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Newfoundland and Labrador Region

Canadian Science Advisory Secretariat
Science Advisory Report 2025/015

ASSESSMENT OF ICELAND SCALLOP IN THE CANADA-FRANCE TRANSBOUNDARY ZONE OF ST. PIERRE BANK (NAFO SUBDIVISION 3Ps)

*Image. Iceland Scallop (*Chlamys islandica*).*

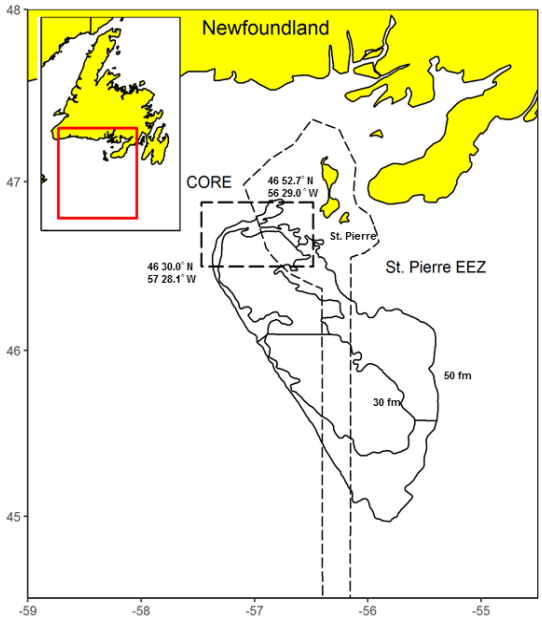

Figure 1. Northern St. Pierre Bank showing the Canada-France Transboundary (CORE) Zone.

CONTEXT

The directed fishery for Iceland Scallops (*Chlamys islandica*) started on St. Pierre Bank in 1989. Populations off Newfoundland and Labrador are normally found in waters from 50-200 m, usually on hard bottom with variable substrate composition, consisting largely of sand, gravel, shell fragments, and stones.

Prior to 1996, the entire catch was taken by Canada. A decision by an International Court of Arbitration in 1992 resulted in jurisdictional changes over the disputed waters south of Newfoundland and St. Pierre and Miquelon (territory of France). Following that decision, an annual total allowable catch (TAC) level has been established for an area called the "Transboundary Zone" or simply the "CORE". Joint TACs have been in place for the CORE since 1995. France and Canada are allocated a fixed percentage of the TAC: 70% and 30%, respectively.

This Science Advisory Report is from the February 23, 2024, regional peer review meeting on the Assessment of Iceland Scallop in the Canada France Transboundary Zone of St. Pierre

Bank (NAFO subdivision 3Ps). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Marine ecosystem conditions indicated overall limited productivity of the fish and shellfish community in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps. The ecosystem has undergone structural changes, with increased dominance of warm water species starting in 2010. In recent years (2019–22), ecosystem indicators have suggested that conditions could be improving.
- Sea surface temperature in 2023 in NAFO Subdivision 3Ps was at the second warmest level on record (2022 being the record). Bottom temperatures were back to normal after being at record-warm levels in 2021 and 2022. This warmer climate corresponded with improved conditions observed at the lower trophic levels, including increased concentrations of chlorophyll-a, earlier spring blooms, and increased zooplankton abundance and biomass.
- Directed fishing started in 1989 and peaked at 6,000 t in 1992. There was no directed fishing activity between 1997 to 2016, and there has been minimal fishing activity since 2017. Since 2018, the total allowable catch (TAC) has been 990 t (for the CORE area).
- In 2023, the minimum dredgeable biomass index was among the lowest in the survey time series, a 45% decrease since the last survey in 2017 and is 8% of the average in the early-1990s.
- The number of scallop meats per 500 g (i.e., average meat count) remains near the survey timeseries high, which indicates smaller-sized scallop meats.
- Natural mortality has sharply increased since the last survey in 2017, but remains far below the survey timeseries high. Biomass of predatory sea stars generally corresponds with natural mortality levels.

BACKGROUND

Biology

Iceland Scallop (*Chlamys islandica*) is widely distributed within the subarctic, but is also found in fishable aggregations as far south as the coast of Massachusetts, United States. Populations off Newfoundland and Labrador (NL) are usually found at depths of 50–200 m, predominantly on hard substrates, consisting largely of sand, gravel, shell fragments, and stones (DFO 2001, Naidu et al. 1983). Iceland Scallop is a filter-feeder, consuming plankton and detritus, and is associated with areas of strong currents. To reside in such areas, the scallop attach to the substrate by a byssal thread (strong, silky fibers that are made from proteins that are used by bivalves to attach to rocks, pilings or other substrates).

Iceland Scallop are dioecious (having separate sexes), become sexually mature at 3–6 years of age, and fully recruit to the commercial fishery at 60 mm shell height (about age 9). Spawning in NL waters begins in April-May and is thought to be initiated by short-term variation in temperature. Eggs are externally fertilized and larvae are planktonic for as long as 10 weeks before settling to the bottom, possibly at considerable distances from the spawning adults. Iceland Scallop frequently live more than 25 years, but seldom exceed 100 mm in shell height (DFO 2010).

Fishery

Directed fishing for Iceland Scallop started in 1989 and peaked at approximately 6,000 t in 1992 (Table 1). Prior to 1996, the entire catch was taken by Canada. In 1992, a decision by an International Court of Arbitration resulted in jurisdictional changes over the disputed waters to the south of Newfoundland and St. Pierre and Miquelon. Following the decision, an annual TAC was established for an area called the “Trans-boundary Zone” or simply the “CORE” (Figure 1). France and Canada are allocated fixed percentages of the TAC at 70% and 30%, respectively. Joint TACs were first established for the CORE in 1995 at 2,800 t (840 t in Canada). However, less than 10% of the TAC was taken in each year from 1995 to 1997. There was no fishing between 1997 and 2015, as well as between 2020 to 2021, with minimal fishing activity by Canadian vessels in the CORE area from 2016 to 2019 and 2022 to 2023 (Table 1). A TAC of 100 t (30 t in Canada) was allocated in 1999–2000, increased to 400 t (120 t in Canada) in 2001, increased to 1,650 t (495 t in Canada) in 2006, and then decreased by 40% to 990 t (297 t in Canada) in 2018.

Table 1. Total allowable catch (TAC) and removals in tonnes (t). (-) indicates estimate is not available for this year. (*) indicates that fishing activity took place, although landings are not included in this report for confidentiality reasons (due to Government of Canada’s Rule of Five Policy).

Year	TAC (t)	Removals (t)
1989	-	36
1990	-	507
1991	-	755
1992	-	5,967
1993	-	0
1994	-	0
1995	2,800	230
1996	3,250	306
1997	2,100	122
1998	630	0
1999	100	0
2000	100	0
2001-2005	400	0
2006-2015	1,650	0
2016-2017	1,650	**
2018-2019	990	**
2020-2021	990	0
2022-2023	990	**

ASSESSMENT

Research Surveys

Canadian resource assessment surveys were conducted from 1990–93, 1996, 1998, 2005 (a joint Canada-France research survey) , 2009, 2017, and 2023 using a stratified random

sampling scheme. Stratification was based on area and depth. Sets were optimally allocated in proportion to stratum-specific areas and variance of the catch rates.

The survey area was reduced in 1991 and the strata were redrawn to focus on aggregations of scallops in the north. Strata were redrawn again in 1993 to accommodate the new Canada-France boundary resulting from the decision by the International Court of Arbitration. All subsequent surveys have used this stratification scheme (Figure 2).

A 12-ft New Bedford scallop dredge equipped with 3” rings and interconnected with 3-top and 4-bottom link configuration was used in the surveys from 1990 to 1998. Since 2005, an 8-ft dredge has been used with the same ring and link configuration. Standard tow length was 1.0 nm with the 12-ft dredge and 0.5 nm with the 8-ft dredge. Towing speed was approximately 3 knots with a warp (wire length) to depth ratio of 3:1. For the Canadian resource assessment surveys, all catch results were standardized to an 8-ft dredge swept area so the results were comparable throughout the survey time series. Upon completion of each tow (set), dead scallops with non-disarticulated valves (“cluckers”) and live scallops, as well as sea stars, were sorted by species for all surveys. Total catches were enumerated and weighed by species.

Shell height of scallops was determined from each set based on either the total catch or a sub-sample. Meat yield and count samples (number of meats per 500 g) were collected during all Canadian surveys from most or all strata. Strata 11 and 22 were sampled all years except for in 2017, when stratum 11 was not sampled.

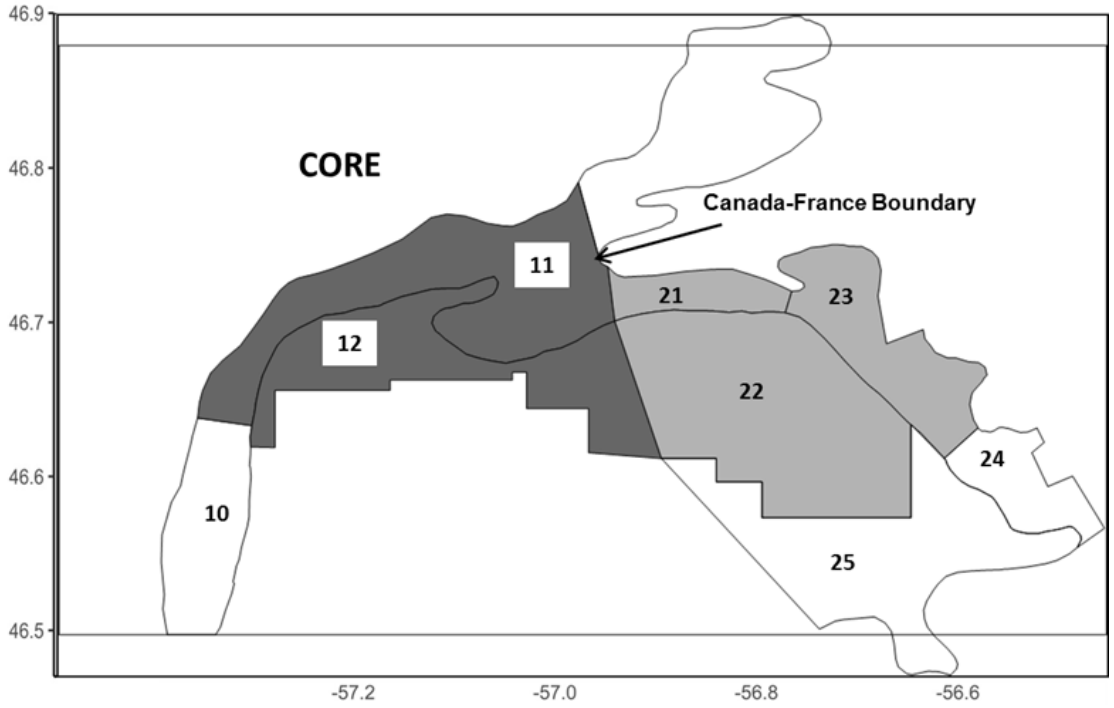

Figure 2. Northern St. Pierre Bank showing the main “commercial” strata (shaded) for Iceland Scallop.

Biomass and Abundance

In previous Iceland Scallop assessments, Stratified Analysis Program (STRAP) (Smith and Somerton 1981) and/or Ogive Mapping (Ogmap) (Evans 2000) were used to calculate Iceland Scallop minimum dredgeable biomass (MDB) and abundance indices (Coughlan et al. 2021), with STRAP also used to determine MDB for sea star species in the CORE area.

The spatial coverage of the Canadian resource assessment surveys has been inconsistent through time. For example, since 1993 stratum 10 was only sampled 5 out of 7 years. In the last Iceland Scallop assessment (i.e., 2018), STRAP and Ogmap biomass estimates were calculated within the CORE area of interest for each year with available data, even though different strata were sampled throughout the time series (see: Table 3 and 4 in Coughlan et al. [2021] for details). To alleviate issues related to inconsistent survey coverage and to improve current and future biomass estimation methodologies, a spatiotemporal model was developed to predict consistent and reliable biomass and abundance indices for Iceland Scallop.

The spatiotemporal models were created for years with available Canadian resource assessment survey data using the R software package '*sdmTMB'* (Anderson et al. 2022). Model-derived MDB estimates were compared with the biomass and abundance estimates derived from STRAP and Ogmap. The model-derived MDB index was comparable to those estimated using STRAP and Ogmap for the main commercial strata and where data were consistently available throughout the survey time series (strata 11–12; 21–23) (Figure 3, Table 2), particularly in most recent years. In survey years from 1990 to 1998, the model-derived MDB estimates were larger than the MDB estimates derived from both STRAP and Ogmap. However, the confidence intervals always overlapped, with the exception of 1993, and the general trend in the time series remained consistent between the methods.

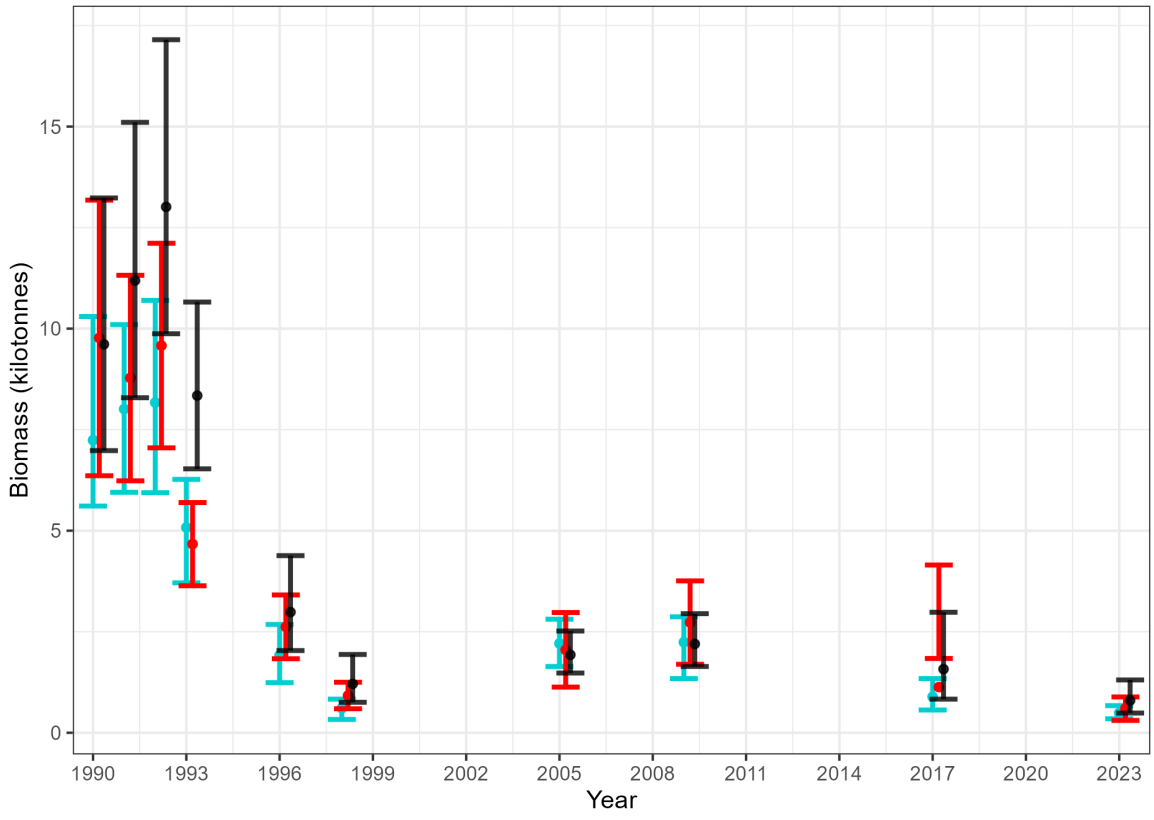

Figure 3. Comparison of model-derived (black), STRAP-derived (red), and Ogmap-derived (turquoise) MDB (in kilotonnes (kt)) estimates of Iceland Scallop in consistently sampled and main commercial strata (11–12, 21–23) with 95% confidence intervals. This data source is based on Canadian resource assessment surveys that took place from 1990 to 2023.

Table 2. Minimum dredgeable biomass (MDB) estimates derived from spatiotemporal model for all strata in the CORE area of St. Pierre Bank (NAFO Subdivision 3Ps) (including strata 10, 11, 12, 21, 22, 23, 24, and 25) and main commercial strata (based on Canadian resource assessment survey data, including joint Canada- France survey in 2005) with 95% confidence intervals (CI).

Year	CORE Area (Strata 10–12; 21–25)			Main Commercial Strata (Strata 11–12; 21–23)			
	MDB-Biomass Estimate (1000s, t)	CI_ Low	CI_ Upper	MDB-Biomass Estimate (1000s, t)	CI_ Low	CI_ Upper	Commercial Strata of Total MDB (%)
1990	10.53	7.75	14.31	9.61	6.98	13.23	91
1991	12.83	9.41	17.51	11.19	8.29	15.10	87
1992	14.93	11.31	19.69	13.01	9.87	17.15	87
1993	10.26	7.99	13.18	8.34	6.53	10.66	81
1996	3.20	2.21	4.63	2.99	2.03	4.38	93
1998	1.33	0.84	2.10	1.21	0.75	1.94	91
2005	2.20	1.69	2.85	1.93	1.48	2.52	88
2009	2.45	1.84	3.25	2.20	1.64	2.95	90
2017	1.84	1.02	3.30	1.57	0.83	2.98	86
2023	1.00	0.64	1.57	0.80	0.49	1.31	80

The 2023 model-derived MDB estimate of 1,000 t for the total CORE area (including strata 10–12, 21–25) is among the lowest in the survey time series and reveals a decrease of approximately 45% from 1,800 t in 2017 (Table 2, Figure 4). This decrease was driven by a drop in MDB estimates in both the Canadian and French zones, with a 45-50% decrease since 2017 (Figures 4). Throughout the survey time series, the MDB was highest in the early-1990s and decreased to a low of 1300 t in 1998 and then increased in 2005 and 2009, due mainly to an increase in MDB in the Canadian zone (Table 2, Figure 4). The main commercial strata (11–12, 21–23) (Table 2, Figure 3) account for 80–90% of the entire Iceland Scallop MDB in the CORE area. The MDB in the main commercial strata declined from 1,570 t in 2017 to 800 t in 2023 (Table 2, Figure 3).

The abundance trends throughout the survey time series are similar to MDB trends, with the highest numbers in the early-1990s, a decrease in 1998, and then an increase in 2005 and 2009. Since then the abundance of Iceland Scallop has declined to the lowest level in the survey time series in 2023. This decrease is driven by a decline in abundance in both the Canadian and French zones, with a decrease of 45% since 2017.

The meat count based on the Canadian surveys increased from 68 meats per 500 g in 2009 to 85 meats per 500 g in 2017 and then decreased to 75 meats per 500 g in 2023 (Figure 5). The slight decrease in the meat count in 2023 compared to 2017 indicates little change in the meat yield, with little change in scallop size in the designated areas.

The abundance at length (shell height) in the length frequency distributions display the size structure for the strata combined within the Canadian (strata 10–12) and French (strata 22–25) zones (Figure 5). The size of scallop in the Canadian zone showed little apparent change, with a mean shell height consistently close to 80 mm throughout the survey time series. Scallop in the Canadian zone were larger than scallop observed in the French zone, where the mean shell height was close to 70 mm in 2017 and 2023 (Figure 5).

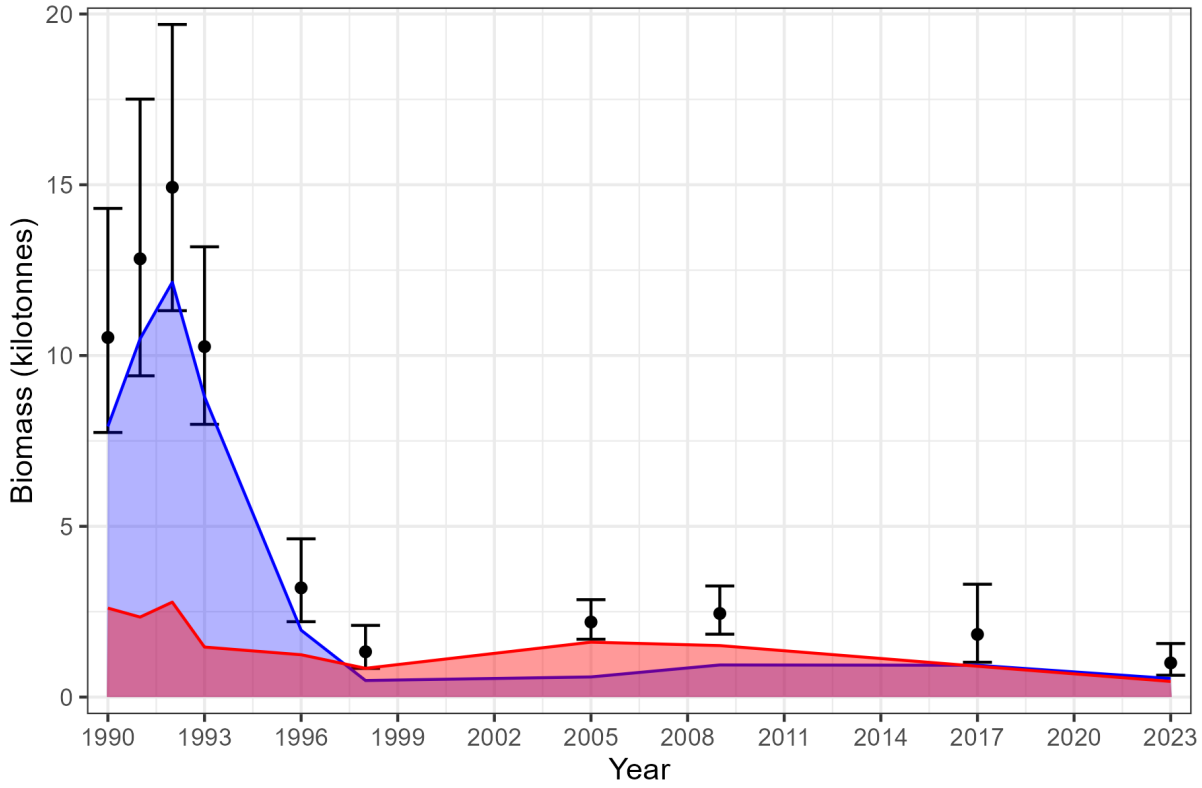

Figure 4. Model-derived Iceland Scallop MDB (in kilotonnes) indices in the CORE area (strata 10-12, 21- 25). Points represent predicted biomass estimates for the whole area strata and bars represent 95% confidence limits around those estimates. The blue shaded area represents biomass estimates in French waters (strata 21-25) and the red shaded area represents biomass estimates in Canadian waters (strata 10-12). Although the shaded areas are filled throughout the time series, there are no biomass estimates in non-surveyed years (e.g.,1999-2004).

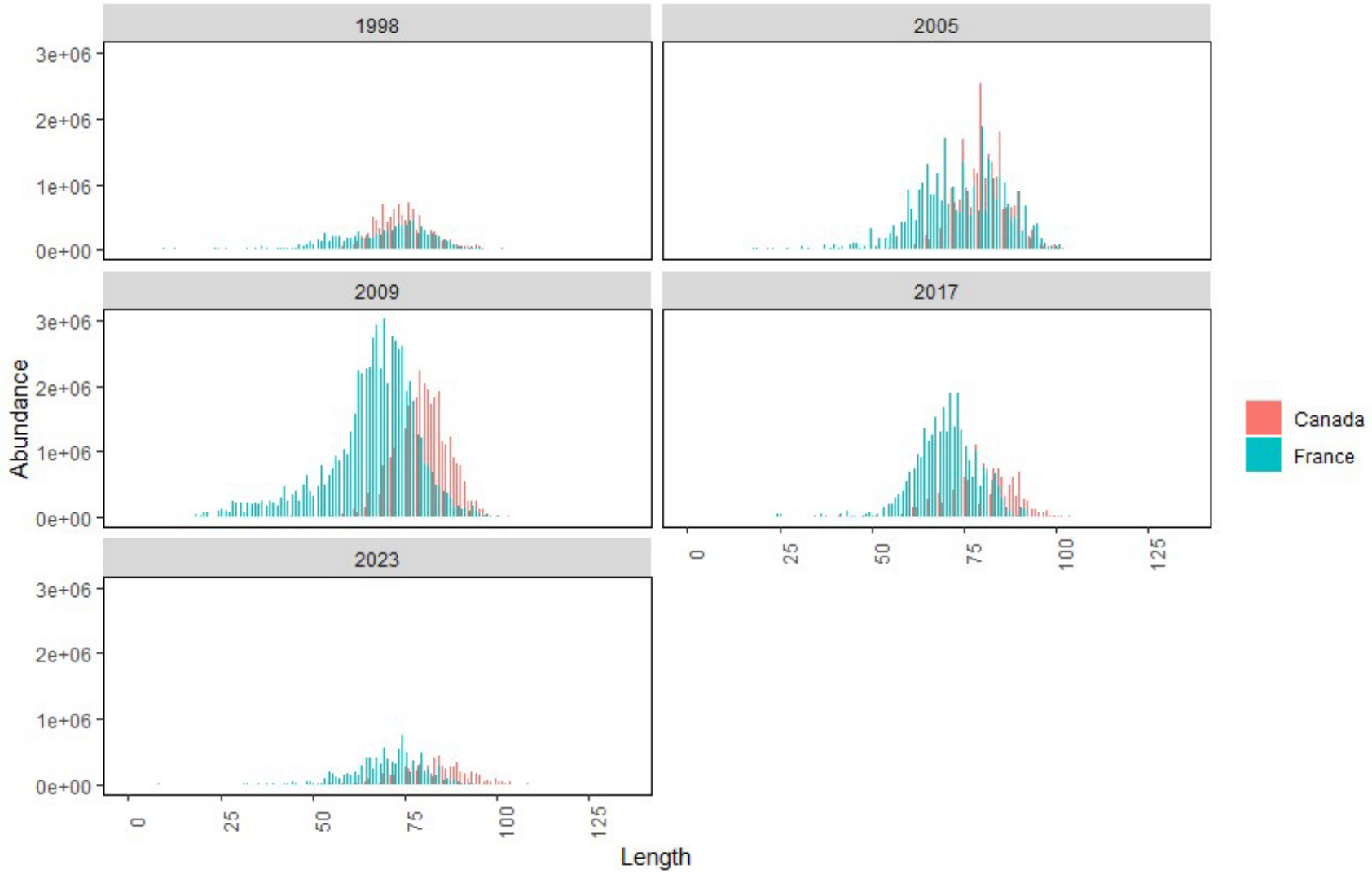

Figure 5. Abundance at length (shell height) in 1998, 2005, 2009, 2017, and 2023 in Canadian (strata 10–12) and French (strata 21–25) zones in the CORE area of St. Pierre Bank (NAFO Subdivision 3Ps).

MORTALITY

The overall natural mortality index, computed as the proportion of cluckers to live scallops (Naidu 1988), gradually increased between 1992 and 1996 from 0.19 to 0.52 and then peaked at a high of 0.88 in 1998 (Figure 6). Since then, the mortality index has decreased to 0.12 and 0.07 in 2009 and 2017, respectively, and then increased to 0.18 in 2023. This increase in natural mortality is likely associated with the MDB of predatory sea stars (Figure 6).

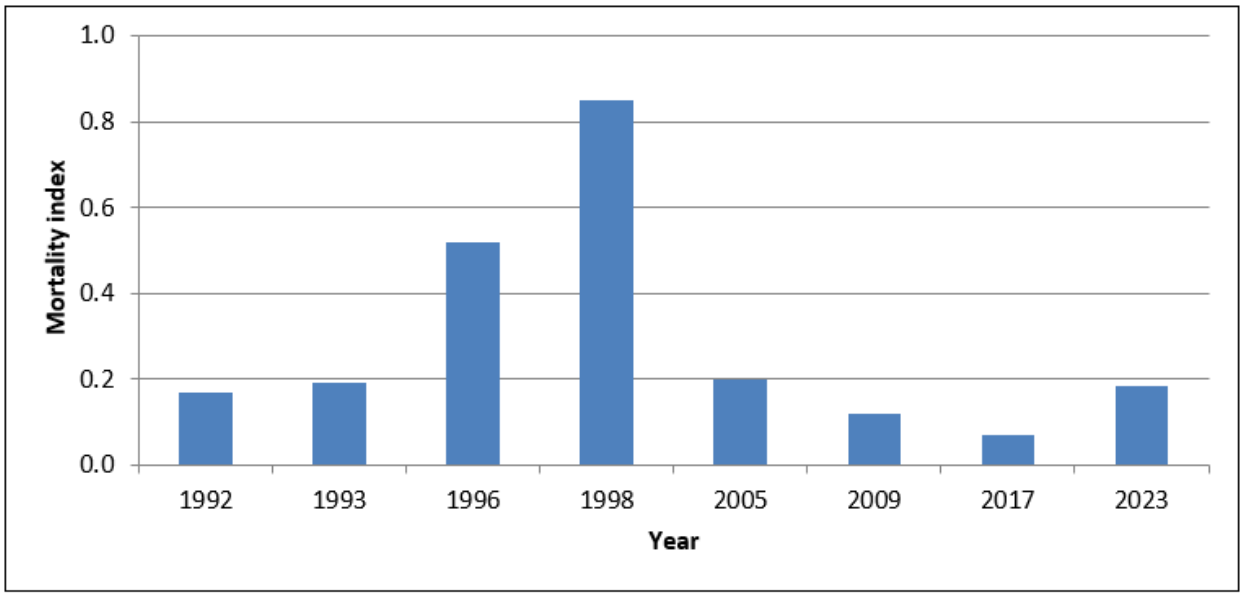

Figure 6. Mortality index for Iceland Scallop in the Canada-France Transboundary (CORE) Area of St. Pierre Bank (NAFO Subdivision 3Ps) based on Canadian resource assessment surveys that took place from 1992 to 2023.

PREDATION

In the early to mid-1990s, a high abundance of predatory sea stars contributed to significant mortality in Iceland Scallop in the CORE Area (Lawrence et al. 1997; Naidu et al. 2001). Biomass of all sea star species increased to a high of 1,600 t (MDB) in 1998, when Iceland Scallop biomass was at its lowest (Figure 7). In the CORE Area, biomass of the main predatory sea star species (*Leptasterias polaris*, *Crossaster papposus, and Solaster endeca)* increased from 1993 to 1998, then decreased to the lowest level in the survey time series in 2017 to 315 t, and since has increased by more than 50% to 686 t in 2023.

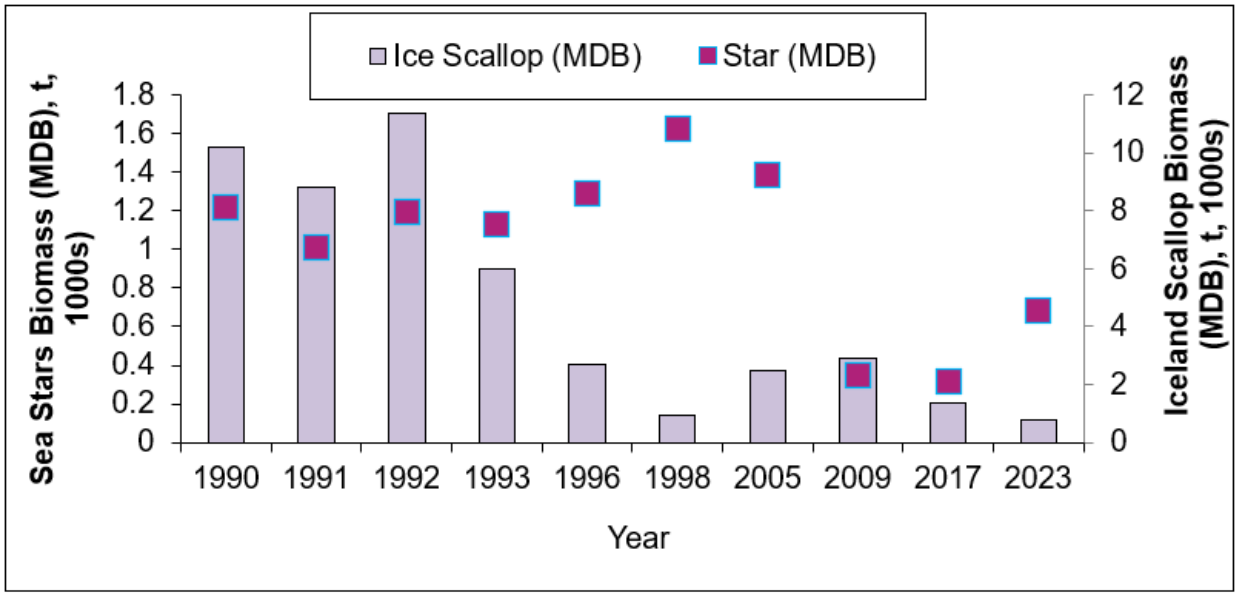

Figure 7. Iceland Scallop and sea star minimum dredgeable biomass (MDB) estimates based on Canadian resource assessment surveys that took place in the CORE area of St. Pierre Bank (NAFO subdivision 3Ps) (in strata 10,11,12,21,22,23,24, and 25) from 1990 to 2023. Both MDB estimates in this figure are derived from STRAP analysis.

Sources of Uncertainty

Resource assessment surveys of this stock have occurred sporadically throughout the time series since the early-1990s. The lack of consistent surveys can result in important changes in population dynamics being easily missed.

ECOSYSTEM CONSIDERATIONS

Marine ecosystem conditions indicated overall limited productivity of the fish and shellfish community in NAFO Subdivision 3Ps. The ecosystem has undergone structural changes with increased dominance of warm water species starting in 2010. In recent years (i.e., 2019–22), ecosystem indicators have suggested that conditions could be improving.

Sea surface temperature in 2023 in NAFO Subdivision 3Ps was at the second warmest level on record (2022 being the record). Bottom temperatures were back to normal after being at record-warm levels in 2021 and 2022. This warmer climate corresponded with improved conditions observed at the lower trophic levels, including increased concentrations of chlorophyll-a, earlier spring blooms, and increased zooplankton abundance and biomass.

CONCLUSION

The 2023 MDB estimate of 1,000 t is among the lowest in the survey time series, exhibiting a decrease of approximately 45% since 2017. The number of scallop meats per 500 g (i.e., average meat count) remains near the survey timeseries high, which indicates smaller-sized scallop meats. Natural mortality has sharply increased since the last survey in 2017, but remains far below the survey time series high. Biomass of predatory sea stars generally corresponds with natural mortality levels. Currently, there are no established reference

points by which to determine stock status in relation to a Precautionary Approach (PA) Framework.

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SOURCES OF INFORMATION

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