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Maritimes Region

Canadian Science Advisory Secretariat
Science Advisory Report 2025/048

ASSESSMENT OF ATLANTIC COD (*GADUS MORHUA*) BYCATCH LEVELS IN LOBSTER (*HOMARUS AMERICANUS*) FISHERIES IN NAFO DIVISIONS 4X5Y

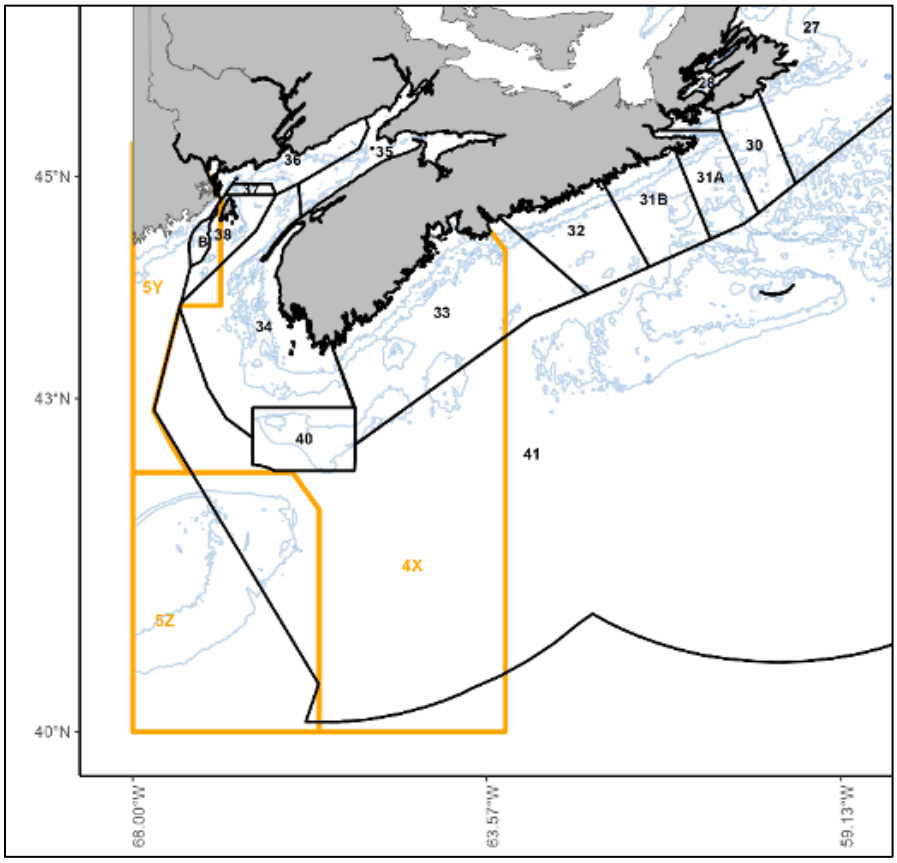

Figure 1. Map of DFO Maritimes Region lobster fishing areas (LFA labelled with numbers and outlined by black lines) and Northwest Atlantic Fisheries Organization Divisions (yellow lines). Blue lines represent depth contours.

CONTEXT

The *Policy on Managing Bycatch* (DFO 2019), part of Fisheries and Oceans Canada's (DFO) Sustainable Fisheries Framework, sets forth the requirement to account for the amount of retained and non-retained bycatch when assessing stocks. DFO Maritimes Region, Resource Management has requested information on the level of bycatch of Atlantic Cod (*Gadus morhua*) in Lobster fisheries in the Northwest Atlantic Fisheries Organization (NAFO) Divisions 4X5Y stock area. Management objectives included in the Rebuilding Plan for Atlantic Cod in NAFO 4X5Y (DFO 2021) recommend the collection of bycatch data from Lobster fisheries in lobster fishing areas (LFA) 33–38 and 41 with the intent to develop estimates of Atlantic Cod bycatch. Incorporation of these bycatch estimates into the 4X5Y Atlantic Cod assessment model

and a review of the impact on Atlantic Cod stock status will be completed in a subsequent peer review meeting, including application of estimated mortality rates. The requested advice will be used by Resource Management to support decisions related to the management of fisheries in relation to bycatch and to inform decisions on data collection and monitoring systems, where necessary.

This Science Advisory Report is from the regional peer review of March 19–20, 2025 on the Assessment of Atlantic Cod Bycatch Levels in Lobster Fisheries in Northwest Atlantic Fisheries Organization Areas 4X5Y. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Resource Management requested information on the level of bycatch of Atlantic Cod in Lobster fisheries in the Northwest Atlantic Fisheries Organization (NAFO) Divisions 4X5Y stock area.
- Data from multiple sources were used to estimate Cod bycatch, including scientific surveys, at-sea sampling programs, and environmental data collected in NAFO Divisions 4X5Y.
- Evaluation of multiple candidate models determined the spatial model to be the best model for prediction of annual total Cod bycatch in the Lobster fishery.
- Predicted annual total bycatch of Cod in the Lobster fishery within NAFO Divisions 4X5Y ranged between 461–1,066 metric tons for years 2018–2023.
- Uncertainty of predicted totals can be high due to gaps in interannual and regional sampling coverage.

INTRODUCTION

In compliance with DFO's *Policy on Managing Bycatch*, a methodology for quantifying the Atlantic Cod bycatch within the lobster fishery in NAFO Divisions 4X5Y was proposed. The approach takes into account the non-uniform distribution of both Cod abundance and lobster fishing effort across the 4X5Y area, utilizing data from multiple sources. Incorporation of the total bycatch estimates from this analysis into the 4X5Y Atlantic Cod assessment model, including application of estimated mortality rates and a review of the impact on Atlantic Cod stock status, will be completed in a separate peer review meeting.

ANALYSIS

Data

The analysis by Yin et al. (In Prep[1]) used data from five sources: the DFO Summer Ecosystem Research Vessel (RV) Survey, the Inshore Lobster Trawl Survey (ILTS), at-sea sampling (AS) program for Lobster fisheries in lobster fishing areas (LFA) 33, 34, 35, and 41, commercial lobster fishing effort (CLFE; trap hauls) data, and bathymetry data for NAFO Divisions 4X5Y from Wang et al (2018).

[1] Yin, Y., Andrushchenko, I., and Cook, A.M. In Prep. Estimating 4X5Y Atlantic Cod Bycatch in Commercial Lobster Fishery. DFO Can. Sci. Advis. Sec. Res. Doc.

Data from the Summer RV Survey and the ILTS from 2016 to 2024 were used to estimate a relative Cod biomass density distribution within the area of NAFO Divisions 4X5Y. The ILTS complements the Summer RV Survey as it samples a larger portion of the near shore habitat as well as having spatial overlap in the mid-shore and offshore areas. This sampling in nearshore habitat is important for characterizing Cod distribution in areas where the Lobster fishery occurs.

The AS data from 2016–2023 was used for analysis and estimation of total Cod bycatch. The complete data set for 2024 was not available at the time the analysis was conducted. The fishery level estimates of Cod bycatch are scaled up by the total CLFE data, which is derived from mandatory logbook data and sales slips provided from commercial harvesters (Cook et al. 2024).

Bathymetry data for NAFO Divisions 4X5Y was incorporated in both the model that estimates Cod population density distribution and the model that estimates Cod bycatch in the Lobster fisheries.

Analysis

A model was developed to integrate the Summer RV Survey and the ILTS. This model estimated a relative Cod population density across both space and time which was subsequently used as a predictor in the bycatch analysis (Yin et al In Prep[1]).

For the bycatch analysis, four candidate models were developed and optimized within their respective modeling frameworks and subsequently evaluated and compared: Mean Estimator, Random Forest, Generalized Linear Model, and a Spatial Model. This analysis examined the relationship between the Cod bycatch and potential predictors such as Cod density, depth, and day of year. The Spatial Model was recommended after extensive diagnostics and cross-validation and was used to estimate annual total Cod bycatch (Yin et al In Prep[1]).

Overall, annual Cod bycatch amounts were in the range of 461–1,066 metric tons (Table 1) when aggregated to the entire study area. Detailed numbers for each LFA are included in Yin et al (In Prep[1]). Due to the lack of observer coverage for years 2016–2017, an analysis to extrapolate for these years was attempted. Results indicated high uncertainty in the estimates and were deemed unreliable for 2016–2017. The confidence interval for the 2018 estimate is high compared to other years due to partial sampling coverage; however, it was deemed to be acceptable during the peer review. For the years 2018–2023, there is consistency between the estimates of Cod bycatch from this analysis and the percentage of Cod bycatch observed in traps; therefore, the estimates presented in Table 1 were generally in line with expectations.

Table 1. Predicted annual total bycatch of Cod (mt=metric tons) in lobster fisheries within 4X5Y.

Year	Total Cod Bycatch (mt)	Coefficient of Variation	95% Confidence Interval (mt)
2018	1,066	1.84	98–11,562
2019	461	0.44	201–1,060
2020	527	1.92	46–6,022
2021	576	1.29	83–4,018
2022	711	0.72	202–2,504
2023	831	0.34	434–1,591

Sources of Uncertainty

Bycatch estimates are more uncertain for locations or years with limited or absent at-sea sampling coverage. As noted previously, bycatch estimates for years 2016–2017 are not provided due to the high uncertainty in the estimates related to limited at-sea sampling coverage in these years. Estimates provided for years 2020 and 2021 also had higher levels of uncertainty, possibly linked to sampling limitations within these years due to COVID restrictions.

Although attempts were made for sampling to be representative of the fishery and habitats, the sampling programs are subject to potential sampling bias related to operational limitations that were not possible to account for in this analysis. Uncertainty could also arise from simplifications in model assumptions, such as the absence of a seasonal effect in the Cod density model.

CONCLUSIONS

Evaluation of multiple candidate models determined the Spatial Model to be the best model for prediction of annual total Cod bycatch in the Lobster fishery. Predicted annual total bycatch of Cod in the Lobster fisheries within NAFO Divisions 4X5Y, for years 2018–2023, ranges between 461–1,066 mt (Table 1).

OTHER CONSIDERATIONS

In future years, the accepted method can be used to produce annual estimates of total Cod bycatch once quality control is completed for the full dataset for a given year.

The at-sea sampling program in Lobster fisheries provides important information on bycatch and would benefit from expanded spatial coverage using the same established sampling protocols.

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SOURCES OF INFORMATION

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