



DEVELOPMENT OF THE PRECAUTIONARY APPROACH FOR THE ICELAND SCALLOP STOCK IN AREA 16F ON THE NORTH SHORE OF QUEBEC

CONTEXT

The Iceland scallop stocks in areas 16E and 16F were identified as a priority for a rebuilding plan in response to Recommendation 2.63 of the Commissioner of the Environment and Sustainable Development in her 2016 audit report, “Sustaining Canada’s Major Fish Stocks—Fisheries and Oceans Canada.” DFO has committed to setting targets and timelines for the establishment of precautionary approach harvest control rules for the major stocks under its management control, where harvest control rules do not exist. Scallop stocks in areas 16E and 16F are also included in the second batch of stocks being proposed for the Fish Stocks provisions of the *Fisheries Act*. Under these provisions, DFO is required to maintain major fish stocks at levels necessary to promote sustainability of the stock and to develop and implement rebuilding plans for stocks that have declined below their limit reference point (LRP). At the request of the Fisheries Management Branch, an LRP was proposed and approved for Area 16E in the March 2023 scallop stock assessment. An LRP for Area 16F should also be proposed and approved, given the uncertain status of the stock, the decline in catch per unit effort (CPUE) in recent years and other indicators suggesting that this stock is overfished.

This Science Response Report results from the regional peer review of March 27, 2024 on Development of a Precautionary Approach for Scallop Stocks in Area 16F on Quebec’s North Shore.

BACKGROUND

The Iceland scallop (*Chlamys islandica*) is the predominant scallop species on the seabed in the Côte-Nord (North Shore in Figure 1) administrative region and around Anticosti Island. The sea scallop (*Placopecten magellanicus*) can also be found, but in low densities. Scallops are sedentary and live in aggregations called “beds.” This characteristic must be taken into account in developing conservation strategies and harvesting plans (Smith 2003).

The commercial fishery generally targets both scallop species, but Area 16F landings are considered to be composed primarily of Iceland scallop. The commercial fishery in Area 16F (Figure 1) began before 1987, but the landings data in the time series are accurate and usable only from 1987 onward. Scallop landings in Area 16F were high in the early years, reaching a record peak of 65 t of meat in 1989. They hovered around 30 t from 1992 to 2006 without any clear trend, plummeted to 7.8 t in 2007 and remained below 5 t from 2008 to 2022 (DFO 2023). Since 2011, the fishery has been conducted primarily on bed “C,” with landings from the area totalling 1.3 t, 3.9 t and 1.9 t of meat in 2020, 2021 and 2022, respectively (Figure 2A). Fishing effort has also declined, from over 249 fishing days in 1987 to an average of 11 days for the 2020–2022 period out of an authorized total of 25 days in 2022.

A population assessment model for the stock in Area 16E was developed and adopted in 2023 (DFO 2023). This Bayesian surplus production model (SPM) makes it possible to estimate the

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biomass of the population under the effects of the fishery and to determine a sustainable fishing limit. To determine the LRP for the stock in Area 16F, an assessment model similar to the one for Area 16E was applied. Details of the model used for Area 16E are described in Belley et al. (in press).

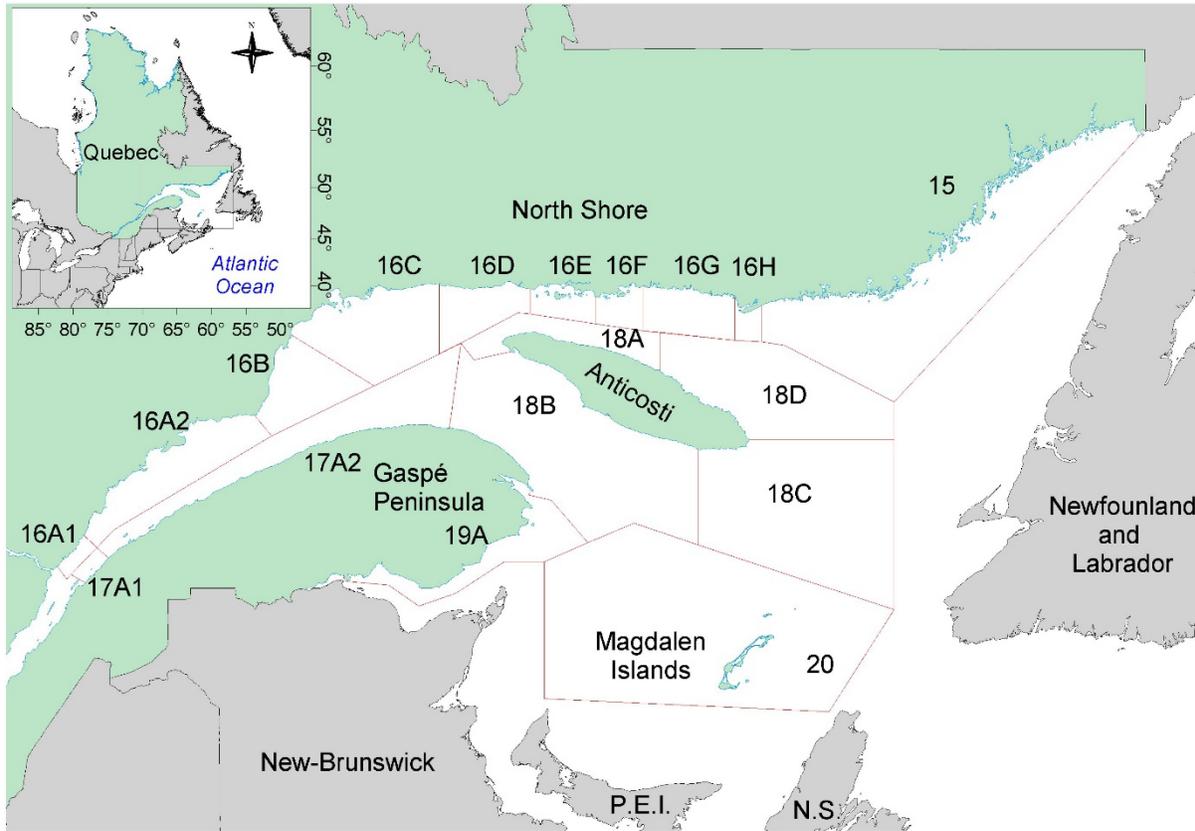


Figure 1. Map of scallop fishing areas in Quebec.

ANALYSIS AND RESPONSE

Model data

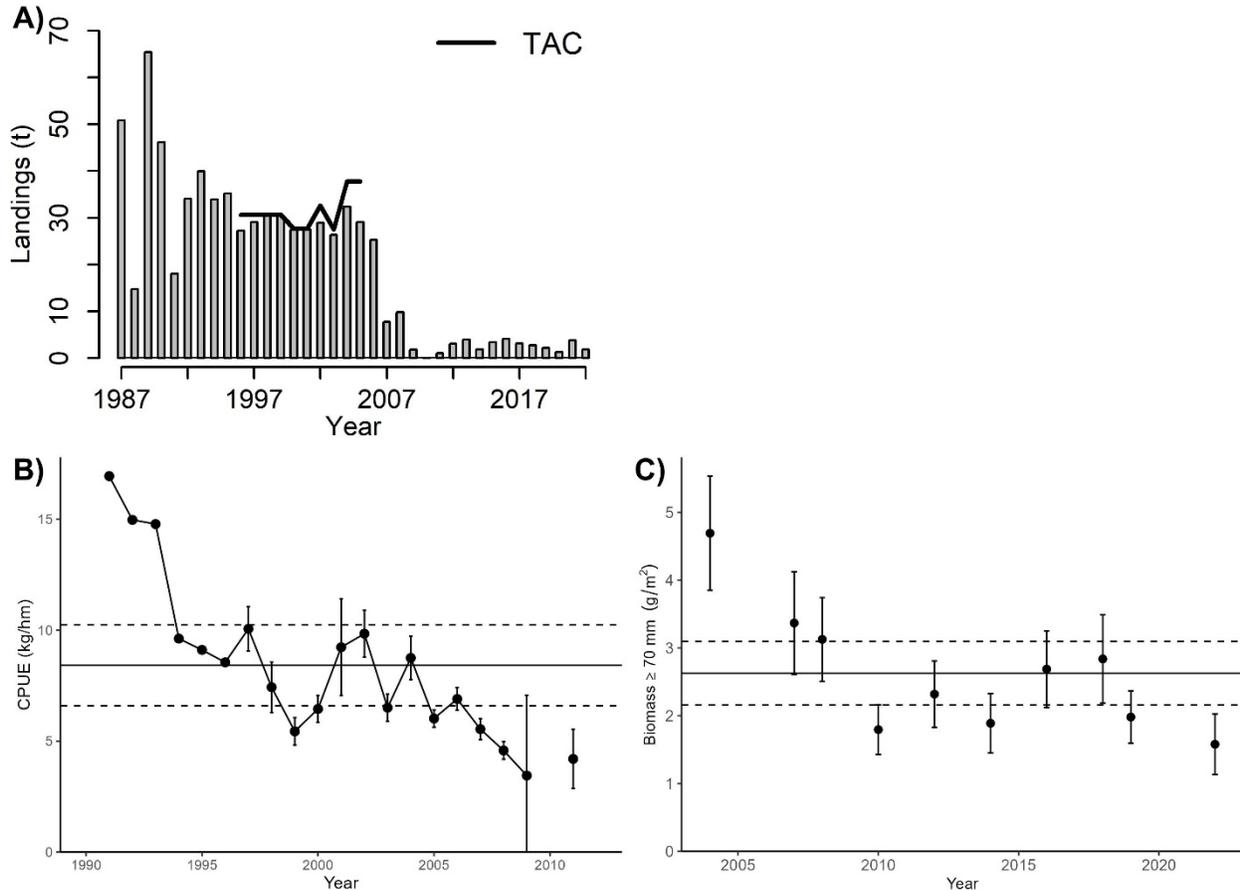


Figure 2. Indices used in the SPM for scallop in Area 16F. (A) Scallop landings (t of meat) for all of Area 16F along Quebec’s North Shore. The solid black line represents the total allowable catch (TAC). (B) CPUE measured in at-sea sampling from 1991 to 2011 (kg/hm). The vertical lines represent the confidence intervals. (C) Iceland scallop biomass index (g/m^2) (≥ 70 mm) from the DFO research survey from 2004 to 2022 for stations whose data were selected for use in the SPM. In (B) and (C), the vertical lines represent the standard error; the solid horizontal line, the mean for all years; and the dotted lines, $\pm \frac{1}{2}$ standard deviation.

The biomass indices are based on two separate data sources: the Iceland scallop biomass index from the DFO research survey that has been conducted annually or biannually in May-June since 2004 and the at-sea catch per unit effort (CPUE) from a collaboration with harvesters and the DFO dockside commercial catch sampling program that ran from 1991 to 2011. These two indices are used in the population assessment model. For the DFO research survey abundance index, stations with very low biomass values ($< 0.1 \text{ g/m}^2$) over the entire time series (stations B1, B4, C3, C9, C16 and D2) were excluded because they were considered unrepresentative of Iceland scallop habitat. In addition, since there was no fishery in 2010, a placeholder value of 1 kg was added for landings in that year because the model cannot handle gaps in the landings data.

The at-sea CPUE fell sharply between 1991 and 2011 (Figure 2B). The biomass index from the DFO research survey also displayed the same downward trend between 2004 and 2010, and then varied with no clear trend from 2012 to 2022 (Figure 2C).

Considerations regarding the model's prior distributions

Prior distributions, process and observation error variance, and intrinsic rate of increase (r) and biomass index catchability coefficient (q) priors are the same as those used in the Bayesian SPM for Area 16E, as described in Belley et al. (in press). However, the following adjustments were made to the SPM model for Iceland scallop stock biomass in Area 16F compared with the model used for Area 16E (Belley et al. in press):

- Since the initial carrying capacity (K) for the stock is unknown, the prior distribution for K is uniform, with ranges of minimum and maximum values between 100 and 1,200 t for the stock, which are uninformative.
- Because of the greater distance between the main wharf in the region and the scallop bed—and the presumably less intensive fishing effort directed at the stock in Area 16F than that in Area 16E—it was assumed that the biomass of the Iceland scallop stock in Area 16F was in better condition than that in Area 16E, relative to its carrying capacity at the beginning of the series in 1987 (B_1/K). Consequently, we have determined that the B_1/K for the stock is described by a log-normal distribution with a mean value of 0.8 and a coefficient of variation of 0.5.

Results

For the Iceland scallop stock in Area 16F, the model estimates the initial unfished carrying capacity (K) at 751.37 t, the ratio of the biomass at the beginning of the time series in 1987 to the carrying capacity (B_1/K) at 0.69 and the intrinsic rate of natural increase (r) of the population at 0.08. The SPM estimates the biomass at maximum sustainable yield (B_{MSY}) at 375.69 t, or $0.5 \cdot K$. These estimates are based on the assumption that environmental conditions have remained stable since 1987. All model diagnostics and sensitivity analyses described in Belley et al. (in press) were performed and the results were deemed reasonable for the proper functioning of the SPM (results not shown here).

Since 1987, the first year for which fishery data are available, the Iceland scallop stock biomass estimated by the SPM shows a gradual and steady decline (Figure 3A). In 2022, the stock's biomass was estimated at 86.32 t, with a B/B_{MSY} ratio of 0.23 (Figure 3B). This value places the Iceland scallop stock in Area 16F below the LRP (B/B_{MSY} of 0.4), and indicates that it is in the critical zone of the precautionary approach.

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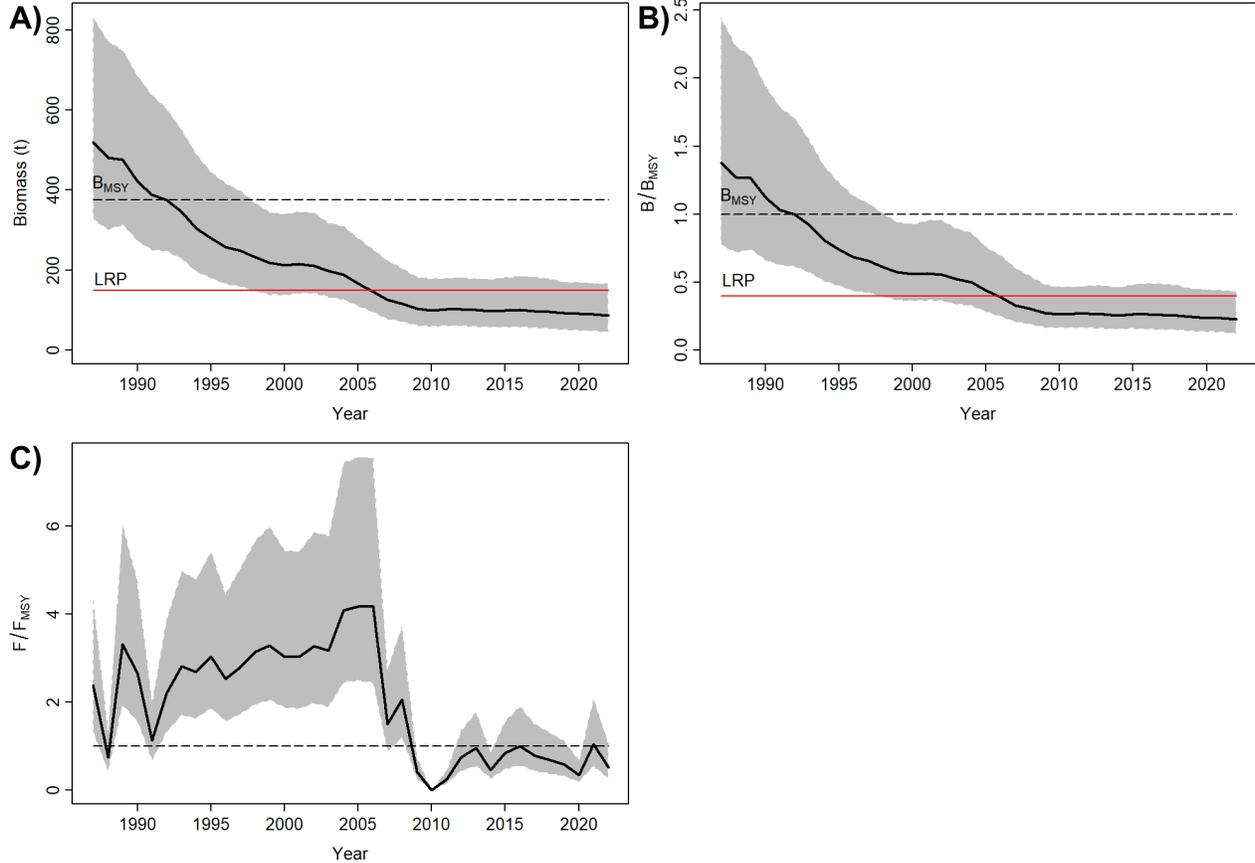


Figure 3. (A) Estimated biomass (in t); (B) ratio of estimated biomass to biomass at maximum sustainable yield (B/B_{MSY}); and (C) ratio of instantaneous fishing mortality to fishing mortality at maximum sustainable yield (F/F_{MSY}) for the Iceland scallop stock in Area 16F. The grey area represents the 95% confidence interval. The solid red line represents the limit reference point (LRP). The dotted line in (A) and (B) represents biomass at maximum sustainable yield (B_{MSY}) and, in (C), fishing mortality at maximum sustainable yield (F_{MSY}).

The SPM suggests that, between 1987 and 2008, the Iceland scallop stock in Area 16F was generally exploited at a level above the threshold for fishing at maximum sustainable yield (F/F_{MSY}). However, since 2009, the SPM suggests that the removal level has been close to or below this threshold (Figure 3C).

CONCLUSIONS

According to the SPM, the Iceland scallop stock in Area 16F has been below the LRP (B/B_{MSY} value of 0.4) since 2006, placing it in the critical zone. The stock's biomass in 2022 was estimated at 86.32 t, or a B/B_{MSY} value of 0.23. These results suggest that a rebuilding plan is needed to help rebuild the stock above the LRP, in accordance with the precautionary approach. The implementation of appropriate management measures is therefore crucial to restoring the sustainability of the stock.

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SOURCES OF INFORMATION

- Belley, R., Sean, A.-S., and Bermingham, T. In press. Determination of a Limit Reference Point for Iceland Scallop in Area 16E. DFO Can. Sci. Advis. Sec. Res. Doc.
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