings from 4VW and 5Z have been near zero since before 2000.

At-sea observations of fishing operations are the only source of discard information for Atlantic Wolffish because not all fisheries are required to retain them, and there is no requirement to report encounters with Atlantic Wolffish in fishing or SARA logs. Observations of Atlantic Wolffish by at-sea observers during commercial fishing operations have decreased since 2000; however, catches were not scaled by the total effort of a fishery (e.g., proportion of trips observed compared to total trips undertaken) (Figure 9). The percentage of Atlantic Wolffish discarded catch is around 30% of total in observed trips. These 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.

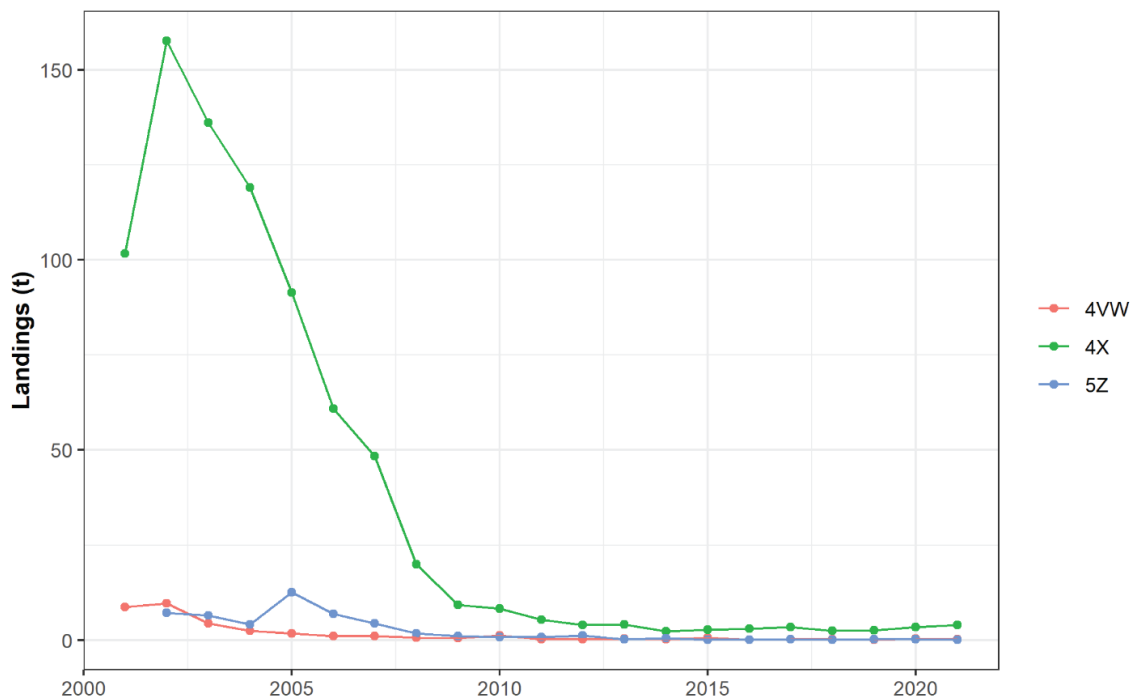


Figure 8. Distribution of reported commercial landings (t) of Atlantic Wolffish from 4VW, 4X and 5Z (2001–2021).

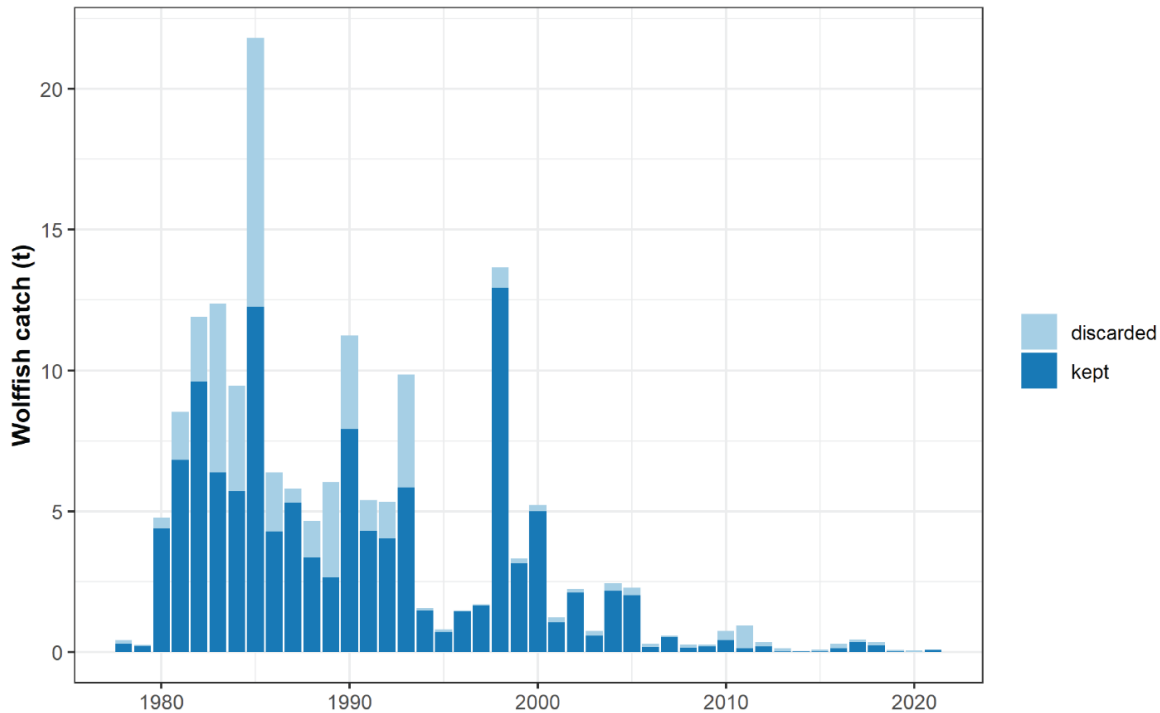


Figure 9. Annual total catch (t) of Atlantic Wolffish reported as discarded and kept in the Maritimes At-Sea Observer Program, in 4VXW and 5Z from 1978–2021.

### Sources of Uncertainty

All abundance and biomass estimates constitute relative indices because the catchability of wolffish by survey gear is not known.

An appropriate length-at-maturity has not been assessed for the Scotian Shelf. Size-at-maturity of Atlantic Wolffish is difficult to determine because eggs may be visible in immature fish several years before they spawn for the first time (Simon et al. 2012). Maturity lengths other than 53 cm have been proposed in the published literature (Nelson and Ross 1992, Templeman 1986), they and may vary due to temperature effects (Templeman 1986).

While Atlantic Wolffish discards are observed in multiple fisheries, estimates of total discards were not determined. The contribution of discards to estimates of fishing mortality on Atlantic Wolffish from various fisheries have not been assessed. Any future assessment should consider the uncertainty related to fisheries monitoring and survivability of discards from the various gears encountered.

### CONCLUSIONS AND ADVICE

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 (Division 4V) and the western side on Brown's Bank (Division 4X). Abundance of both immature (1–53 cm) and mature individuals (> 53 cm) have decreased > 90% since the start of the Summer RV survey series. Immature individuals, however, 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. Atlantic Wolffish continue to be caught in longline and mobile gear industry surveys; however, catches are generally low.

There is little evidence for seasonal movement of Atlantic Wolffish along the Scotian Shelf between the Summer and Winter/Spring surveys, although winter/spring sampling has been very limited over the past 10 years.

Although there are no directed fisheries for Atlantic Wolffish in the Maritime Region, the species is landed as bycatch in other fisheries. Annual landings of Atlantic Wolffish have been on the decline since the 1980s. Since 2010, the average annual catch of Atlantic Wolffish reported in commercial landings has been 4 t per year.

Atlantic Wolffish were also found inshore of the 50-fathom line in 4X and 4W. Currently, only the Lobster survey in 4X and the 4VsW Sentinel survey in 4W conduct sampling so far 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 survey by providing more information on individuals occurring in shallower coastal regions.

Given the data sources available, abundance of Atlantic Wolffish on the Scotian Shelf remains low. The eastern and western parts of the Scotian Shelf remain the primary areas of concentration for both size classes, while distribution between these regions has largely collapsed.

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 and observer coverage, these data are not sufficient to provide an estimate of the impacts of fishing on the population.

Currently, the DFO Summer RV Survey in 4VWX provides the best source of information to monitor trends in population abundance and distribution. Conversion factors should be developed if necessary to account for the adoption of a new survey vessel and trawl in 2021.

## LIST OF MEETING PARTICIPANTS

Name	Affiliation
Elizabetha Tsitrin (Lead)	DFO Science, Maritimes Region
Kayla Silver	DFO Science, Maritimes Region
Daphne Themelis	DFO Science, Maritimes Region
Leslie Nasmith (Co-chair)	DFO Science, Maritimes Region
Rabindra Singh (Co-chair)	DFO Science, Maritimes Region
Donald Clark	DFO Science, Maritimes Region
Claire Mussells (Reviewer)	DFO Science, Maritimes Region
Catriona Regnier-McKellar (Reviewer)	DFO Science, Maritimes Region
Tania Davignon-Burton	DFO Science, Maritimes Region
Una Goggin	DFO Science, Maritimes Region
Adam Mugridge	Nova Scotia Fisheries and Aquaculture
Paige Crowell	DFO Species at Risk Program, Maritimes Region
Koren Spence	DFO Resource Management, Maritimes Region
Penny Doherty	DFO Resource Management, Maritimes Region
Luiz G.S. Mello	DFO Science, Newfoundland and Labrador Region
Candace Nickerson	DFO Resource Management, Maritimes Region
Jarrad Sitland	DFO Resource Management, Maritimes Region
Kathryn Cooper-MacDonald	DFO Resource Management, Maritimes Region
Kris Vascotto	Groundfish Enterprise Allocation Council
Katie Schleit	Oceans North
Aruna Jayawardane	Maliseet Nation Conservation Council

## SOURCES OF INFORMATION

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**THIS REPORT IS AVAILABLE FROM THE:**

Center for Science Advice (CSA)  
Maritimes Region  
Fisheries and Oceans Canada  
Bedford Institute of Oceanography  
1 Challenger Drive, PO Box 1006  
Dartmouth, Nova Scotia  
Canada B2Y 4A2

E-Mail: [MaritimesRAP.XMAR@dfo-mpo.gc.ca](mailto:MaritimesRAP.XMAR@dfo-mpo.gc.ca)  
Internet address: [www.dfo-mpo.gc.ca/csas-sccs/](http://www.dfo-mpo.gc.ca/csas-sccs/)

ISSN 1919-5087

ISBN 978-0-660-45420-7 N° cat. Fs70-6/2022-044E-PDF

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Department of Fisheries and Oceans, 2022



Correct Citation for this Publication:

DFO. 2022. Assessment of Atlantic Wolffish population trends in the Maritimes Region. DFO  
Can. Sci. Advis. Sec. Sci. Advis. Rep. 2022/044.

*Aussi disponible en français :*

*MPO. 2022. Évaluation des tendances de la population de loups atlantiques dans la région des  
maritimes. Secr. can. des avis sci. du MPO. Avis sci. 2022/044.*