Capelin

Mallotus villosus

Canada: Northwest Atlantic

Purse seines, seine nets, barriers, fences, weirs, corrals, etc.; Stationary uncovered pound nets

Report ID 27973

December 2, 2024

Seafood Watch Standard used in this assessment: Fisheries Standard v4

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they’re caught or farmed in ways that harm other marine life or the environment.

[1] “Fish” is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

The following Seafood Watch report provides recommendations for two domestic fisheries of capelin (*Mallotus villosus*) caught in the Estuary and Gulf of St. Lawrence (both regions hereby known as "Gulf") and the North Atlantic Ocean by Canadian fishing vessels.

Capelin is a small pelagic schooling finfish species with major populations occurring in the Northwest Atlantic Ocean, in waters around Iceland, in the Barents Sea, and in the Northern Pacific Ocean. Several reports by the Canadian Department of Fisheries and Oceans (DFO) and academics indicate that five biologically distinct capelin stocks exist in the Northwest Atlantic Fisheries Organization (NAFO) areas: 2J3KL (Eastern Newfoundland and Labrador, which exists as a stock complex that frequently mixes), 3Ps (St. Pierre Bank), 4RST (Gulf of St. Lawrence), 4W (Scotia Shelf), and 3NO (Southeast Shoal, which is a straddling stock that is internationally managed). This report will focus on the two domestic management units residing in the NAFO areas 4RST (Gulf) and 2J3KLPs (2+3; North Atlantic), respectively. These two fisheries contribute 100% of the Canadian domestic catch. Canadian fishers capture capelin using a variety of methods, including purse seine, other vessels using seine nets (a.k.a. "bar/tuck" seine), trapnets (a.k.a. "pound nets"), and weirs (only used in the St. Lawrence Estuary).

All capelin stocks, throughout this species' range, have a moderate inherent vulnerability to fishing pressure because they are short-lived, have a high fecundity, and mature quickly. DFO conducts an annual directed acoustic trawl survey on the 2J3KL capelin stock, but not on the 4RST stock. Although this survey does not provide an "absolute" stock abundance/biomass or SSB (spawning stock biomass), this index is used in statistical models as an index of 2J3KL capelin biomass (i.e., capelin forecast model; capelin LRP; capcod model; Northern Cod stock assessment model). Total allowable catches (TACs) are applied through a calculated science and management review process. The TAC for the 4RST fishery was set at 10,225 MT for 2022 (8,805 MT for Division 4R and 1,420 for Divisions 4ST), the fixed gear fleet (which includes both the tuck seine and trapnet gear types) quota allocation was 3,867 MT (37.8% of the TAC), and the mobile fleet (purse seine) quota allocation was 4,938 MT (48.3% of the TAC). Landings in 4R accounted for 7,876 MT in 2020. On average, between 2000 and 2020, landings in 4R accounted for 93% of 4RST capelin landings (DFO has a "Rule of Five" policy, where they do not provide landings and catch information for a specific fishery when the fishery has fewer than five fishing enterprises, five fishing vessels, or five buyers participating in a fishery). The TAC for the 2+3 fishery was set at 19,377 MT for 2020, the fixed gear fleet landed 10,122 MT (63% of the TAC), and the mobile fleet landed 5,988 MT (37% of the TAC). There were no catches in NAFO areas 2J and 3Ps. Although there were no catches in several areas, the report is still based on the DFO management units. Landings in both management areas have remained stable over the long term (10 years), which would indicate the sustainability of the resource, except in the Northwest Atlantic, where current abundance indices are only 6% of historical levels, and observations of prey consumption by fish predators, capelin distribution, growth rates, and maturation at age in 2019 are consistent with historical patterns of low capelin abundance. Gulf capelin is scored a "moderate concern" for Criterion 1, and Northwest Atlantic capelin is scored a "high concern."

Both capelin fisheries in 4RST and 2+3 are only authorized to retain the directed species; all other bycatch species are discarded. Most bycatch species are of "high concern" because they are listed as threatened, endangered, or of special concern: Atlantic cod, Atlantic salmon, and marine mammals. Atlantic herring are also caught as bycatch in both fisheries, and the statuses of these stocks are of a high concern because biomass indices specify that they are below the limit reference points. (This applies only to Atlantic herring

stocks in the Gulf. Herring in 2+3 do not have LRPs. It is also important to note that not all herring stocks caught as bycatch are considered to be under the LRP). A 2011 DFO bycatch report for all areas details that the purse seine fleets have a negligible impact on all bycatch species. But there are no bycatch reports for the fixed gear (tuck seine and trapnet) fleets; therefore, a "moderate concern" score was awarded because a moderately effective management regime exists.

The 4RST fishery is comanaged by three regions: Quebec (management office in Quebec City, QC), Gulf (management office in Moncton, NB), and Newfoundland (management office in St. John's, NL). Both fisheries in 4RST and 2+3, within Canada's 200 nm jurisdiction, are assessed by the DFO area offices—in St. John's, NL and Mont-Joli, QC, respectively—through scientific peer review (fisheries-dependent and fisheries-independent surveys) and regional advisory (which includes all stakeholder groups) processes. DFO management then sets TACs, in both 4RST and 2+3, based on the advice gathered from the internal and external review processes. DFO management has a proven track record of following this advice. DFO reports on bycatch for both the mobile and fixed gear fleets in both management areas through the use of at-sea observers; however, observer coverage is low (< 5%). Both fisheries in 4RST and 2+3 are governed by a regulatory framework and are subjected to 100% dockside monitoring, vessel monitoring systems (VMS), hail requirements, logbooks, and fisheries (Conservation and Protection) officers. Consequently, the purse seine fisheries in both areas are well managed, whereas the management regime needs to be improved for the fixed gear fleets in both 4RST and 2+3.

Except during rare occurrences, the purse seine and tuck seine gears do not contact the substrate and consequently do not have a significant impact on benthic habitats and ecosystems. Trapnet gear (weirs and pound nets) does come into contact with the substrate, but it has been scientifically studied that this gear type only affects habitats of low complexity, with minimal impact. There are also moderate mitigation measures (e.g., mesh size restrictions and season closures) in place to further reduce the impacts on ecosystems for this fishery type. Based on these results, Criterion 4.1 is ranked high (green), meaning that all gear types, in all areas, have a low impact on the ecosystem. Capelin is considered a forage species, which is defined in terms of its functional role in providing a critically important route for energy transfer from lower to higher trophic levels in marine ecosystems. DFO provides ecological and food web impact analysis for this exceptional species of importance. But there is insufficient information to determine whether there are appropriate conservative, ecological harvest control rules that are consistent with the Lenfest Forage Fish Task Force Recommendations, and fishing mortality is poorly understood, so the overall rating for Criterion 4 is red.

Capelin caught in the Canadian Northwest Atlantic have a red (Avoid) rating, because it is probable that the capelin stock is depleted and there are management concerns relating to capelin as a forage species. All other Canadian capelin fisheries have a red (Avoid) rating, because of concerns over bycatch of endangered, sensitive, and overfished species, uncertainties regarding capelin abundance, and management concerns relating to capelin as a forage species. Recommendations in this report cover all capelin products, including whole fish, as well as the roe (known as masago).

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Capelin | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.	2.644	1.732	3.000	2.646	**Avoid (2.455)**	Unknown
Capelin | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines	2.644	1.732	3.000	2.828	**Avoid (2.497)**	Unknown
Capelin | Northwest Atlantic | Canada | Purse seines	1.732	2.236	3.000	2.828	**Avoid (2.394)**	Unknown
Capelin | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets	2.644	1.732	3.000	2.828	**Avoid (2.497)**	Unknown
Capelin | Northwest Atlantic | Canada | Seine nets	1.732	2.236	3.000	2.828	**Avoid (2.394)**	Unknown
Capelin | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets	2.644	1.732	3.000	2.646	**Avoid (2.455)**	Unknown
Capelin | Northwest Atlantic | Canada | Stationary uncovered pound nets	1.732	1.732	3.000	2.646	**Avoid (2.209)**	Unknown

Summary

Capelin caught in the Gulf of St. Lawrence and the Northwest Atlantic off Canada receive a red rating because of concerns regarding stock status (Northwest Atlantic), a high concern regarding the management of the species with respect to its role as a forage species in the ecosystems where it is fished, and concerns regarding bycatch in some areas.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern[2], and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

The following Seafood Watch report provides recommendations for two domestic fisheries of capelin (*Mallotus villosus*) caught in the Gulf of St. Lawrence and North Atlantic Ocean by Canadian fishing vessels.

Species Overview

Capelin is a small pelagic schooling finfish species with major populations occurring in the Northwest Atlantic Ocean, in waters around Iceland, in the Barents Sea, and in the Northern Pacific Ocean (Figure 1) (Rose 2005)(DFO 2021c)(DFO 2022a).

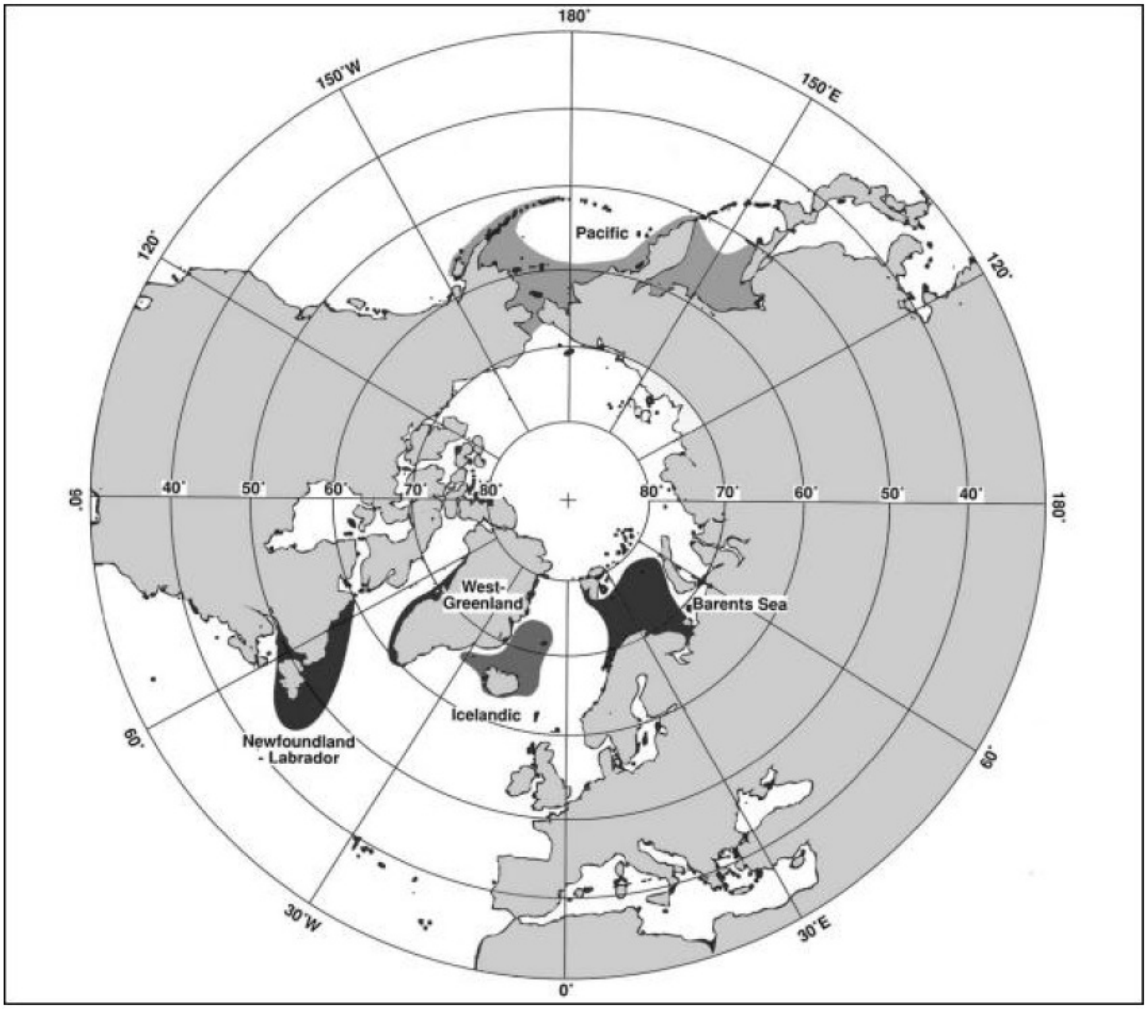

Figure 1: Map of global capelin (*Mallotus villosus*) distribution (Rose 2005).

Several reports by the Canadian Department of Fisheries and Oceans (DFO) and academics indicate that five biologically distinct capelin stocks exist in the Northwest Atlantic Fisheries Organization (NAFO) areas:

2J3KL (Eastern Newfoundland and Labrador; stock complex), 3Ps (St. Pierre Bank), 4RST (the Estuary and Gulf of St. Lawrence), 4W (Scotia Shelf), and 3NO (Southeast Shoal; straddling stock that is internationally managed) (Figure 2) (DFO 2021c)(DFO 2022a).

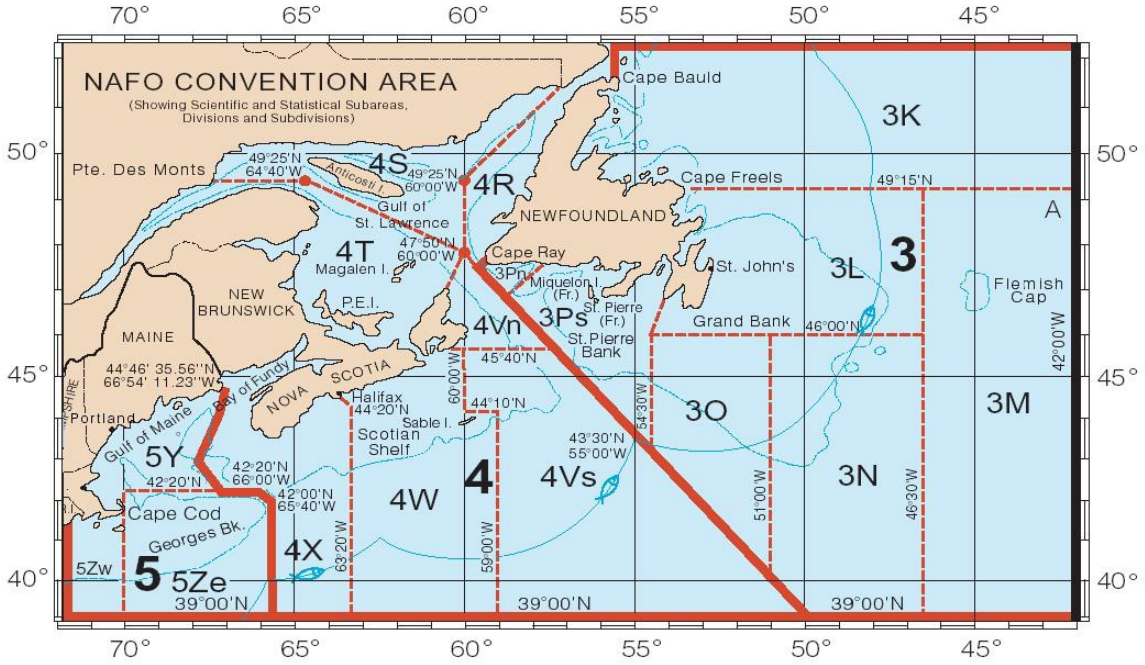

Figure 2: Canadian capelin Northwest Atlantic fisheries subareas and NAFO divisions (DFO 2021c).

This report will focus on the two domestic management units residing in the NAFO areas 4RST (Gulf) and 2J3KLPs (North Atlantic), respectively (Figure 3). These two fisheries contribute 100% of the Canadian domestic catch. Canadian fishers capture capelin using a variety of methods, including purse seine, other vessels using seine nets (a.k.a. “bar/tuck” seine), trapnets (a.k.a. “pound net”), and weirs (only used in the St. Lawrence Estuary) (DFO 2021c)(DFO 2022a).

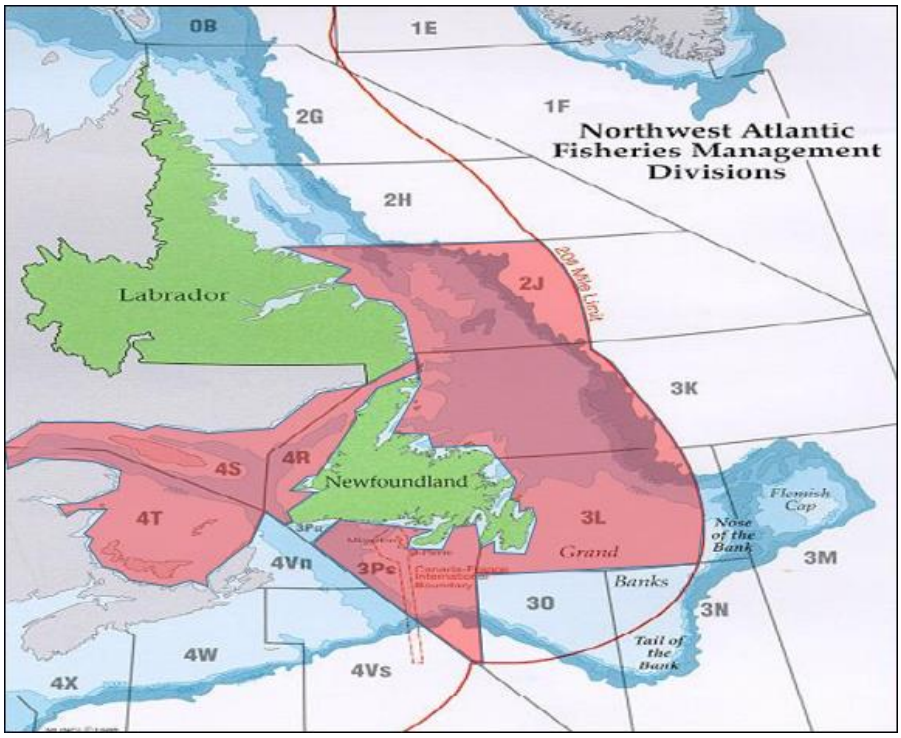

Figure 3: Northwest Atlantic Fisheries Organization (NAFO) areas map. 4RST and 2J3KLPs (2+3) capelin fisheries management areas are highlighted in red (DFO 2022a).

Capelin, part of the Osmeridae (smelt) family, ranges from a metallic blue to green, yellow-green, or brassy brown color, and has an elongated body (DFO 2021d)(DFO 2022a). Capelin overwinters in offshore waters, move shoreward in early spring to spawn on coastal beaches in spring–summer, and returns to offshore waters in autumn (DFO 2019b). Capelin is sexually dimorphic (males are larger than females) and range in size from 12 to 23 cm (DFO 2019b). Spawning essentially occurs at water temperatures of 2–12 °C and is more predominant at night (Carscadden et al. 1989)(Penton et al. 2013). Capelin can spawn at 2 years of age, and there is high mortality of mature fish, particularly males, after beach spawning (DFO 2021d)(DFO 2022a).

There are five biologically distinct stock complexes residing in NAFO subdivisions 2J3KL (Eastern NL), 3Ps (St. Pierre Bank), 4RST (Gulf of St. Lawrence), 3NO (Southeast Shoal), and 4W (Scotian Shelf) (DFO 2021d) (DFO 2022a). But there has been no commercial fishery in 4W, and the 3NO international straddling stock is managed by NAFO, so these stocks have been removed from the Canadian domestic commercial capelin assessments and integrated fisheries management plans (IFMPs). Consequently, DFO manages the domestic capelin fisheries in the North Atlantic via two separate management units: NAFO area 4RST (Gulf Region) and 2J3KLPs (Eastern Newfoundland Region).

The 4RST fishery is comanaged by three regions: Quebec (management office in Quebec City, QC), Gulf (management office in Moncton, NB), and Newfoundland (management office in St. John's, NL and assessed by DFO in Mont-Joli, QC; the 2J3KLPs (2+3) fishery is managed and assessed by DFO in St. John's, NL, based on the adjacency of the offices to the management units. These two offices manage and assess the

units independently of one another. DFO offices in Moncton, NB, Quebec, QC, and Corner Brook, NL support science and management operations for these fisheries. The 4RST and 2J3KLPs fisheries represent 100% of the Canadian domestic catch. Both fisheries are managed using an Integrated Fisheries Management Plan (IFMP) process that evaluates multiple parameters: ecological (e.g., capelin biology, life history, limited population dynamics, landings and predator/prey relationships), socioeconomic (e.g., landings and ex-vessel value, local and export market trends, and economic dependency), and governance (e.g., monitoring, compliance, enforcement, regulatory framework, and stakeholder consultation). The IFMP process also involves a regional advisory process (RAP) in which there is a thorough scientific review and there are public consultations with key stakeholder groups (harvesters, processors, and aboriginal groups) (see Criterion 3 for a full explanation of the IFMP process) (DFO 2021d).

Capelin fishing seasons are generally short and correspond to the prespawning period for the seine fisheries (purse and tuck) and to the spawning period for the trapnet fisheries. The seine and trapnet fisheries mainly target mature females for the Japanese roe market. Historical records show that small domestic fisheries (for both the 4RST and 2J3KLPs management units) existed for spawning capelin (on beaches) in the 1960s, which provided food, bait, and fertilizer for local residents. The emergence and prominence of the Japanese roe market, throughout the late 1970s and early 1980s (there was an offshore capelin fishery in 2+3KL in August–December, from 1972 to 1992), is responsible for sharp increases in landings within both fisheries. The inshore fishery (which started in 1978) can be categorized as cyclical and highly dependent on global market and processor demand. As of 2020, the most recent IFMP states that there are 278 fixed gear (trapnet/pound net and/or weir) and 37 mobile gear (seine; both purse and tuck) licenses in 4RST (DFO 2021c). Within the same management year, the 2J3KLPs fishery had 1,409 fixed gear and 230 mobile gear licenses (DFO 2022a).

Production Statistics

The landings for the 4RST capelin fishery (from 1985 to 2022) can be described as cyclical (Figure 4). Between 2009 and 2019, the fishery experienced a low of 1,965 MT in 2017 and a high of 12,300 MT in 2011 {DFO2023a}. The landed value of capelin in 4RST (over the same period) generally mirrors the trends of the landings. As the value of capelin decreases or increases over time, the level of effort generally reflects these market fluctuations. Over the 2009 to 2019 period, the landed value of the capelin fishery in NAFO Divisions 4RST ranged from a low of around CAN600,000 in 2017 to a high of approximately $4.6 million in 2019 (DFO 2021c).

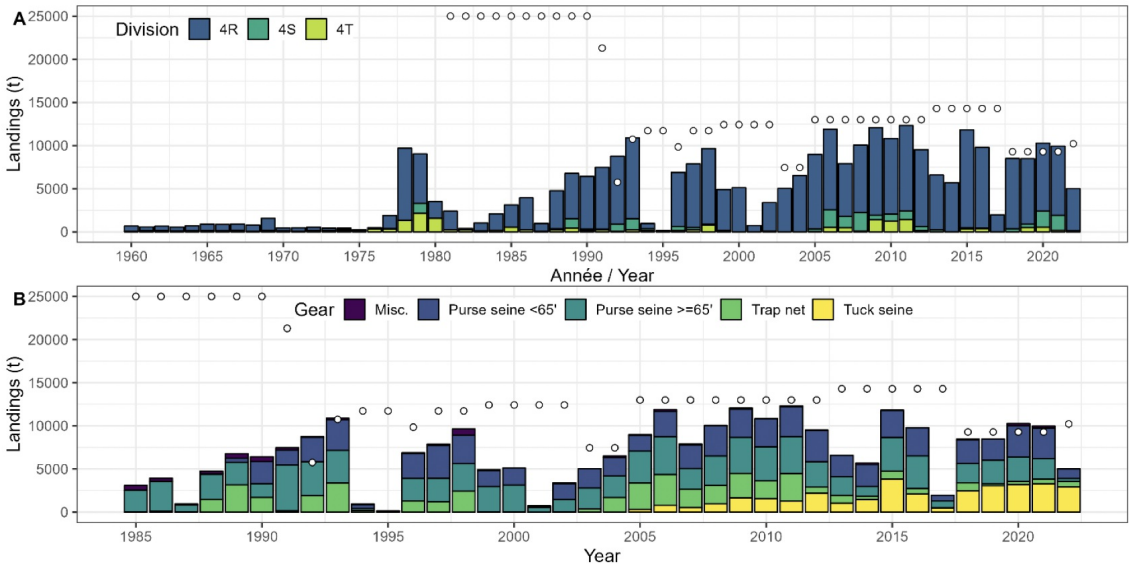

Figure 4: Capelin landings (tonnes, t) by A) NAFO Division from 1960 to 2022, and B) main fishing gear for the 1985–2022 period. The white circles represent the TAC. Landings for 2020, 2021, and 2022 are preliminary (DFO 2023a).

Table 1 shows the most recent landings data for the 4RST fishery, divided by fleet sector (where fixed gear encompasses both the trapnet and tuck seine sectors, and the mobile fleet represents the purse seine sector). The total landings in this area for the 2022 period were 5,013 MT. The table also includes the total allowable catch (TAC; allocated by fleet sector), which has been set on a 2-year management cycle, meaning that the TAC is set by DFO's Fisheries and Aquaculture Management (FAM) Division (which is informed by scientific assessments and advice from industry) for two subsequent years. The TAC for the 2020 season was set at 9,295 MT (which was applied to the entire stock for the 2018, 2019, and 2020 fishing seasons) (DFO 2021a), while a TAC of 10,225 MT was adopted for the 2022 (and 2023) fishing season (DFO 2023a).

Table 1: 2022 4RST capelin fishery preliminary total allowable catch (TAC) allocations and landings by gear sector (DFO 2023a).

Table 1

Area	Gear	Quota/TAC (MT)	Landings (MT)
4R	Fixed	3,867	3,547
	Mobile	4,938	1,431
4R	Total	8,805	4,886
4ST	Fixed + Mobile	1,419	174
4RST	**Total**	**10,225**	**5,061**

Figure 5 shows the landings for the 2J3KLPs (2+3) capelin fishery from 1972 to 2022. Again, the landings are cyclical and correspond to the market trends (from 2011 to 2020) shown in Figures 6 and 7. Since 2011, landings ranged from a low of about 16,090 tonnes (MT) in 2020 (preliminary in this graph) to a high of about 27,390 MT in 2016. Landings in 2021 were approximately 13,945 MT (96% of the 14,533 TAC for Divs. 2J3KL + 3Ps), which was a decline of roughly 13% (or approximately 2,145 MT) from 2020 (Murphy et al.

2024). For most years throughout the time series, the catch remains consistently below the TAC set; however, in the 2018 fishing season, the fishery experienced a slight overage (ibid).

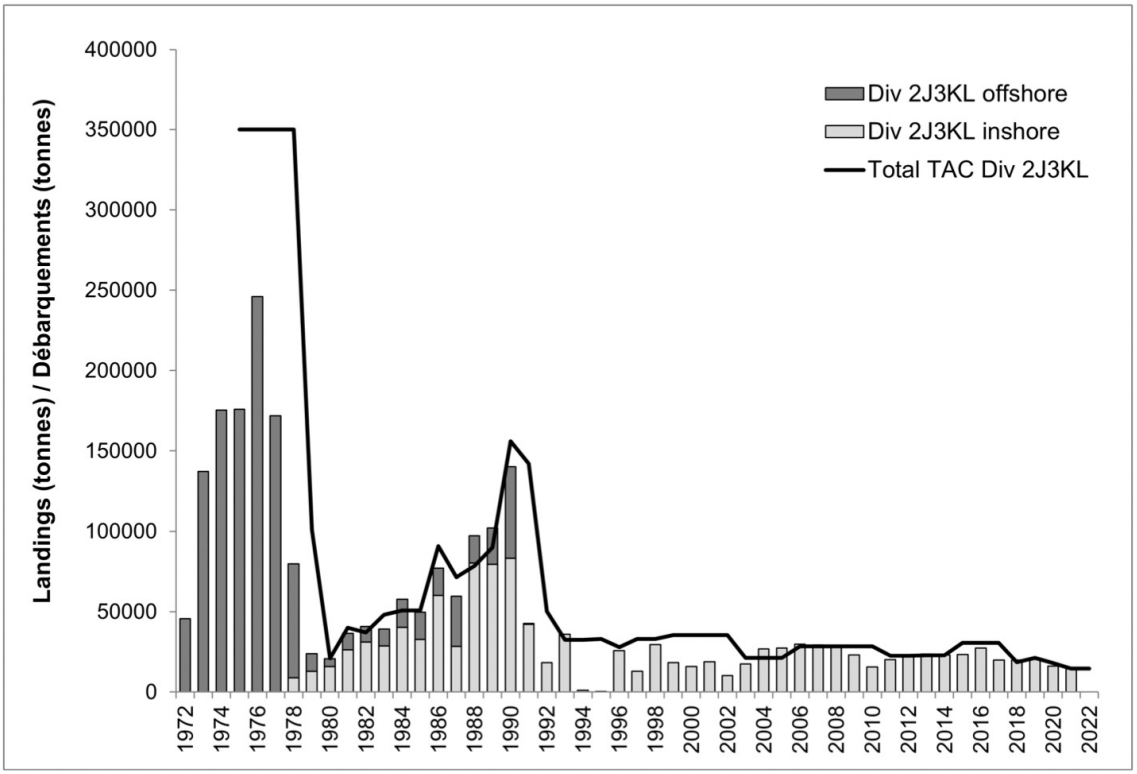

Figure 5: Inshore landings (light grey bars), offshore landings (dark grey bars) and TAC (line) for capelin in Divs. 2J3KL from 1972 to 2022. Note that annual inshore landings were likely greater than 0 MT between 1972 and 1977, but they were not recorded before 1978. There was no commercial fishery in 1994, 1995, and 2022 (Murphy et al. 2024).

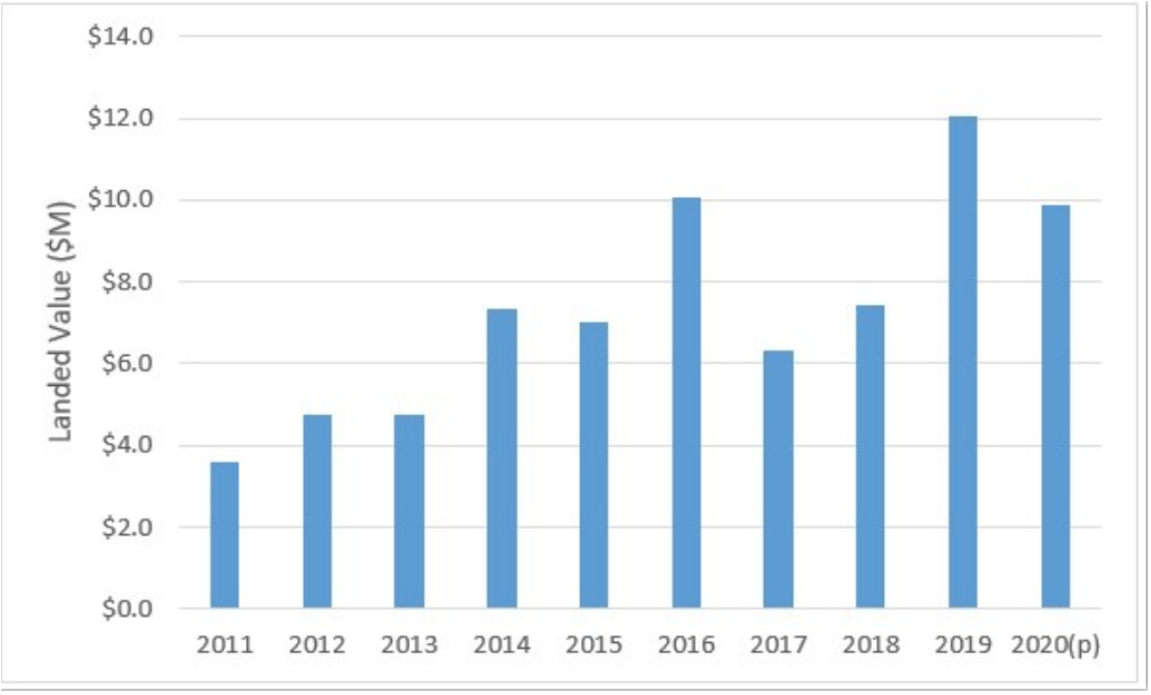

Figure 6: Capelin landed value (in millions) for the 2+3 fishery from 2011 to 2020. The 2020 data are preliminary {DFO 2022a).

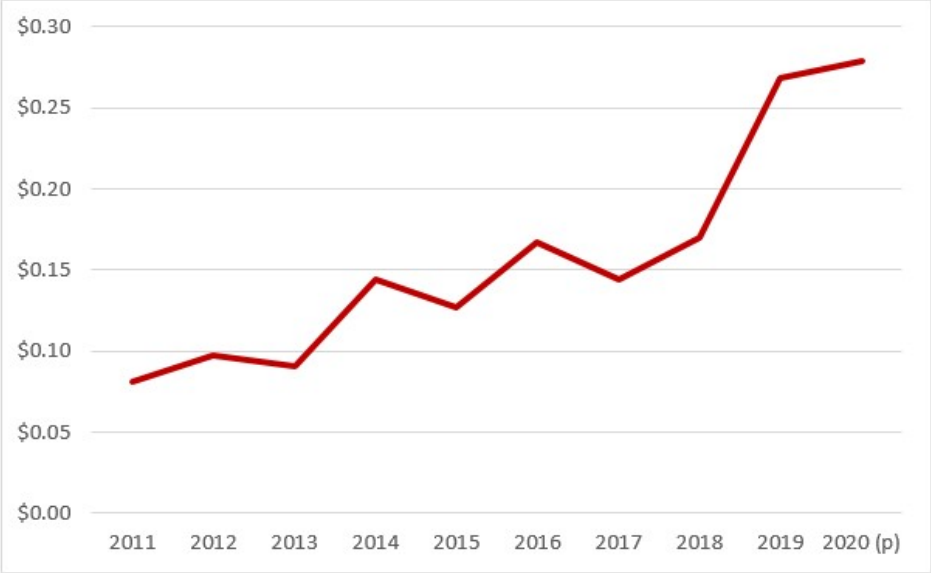

Figure 7: Capelin average landed price per pound for the 2+3 fishery from 2011 to 2020. The 2020 data are preliminary (DFO 2022a).

Table 2 shows the 2020 landings data, divided by fleet sector, for the 2+3 fishery. The total landed weight in

this area for 2020 was 16,109 MT. The table also includes the TAC (allocated by fleet sector), which has been set on an annual management cycle. The TAC for the 2022 season was set at 14,533 MT (Murphy et al. 2024).

Table 2. 2020 2+3 capelin fishery TAC allocations and landings by gear sector (DFO 2022a).

Table 2

Area	Gear	TAC/Quota (MT)	Landings (MT)
2J	Fixed	77	0
3K	Fixed	5,287	2,850
	Mobile	1,524	1,544
3K Total		6,811	4,394
3L	Fixed	6,860	7,271
	Mobile	4,338	4,444
3L Total		11,198	11,715
3Ps	Fixed	1,143	0
	Mobile	148	0
3Ps Total		1,291	0
Total 2+3		**19,377**	**16,109**

Importance to the US/North American market.

The total Newfoundland and Labrador allocation for NAFO Divisions 2J3KLPs and 4RST capelin was 23,338 MT in 2022, an increase of 9% from 2021. Capelin landings in 2022 were down 78% to 4,935 MT, and value also decreased 90% to $1.8 million compared to 2021. The volume of capelin exports decreased 69% to 4,134 MT and value decreased 79% to $9 million in 2022, compared to 2021. China was the largest market for capelin, accounting for 30% of export value, followed by Japan at 22% and the United States at 19% (Figure 8). The “Other” category includes Thailand, Vietnam, the Netherlands, South Korea, Lithuania, and Hong Kong, among others. The decrease in export value and volume was mainly driven by reduced landings due to a disruption in the commercial fishery in 2022 (Government of Newfoundland and Labrador 2023).

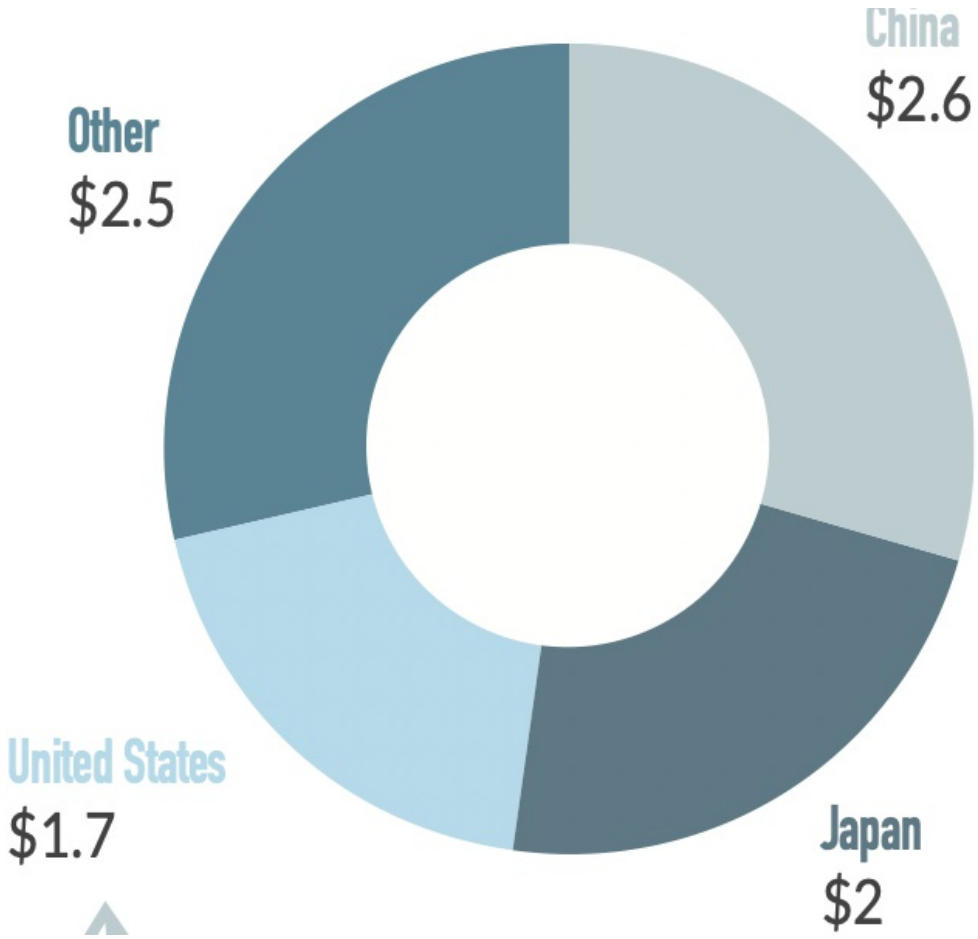

Figure 8: Canadian capelin exports by country of destination (2022) based on export value (Government of Newfoundland and Labrador 2023).

In 2020, Newfoundland and Labrador alone (2+3 fishery) exported approximately 16,500 MT of capelin, with a total export value of approximately CAN53.9 million. China was the largest export destination for capelin products, accounting for about 46% of export value. Other top export destinations included the United States (17%), Japan (11%), Vietnam (6%), and Taiwan (6%) (Figure 9) (DFO 2022a).

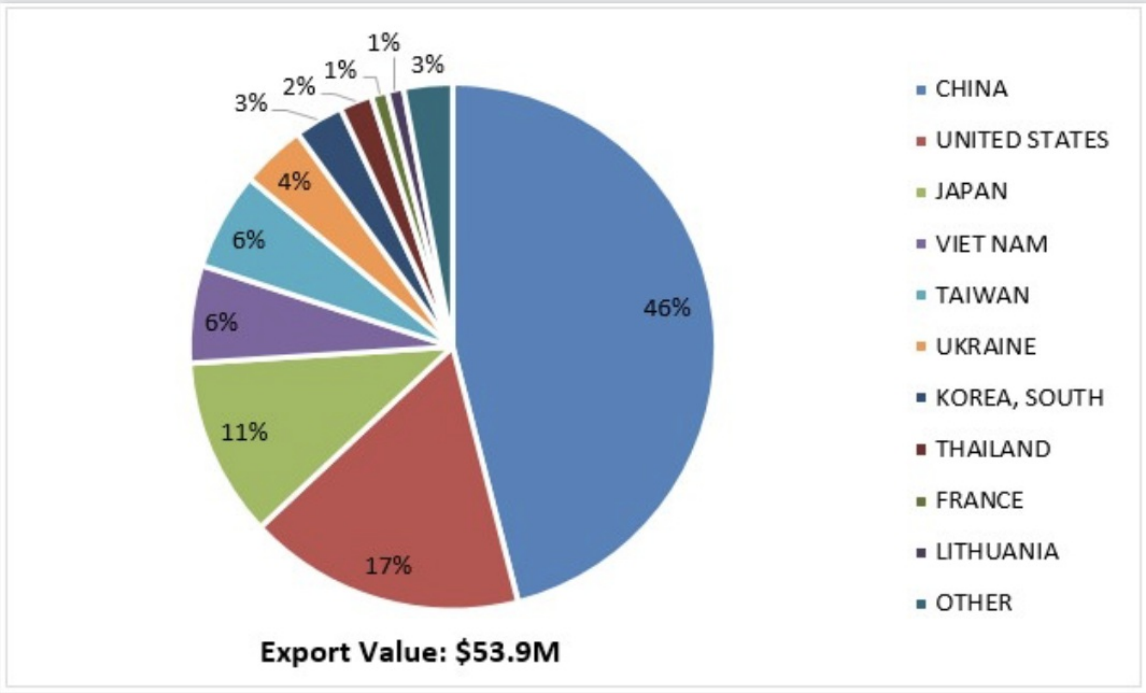

Figure 9: Capelin exports from Newfoundland and Labrador (2+3) by country of destination, based on export value (2020) from Statistics Canada (DFO 2022).

Capelin fisheries in other countries, like Iceland and Norway, often tend to influence the level of demand and price for Newfoundland and Labrador capelin. The capelin fisheries in these areas typically occur between January and April, which is much earlier than the capelin season in Newfoundland and Labrador. For the first time in three years, ICES has established a 2021 capelin quota of 127,300 MT, of which 69,834 MT were allotted to Iceland and 57,466 MT to Norway. But difficulties with the capelin fisheries in Norway and Iceland have resulted in increased demand for capelin products from Newfoundland and Labrador, resulting in improved market opportunities and prices (DFO 2021c).

Common and market names.

Common names: Capelin, caplin, capeling, roller, whitefish; in French: capelan. Market names: Capelin, tea fish, breakfast fish (Froese and Pauly 2022).

Primary product forms

Canada primarily exports mature egg-bearing females to supply the Asian roe market {DFO 2022}. The capelin eggs are later transformed into “masago” and used in the sushi industry. The secondary products (male and female carcasses) are exported for use as fishmeal (i.e., fertilizer or animal feed) or whole (primarily males) for use as animal feeds, namely for zoos and aquariums in the United States and Canada. All Canadian products are exported whole and frozen. The domestic catch is sold whole and frozen for bait or fishmeal (SFW 2014)(Cyprian et al. 2017).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

CAPELIN			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | Canada | Purse seines	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | Canada | Seine nets	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | Canada | Stationary uncovered pound nets	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very LowConcern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (LowConcern) — Population may be belowtarget abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality
Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (LowConcern) — Probable (>50%) that fishing mortality from all sources is at or belowa sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is lowenough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Capelin (Mallotus villosus)

Factor 1.1 - Abundance

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

Moderate Concern

The most recent 4RST capelin species assessment (data from 2022) collected fisheries-dependent data [landings by area, gear type, and year (Figure 4), and mean lengths of males and females by year] and fisheries-independent data (multispecies trawl survey) (DFO 2023a). But because there is no directed abundance survey for capelin in this area, DFO is unable to calculate biomass (B) or spawning stock biomass (SSB) indices, or target reference points (e.g., biomass that is required for the maximum sustainable yield; B_{MSY}). Capelin fishing in the Estuary and Gulf of St. Lawrence (GSL) is managed by a total allowable catch (TAC). Capelin abundance in the area is also heavily influenced by environmental factors such as ocean temperatures, prey availability, the abundance of predators, and the abundance of other forage species (in particular, northern shrimp) (DFO 2021a)(DFO 2022n) (Lehoux et al. 2022)(DFO 2023a).

These stocks have not been classified as overfished, based on landings in relation to the TAC, for a long-term duration of greater than 5 years (Figure 4) (DFO 2021a)(DFO 2022n)(DFO 2023a). In addition, 1) approximations of the fishing mortality rates from 1997 to 2021 were likely much smaller than natural mortality rates typical of short-lived forage species such as capelin; 2) a new composite index, including five independent indices (northern GSL and southern GSL relative abundance indices, percentage in weight of capelin in diets of two key predators, and timing of last ice), of capelin 4RST stock status varied around the 1990–2021 long-term average since 2016; and 3) available evidence (low approximations of fishing mortality and the composite index around the long-term average) indicate that any of the harvest levels attained over the past decade are unlikely to pose a risk to the 4RST capelin stock in 2022.

Capelin abundance in NAFO area 4RST is assessed a “moderate concern,” because the inherent vulnerability is medium (see PSA in the Justification) and there is no evidence to suggest that the stock is above or below a sustainable biomass (because there are no biomass estimates or reference points) (Seafood Watch 2020).

Justification:

Productivity-Susceptibility Analysis (PSA):

Scoring Guidelines

1) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as

follows: S = [(S1 × S2 × S3 × S4) – 1/40] + 1.

3) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: V = √(P² + S²)

Table 4

Productivity Attribute	**Relevant Info**	**Score (1 = low risk, 2 = med, 3 = high)**	**Resource(s)**
Average age at maturity	2–3 years of age	1	(DFO 2021c) (DFO 2022a)
Average maximum age	6 years	1	(Boudreau et al. 2023)
Fecundity	6,000–12,000 egg per female	2	(Froese and Pauly 2022)
Average maximum size	13–25.2 cm	1	(Froese and Pauly 2022)
Average size at maturity	10.8 cm	1	(Chamberland et al. 2022a)
Reproductive strategy	Broadcast spawner	1	(Froese and Pauly 2022)
Total Productivity (average)		**1.167**	
Susceptibility Attribute	**Relevant Info**	**Score (1 = low risk, 2 = med, 3 = high)**	**Resource(s)**
Aerial overlap (considers all fisheries)	> 30% of the species concentration is fished, considering all fisheries.	3	Default scoring
Vertical overlap (considers all fisheries)	High degree of overlap between fishing depths and depth range of species .	3	(DFO 2021a) (DFO 2021b)
Seasonal availability (considers all fisheries)	Fishing seasons correspond to the prespawning period (seine fisheries [purse and tuck]) and to the spawning period (trapnet fisheries)	3	(DFO 2021a) (DFO 2021b)
Selectivity of fishery (considers all fisheries)	Species is targeted and is not likely to escape the gear, but conditions under “high risk” do not apply.	2	(DFO 2021a) (DFO 2021b)
Post-capture mortality (specific to fishery under assessment)	Retained species	3	(DFO 2021a) (DFO 2021b)
Total Susceptibility (multiplicative)		**2.8**	

PSA score for capelin in purse seine, seine net, and trapnet fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S^2)}$

$V = \sqrt{(1.167^2 + 2.8^2)}$

$V = \sqrt{(1.36 + 7.84)} = 3.03$ (Medium inherent vulnerability)

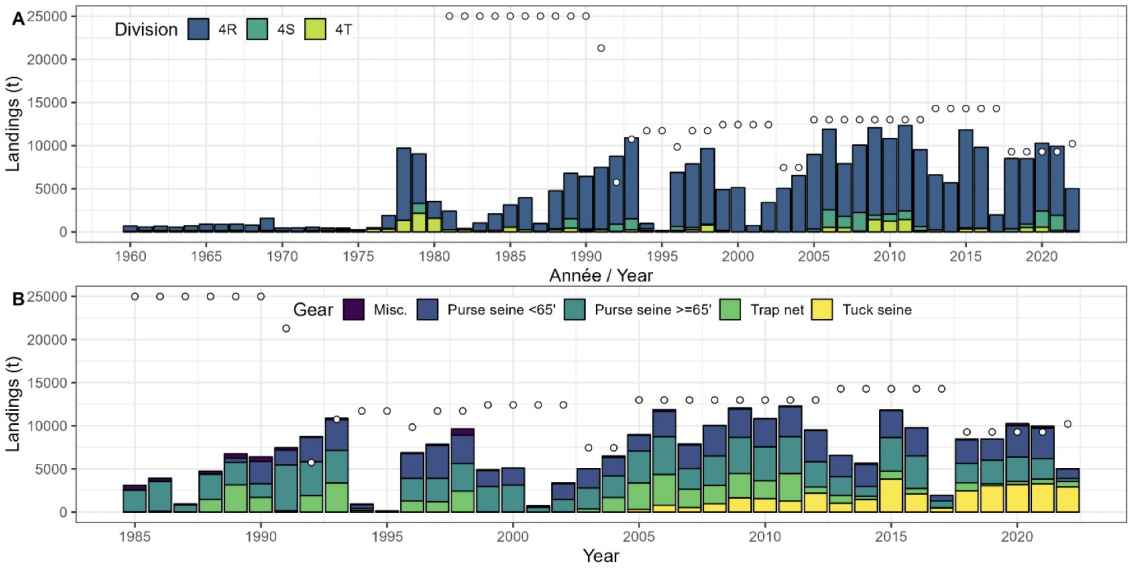

Figure 4: Capelin landings (tonnes, t) by A) NAFO Division from 1960 to 2022, and B) main fishing gear for the 1985–2022 period. The white circles represent the TAC. Landings for 2020, 2021, and 2022 are preliminary (DFO 2023a).

Environmental and biological conditions known to regulate capelin survival and cohort strength explain a large part of the variations in capelin abundance indices from the multidisciplinary groundfish and shrimp bottom trawl surveys (BTS) conducted annually by Fisheries and Oceans Canada in the Estuary and GSL (Lehoux et al. 2022). In the GSL, capelin abundance indices were mainly associated with variations in body condition in June and/or August–September, or in environmental predictors such as the timing of ice retreat, the sea surface temperature, and the abundance and phenology of preys of the genus *Calanus* (ibid). This supports the conceptual hypothesis that capelin abundance is determined by bottom-up processes regulating survival during its first 2 years of life (Lewis et al. 2019} (Lehoux et al. 2022). Thus, favorable environmental conditions in summer and fall of its first year of life will lead to good body condition and increased winter survival, and added to favorable conditions during spring of year 2, will increase the likelihood of producing a strong cohort.

There is no directed abundance survey for capelin in the Estuary and Gulf of St. Lawrence; however, two bottom trawl surveys (one in the Northern Gulf of St. Lawrence and one in the Southern Gulf of St. Lawrence) are conducted from August to September. Capelin catches during those surveys are used to estimate a relative abundance index (mean number of capelin per tow). The relative abundance index helps us understand temporal trends in the stock along with the approximation of the stock biomass and fishing mortality rates for methodological details (see (Boudreau et al. 2023)). Thus, it is not possible to calculate abundance, fishing mortality, and limit reference points, which could help to establish a strategic framework for the fishery and a TAC according to the Precautionary Approach. The current TACs (8,805 MT for Division 4R and 1,420 MT for Divisions 4ST), which were increased in 2022 following the stock assessment, were based on the condition of fish, the composite index around the average, and the approximation of fishing mortality of low values compared to natural mortality for a short-lived species such as capelin (DFO 2023a).

The 2022 composite index, which was developed and accepted during the 2022 stock assessment and used again in the stock status update in 2023 (see (Boudreau et al. 2023)), was developed to provide insight into the relative stock status (from 1990 to 2022) by synthesizing five independent indices (northern GSL and southern GSL relative abundance indices, percentage in weight of capelin in diets of two key predators, and timing of last ice) (DFO 2023a). This approach used indices considered to be proxies of the stock status and can provide meaningful information to guide risk-based management decisions, but it cannot provide biologically based reference points (ibid). Capelin stock status varied around the 1990–2022 long-term average since 2016 (Figure 13) (DFO 2023a).

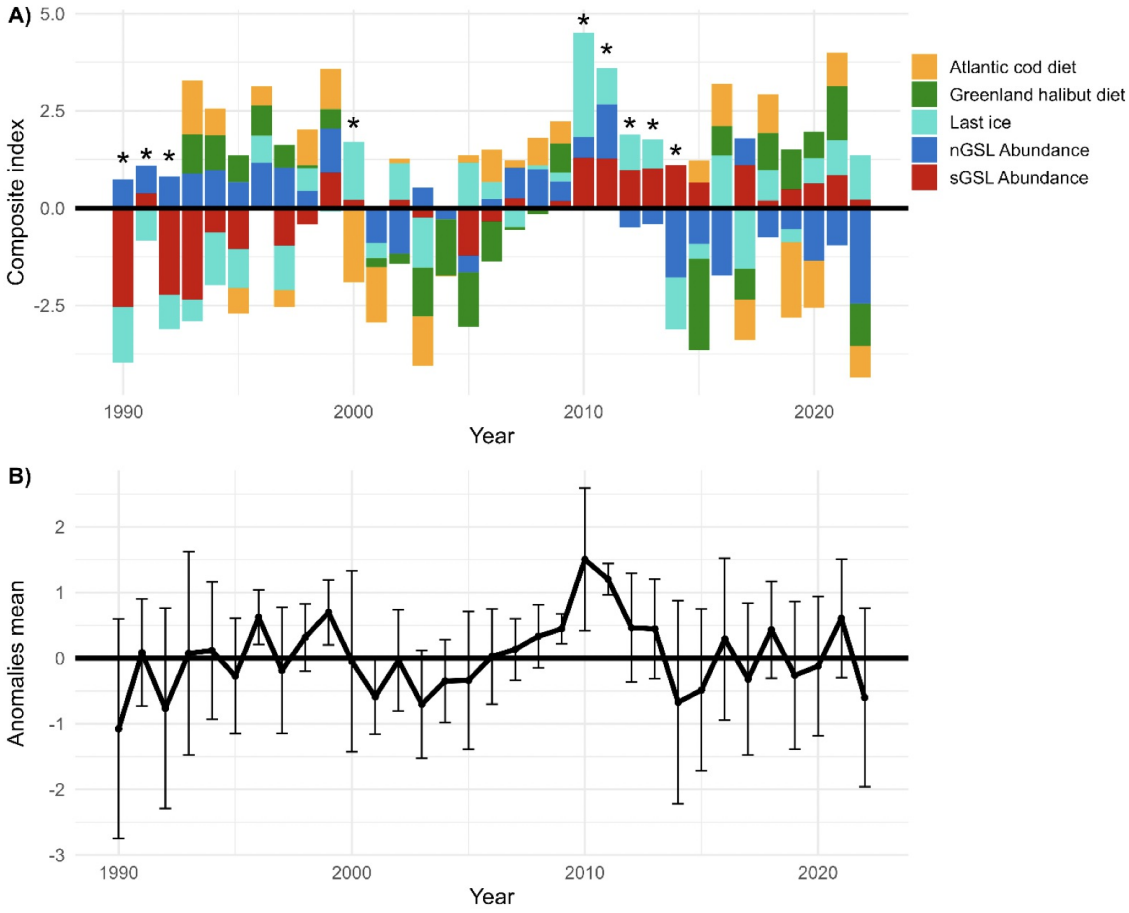

Figure 13: Composite index of stock status between 1990 and 2022 when considering the combination of A) relative abundance, capelin consumption by predators, and timing of ice retreat indices anomalies. Asterisk symbols are showing years where data on predator consumption were not available. Annual estimates of the anomalies mean value with their standard deviation (vertical lines) are presented on a different scale (B) (DFO 2023a).

In the 2022 stock assessment, in attempts to provide information on the relative abundance of capelin, their catchability in DFO bottom trawl surveys was analyzed in relation to habitat characteristics and demersal predators (DFO 2022a). These analyses showed that capelin was relatively abundant and consistently captured in hauls made in areas of the GSL where the cold intermediate layer (CIL) touches the seafloor, therefore suggesting that it is possible to use the tows data from the surveys to

estimate capelin relative abundance indices (ibid). Capelin caught in the southern GSL (sGSL) and northern GSL (nGSL) surveys are, on average, smaller than those caught in the commercial fishery. The differences in size structure observed in the nGSL and sGSL surveys suggest regional differences in the demographic structure (ibid).

Two capelin abundance indices were calculated for each of the sGSL and nGSL bottom trawl surveys. The first index was based on tows performed in the core survey strata (which were consistently part of the sampling plan over the survey series: 1971–2020 for the sGSL and 1990–2020 for the nGSL), and the second index only considered tows performed in the capelin's preferred habitat and assumed that capelin density in this habitat was homogenous {DFO 2021}.

In the nGSL, the abundance index based on the core strata was high and increased slightly during the 1990s, and has fluctuated around a relatively low level (Figure 14) (DFO 2021a). In 2022, the MNPT (mean number per tow) in the nGSL remained under the times series average and declined slightly compared to 2021 (DFO 2023a). In the sGSL survey, capelin was caught only in small quantities before 1990, suggesting that capelin was scarce and/or less available to bottom trawl due to the high abundance of cod in 4T during the period preceding its collapse in the early 1990s (ibid). The abundance index for the core strata then fluctuated at low levels until 2010, and subsequently increased to remain generally near or above the long-term average until 2021 (Figure 14) (ibid)(DFO 2022n). In 2022, the estimate of relative abundance decreased compared to 2021 and was slightly below the time series average (DFO 2023a).

There are a few sources of uncertainty associated with capelin abundance indices from the scientific bottom trawl surveys: 1) uncertainty whether the density of capelin is horizontally homogeneous in the core survey strata, or if the densities in this habitat are lower when the CIL is found above deeper depths; 2) the analyses did not allow the catchability of capelin to be quantified for the nGSL survey (violation of model premises); and 3) the fishery, which is concentrated on the west coast of Newfoundland, has been linked to indices of abundance at the GSL scale, so there is a possibility of local depletion that has yet to be addressed (ibid).

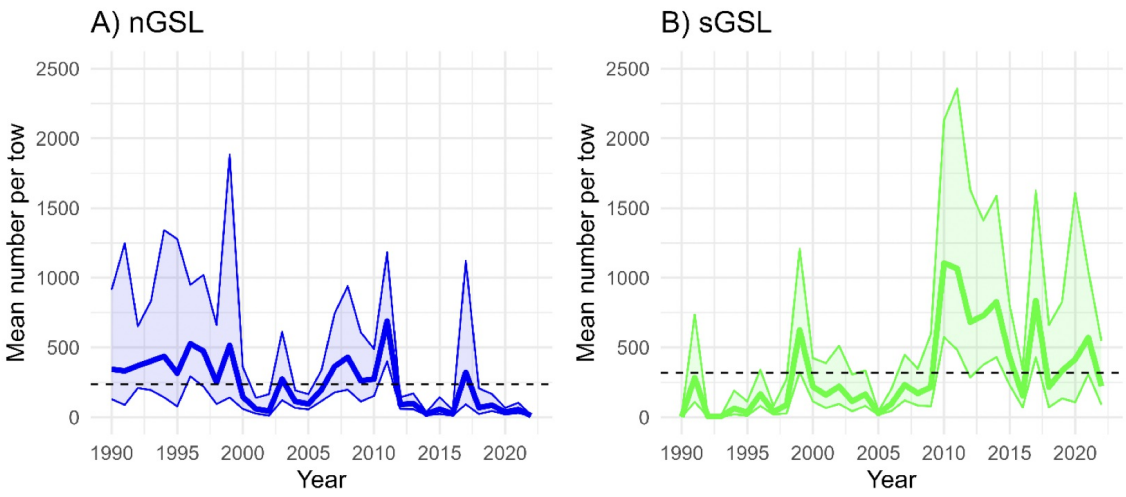

Figure 14: Capelin relative abundance indices for the (A) nGSL and (B) sGSL bottom trawl survey based on core strata. The shaded areas represent 95% confidence intervals. Indices for the sGSL before 1990 are not shown. The horizontal dashed lines represent the 1990–2022 average (DFO 2023a).

Northwest Atlantic | Canada | Purse seines
Northwest Atlantic | Canada | Seine nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

High Concern

The 2J3KL (2+3) capelin stock was last fully assessed in 2021, with data up to 2020 and a capelin biomass forecast for the 2021 spring (May) acoustic survey. The current stock assessment (2023) contains new fishery-independent survey data (spring acoustic survey, larval survey, biological characteristics from the spring acoustic and fall bottom-trawl surveys, and citizen science beach spawning diary program), including data from 2022. There was no commercial capelin fishery in 2022 due to market reasons (Murphy et al. 2024)(DFO 2024). In 2022, the 2J3KL capelin acoustic biomass index was above the post-collapse median and similar to 2018 and 2019, but well below the recent stock high of 2013–14 and a fraction of the 1980s median. The capelin fall relative condition was the highest in the time series, but the 2022 condition value may not be directly comparable with prior estimates due to an earlier than usual sampling time in 2022. Because the capelin forecast model is sensitive to fall condition, the results can only be described qualitatively due to uncertainty in the 2022 condition value. The capelin acoustic biomass index in 2023 is expected to be at or above the level of 2022.

The 2023 stock assessment contained fishery-independent data and catch data from 2021 (DFO 2023). Based on a Science Response Update (carried out in 2022, based on data from 2021), the 2021 partial spring acoustic survey yielded an abundance index of 474 kt, whereas in the last complete acoustic survey (in 2019), the abundance index was 283 kt, relative to a historical index of 4,593 kt (DFO 2021b). But the 2021 survey results were considered with caution when comparing trends in biomass to the typical May surveys, because they were conducted in June (which is closer to spawning timing, mid-June, than any previous acoustic survey), and there were few capelin samples collected during the acoustic survey, with only 5 trawl sets conducted compared to the typical 25–50 sets for the entire survey area (DFO 2023). Because of these data limitations, stock status could not

be updated, so we deferred to the 2021 stock assessment results.

The 2021 2J3KL (2+3) capelin species assessment (with data through 2019) collected fisheries-dependent data (landings by year and mean lengths of males and females by year) and fisheries-independent data (multispecies trawl survey, ichthyoplankton nets for larval abundances, acoustic monitoring for spring spawning stock abundances, and monitoring area ocean temperature trends) (DFO 2021b). This 2019 assessment for 2+3KL found that the capelin in this region continue to be small, continue to mature at a young age, are in poor condition, and are late spawning compared to those taken in the mid-2010s (DFO 2021b)(DFO 2023).

The spring acoustic survey is a directed survey for capelin and provides a biomass index that is used in the limit reference point (LRP) and the provision of science advice, but does not provide “absolute” stock biomass (B) or spawning stock biomass (SSB) indices, or target reference points (e.g., biomass that is required for the maximum sustainable yield, B_{MSY}). Consequently, DFO is unable set a total allowable catch (TAC) based on such indices. A bottom-up population regulation mechanism (where environmental conditions affect phytoplankton blooms, which in turn affect zooplankton and capelin populations) has been independently observed in the management area and will aid in the ecosystem-based fisheries management of capelin in 2J3KL {Buren et al 2014}(Buren et al. 2019). These stocks have also not been classified as overfished, based on landings in relation to the TAC (DFO 2021b).

Capelin abundance in NAFO area 2J3KL is assessed a “high concern,” because it is probable that the stock is depleted. The 2021 abundance index (data through 2019) was 28 3kt, relative to a historical index of 4,593 kt, which is just 6% of historical levels (DFO 2021b). Observations of 1) prey consumption by fish predators, 2) capelin distribution, 3) growth rates, and 4) maturation at age in 2019 are consistent with historical patterns of low capelin abundance. In addition, capelin have declined by an order of magnitude from 6 million t (MT) in the late-1980s to less than 150,000 t in 1991, and since then, the index has remained low, averaging 250,000 t over the past three decades.

Justification:
There is a directed acoustic survey for capelin that covers the nursery area (Div. 3L; 1982–2023). This survey produces a biomass index (and abundance index) and provides a trend to determine stock status, but it cannot use it to estimate SSB (pers comm, DFO, August 11, 2023). The 2019 spring survey acoustic abundance index was 18.5 billion, which is below the average levels observed from 1999 to 2019 (26.6 billion) and the late 1980s (1988–90, 413.3 billion) (DFO 2021b). Observations of 1) prey consumption by fish predators, 2) capelin distribution, 3) growth rates, and 4) maturation at age in 2019 are consistent with historical patterns of low capelin abundance. In 2019, there was a lower than average proportion of age 2 capelin in the spring acoustic survey, 80% of which were maturing.

The post-spawning mortality rate is high, and as a result, a decrease in the availability of these capelin to the fishery and to predators, at age 3, is expected in 2020 (DFO 2021b). There have been six consecutive low larval abundance years (2014–19), including all the year-classes available to the fishery in 2020. The forecast model projects that the spring acoustic biomass index in 2020 will be lower than in 2019, with a high probability (90%) of returning to levels similar to those observed in 2017 (ibid)(Lewis et al. 2019).

The commercial fishery in 2021 landed 13,945 t of the 14,533 t TAC, and in 2019 landed 20,405 t, which is consistent with average landings for the past 10 years (22,000 t) (DFO 2021b)(DFO 2023). Current removals from predation are large compared to the fishery, but with declining predation by groundfish and declining stock size, the proportional impact of fishing has increased (ibid).

Factor 1.2 - Fishing Mortality

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

Moderate Concern

Fishing mortality (F) for the whole stock (4RST) was estimated using data from bottom trawl surveys, catchability coefficients (*q*) from the literature for small pelagics in this type of survey, and average landings over the past decade (DFO 2022n)(Boudreau et al. 2023). An estimate of the stock biomass between 1998 and 2021 was evaluated and considered a lag of one year for the relative abundance indices (the one-year lag was applied to account for the timing of the bottom trawl surveys [August to September] and the fishing activities [May to July of the following year]). Using data compiled by Patterson (Patterson 1992) for 28 stocks of 11 small pelagic species, it was concluded that F lower than 1/2 M (natural mortality) or a relative E (exploitation rate) lower than 30% would allow stock sizes to increase.

If these findings can be extended to capelin, which were not included in Patterson's model, given M = 0.62, this would suggest that F lower than 0.31 should allow capelin stocks to increase. Scenario 1 produced approximations of the stock biomass during the 1997–2021 time series that varied between 655,237 and 14,824,278 MT using low *q* and ranged from 255,117 to 6,248,675 MT using high *q*. Mean values of E for both *q* were lower than 2% (F < 0.0202), and maximum values of E for low and high *q* were 1.5% (F = 0.0150) and 3.83% (F = 0.0391), respectively. Average stock biomass of 771,210 MT (high *q*) and 2,020,818 MT (low *q*) were estimated under the cautious scenario (Scenario 2) for the 1998–2021 time series. Using conservative values of the stock biomass (high *q*), the 1998–2021 average of E was 1.85% (F = 0.0188), with minimum and maximum values of 0.16% (F = 0.0016) and 5.70% (F = 0.0587), respectively.

Maximum values of E and F during the time series resulted from a combination of relatively low stock biomass and high landings. Maximum values obtained with the cautious scenario and the conservative estimates of the stock biomass were five times lower than the thresholds (E < 30% and F < ½ M) that are likely to allow the stock biomass to increase (Patterson 1992). Therefore, plausible levels of the inferred fishery exploitation rate between 1998 and 2021 are considered low and sustainable when compared to those of other cautiously managed stocks of small pelagic fish like Atlantic herring.

Fishing mortality appears to be at or below a sustainable level; however, because there are no directed capelin surveys and there are a variety of other factors that contribute to a potentially inaccurate estimate of the fishing impact on the GSL capelin populations (short lifespans, populations consisting of only a few age groups, their abundance being subject to large fluctuations mostly regulated by environmental factors, exploitation rates being computed based on estimates of the order of magnitude of capelin abundance at the GSL scale, while the fishery is concentrated on the west

coast of Newfoundland; not taking into account the potential for local depletion) (Chamberland et al. 2022b), fishing mortality is considered a “moderate concern.”

Justification:
In the 2021 stock assessment, using only the trawlable biomass, the exploitation rate estimates varied between 16% and 36% (F = 0.17 and F = 0.44, respectively) depending on the choice of the abundance index and their interannual variation (ibid). Using trawlable biomass and a maximum value of *q* identified in the literature (*q* = 0.0045, herring in the sGSL survey {Benoit and Swain 2008}), the estimated exploitation rates varied between 0.07% and 0.16% (F = 0.0007 and F = 0.0016, respectively). By comparison, natural mortality estimated from the maximum age of capelin would vary between 46% and 56% (M = 0.62 and M = 0.82, respectively) according to conservative estimates {DFO 2021}(DFO 2021a).

Capelin landings in 4RST have consistently remained below the TAC from 2000 to 2019 (see Figure 4) (DFO 2020), with prevalent fluctuations over the long term. The fluctuations in landings have been attributed to variability in global markets. The TAC, which is currently 10,225 MT, is set using a moderately effective management mechanism, which will be described in Criterion 3. In 2020, the TAC was exceeded for the first time since 1993 (landings were 9,848 MT) {DFO 2021}.

Capelin is also regularly caught as bycatch in the shrimp fishery in 4RST. Between 2000 and 2019, this fishery caught an average of 146 MT per year of capelin, and about 87 MT in 2020 {Chamberland et al. 2022}. These catches represent only 0.89%–1.48% of the total landings, which is a minimal impact. All capelin caught in this fishery were discarded (DFO 2013).

Predation is estimated to be the largest source of capelin mortality in the GSL, with variations associated with the abundance of predators (Figure 15) (Savenkoff et al. 2004)(Savenkoff et al. 2005) (Savenkoff et al. 2009)(DFO 2017)(Ouellette-Plante et al. 2022). Preliminary results from the 2020 stock assessment showed that total annual consumption of capelin by two predators, Atlantic cod and Greenland halibut, would be on average eight times higher than landings from the commercial fishery (DFO 2020). Because capelin consumption by these two predators only represents a portion of capelin consumed annually in the nGSL, fishing mortality would only represent a small proportion of total mortality (ibid).

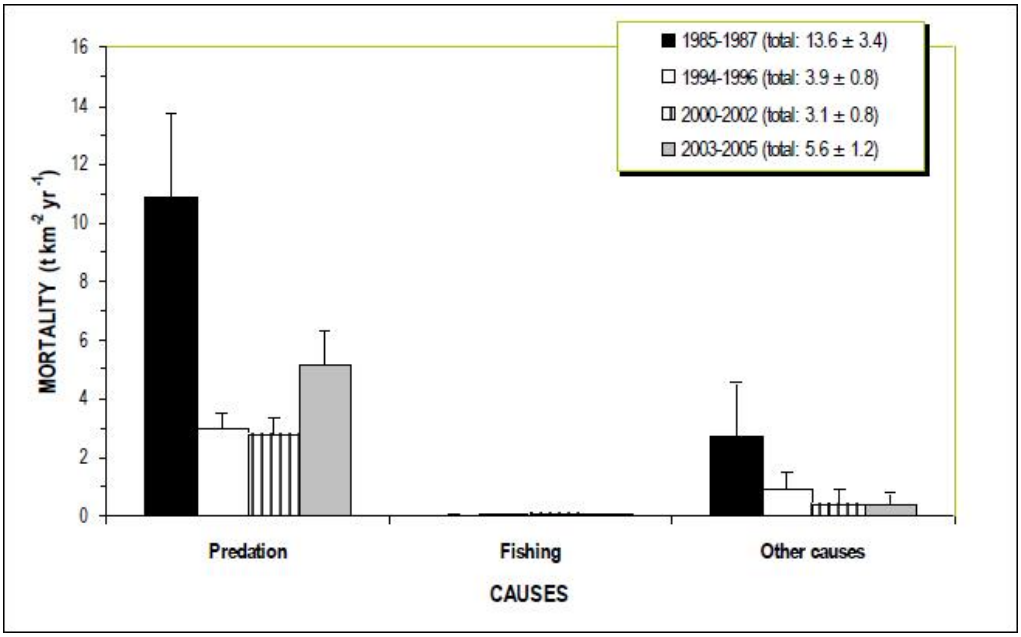

Figure 15: Main causes of mortality (t km^{-2} yr^{-1}) for the northern Gulf of St. Lawrence capelin (NAFO Divisions 4RS) from the mid-1980s to the mid-2000s.

Northwest Atlantic | Canada | Purse seines
Northwest Atlantic | Canada | Seine nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderate Concern

Capelin landings in 2J3KLPs have consistently remained below the TAC in all but a few years from 1972 to 2021 (Figure 16). The time series depicts that the fishery commonly experiences fluctuations over the long term. The fluctuations in landings have been attributed to variability in global markets. The TAC, which was held steady at 30,000 MT from 2006 to 2010 (Figure 16), has gradually fluctuated over the last 10 years, and is currently 14,533 MT; it is set using the management mechanism described in Criterion 3 (DFO 2023).

Landings for 2021 (13,945 MT) by area and fleet sector are below the TAC for the period (DFO 2023). In 2022, the TAC for the 2J3KL + 3Ps capelin stock areas was 14,533 MT; however, the fishery was not opened due to market reasons (Murphy et al. 2024). There are no catch per unit effort (CPUE) data available in the DFO assessments or primary literature (last used in 1993, because the fishery is predominantly driven by market forces, not the availability of fish). The 2013 Canadian Science Advisory Secretariat (CSAS) stock assessment has not been used for this factor because it does not include NAFO area 3Ps. Current removals from predation are large compared to those from the fishery, but the impact of fishing mortality on the 2J3KLPs stock is not quantified and is not well understood. But with declining predation by groundfish (recent declines in total finfish biomass may be associated with simultaneous reductions in capelin and shrimp availability) and declining stock size, the proportional impact of fishing has increased.

Because capelin biomass in 2J3KLPs is unknown, it is impossible to know what fishing mortality rate will result in a maximum sustainable yield (i.e., F_{MSY}). But there is a moderately effective management

strategy in place: this is defined by the results of Criterion 3 in this report {DFO 2022}(Seafood Watch 2020). Also, there is no evidence of overfishing, because fishing is a minor proportion of total mortality, and the fishery has been persecuted without major signs of collapse (DFO 2021b). Based on this information, a score of “moderate concern” is appropriate.

Justification:

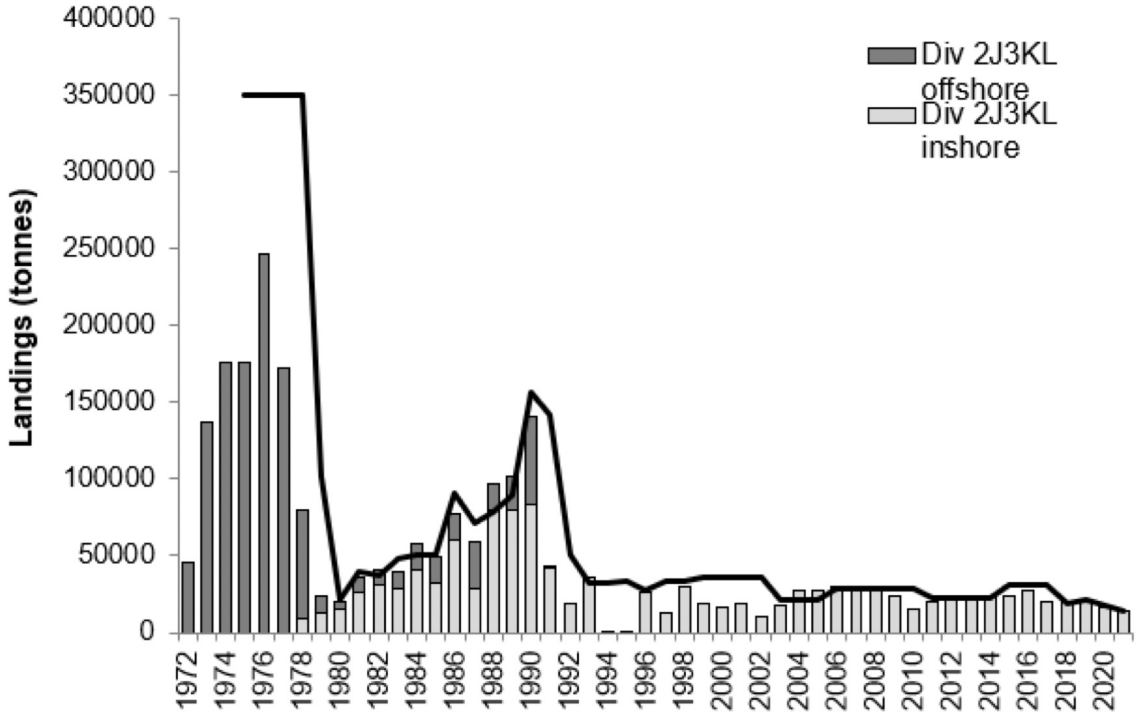

Figure 16: Inshore landings (light grey bars), offshore landings (dark grey bars), and total allowable catch (TAC) (line) for capelin in Divs. 2J3KL from 1972 to 2021. Note that annual inshore landings were likely greater than 0 MT between 1972 and 1977, but they were not recorded before 1978 (DFO 2023).

Since 2011, capelin landings in NAFO Divisions 2J3KLPs ranged from a low of about 16,090 MT in 2020 to a high of about 27,390 MT in 2016. Landings in 2021 were approximately 13,945 MT, a decline of approximately 31.5% (or approximately 6,400 MT) from 2019 (20,405 MT) {DFO 2022}.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

CAPELIN			
REGION / METHOD	SUB SCORE	DISCARD RATE/LANDINGS	SCORE
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.	1.732	1.000: < 100%	Red (1.732)
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines	1.732	1.000: < 100%	Red (1.732)
Northwest Atlantic | Canada | Purse seines	2.236	1.000: < 100%	Yellow (2.236)
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets	1.732	1.000: < 100%	Red (1.732)
Northwest Atlantic | Canada | Seine nets	2.236	1.000: < 100%	Yellow (2.236)
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets	1.732	1.000: < 100%	Red (1.732)
Northwest Atlantic | Canada | Stationary uncovered pound nets	1.732	1.000: < 100%	Red (1.732)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

GULF OF ST. LAWRENCE | ATLANTIC, NORTHWEST | CANADA | BARRIERS, FENCES, WEIRS, CORRALS, ETC.			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Atlantic cod	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic herring	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic salmon	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Marine mammals	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Capelin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

GULF OF ST. LAWRENCE | ATLANTIC, NORTHWEST | CANADA | PURSE SEINES			
SUB SCORE: 1.732	DISCARD RATE: 1.000		SCORE: 1.732
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic herring	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic cod	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic salmon	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Capelin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

GULF OF ST. LAWRENCE | ATLANTIC, NORTHWEST | CANADA | SEINE NETS			
SUB SCORE: 1.732	DISCARD RATE: 1.000		SCORE: 1.732
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic herring	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic cod	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic salmon	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Marine mammals	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Capelin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

GULF OF ST. LAWRENCE | ATLANTIC, NORTHWEST | CANADA | STATIONARY UNCOVERED POUND NETS			
SUB SCORE: 1.732	DISCARD RATE: 1.000		SCORE: 1.732
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic cod	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic herring	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic salmon	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Marine mammals	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Capelin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | CANADA | PURSE SEINES			
SUB SCORE: 2.236	DISCARD RATE: 1.000		SCORE: 2.236
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Capelin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic cod	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic herring	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

NORTHWEST ATLANTIC | CANADA | SEINE NETS			
SUB SCORE: 2.236	DISCARD RATE: 1.000	SCORE: 2.236	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Capelin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic cod	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Marine mammals	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic herring	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

NORTHWEST ATLANTIC | CANADA | STATIONARY UNCOVERED POUND NETS			
SUB SCORE: 1.732	DISCARD RATE: 1.000	SCORE: 1.732	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic cod	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Atlantic salmon	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Capelin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Marine mammals	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic herring	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

The selected species—Atlantic cod, Atlantic herring, Atlantic salmon, and marine mammals (nonspecified)—have been identified (by members of DFO management and science branches) as the main bycatch species caught by all gear types in both Canadian capelin fisheries in 4RST and 2J3KLPs (2+3). Other bycatch species (winter flounder, nonspecified redfish, and American plaice) have not been included in the assessment because they represent less than 0.01% of the total catches in both fisheries (SFW 2014)(SFW 2020)(DFO 2014a).

Based on their life histories, and being designated as “Endangered” species or species of “Special Concern” (and considered for addition to Schedule 1), Atlantic cod, Atlantic salmon, and marine mammals all have high vulnerability to fishing. Atlantic herring has a medium vulnerability to fishing because it possesses positive life history traits (e.g., high fecundity), but has been susceptible to population declines in the past. Most of the current data associated with capelin are not releasable, and the quota reports do not section out bycatch from directed fisheries.

When the fishery was dominated by traps in the past, there was bycatch of cod, and occasionally salmon. During those times, DFO conducted telephone surveys inquiring about bycatch (discontinued in 2000); in nearly all cases, catches with high amounts of bycatch were released alive (pers comm, Erin Dunne, Mathieu Pellerin, Aaron Adamack, and Fran Mowbray, DFO, October 25–26, 2022). It is unclear whether salmon catches are over 5% of the total catches, so they are included, to be conservative. A 2011 report released by DFO showed that the purse seine fisheries in both 4RST and 2J3KLPs have minimal impacts on all bycatch species and thus receive a “low concern” score. But here have been no catch composition reports released for the “tuck” seine (i.e., seine net, boat) and trapnet fisheries (and there were bycatch issues in the past), so they receive a “moderate concern” score, because there are moderately effective management strategies in place for all fisheries in both areas.

Because most of the current data associated with capelin are not releasable and the quota reports do not section out bycatch from directed fisheries, a 2011 DFO catch composition report from the 2014 SFW capelin assessment is being used (SFW 2014). Because the 2011 DFO catch composition report did not list Atlantic salmon and marine mammals as being caught or interacting with the fishery, these species are not included for the 2+3 purse seine fishery, and marine mammals were not included in the 4RST purse seine fishery (DFO 2014a).

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Atlantic cod (Gadus morhua)

Factor 2.1 - Abundance

Northern Gulf of St. Lawrence (3Pn, 4RS) Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Northern Gulf of St. Lawrence (3Pn, 4RS) Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Northern Gulf of St. Lawrence (3Pn, 4RS) Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

High Concern
The Northern Gulf cod SSB has been in the critical zone, well below the limit reference point (LRP), since 1990. In 2010, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Laurentian North (3Pn, 4RS and 3Ps) cod population, part of which consists of Northern Gulf of St. Lawrence (3Pn, 4RS) cod, as “Endangered” based on the extent of the decline (78–89%) in adult abundance over three generations (30 years; the status on Schedule 1 is under consideration for addition) (DFO 2019a)(DFO 2022b)(COSEWIC 2023). Therefore, Laurentian cod abundance is deemed a “high concern.”

Northwest Atlantic | Canada | Purse seines
Northwest Atlantic | Canada | Seine nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

High Concern
There are two Atlantic cod stocks in the North Atlantic management area 2J3KLPs: Northern cod (2J3KL) and Southern Newfoundland cod (3Ps). This subcriterion will provide information for both stocks.

The 2019 Northern cod (2J3KL) stock assessment reported that the stock remained at 48% of the LRP, in the critical zone of DFO’s Precautionary Approach (PA) framework (DFO 2009)(DFO 2019b). The advice from this assessment stated: “Consistency with the DFO decision-making framework incorporating the precautionary approach requires that removals from all sources must be kept at the lowest possible level until the stock clears the critical zone” (DFO 2019b). The 2021 stock assessment reiterated the previous advice (DFO 2021d).

For the Southern Newfoundland cod stock (3Ps), the SSB is projected to be 25 kt with an assumed catch of 2,702 t (DFO 2021e). The stock is also in the critical zone (38% of the LRP, 27–53%) of DFO’s PA framework. The probability of being below the LRP is >99.9% (ibid). In 2010, COSEWIC designated the Newfoundland and Labrador cod populations as “Endangered” based on the extent of the decline (78–89%) in adult abundance over three generations (30 years) (DFO 2019a)(COSEWIC 2021)(DFO 2022b). As of 2022, COSEWIC maintains a listing of “Endangered” for both stocks. Therefore, Northern and Southern Newfoundland cod abundance is deemed a “high concern.”

Factor 2.2 - Fishing Mortality

Northern Gulf of St. Lawrence (3Pn, 4RS) Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderate Concern
Because there are no public bycatch records available for the trapnet fisheries in 4RST and 2+3 (and there were bycatch issues in the past), but effective management is in place for all fisheries, a score of "moderate concern" is given.

Northern Gulf of St. Lawrence (3Pn, 4RS) Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines

Low Concern
In a requested catch composition report from DFO in 2011, Atlantic cod bycatch in the 4R purse seine fishery constituted 0.45% of the total extrapolated catch (11,262 MT) (DFO 2014). These bycatch landings only contributed 4.4% to the overall fishing mortality of cod in 4RST during this time (51 MT/1,152 MT); a negligible effect on cod fishing mortality (DFO 2014) (DFO 2014a}. Conclusions based on the 2011 data can be supported by current expert input that maintains that this situation is the same (pers comm, Erin Dunne, DFO, May 24, 2023). Therefore, a score of "low concern" is considered appropriate.

Justification:
Appendix B shows the extrapolation of the 2011 DFO catch composition report. Cod bycatch in 4ST was not sampled because the directed capelin fishery in the area only represented 1.25% of the total extrapolated catch.

Northern Gulf of St. Lawrence (3Pn, 4RS) Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets

Low Concern
It can be estimated that tuck seines have similar bycatch compositions and ratios as purse seines, because their methods of capture are almost identical (one purses the lead line, while the other does not). Therefore, according to the 2011 DFO catch composition report, it is probable that the fishing mortality of cod as bycatch in the 4RST capelin tuck seine fishery will have a negligible effect on the total fishing mortality for cod in 4RST (which was less than 5%). Conclusions based on the 2011 data can be supported by current expert input that maintains that this situation is the same (pers comm, Erin Dunne, DFO, May 24, 2023). As a result, a score of "low concern" is appropriate.

Northwest Atlantic | Canada | Purse seines

Low Concern
In a requested catch composition report from DFO in 2011, Atlantic cod bycatch in the 2+3 purse seine fishery constituted less than 0.1% of the total extrapolated catch (DFO 2011a)(DFO 2014). Conclusions based on the 2011 data can be supported by current expert input that maintains that this situation is the same (pers comm, Erin Dunne, DFO, May 24, 2023). Therefore, a score of "low concern" is considered appropriate.

Justification:
Appendix B shows the extrapolation of the DFO catch composition report. 2J and 3Ps were not sampled because there were no purse seine catches in these subareas.

Northwest Atlantic | Canada | Seine nets

Low Concern
It can be estimated that tuck seines have similar bycatch compositions and ratios as purse seines, because their methods of capture are almost identical (one purses the lead line, while the other does not). Therefore, according to the 2011 DFO catch composition report, it is probable that the fishing mortality of cod as bycatch in the 2+3 capelin tuck seine fishery will have a negligible effect on the total fishing mortality for cod in 2+3 (which was less than 5%) (DFO 2014). Conclusions based on the 2011 data can be supported by current expert input that maintains that this situation is the same (pers comm, Erin Dunne, DFO, May 24, 2023). As a result, a score of “low concern” is appropriate.

Atlantic herring (Clupea harengus)

Factor 2.1 - Abundance

Southern Gulf of St. Lawrence Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Southern Gulf of St. Lawrence Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Southern Gulf of St. Lawrence Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

High Concern
There are three Atlantic herring stocks in the Gulf of St. Lawrence: Northern Gulf (4S), Southern Gulf (4T), and Western Newfoundland (4R). This factor will evaluate all three stocks.

4S
For the Northern Gulf (4S), a 2023 herring assessment (with data through 2022) stated that the assessment in Division 4S depends primarily on samples of herring obtained each year from the commercial fishery, but because fishing takes place almost exclusively in the eastern part of 4S (since 2007), the sampling is not representative of Division 4S as a whole (DFO 2023b). Therefore, the data available are not sufficient to quantitatively assess the status of the herring stock. But newer evidence as of 2022 (age composition of the commercial catch and the acoustic survey) is available that indicates that current catch levels should not pose any significant risk to the two herring spawning stocks in Division 4S in the short term (DFO 2023b).

Because there is no abundance survey for the total area, DFO is unable to distinguish if the stock is above or below reference points (DFO 2023b). But the species has a medium inherent vulnerability, so this stock receives a score of “moderate concern” (2.33).

4T

In 2021, DFO completed an assessment for the Atlantic herring stock in the Southern Gulf of St. Lawrence (4T). For both the spring and fall spawners, a statistical catch-at-age (SCA) model was used that allowed for time-varying catchability and time-varying natural mortality. For the spring spawner component, the model estimated that SSB has been in the critical zone of the Precautionary Approach framework since 2002 (Turcotte et al. 2021)(DFO 2022c). As of 2020–21, the estimated SSB of spring spawners is still likely (> 80%) in the critical zone. Given the current conditions of high natural mortality, decline in weight-at-age, and low recruitment, the probability that SSB will increase by 2024 ranges from 44% to 42% (catch of 0 MT to 1,250 MT, respectively). Irrespective of fishery removals, the stock will likely remain in the critical zone by 2027 (DFO 2022c).

For the fall spawner component, the estimated SSB has been in the cautious zone since 2017, and is still likely there to date, because the stock has declined over the past 10 years (DFO 2022c). Given the current conditions of high natural mortality, decline in weight-at-age, and low recruitment, the probability that SSB will increase by 2024 ranges from 35% to 40% (18,000 MT to 2,000 MT). It is unlikely (< 1%) that SSB will increase into the healthy zone or decline into the critical zone by 2027 (DFO 2022c). Because of this information, both the spring and fall spawner components of the herring stock in 4T receive a score of “high concern” (1).

4R

For the Western Newfoundland Stock (4R), the 2022 DFO assessment (with data through 2021) stated that the proportion of spring-spawner landings increased from 1.6% in 2014 to 89.6% in 2021, as did the proportion of spring spawners in the summer and fall acoustic surveys, from an average of 7.3% for the 2009–17 period to an average of 44.6% in 2020 and 51.5% in 2021 (DFO 2022d). Since the beginning of the 2021 acoustic survey, both spring (122,145 MT) and fall spawner (226,005 MT) biomass was estimated to be the highest yet (DFO 2022d).

According to the low exploitation rates, commercial and acoustic survey catch-at-age, and age- and length-age-maturity data, it is indicated that maintaining the current TAC will not “pose a significant short-term risk” to the 4R herring stock (DFO 2022d). But there is still uncertainty regarding some aspects of the acoustic survey, which led to the rejection of the assessment model as the basis for scientific advice. Hence, the available data are not sufficient to quantitatively assess this stock, and a score of “moderate concern” (2.33) for 4R is given.

Because the 4T herring stock is considered a “high concern” (and the average of all three stocks is 1.89), all Atlantic herring stocks in NAFO area 4RST receive an abundance score of “high concern.”

Justification:

Atlantic herring in 4R and 2+3 do not currently have LRPs, but work is ongoing to develop an LRP for both stocks (pers comm, DFO).

Southern Gulf of St. Lawrence Stock | Northwest Atlantic | Canada | Purse seines
Southern Gulf of St. Lawrence Stock | Northwest Atlantic | Canada | Seine nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderate Concern

Herring on the south and northeast coasts of Newfoundland are divided into five stock complexes: White Bay-Notre Dame Bay (WBNDB), Bonavista Bay-Trinity Bay (BBTB), Conception Bay-Southern Shore (CBSS), St. Mary's Bay-Placentia Bay (SMBPB), and Fortune Bay (FB). Instead of using traditional abundance indices, stocks were assessed using a multimethod approach by combining data from research and commercial gillnet surveys, logbook landings data, and qualitative harvester surveys. Atlantic herring in 4R and 2+3 do not currently have LRPs, but work is ongoing to develop an LRP for both stocks (pers. comm., DFO).

Quantitative values were not shown. Instead, a "traffic light" assessment approach was used to evaluate the stock. The inputs to the calculation of the stock status and their relative weights were discussed in the previous assessment {Bourne et al. 2015}; at that time, it was decided that the performance table would still be provided for all stock areas to summarize available information, but only three metrics would be used to update the stock status index (SSI) and determine the "traffic light" color for the stock area.

These metrics, which are evenly weighted in the SSI calculation, are: overall catch rates in the research gillnet program (scored as a percentage of the long-term mean), catch rates of mature year classes (ages 7–11, scored as a percentage of the long-term mean), and the number of mature year classes that are of above-average strength (Bourne et al. 2018). Because stock status calculations depend on indices derived from the research gillnet program, WBNDB and CBSS were not evaluated during this assessment; results from the 2016 acoustic survey were used to update SMBPB stock status (ibid).

BBTB (the SSI has an increasing trend over the past 5 years) and SMBPB (the estimate of relative abundance derived from the survey were slightly below the mean of previous surveys) both had a positive (green) SSI, but FB had a negative (red) SSI, because the SSI has been declining since 2010 (ibid). Because the data-limited approaches are showing conflicting information, a productivity-susceptibility analysis (PSA) was performed. The PSA suggests that Atlantic herring is moderately vulnerability to fishing pressure; therefore, an overall score of "moderate concern" is awarded for all five stock complexes in the Northwest Atlantic.

Justification:
Productivity-Susceptibility Analysis (PSA):

Scoring Guidelines

1) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: S = [(S1 × S2 × S3 × S4) – 1/40] + 1.

3) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: V = $\sqrt{(P^2 + S^2)}$

Table 5

Productivity Attribute	Relevant Info	Score (1 = low risk, 2 = med, 3 = high)	Resource(s)
Average age at maturity	4 years of age	1	(Bourne et al. 2018)
Average maximum age	25 years	2	{Froese and Pauly 2023}
Fecundity	< 360,000 egg per female	1	{Froese and Pauly 2023}
Average maximum size	45 cm	1	{Froese and Pauly 2023}
Average size at maturity	23.5 cm	1	{Froese and Pauly 2023}
Reproductive strategy	Demersal egg layer	2	{Froese and Pauly 2023}
Total Productivity (average)		**1.33**	
Susceptibility Attribute	**Relevant Info**	**Score (1 = low risk, 2 = med, 3 = high)**	**Resource(s)**
Aerial overlap (considers all fisheries)	> 30% of the species concentration is fished, considering all fisheries.	3	Default scoring
Vertical overlap (considers all fisheries)	High degree of overlap between fishing depths and depth range of species.	3	(Bourne et al. 2018)
Seasonal availability (considers all fisheries)	Fishing seasons correspond to the prespawning period (seine fisheries [purse and tuck]) and to the spawning period (trapnet fisheries)	3	(Bourne et al. 2018)
Selectivity of fishery (considers all fisheries)	Species is targeted and is not likely to escape the gear, but conditions under “high risk” do not apply.	2	(Bourne et al. 2018)
Post-capture mortality (specific to fishery under assessment)	Retained species	3	(Bourne et al. 2018)
Total Susceptibility (multiplicative)		**2.8**	

PSA score for capelin in purse seine, seine net, and trapnet fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S^2)}$

V = $\sqrt{(1.33^2 + 2.8^2)}$

V = $\sqrt{(1.78 + 7.84)}$ = 3.10 (Medium inherent vulnerability)

Factor 2.2 - Fishing Mortality

Southern Gulf of St. Lawrence Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderate Concern

Because there are no public bycatch records available for the trapnet fisheries in 4RST and 2+3 (and there were bycatch issues in the past), but effective management is in place for all fisheries, a score of “moderate concern” is given.

Southern Gulf of St. Lawrence Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines

Moderate Concern

In a requested catch composition report from DFO in 2011 (see Appendix B), Atlantic herring bycatch in the 4R capelin purse seine fishery was 10.41% (1,173 MT) of the total extrapolated catch (11,262 MT). But this same amount of herring catch constituted approximately 5.7% of the total herring landings (20,436 MT) in 4R in 2011 (DFO 2014)(DFO 2014a)(SFW 2014). Because the fishery is a substantial contributor to herring fishing mortality (> 5% of total fishing mortality) and there is no current estimate of fishing mortality relative to a sustainable level, a score of “moderate concern” is given.

Justification:

Herring bycatch in 4ST was not sampled because the directed capelin fishery in the area only represented 1.25% of the total extrapolated catch of the entire 4RST fishery for 2011 (141 MT/11,262 MT) (DFO 2014)(DFO 2014a).

Southern Gulf of St. Lawrence Stock | Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets

Moderate Concern

It can be estimated that tuck seines have similar bycatch compositions and ratios as purse seines, because their methods of capture are almost identical (one purses the lead line, while the other does not). Therefore, according to the 2011 DFO catch composition report, it is probable that the fishing mortality of herring caught as bycatch in the 4RST capelin tuck seine fishery will have a slightly above negligible effect on the total fishing mortality for cod in 4RST (approximately 5.7%) (DFO 2014). Because the fishery is a substantial contributor to herring fishing mortality (> 5% of total fishing mortality) and there is no current estimate of fishing mortality relative to a sustainable level, a score of “moderate concern” is given.

Southern Gulf of St. Lawrence Stock | Northwest Atlantic | Canada | Purse seines

Low Concern

In a requested catch composition report from DFO in 2011 (see Appendix B), herring bycatch in the 3KL capelin purse seine fishery was 0.13% (27 MT) of the total extrapolated catch (DFO 2014a). This exploitation rate was negligible (0.73%) compared to the overall herring fishing mortality (3,702 MT) for the area (DFO 2014)(DFO 2014a)(SFW 2014). Therefore, a score of “low concern” is appropriate.

Justification:

NAFO subareas 2J and 3Ps were not sampled because there were no purse seine catches in these areas (DFO 2014a).

Southern Gulf of St. Lawrence Stock | Northwest Atlantic | Canada | Seine nets

Low Concern

It can be estimated that tuck seines have similar bycatch compositions and ratios as purse seines, because their methods of capture are almost identical (one purses the lead line, while the other does not). Therefore, according to the 2011 DFO catch composition report, it is probable that the fishing mortality of herring caught as bycatch in the 2+3 capelin tuck seine fishery will have a negligible effect on the total fishing mortality for herring in 2+3 (< 5% of 3,702 MT) (DFO 2011b)(DFO 2014b). As a result, a score of "low concern" is appropriate.

Atlantic salmon (Salmo salar)

Factor 2.1 - Abundance

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

High Concern

COSEWIC listed Atlantic salmon stocks in the Gulf of St. Lawrence (4RST) as "Special Concern" (the status on Schedule 1 is under consideration for addition) (COSEWIC 2023). In an update of the status of Atlantic salmon stocks in the DFO Gulf Region, estimated returns of large salmon (fork length [FL] ≥ 63 cm) to Gulf Region rivers in 2020 and 2021 were 44,100 and 23,300 fish, respectively, and small salmon (FL < 63 cm) returns were estimated at 26,400 and 25,300 fish, respectively. Over the most recent 12 years (approximately two generations for Atlantic salmon), the estimated abundance of large salmon in Gulf Region rivers has declined by 23%, whereas the small salmon abundance has declined by 51% (DFO 2022k).

Based on the trends in abundance of large and small salmon, and the generally declining/stable juvenile abundance indices, there is no expectation of increased abundance of salmon in the Gulf Region in 2022. Current abundances for large and small Atlantic salmon are far below historic levels (Chaput 2012). Because of these factors, abundance is scored a "high concern."

Justification:

Based on the trends in abundance of small salmon and large salmon and the generally declining or stable juvenile abundance indices, there is no expectation of increased abundance of salmon in rivers of the DFO Gulf Region in 2022 (DFO 2022k).

Northwest Atlantic | Canada | Stationary uncovered pound nets

High Concern

Per the 2020 Newfoundland and Labrador Atlantic salmon stock assessment, estimated Atlantic salmon spawning escapements (eggs) exceeded the upper stock reference point (USR) on 2 of 3 assessed rivers in Labrador, and on 5 of 14 assessed rivers in Newfoundland (Figure 16) (DFO 2022e). Estimated egg deposition fell within the cautious zone (i.e., between the USR and LRP) on 2 Newfoundland rivers (Figure 16), and was in the critical zone (below the LRP) on 1 of 3 assessed rivers in Labrador and on 7 of 14 assessed rivers in Newfoundland (DFO 2022e). Only southern Newfoundland (Designable Unit [DU] 4) has been reviewed by COSEWIC, where salmon populations were designated as "Threatened" (COSEWIC 2010). Because about half of the Atlantic salmon

populations assessed in 2020 were in the critical zone, abundance is considered a “high concern.”

Justification:
In Newfoundland and Labrador, there are 15 Atlantic salmon management areas, known as Salmon Fishing Areas (SFAs) 1–14B. Within these areas there are 394 rivers known to contain wild Atlantic salmon populations that are characterized by differences in life-history traits, including freshwater residence time, timing of return migration, age at first spawning, and the extent of ocean migration.

Since 2017, the Fishery Decision-Making Framework Incorporating the Precautionary Approach (DFO 2015) identifies two reference points for managing Atlantic salmon stocks in Newfoundland and Labrador: the limit reference point (LRP) and the upper stock reference point (USR). These reference points are based on the river-specific percent of conservation achieved (i.e., the number of eggs deposited per square meter of habitat). Conservation egg requirements for Atlantic salmon were previously established for individual rivers in Labrador (SFAs 1–2) based on 1.9 eggs per m^2 of river rearing habitat, in Northwest Newfoundland and the Straits Area of Labrador (SFAs 14A–14B) based on 2.4 eggs per m^2 of river rearing habitat and 105 eggs per hectare (ha) of lake habitat, and in Newfoundland (SFAs 3–13) based on 2.4 eggs per m^2 of river rearing habitat and 368 eggs per ha of lake habitat (O’Connell and Dempson 1995)(O’Connell et al. 1997)(Reddin et al. 2006). Conservation egg requirements were considered to be equivalent to an LRP.

The LRP is set at 100% river-specific conservation, while the proposed USR is 150% of the river-specific conservation (DFO 2020). Per the Precautionary Approach (PA) Framework, Atlantic salmon stock status is assessed based on the proportion of the river-specific LRP and USR achieved. In 2020, 17 populations of Atlantic salmon were assessed (DFO 2022e).

For each monitored river, the LRP is set at 100% of the previously defined conservation egg requirement (CER), and if populations below the LRP fall in the critical zone, management actions should both promote stock growth and minimize fisheries-related mortality. The interim USR is set at 150% of the previously defined conservation egg deposition rate, and populations above the USR are considered to be in the healthy zone and are therefore available for exploitation at some predetermined maximum exploitation rate. Populations with a status between the LRP and USR fall within the cautious zone, which triggers management actions to promote stock rebuilding to the healthy zone (DFO 2022e).

Factor 2.2 - Fishing Mortality

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.

Moderate Concern
Because there are no public bycatch records available for the trapnet fisheries in 4RST and 2+3 (and there were bycatch issues in the past), but effective management is in place for all fisheries, a score of “moderate concern” is given. There has also been no commercial catch for Atlantic salmon in 4RST or 2+3 since 1985 {COSEWIC 2022}.

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines

Low Concern

In a requested catch composition report from DFO in 2011 (see Appendix B), Atlantic salmon bycatch in the 4R capelin purse seine fishery represented a negligible amount (0.2 MT) of the total extrapolated catch (11,262 MT). This incidental catch also represented a negligible amount compared to the total approximated Atlantic salmon catch in the Gulf of St. Lawrence (approximately 80,884 individuals); consequently, the “low concern” score is appropriate. In addition, a report conducted by COSEWIC in 2010 (when salmon was last assessed) makes no mention that any capelin fishery in Canada has a detrimental effect on Atlantic salmon populations (COSEWIC 2023). There has also been no commercial catch for Atlantic salmon in 4RST since 1985 (DFO 2022l).

Justification:
Atlantic salmon bycatch in 4ST was not sampled, because the directed capelin fishery in the area only represented 1.25% of the total extrapolated catch of the entire 4RST fishery for 2011 (DFO 2014).

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets

Low Concern
It can be estimated that tuck seines have similar bycatch compositions and ratios as purse seines, because their methods of capture are almost identical (one purses the lead line, while the other does not). Therefore, according to the 2011 DFO catch composition report, it is probable that the fishing mortality of salmon caught as bycatch in the 2+3 capelin tuck seine fishery will have a negligible effect on the total fishing mortality for salmon in 2+3 (< 5% of approximately 80,884 individuals) (DFO 2011b) (DFO 2014b). A report conducted by COSEWIC in 2010 (when capelin fisheries were last assessed) makes no mention that any capelin fishery in Canada has a detrimental effect on Atlantic salmon populations (COSEWIC 2023). As a result, a score of “low concern” is appropriate. There has also been no commercial catch for Atlantic salmon in 4RST since 1985 (DFO 2022l).

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderate Concern
Because there are no public bycatch records available for the trapnet fisheries in 4RST and 2+3 (and there were bycatch issues in the past), but effective management is in place for all fisheries, a score of “moderate concern” is given. There has also been no commercial catch for Atlantic salmon in 4RST or 2+3 since 1985 {COSEWIC 2022l}.

Justification:
According to the 2022 salmon stock assessment, there should be no human-induced mortality on populations that were below the LRP except possibly for areas that have in-season reviews or special management plans (DFO 2022e).

Marine mammals (Mammalia)

Factor 2.1 - Abundance

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Northwest Atlantic | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

High Concern

The Species at Risk Act (SARA) has listed all species of cetaceans in all areas of Atlantic Canada as either “Threatened,” “Endangered,” or of “Special Concern” {DFO 2022}, Cetaceans are also designated “At Risk” by COSEWIC. The risk to cetaceans in the capelin fishery is estimated to be quite low, but not nonexistent (pers comm, Jessica Dickson, DFO, April 24, 2024). Because there are possible interactions with cetaceans, as well as the designations under SARA and by COSEWIC, a score of “high concern” is appropriate.

Justification:

It is unknown at this time exactly which species of marine mammals are affected, but it is probable that some are also seals, considering their population sizes and capelin fishing patterns (pers comm, Mathieu Pellerin, DFO, May 29, 2023).

Factor 2.2 - Fishing Mortality

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Northwest Atlantic | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Low Concern

To date, there are no public records for bycatch species in both the seine net (purse and tuck seines) and trapnet fisheries in 4RST and 2J3KLPs, but DFO fishery managers stated that interactions with marine mammals might occur in capelin fisheries (pers comm, Mathieu Pellerin, DFO, May 29, 2023). The Seafood Watch Criteria for Fisheries includes fishing mortality scoring criteria for unknown species (using the Unknown Bycatch Matrix); pelagic seine nets and trap gears score a “low concern” (3.5 and 4, respectively) for marine mammal mortality (Seafood Watch 2020).

Factor 2.3 - Discard Rate/Landings

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

< 100%

Currently, no data regarding bait use or discard rates exist for the trapnet fishery in 4RST or 2+3. High discard rates were characteristic of the capelin fishery in the past; the 1996 United Nations Food and Agriculture Organization (FAO) global assessment of bycatch provided an 80% discard rate for Canadian capelin fisheries {Alverson et al. 1996}. In recent years, several Canada-wide management measures and access to other markets have mitigated these concerns. Monitoring capelin quality before opening the fishery and relatively short fishing seasons (2 to 3 days) have significantly reduced at-sea discarding. A condition of provincial processing licenses requiring full utilization of capelin has been in effect since 2006. This requirement, along with newer markets for male capelin, have increased the utilization of male capelin (DFO 2021c)(DFO 2022a). Based on these requirements, SFW estimates a discard ratio of < 20%. Because no data exist regarding post-release survivorship, a 100% mortality rate is assumed for all discarded species. The regulation measures in the 2021–22 IFMPs stipulate that only capelin can be retained in this fishery; however, it does not explicitly state that there is a discard ban for the directed capelin fishery (DFO 2021c)(DFO 2022a).

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Northwest Atlantic | Canada | Purse seines

< 100%

Currently, no data regarding discard rates or bait use exist for the capelin fisheries in 4RST and 2+3. Based on the 2011 DFO catch composition report (see Appendix B), all bycatch species caught in these fisheries represented < 20% of the total extrapolated catch. The regulation measures in the 2021–22 IFMPs stipulate that only capelin can be retained in this fishery; however, it does not explicitly state that there is a discard ban for the directed capelin fishery (DFO 2021c)(DFO 2022a). Because no data exist regarding post-release survivorship, a 100% mortality rate is assumed for all discarded species.

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Northwest Atlantic | Canada | Seine nets

< 100%

Currently, no data regarding discard rates or bait use exist for the capelin fisheries in 4RST and 2+3. Based on the 2011 DFO catch composition report and extrapolation table (see Appendix B), all bycatch species caught in these fisheries represented less than 20% of the total extrapolated catch. The regulation measures in the 2021–22 IFMPs stipulate that only capelin can be retained in this fishery; however, it does not explicitly state that there is a discard ban for the directed capelin fishery (DFO 2021c)(DFO 2022a). Because no data exist regarding post-release survivorship, a 100% mortality rate is assumed for all discarded species.

High discard rates were characteristic of the capelin fishery in the past; the 1996 United Nations Food and Agriculture Organization (FAO) global assessment of bycatch provided an 80% discard rate for Canadian capelin fisheries {Alverson et al. 1996}. In recent years, several Canada-wide management measures and access to other markets have mitigated these concerns. Monitoring capelin quality before opening the fishery and relatively short fishing periods (2 to 3 days) have significantly reduced at-sea discarding. A condition of provincial processing licenses requiring full utilization of capelin has been in effect since 2006. This requirement, along with newer markets for male capelin, have increased the utilization of male capelin (DFO 2021c)(DFO 2022a). Based on these requirements, SFW estimates a discard ratio of < 20%. Because no data exist regarding post-release survivorship, a 100% mortality rate is assumed for all discarded species. The regulation measures in the 2021–22 IFMPs stipulate that only capelin can be retained in this fishery; however, it does not explicitly state that there is a discard ban for the directed capelin fishery (DFO 2021c)(DFO 2022a).

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very LowConcern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (LowConcern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	DATA COLLECTION AND ANALYSIS	ENFORCEMENT	INCLUSION	SCORE
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | Canada | Purse seines	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | Canada | Seine nets	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | Canada | Stationary uncovered pound nets	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages followscientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? Howsuccessful are these management measures? To achieve a Highly Effective rating, the fishery must have no or lowbycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: Howmuch and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Northwest Atlantic | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Northwest Atlantic | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderately Effective

As of 2023, there are no directed abundance surveys for capelin in NAFO area 4RST, while 2J3KLPs (2+3) has one that does not provide absolute stock biomass; therefore, DFO is unable to set target or limit reference points. But both fisheries are managed by separate Integrated Fisheries Management Plans (IFMPs) that evaluate—either annually (2+3) or biennially (4RST)—multiple components of the fisheries' dynamics, including ecological (e.g., capelin biology, life-history, predator-prey relationships, and other ecosystem factors), socioeconomic (e.g., landings and ex- vessel value, local and export market trends, and economic dependency), and institutional (e.g., monitoring, compliance, enforcement, regulatory framework and stakeholder consultation) (DFO 2021c)(DFO 2022a). Within the management cycle for the IFMPs, management measures (such as the implementation of individual quotas, licenses, and season and area closures, as well a comprehensive compliance strategy) are mapped against the DFO management objectives. This governance evaluation apparatus (which is known as a management performance review and is conducted separately for each fishery) is used to monitor the effectiveness of the management strategies (which are independently chosen for each fishery; ibid).

4RST

Specifically, the commercial capelin fishery in the GSL is comanaged by DFO's Newfoundland and Quebec Regions under an evergreen (no expiry date) IFMP that was approved in 2017 and updated in 2020. The commercial fleet is mostly based on the west coast of Newfoundland (NAFO Division 4R), and fishing seasons are relatively short and coincide with the inshore spring migration to spawn {Chamberland et al. 2021a}. Capelin is fished using both fixed and mobile gear: the fixed gear capelin fishery in all areas uses traps and modified bar seines known as tuck seines (occurring in specific areas or bays), while the mobile gear fleet is made up of purse seine vessels. The opening of the commercial fishery is largely based on the availability of capelin to fishing gear, the weather, socioeconomic concerns, and recommendations from the fishing industry, in order to maximize the number of larger, roe-bearing females in their catch for export to foreign markets. Females and their roe are typically sold for human consumption, while males are used as animal feed and bait; however, both males and females are increasingly being exported to zoos and marine parks as animal feed, both domestically and abroad (ibid).

The TAC for the capelin fishery in the Gulf of St Lawrence has seldom been limiting, and landings have historically been market-driven (Grégoire et al. 2013). The TAC is currently split by fleet and NAFO Division. The 4R fixed gear fleet, which includes tuck seiners, has an allocation of 37.82% of the TAC;

large purse seiners (vessel > 19.81 m [65 ft.]) and small purse seiners (vessel < 19.81 m), which compose most of the mobile gear fleet, each have an allocation of 24.15% of the TAC. The allocation for 4ST is 13.88% of the total TAC. All licence holders in 4R are required to have their catch monitored at dockside, and the return of logbooks is mandatory {Chamberland et al. 2021a}(DFO 2023a).

2J3KLPs (2+3)

Specifically, the 2J3KL and 3Ps (2+3) commercial capelin fishery in eastern and southern Newfoundland and Labrador is managed by an evergreen (no expiry date) IFMP, with the current management cycle running from January 1 to December 31. The bulk of today's inshore 2+3 capelin fishery occurs along the east and northeast coast of Newfoundland and Labrador where the major stock component is located (NAFO Division 3KL; Island of Newfoundland). Capelin is fished using both fixed and mobile gear: the fixed gear capelin fishery uses traps and modified bar seines known as tuck seines, whereas the mobile gear fleet uses purse seines (DFO 2022a). The opening of the commercial fishery is largely based on the availability of capelin to fishing gear, the weather, socioeconomic concerns, and recommendations from the fishing industry, in order to maximize the number of larger, roe-bearing females in their catch for export to foreign markets. Females and their roe are typically sold for human consumption, while males are used as animal feed and bait; however, both males and females are increasingly being exported to zoos and marine parks as animal feed, both domestically and abroad (DFO 2022a).

The TAC for the capelin fishery in eastern and southern Newfoundland and Labrador, which is based partly on the biomass index from the spring acoustic survey, has seldom been limiting, and landings have historically been market-driven (DFO 2022a). The TAC is currently split by fleet and NAFO Division. All license holders in 2+3 are required to have their catch monitored at dockside, and the return of logbooks is mandatory (DFO 2022a).

The management strategies for both regions do not receive an "ineffective" score, because the strategies have been implemented and adaptively managed with measurable success: the fisheries have been prosecuted mostly below the TAC over the long-term {Chamberland et al. 2021a}. But the management strategies do not warrant a "highly effective" score, because there are no abundance indices available, so it is unknown whether TACs are set appropriately. Consequently, a management strategy score of "moderately effective" is adequate for both fisheries.

Justification:

Management performance reviews provide fisheries managers with tools that allow them to make in-season adjustments for each fishery (i.e., they allow for adaptive management). In particular, specific tools used within the performance reviews are the species quota reports, which allow for the in-season monitoring of catch levels and "provide guidance as to when a season should close for a particular gear type and area (based on when the fisheries' approach their corresponding TAC)" (DFO 2021c) (DFO 2022a)(DFO 2022h)(DFO 2022j). Capelin TACs are not based on biomass and/or spawning stock biomass indices, because there are no directed abundance surveys for these fisheries. Instead, TACs are set via a series of internal and external DFO review processes, which occur within the 2-year management cycle (for 4RST) and annually (for 2+3).

First, DFO Science Branches (in the Quebec and the Newfoundland and Labrador regions; 4RST and 2+3, respectively) collect all relevant fisheries-dependent data (e.g., landings relative to current TAC,

CPUE data, and capelin length frequencies) and fisheries-independent data (e.g., indirect multispecies trawl survey) for each fishery. The scientific studies for both fisheries are then independently internally peer-reviewed by DFO's Canadian Science Advisory Secretariat (CSAS) within the fisheries' respective regions. The peer-reviewed reports are then externally presented (within the fisheries' respective regions) through Regional Advisory Processes (RAPs), where industry, academic, and public stakeholders are able to provide feedback on both scientific assessments. The results of these respective meetings are compiled into two separate Science Advisory Reports (SARs). The SARs are then presented at the corresponding industry advisory meetings, which are held by the respective DFO Fisheries and Aquaculture Management (FAM) Regional Branches, where the regional DFO scientists can provide clarification regarding the SARs to members of the respective FAM branches. The respective FAM branches finally set the TACs (for 2 consecutive years for the 4RST fishery to allow time for the following IFMP cycle, and annually for the 2J3KLPs fishery), in consultation with industry representatives from each fishery (SFW 2014).

Factor 3.2 - Bycatch Strategy

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

Moderately Effective

DFO has specific management measures in place within its Fisheries (General) Regulations to mitigate the capture of bycatch species in the 4RST capelin fishery, specifically salmon and cod. This issue has been discussed with industry over the past several years, and measures were taken to minimize the potential for bycatch in the commercial fishery: 1) in 1996, monofilament netting material was banned from use in capelin trap leaders; 2) in 1998, the use of trap net leaders with a mesh size between 76.2 mm and 177.8 mm was prohibited; and 3) in 2007, the use of trap net leaders with a mesh greater than 50.8 mm to less than 177.8 mm was prohibited.

DFO agreed to open the fishery during the June 15 to July 3 period in certain areas, provided there was some protection afforded for migrating salmon. Consequently, fishing is permitted in Capelin Fishing Areas 13 and 14 (4R) from June 15 to August 1. But there are areas around the mouths of certain salmon rivers that could potentially be closed if salmonid bycatch became a concern. There is also a prohibition in the Province of Quebec to fish inside 500 m of any point around the mouth of a salmon river, as set out in Schedule 6 of the Quebec Fishery Regulations (1990).

Since 1981, a large portion of the Bay of Islands has been closed to all pelagic fixed gear, to protect migrating salmon. Specifically, no fishing with fixed gear is permitted in the inner portion of the Bay of Islands (North Arm, Humber Arm, York Harbour, and Lark Harbour), inside a straight line from Crabb Point to North Arm Point to Middle Arm Point to Peter Point, Woods Island to Shoal Point to Fleming Point.

In particular, modified bar seines or tuck seines (labeled here as "seine nets"), fitted with rings that allow the bottom and sides of the seine to be brought or hauled together, shall not exceed a length of

80 fathoms (per Government of Canada 1993). The use of these seines has been authorized in the fixed gear herring, capelin, and mackerel fisheries in Divisions 2+3 and 4R following consultations with stakeholders at advisory committee meetings.

DFO is committed to conserving and protecting Atlantic salmon in Newfoundland and Labrador waters, and will continue to consult with stakeholders about salmon possibly being taken as bycatch by capelin seiners in the approaches to salmon rivers in western Newfoundland and Labrador and the Labrador Strait. The areas near the mouths of these rivers are closed to all commercial fishing activity to protect Atlantic salmon and are designated by caution signs that define inland versus coastal waters. Capelin fishing must occur outside the caution signs.

Any incidental catch of cod or salmon must be immediately returned to the water, and if it is alive, in a manner that causes the least harm (DFO 2021c). DFO implements these bycatch management measures for this fishery through routine checks by at-sea fisheries observers and fisheries officers (DFO 2021c).

Although management measures to reduce bycatch are implemented, there are currently no bycatch reports or statistics to verify their effectiveness. Consequently, the “moderately effective” score for the bycatch management strategy is adequate.

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Northwest Atlantic | Canada | Purse seines

Highly effective

DFO only enforces one bycatch management measure for the 4RST and 2+3 purse seine fisheries: any incidental catch must be immediately returned to the water, and if it is alive, in a manner that causes the least harm (DFO 2021c). Specifically, DFO is committed to conserving and protecting Atlantic salmon in Newfoundland and Labrador waters, and will continue to consult with stakeholders about salmon possibly being taken as bycatch by capelin seiners in the approaches to salmon rivers in western Newfoundland and Labrador and the Labrador Strait. The areas near the mouths of these rivers are closed to all commercial fishing activity to protect Atlantic salmon and are designated by caution signs, which define inland versus coastal waters. Capelin fishing must occur outside the caution signs.

DFO implements the bycatch management measures for this fishery through routine checks by at-sea observers and fisheries officers (ibid). Although there are no bycatch limits set during the TAC setting process, Appendix B details that bycatch is minimized to the greatest extent possible (DFO 2014). As a result, bycatch management in the 4RST and 2+3 purse seine is “highly effective.”

Northwest Atlantic | Canada | Seine nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderately Effective

DFO has specific management measures in place within its Fisheries (General) Regulations to mitigate the capture of bycatch species in the 2J3KLPs capelin fishery, specifically salmon and cod. This issue has been discussed with industry over the past several years, and measures were taken to minimize the potential for salmon bycatch in the commercial fishery: 1) in 1996, monofilament netting

material was banned from use in capelin trap leaders; 2) in 1998, the use of trap net leaders with a mesh size between 76.2 mm and 177.8 mm was prohibited; and 3) in 2007, the use of trap net leaders with a mesh greater than 50.8 mm to less than 177.8 mm was prohibited.

In particular, modified bar seines or tuck seines (labeled here as “seine nets”), fitted with rings that allow the bottom and sides of the seine to be brought or hauled together, shall not exceed a length of 80 fathoms (per Government of Canada, 1993). The use of these seines have been authorized in the fixed gear herring, capelin, and mackerel fisheries in Divisions 2+3 and 4R following consultations with stakeholders at advisory committee meetings.

Any incidental catch must be immediately returned to the water, and if it is alive, in a manner that causes the least harm (DFO 2022a).

Although management measures to reduce bycatch are implemented, there are currently no bycatch reports or statistics to verify their effectiveness. Consequently, the “moderately effective” score for the bycatch management strategy is adequate.

Factor 3.3 - Scientific Data Collection and Analysis

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

Moderately Effective

Stock assessments in 4RST are conducted biennially, and review of the short-term and long-term objectives during the 2-year management cycle is an essential part of assessing the performance of the fishery. During the regional assessment process on the status of the stock, DFO Science may consider the applicable objectives in providing its advice. For fisheries management, the advisory meeting with industry is a formal setting to review both short- and long-term objectives. In addition, DFO officials and industry representatives have an informal, ongoing dialogue about the fishery on a year-round basis. These informal discussions provide opportunities to review objectives and identify issues for discussion at the annual advisory meeting.

DFO conducts the following research and monitoring in 4RST throughout the 2-year management cycle:

1. Mandatory accurate completion of logbooks. Fish harvesters are required to record information about fishing catch (bycatch) and effort, and submit this data as specified in the conditions of license.
2. Monitoring 100% of the landings in 4R via the use of a dockside observer network. In 4S, dockside verification is mandatory if capelin is landed in a port outside its region of origin, and in 4T, it is mandatory for all commercial fishing license holders established in the Gulf region. Male and female length frequency and body condition data are collected by these observers and

analyzed by DFO scientists. Trends in mean lengths and body condition are summarized in biennial assessments.
3. Monitoring of catch composition and vessel operations at an “adequate level” of at-sea observer coverage, both spatial and temporal during the fishing season.
4. Monitoring capelin that are regularly caught in the shrimp fishery in the area, via at-sea fisheries observers, at a low coverage of 5% throughout the shrimp fishing season.
5. Mandatory reporting of lost gear.
6. Capelin are regularly caught in the multidisciplinary groundfish and shrimp bottom-trawl surveys, which are conducted annually in the Estuary and GSL. The dispersion of capelin is estimated for the area using this method.

There is no direct abundance survey for capelin in 4RST. Therefore, scientific data collection and analysis receives a “moderately effective” score, because there is some data collection related to stock health, but data are insufficient/too uncertain to help maintain the stock in 4RST (SFW 2020) (DFO 2021c).

Northwest Atlantic | Canada | Purse seines
Northwest Atlantic | Canada | Seine nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Moderately Effective

Stock assessments in 2+3 are conducted annually, and review of the short-term and long-term objectives is an essential part of assessing the performance of the fishery. During the regional assessment process on the status of the stock, DFO Science may consider the applicable objectives in providing its advice. For fisheries management, the advisory meeting with industry is a formal setting to review both short- and long-term objectives. In addition, DFO officials and industry representatives have an informal, ongoing dialogue about the fishery on a year-round basis. These informal discussions provide opportunities to review objectives and identify issues for discussion at the annual advisory meeting.

DFO conducts the following research and monitoring in 2J3KLPs throughout the 2-year management cycle:

1. Monitoring 100% of the landings in 2+3 via the use of a dockside observer network. Male and female length frequency, body condition, and age data are recorded.
2. Monitoring of catch composition and vessel operations at an “adequate level” of at-sea observer coverage, both spatial and temporal during the fishing season.
3. Adherence to electronic vessel monitoring system (VMS) requirements, which provide real-time data on the location of vessels within portions of this fleet.
4. Annual spring offshore acoustic survey of the southern portions of Div. 3K and all of Div. 3L from the 100 m depth contour to the 500 m depth contour. The survey results are used to simulate capelin stock abundance in the survey area. It does not estimate overall capelin stock abundance in 2J3KLPs.
5. Data collection of capelin distribution and biological characteristics from the fall multispecies survey (Divs. 2J3KL), including information on the timing of spawning, biological data of spawning fish from the commercial catch, and environmental parameters. Capelin biomass available to the spring acoustic survey in the upcoming year is forecasted using a statistical

model with a number of these data sources. The capelin fishery targets spawning fish, but no estimate of the total spawning stock biomass is available in 2J3KLPs.

6. An offshore capelin acoustic survey in May in the Div. 3L nursery area (conducted from 1982 to 2023), which provides a biomass and an abundance index of the stock; also, Trinity Bay, NL is often acoustically surveyed during this offshore acoustic survey (from 1999 onward). The larval monitoring has been ongoing in Trinity Bay since 2001.
7. Mandatory reporting of lost gear.
8. Independent and collaborative research projects on capelin include the development limit reference points for capelin, identifying the drivers of recruitment variability in capelin, comparative capelin diet studies, and studies on the caloric value of current capelin prey.

As of 2022, there is no direct abundance survey for capelin in 2J3KLPs. Therefore, research and monitoring methods receive a “moderately effective” score, because there is some data collection related to stock health, but data are insufficient/too uncertain to help maintain the stock in 2J3KLPs (SFW 2020)(DFO 2021b)(DFO 2022a).

Factor 3.4 - Enforcement of and Compliance with Management Regulations

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

Highly effective

In both the 4RST and 2+3 capelin fisheries, there is an extensive compliance plan outlining the details of the Conversation and Protection (C&P), compliance program delivery (using three pillars), and the compliance strategy. All regulatory arrangements—which are specified by license conditions, Atlantic Fishery Regulations and Fishery (General) Regulations of the Canadian Fisheries Act—are regularly enforced and independently verified through the use of vessel monitoring systems (VMS), at-sea and dockside monitoring, routine patrols, aerial surveillance, logbooks, and fisheries (conservation and protection) officers. DFO conducts postseason analysis sessions to review issues encountered during the previous season and to make recommendations on improving management measures. The initial sessions are conducted at the area level, followed by a regional session with other DFO sectors.

Purse seine

There are concerns about noncompliant (illegal and unreported) fishing activities occurring; fortunately, DFO conservation and protection (C&P) branches have detailed protocols, enforcement mechanisms, and personnel (outlined in each fisheries’ IFMP) to prevent these occurrences (Government of Canada 1986)(Government of Canada 1993)(DFO 2021c). Therefore, a score of “highly effective” is given, based on the SFW criteria for fisheries (Seafood Watch 2020).

Seine net/Bar seine/Tuck net

The capelin seine net fisheries in both 4RST and 2+3 lack at-sea observer coverage; however, since all other enforcement methods remain consistent across the gear types in both fisheries, a score of

“highly effective” is appropriate (Government of Canada 1986)(Government of Canada 1993)(DFO 2021c).

Stationary uncovered pound net/Trap net

The capelin trapnet fisheries in both 4RST and 2+3 lack at-sea observer coverage; however, since all other enforcement methods remain consistent across the gear types in both fisheries, a score of “highly effective” is appropriate (Government of Canada 1986)(Government of Canada 1993)(DFO 2021c)(DFO 2022a).

Justification:

The primary focus of C&P efforts for the duration of this fisheries management plan is on verifying compliance with the requirement to report accurately all fishing activities related to capelin, which include:

- bycatch of salmon and other species
- use of other vessels as barges or unlicensed transshipment vessels
- unmonitored landings
- adherence to weekly and daily trip limits (DFO 2021c)

Northwest Atlantic | Canada | Purse seines
Northwest Atlantic | Canada | Stationary uncovered pound nets

Highly effective

In both the 4RST and 2+3 capelin fisheries, there is an extensive compliance plan outlining the details of the Conversation and Protection (C&P), compliance program delivery (using three pillars), and the compliance strategy. All regulatory arrangements—which are specified by license conditions, Atlantic Fishery Regulations and Fishery (General) Regulations of the Canadian Fisheries Act—are regularly enforced and independently verified through the use of vessel monitoring systems (VMS), at-sea and dockside monitoring, routine patrols, aerial surveillance, logbooks, and fisheries (conservation and protection) officers. DFO conducts postseason analysis sessions to review issues encountered during the previous season and to make recommendations on improving management measures. The initial sessions are conducted at the area level, followed by a regional session with other DFO sectors.

Purse seine

There are concerns about noncompliant (illegal and unreported) fishing activities occurring; fortunately, DFO conservation and protection (C&P) branches have detailed protocols, enforcement mechanisms, and personnel (outlined in each fisheries’ IFMP) to prevent these occurrences (Government of Canada 1986){Government of Canada 1993(DFO 2022a). Therefore, a score of “highly effective” is given, based on the SFW criteria for fisheries (Seafood Watch 2020).

Stationary uncovered pound net/Trapnet

The capelin trapnet fisheries in both 4RST and 2+3 lack at-sea observer coverage; however, since all other enforcement methods remain consistent across the gear types in both fisheries, a score of “highly effective” is appropriate (Government of Canada 1986)(Government of Canada 1993)(DFO 2021c)(DFO 2022a).

Justification:
The focus of C&P efforts for the duration of the current fisheries management plan is on the following areas:

- catch reporting/discarding
- fishing beyond quotas or daily limits
- fishing during a closed time
- use of illegal tuck seines
- salmon bycatch in capelin trap leaders
- leader mesh requirements
- discarding: in-port and at-sea
- barging
- fishing the quotas of other fish harvesters (trading/impersonating)

Special attention will be given to inspecting tuck seines (including preseason inspections), barging and quota monitoring, as well as bycatch of salmon and enforcing closures (DFO 2022a).

Northwest Atlantic | Canada | Seine nets

Moderately Effective
In both the 4RST and 2+3 capelin fisheries, there is an extensive compliance plan outlining the details of the Conversation and Protection (C&P), compliance program delivery (using three pillars), and the compliance strategy. All regulatory arrangements—which are specified by license conditions, Atlantic Fishery Regulations and Fishery (General) Regulations of the Canadian Fisheries Act—are regularly enforced and independently verified through the use of vessel monitoring systems (VMS), at-sea and dockside monitoring, routine patrols, aerial surveillance, logbooks, and fisheries (conservation and protection) officers. DFO conducts postseason analysis sessions to review issues encountered during the previous season and to make recommendations on improving management measures. The initial sessions are conducted at the area level, followed by a regional session with other DFO sectors.

The capelin tuck seine fishery in 2+3 lacks at-sea observer coverage. The 2+3 2022 IFMP specifically mentions the need to address illegal tuck seines in this region (DFO 2022a). Because of the issue of illegal tuck seines in this region, combined with the enforcement methods described, a score of “moderately effective” is appropriate (Government of Canada 1986)(Government of Canada 1993) (DFO 2022a).

Factor 3.5 - Stakeholder Inclusion

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Northwest Atlantic | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Northwest Atlantic | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Highly effective

The stakeholder inclusion process is well documented in the proceedings of the Regional Advisory Process (RAP) for both the Gulf (4RST) and Newfoundland and Labrador (2J3KLPs) regions. Both the 2-day RAP for 4RST and the over 3-day RAP in 2+3 consists of DFO scientists (who conduct capelin research and report their findings in the stock assessments) presenting their findings and recommendations to a representative stakeholder and peer group (which includes DFO science and management peers, invited harvesters, provincial department of fisheries representatives, fisheries union representatives, and academics). After each presentation, representatives from each stakeholder and peer group (refer to the citations for a list of all RAP participants) are welcome to comment for a limited period of time. All scientific peer-reviewed advice (based on consensus of stakeholder comments) is written in a Science Advisory Report (SAR), which is used in the decision-making process (DFO 2022h)(DFO 2022j). In the Proceedings documents, the discussions and opinions of participants are captured (pers comm, DFO). Because of all these factors, stakeholder inclusion is scored “highly effective.”

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	FORAGE SPECIES?	SCORE
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.	Score: 3	+.5	High Concern	Yes	**Red (2.646)**
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines	Score: 4	Score: 0	High Concern	Yes	**Red (2.828)**
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets	Score: 4	Score: 0	High Concern	Yes	**Red (2.828)**
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets	Score: 3	+.5	High Concern	Yes	**Red (2.646)**
Northwest Atlantic | Canada | Purse seines	Score: 4	Score: 0	High Concern	Yes	**Red (2.828)**
Northwest Atlantic | Canada | Seine nets	Score: 4	Score: 0	High Concern	Yes	**Red (2.828)**
Northwest Atlantic | Canada | Stationary uncovered pound nets	Score: 3	+.5	High Concern	Yes	**Red (2.646)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very*

low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.

- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.

Score: 3

A fishing weir (Figure 17) is an area method that uses a configuration of fixed posts lined with netting to entrap schools of migrating fish (KBC 2022). The fixed posts are the only part of the structure that contacts the substrate; the impact of this contact is minimal (DFO 2010)(DFO 2021c)(DFO 2022a), so it is deemed a “low concern.”

Justification:

Figure 17: Fishing weir (KBC 2022).

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Northwest Atlantic | Canada | Purse seines

Score: 4

A purse seine (Figure 18) consists of a long, vertical, meshed net that is fashioned atop with small buoys to float the headline and weights attached to the bottom of the net, to sink the leadline. Also attached to the leadline are purse rings, through which a purse line enables the bottom of the net to be closed or “pursed” to entrap the fish. The setting of the net is usually accomplished with two vessels: a larger vessel (approximately 15 m or longer), known as a seiner, that is capable of holding fish and all equipment needed (including the skiff), and a smaller vessel, commonly known as a skiff. The skiff pulls one end of the net away from the seiner, encircles the school of fish, and pulls the net back around to the seiner. The purse line is pursed, and the fish are typically pumped or dip netted aboard the seiner.

This gear primarily does not contact the substrate (except when the water depth is less than the height of the seine during the fishing operations and the lower edge of the gear wipes the sea bottom) (FAO 2022a). Contact with the substrate is rare because gear damage is likely to occur (DFO 2010). Therefore, purse seines are not considered to have a high impact on the ecosystem. Although some seine nets do touch the bottom from time to time, the impact on benthic species and habitats is

minimal (DFO 2021c)(DFO 2022a).

Justification:

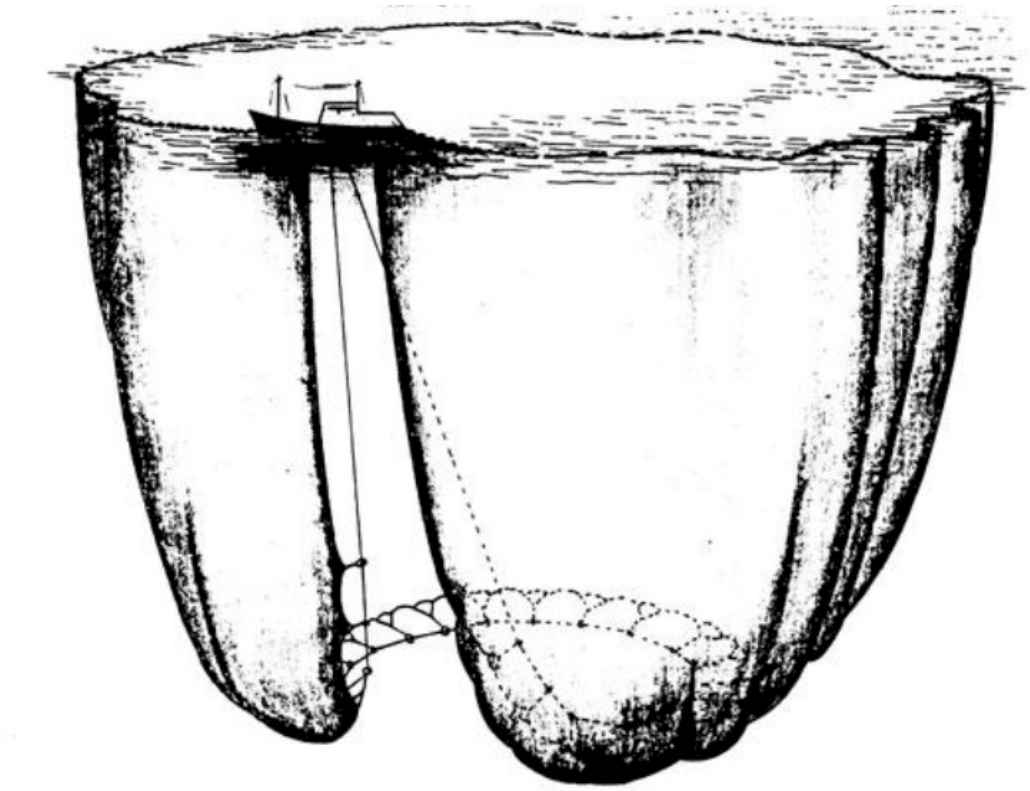

Figure 18: Visual description of a purse seine {FAO 2022}.

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Northwest Atlantic | Canada | Seine nets

Score: 4

A bar seine (Figure 19), which is also known as a tuck seine, is an alternative seine gear that is used in this fishery. The tuck seine operates as a modified purse seine: a school of fish is surrounded by the netting (typically using a larger vessel and a small “skiff” boat) and the leadline (opposite the float line) is drawn but not completely “pursed.”

This gear primarily does not contact the substrate (except when the water depth is less than the height of the seine during the fishing operations and the lower edge of the gear wipes the sea bottom). Therefore, bar/tuck seines are not considered to have a high impact on the seafloor. Although some seine nets do touch the bottom from time to time, the impact on benthic species and habitats is minimal (DFO 2021c)(DFO 2022a).

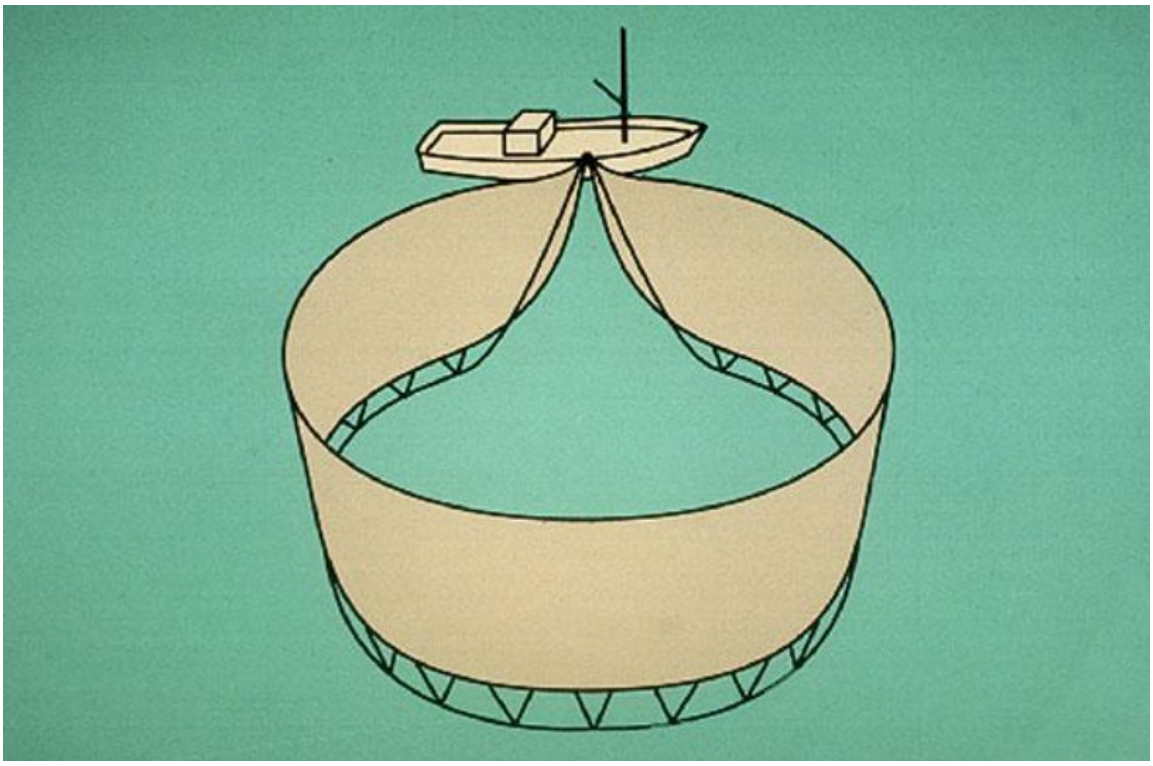

Figure 19: Modified purse seine, also known as a bar seine or "tuck" seine (FAO 2022b).

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

Score: 3

A trapnet (Figure 20), referred to here as a stationary uncovered pound net, is a large net that is usually divided into one or more chambers, anchored with a mooring system or fixed on stakes, and intercepts and traps fish during their migration or daily movement. The fixed posts are the only part of the structure that contacts the substrate; the impact of this contact is minimal (FAO 2024), so it is deemed a "low concern."

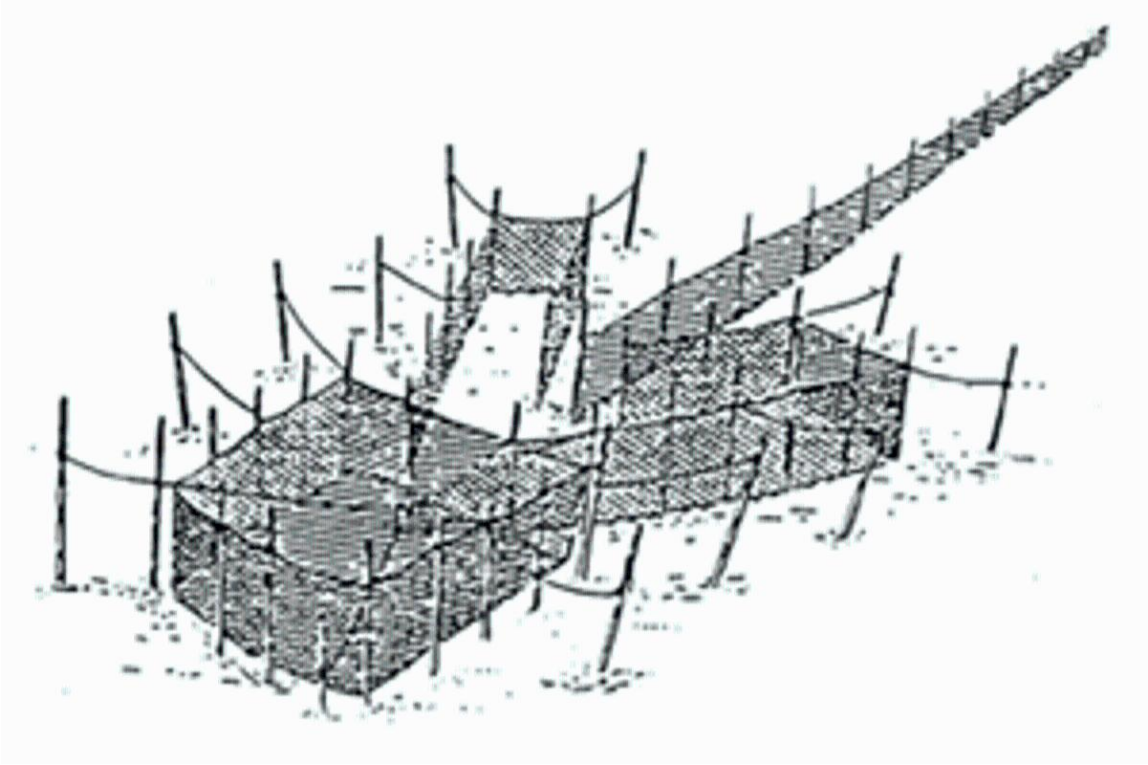

Figure 20: Stationary uncovered pound net, also known as a trapnet (FAO 2024).

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

+.5

A report on the impacts of fishing gears on the benthic environment was published by the Canadian Department of Fisheries and Oceans Canada (DFO) in 2010 and states: “When set on the bottom, traps [refers to netted traps or weirs] are usually set on substrate of low complexity. Thus, impacts are localized to the footprint of the trap and generally restricted to a reduction in available habitat. Little physical habitat modification occurs except for the anchoring mechanisms and driving of stakes in the sediment” (DFO 2010).

Since 2010, mobile gear restrictions have been in place to avoid disturbance to lobster habitat. Purse seine vessels are restricted from fishing in water depths less than 15 fathoms in that portion of the Bay of Islands, identified as follows: 1) in North Arm, inside a line drawn from Crabb Point (lat. 49°14', long. 58°12') to North Arm Point (lat. 49°11', long. 58°07'); 2) in Middle Arm, inside a line drawn from Northern Head (lat. 49°09', long. 58°07') to Middle Arm Point (lat. 49°08', long. 58°09').

Also, within the capelin fisheries regulations, fixed gear (specifically pertaining to trapnet/pound net)

harvesters are only allowed to fish a maximum of two traps, the traps cannot contain mesh size between 2 and 7 in, and traps may not be made of monofilament. Because gear modifications have been implemented (which are reasonably expected to be effective), and trapnets have been assessed to have minimum impacts on the substrate, this gear type appears to have moderate mitigation measures in place for the 4RST fishery (DFO 2021c)(DFO 2022a).

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Northwest Atlantic | Canada | Purse seines

Score: 0

Since 2010, mobile gear restrictions have been in place to avoid disturbance to lobster habitat. Purse seine vessels are restricted from fishing in water depths less than 15 fathoms in that portion of the Bay of Islands, identified as follows: 1) in North Arm, inside a line drawn from Crabb Point (lat. 49°14', long. 58°12') to North Arm Point (lat. 49°11', long. 58°07'); 2) in Middle Arm, inside a line drawn from Northern Head (lat. 49°09', long. 58°07') to Middle Arm Point (lat. 49°08', long. 58°09').

The DFO effectively controls fishing effort and intensity in the 4RST and 2+3 purse seine fisheries through the use of catch limits, seasonal closures, and area closures. DFO does not have explicit management plans to mitigate the benthic impacts of this gear type for this fishery (DFO 2021c)(DFO 2022a).

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Northwest Atlantic | Canada | Seine nets

Score: 0

Since 2010, mobile gear restrictions have been in place to avoid disturbance to lobster habitat. Purse seine vessels are restricted from fishing in water depths less than 15 fathoms in that portion of the Bay of Islands, identified as follows: 1) in North Arm, inside a line drawn from Crabb Point (lat. 49°14', long. 58°12') to North Arm Point (lat. 49°11', long. 58°07'); 2) in Middle Arm, inside a line drawn from Northern Head (lat. 49°09', long. 58°07') to Middle Arm Point (lat. 49°08', long. 58°09').

The DFO effectively controls fishing effort and intensity in the 4RST and 2+3 tuck seine fishery through the use of catch limits, season closures, and area closures. DFO does not have explicit management plans to mitigate the benthic impacts of this gear type for this fishery (DFO 2021c) (DFO 2022a).

Factor 4.3 - Ecosystem-based Fisheries Management

Gulf of St. Lawrence | Atlantic, Northwest | Canada | Barriers, fences, weirs, corrals, etc.
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Purse seines
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Seine nets
Gulf of St. Lawrence | Atlantic, Northwest | Canada | Stationary uncovered pound nets

High Concern

All main species caught within the 4RST capelin fishery are considered exceptional species. Both capelin and Atlantic herring are small forage species and play an integral role in the transfer of energy

from lower to higher trophic levels (DFO 2021c)(DFO 2021c){Chamberland et al. 2022}. Both Atlantic cod (*Gadus morhua*) and Atlantic salmon (*Salmo salar*) are secondary consumers and have shown that reductions in their biomass have led to trophic cascade effects. Marine mammals (cetaceans, seals) are top predators (tertiary consumers) that also play an integral role in the ecosystem by balancing/managing populations in the food web (Odum 1971)(Hislop 2013).

DFO has a Sustainable Fisheries Framework (developed through public consultation) that describes its commitment to implement the principles of ecosystem-based fisheries management (EBFM). The Sustainable Fisheries Framework provides the basis for ensuring that Canadian fisheries support the conservation and sustainable use of resources. The framework: (1) establishes a precautionary approach to fisheries management; (2) provides the basis for an ecosystem approach to fisheries management; (3) includes tools to monitor and assess environmentally sustainable initiatives; and (4) combines new and evolving fisheries management policies with current ones (DFO 2022i). Capelin harvesting levels are set that allow for the stock to grow and the mature biomass to increase. Consideration is given to the level of recruitment in this stock, and capelin fishing is managed such that catches are not concentrated in ways that result in high exploitation rates on any of the stock components (DFO 2021c).

Capelin was recognized as a species of ecological importance for the integrated management of the Gulf of St. Lawrence ecosystem, and the conservation objective is to ensure that capelin is not perturbed by human activities to a point where it cannot fill its role as an important element of the trophic network of the ecosystem. Therefore, a multidisciplinary, ecosystem-based approach is taken in the most recent 4RST capelin stock assessment, to improve upon the current data limitations by using preliminary estimates of capelin consumption by two important demersal predators and by using qualitative network modeling. The consumption of capelin by these demersal predators in the nGSL—Atlantic cod (*Gadus morhua*) and Greenland halibut (*Reinhardtius hippoglossoides*)—was considered from two perspectives: the interannual variation in the proportion of capelin in the diet of these predators as a potential indicator of capelin abundance, and the total annual consumption of capelin by these two predators to represent the lower limit of total consumption by all predators in the nGSL and comparing these estimates to fishing removals, to determine an upper bound of the ratio of fishing mortality to natural mortality, which in turn was used as an indicator of the sustainability of the fishery (ibid). The interannual variations in the proportion of capelin in the diet of predators roughly corresponded to those of commercial landings, suggesting common changes in the availability of capelin to both predators and the fishery (DFO 2021c).

In addition, preliminary results showed that the total annual consumption of capelin by Atlantic cod and Greenland halibut would be, on average, eight times higher than landings from the commercial fishery; because capelin consumption by these two predators only represents a portion of what is consumed annually in the nGSL, fishing mortality would only represent a small proportion of total mortality (ibid). In support of these results, and those obtained from previously published ecosystem models (Savenkoff et al. 2004){Savenkoff et al 2005}(Savenkoff et al. 2009), Ouellette-Plante et al. (2022) examined the stomach contents of Atlantic cod and Greenland halibut collected during the summer nGSL multispecies survey, and using a bioenergetics approach, estimated that annual capelin consumption by those two predators continued to be higher than the commercial landings recorded for the GSL. Considering that other predators of capelin were present in the ecosystem [see Table 3 in Ouellette-Plante et al. (2022) for a summary of capelin predators], the results suggest that fishing mortality

appears to be lower, or even much lower, than natural mortality (Ouellette-Plante et al. 2022).

Qualitative network modeling was also used in the current stock assessment to assess the relative importance of top-down and bottom-up ecosystem effects on stock productivity indices, based on available knowledge in the scientific literature and in consultation with experts, and entailed identifying the variables of interest/importance, as well as defining the direction (positive, negative, or neutral) of the links (effects) between the variables (DFO 2021c). The GSL capelin network comprised 25 variables, classified into 6 categories, including stock productivity parameters, environmental variables, the main competitors and predators of capelin, as well as fishing activities (Figure 21) (ibid). This network was then translated into a matrix of interaction coefficients for each pair of variables, and the effect of a sustained change (disturbance) in one or more components of the network was evaluated for the variables of interest (e.g., abundance of capelin). The results obtained need to be further corroborated, but even when combined with changes in prey, they indicated a positive effect of an increase in water temperature combined with a decrease in ice cover on the abundance of capelin (i.e., an increase in capelin abundance). Only an increase in directed fishing slightly decreased the probability of an increase in capelin abundance, but the positive effect of environmental variables remained predominant (DFO 2021c).

At the current catch level, fishing mortality has no noticeable effects on the capelin population. Nevertheless, it is unfeasible to evaluate how this population and the rest of the ecosystem would be affected by a significant catch increase, since capelin abundance fluctuations are mainly the result of natural causes (predation and spawning). Due to the capelin maximum lifespan being short (4–5 years), their abundance is subject to sudden changes because the population is only made up of a few age groups. And, although the commercial fishery may harvest a quite small proportion of total capelin biomass, it is recommended that any TAC increase should be made cautiously, due to the absence of a directed abundance survey and to capelin's role as a forage species in the marine ecosystem, and should not exceed 10% in a given year (DFO 2021c).

There appears to be no policy to protect the ecosystem role of these species, but DFO has a Sustainable Fisheries Framework that describes its commitment to implement the principles of EBFM, and there are multiple, ongoing studies of capelin and the ecosystem function of each species caught in the capelin fisheries (COSEWIC 2021)(COSEWIC 2023)(DFO 2021a)(DFO 2021c)(DFO 2021f).

The fishery is managed such that individual components of the stock are not subject to excessive exploitation, which pertains to having appropriate temporal and spatial management for the scale of the fishery; however, there is insufficient information to determine whether there are appropriate conservative, ecological harvest control rules that are consistent with the Lenfest Forage Fish Task Force Recommendations, because fishing mortality is poorly understood (and therefore cannot be compared to an appropriate level of take). Thus, EBFM is considered a "high concern."

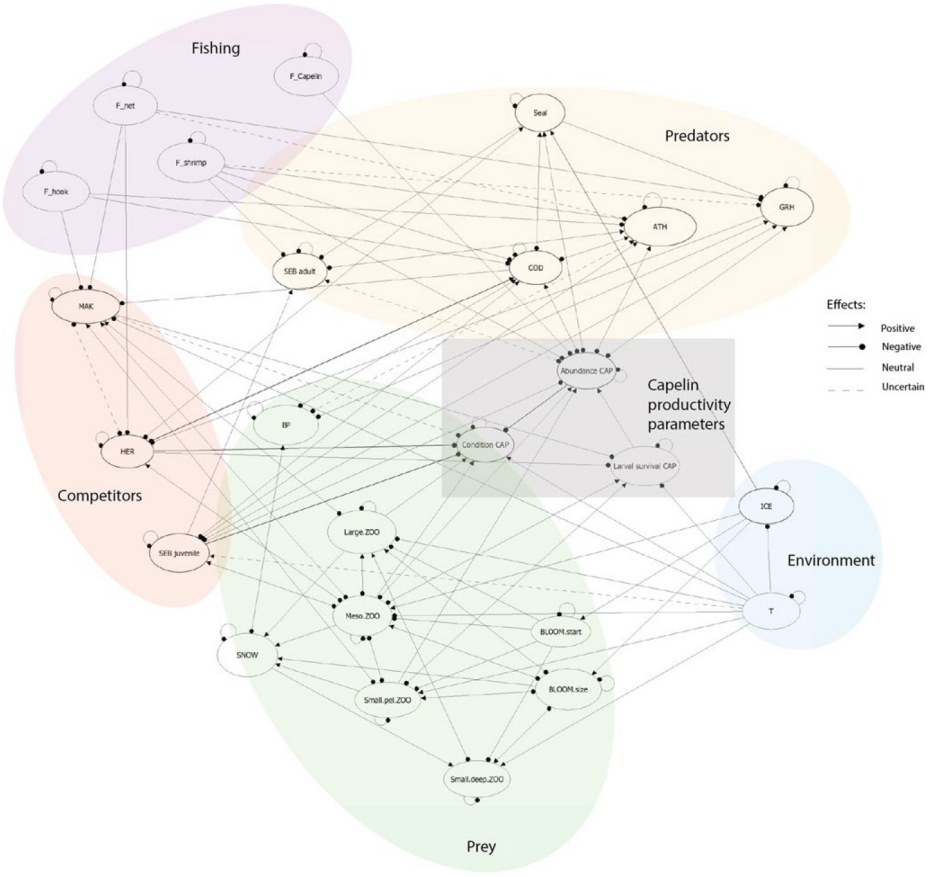

Figure 21: Conceptual model of capelin in the GSL ecosystem, including stock productivity parameters (gray box), environmental variables (blue bubble), lower GSL trophic levels (green bubble), a set of key competitors and predators (orange and yellow bubbles, respectively), and fishing activities (purple bubble). Arrows indicate positive links and dots indicate negative links (DFO 2021c). See DFO 2021c for more details.

Between the mid-1980s and mid-2000s, marine ecosystem models showed that capelin was the primary prey for the nGSL ecosystem, and represented around 50% of the consumed matter in the ecosystem; in the mid-1980s, the annual capelin consumption by its main predators was approximately one million tons (DFO 2021c). In the early 2000s, even with a steep decrease in cod and redfish abundances, almost 400,000 MT of capelin were still consumed by predators. More recent models, as well as stomach content analyses of capelin's main predators, show that it is not currently an important prey source for redfish or harp seal, but remains important prey for many other species in the ecosystem. Fishing mortality does not appear to have a noticeable effect on capelin at current catch levels, although this is impossible to evaluate, considering the absence of a directed capelin acoustic survey (ibid).

Capelin is one of the main species found in catches of the nGSL and sGSL multidisciplinary groundfish annual research surveys. Current research is attempting to decipher whether the occurrence of capelin and its realized niche varies as a function of the presence of its main predators (cod, halibut, and turbot). This research is a follow-up from recent observations that capelin was not

found in areas where cod was also being caught, and therefore might represent a form of predator avoidance (DFO 2021c).

Capelin is also regular bycatch in the shrimp fishery, and depending on the area fished, the number of capelin caught by shrimp harvesters can be significant. Some fishers avoid certain sectors (where capelin school) to avoid catching too many capelin. According to observers' data (coverage of 5%), capelin bycatch by shrimpers decreased significantly from 1993 (877 MT) to 1996 (113 MT), a direct consequence of the arrival of the Nordmore grid (an efficient bycatch-reducing device that is used in various shrimp trawl fisheries globally) (Larsen et al. 2019). Thereafter, capelin bycatch has fluctuated/decreased and reflects recent decreases in commercial shrimp landings (and likely efforts by the industry to avoid capturing capelin), occurring in 84% of tows (mean of ≈146 MT/year) between 2000 and 2019, 73% of tows (≈132 MT) in 2018, 92% of tows (≈88 MT) in 2019, and 60% of tows (≈100 MT) in 2020 (DFO 2021c){Chamberland et al. 2022}. The majority of capelin caught as bycatch by this fleet occurs in the lower estuary, the Northwest GSL, the Laurentian channel south of Anticosti Island, the Anticosti Channel, and the Esquiman Channel (Chamberland et al. 2022a).

Northwest Atlantic | Canada | Purse seines
Northwest Atlantic | Canada | Seine nets
Northwest Atlantic | Canada | Stationary uncovered pound nets

High Concern

All main species caught within the 2+3 capelin fishery are considered exceptional species. Both capelin and Atlantic herring are small pelagic species and play and integral role in the transfer of energy from lower to higher trophic levels (DFO 2022a){Chamberland et al. 2022}{DFO2022a}. Both Atlantic cod (*Gadus morhua*) and Atlantic salmon (*Salmo salar*) are secondary consumers and have shown that reductions in their biomass have led to trophic cascade effects. Marine mammals (cetaceans, seals) are top predators (tertiary consumers) and also play an integral role in the ecosystem by balancing/managing populations in the food web (Odum 1971)(Hislop 2013).

DFO has a Sustainable Fisheries Framework (developed through public consultation) that describes its commitment to implement the principles of ecosystem-based fisheries management (EBFM). The Sustainable Fisheries Framework provides the basis for ensuring that Canadian fisheries support conservation and sustainable use of resources. The framework: (1) establishes a precautionary approach to fisheries management; (2) provides the basis for an ecosystem approach to fisheries management; (3) includes tools to monitor and assess environmentally sustainable initiatives; and (4) combines new and evolving fisheries management policies with current ones (DFO 2022i). Capelin harvesting levels are set to allow for the stock to grow and the mature biomass to increase. Consideration is given to the level of recruitment in this stock, and capelin fishing is managed such that catches are not concentrated in ways that result in high exploitation rates on any of the stock components (DFO 2022a).

Capelin was recognized as a species of ecological importance for the integrated management of the Newfoundland and Labrador ecosystem, and the conservation objective is to ensure that capelin is not perturbed by human activities to a point where it cannot fill its role as an important element of the trophic network of the ecosystem. Therefore, a multidisciplinary, ecosystem-based approach is taken in the most recent 2+3 capelin stock assessment, to improve upon the current data limitations. The impacts of consumption by predators and fishing on the capelin stock were evaluated by estimating

the amount of capelin likely available in the ecosystem integrated (Integrated Capelin Availability; ICA) over a year (DFO 2022a). This was roughly estimated by a) assuming that the acoustic capelin index is an adequate proxy for the order of magnitude of the stock size (minimum estimate), and b) considering a production/biomass (P/B) ratio for capelin of 1.15 (Tam and Bundy 2019). Capelin consumption by finfish correlated reasonably well with the ICA derived from the spring acoustic survey, with both showing low levels in the 1990s, an increase in the mid-2000s, further elevated levels in the mid-2010s, and a decline in the late 2010s (DFO 2022a). The overall correlation between consumption and availability estimates, both in trajectory and general magnitude, implies that the results are logical approximations of these processes (ibid).

Overall, current removals from predation by fishes are large compared to the expected removals from the fishery; however, with declining predation and declining stock size, the proportional impact of fishing relative to consumption has increased, reaching (in 2019) similar levels to those of the mid- to late 2000s. Total capelin consumption estimates are unknown. Observations of prey consumption by fish predators (which does not include consumption by seals, whales, and seabirds), capelin distribution, growth rates, and maturation at age in 2019 are consistent with historical patterns of low capelin abundance (DFO 2022a). The impact of fishing mortality on the capelin stock is not quantified and is not well understood.

Capelin also interacts with lower trophic levels in marine food webs. Primary (chlorophyll) and secondary (zooplankton biomass) production indices have improved over the past 3–4 years. Recent changes in zooplankton community structure have resulted in fewer large, lipid-rich copepods, which are an important energy source for adult capelin, and increased abundance of small copepods (DFO 2019), which can result in poor foraging conditions for adult capelin (Buren et al. 2014) but better foraging conditions for larval capelin {Murphy et al. 2018}(DFO 2022a).

Ecosystem conditions continue to be indicative of limited productivity of the fish community. Total research vessel (RV) biomass levels are much lower than before the 1990s collapse. The increases in groundfish observed in the late 2000s and early 2010s seem to be associated with bottom-up processes, including a temporarily improved prey field, with modest increases in capelin availability in the mid-2010s, in comparison with the 1990s (Buren et al. 2019). More recent declines in total finfish biomass may be associated with simultaneous reductions in the availability of capelin and shrimp (which are important prey species in the ecosystem) (DFO 2022a).

There appears to be no clear policy to protect the ecosystem role of these species, but DFO has a Sustainable Fisheries Framework that describes its commitment to implement the principles of EBFM, and they conduct research activities both independently and in collaboration with other organizations. Current research projects on capelin include the development of limit reference points for capelin, identifying the drivers of recruitment variability in capelin, comparative capelin diet studies, and studies on the caloric value of current capelin prey (DFO 2022a).

The fishery is managed such that individual components of the stock are not subject to excessive exploitation, which pertains to having appropriate temporal and spatial management for the scale of the fishery; however, there is insufficient information to determine whether there are appropriate conservative, ecological harvest control rules that are consistent with the Lenfest Forage Fish Task Force Recommendations, because fishing mortality is poorly understood (and therefore cannot be compared to an appropriate level of take). Thus, EBFM is considered a “high concern.”

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Appendix A: Forage Species Determination

Version 4 of the Seafood Watch Standard for Fisheries (Seafood Watch 2020) updated requirements around "forage species" as follows {Seafood Watch 2020a}:

- Criterion 1: Acknowledges the high level of uncertainty associated with static reference points and lowers the score where B > B_{MSY} for forage species (relative to nonforage species). Specifically, static reference points with stationary parameters, such as unfished biomass and B_0, are not considered to meet this requirement for forage species, because of those species' dynamic productivity that shifts in response to environmental conditions.
- Criterion 3: Requires adaptive and flexible management to account for environmentally driven biomass and fluctuating populations (not just for forage species).
- Criterion 4: Requires a greater understanding of forage species' roles in the ecosystem to get a moderate concern score or better. Addition of a critical score when there is evidence of fisheries affecting the ecosystem (e.g., trophic cascades).

According to the glossary for the Version 4 of the Seafood Watch Standard for Fisheries (Seafood Watch 2020):

"Forage species play an important role in food webs because they 1) exhibit high connectance to other organisms in the ecosystem, and 2) a large amount of energy is channeled through those species. Forage species typically exhibit highly variable productivity, such that there may be high uncertainty in their reference points, making it difficult to evaluate their stock status. The drivers of this variability in productivity may be environmental forcing and/or other factors. As a result of their importance in food webs, these stocks require management that is tailored to their specific life histories and ecological roles. Species that generally qualify as forage species include sandeels, sandlances, herrings, menhaden, pilchards, sardines, sprats, anchovies, krill, lanternfish, smelts, capelin, mackerels, silversides, sand smelts, and Norway pout (adapted from MSC Fisheries Standard V2.01, p. 14). Other species or stocks may qualify if they meet the definition above."

To determine whether a species within a particular ecosystem is defined as a "forage species," it must fulfill both criteria in the glossary term: 1) exhibits high connectance, and 2) serves as a channel for a large amount of energy. To identify its potential key role, a forthcoming white paper commissioned by Seafood Watch computed three indices using data and food webs applied to existing static ecosystem models. The connectance index and the Supportive Role to Fishery ecosystems (SURF) index were calculated from mass-balanced models and an energy index from energy-balanced models. Excerpts from that study are presented as follows. The supporting data are available upon request.

Northwest Atlantic, Canada

The model area as considered for the Northwest Atlantic Canadian model by Tam and Bundy (2019) comprises the southern part of the Labrador Shelf, the Northeast Newfoundland Shelf, and the Grand Bank, and stretched up to the 1,000 m isobaths offshore (Figure 10). The area has a size of approximately 495,000 km^2 and includes most major commercial species. The authors developed this model to assess the general functioning of the ecosystem between 2013 and 2015, when the biomasses of major commercial species were relatively constant.

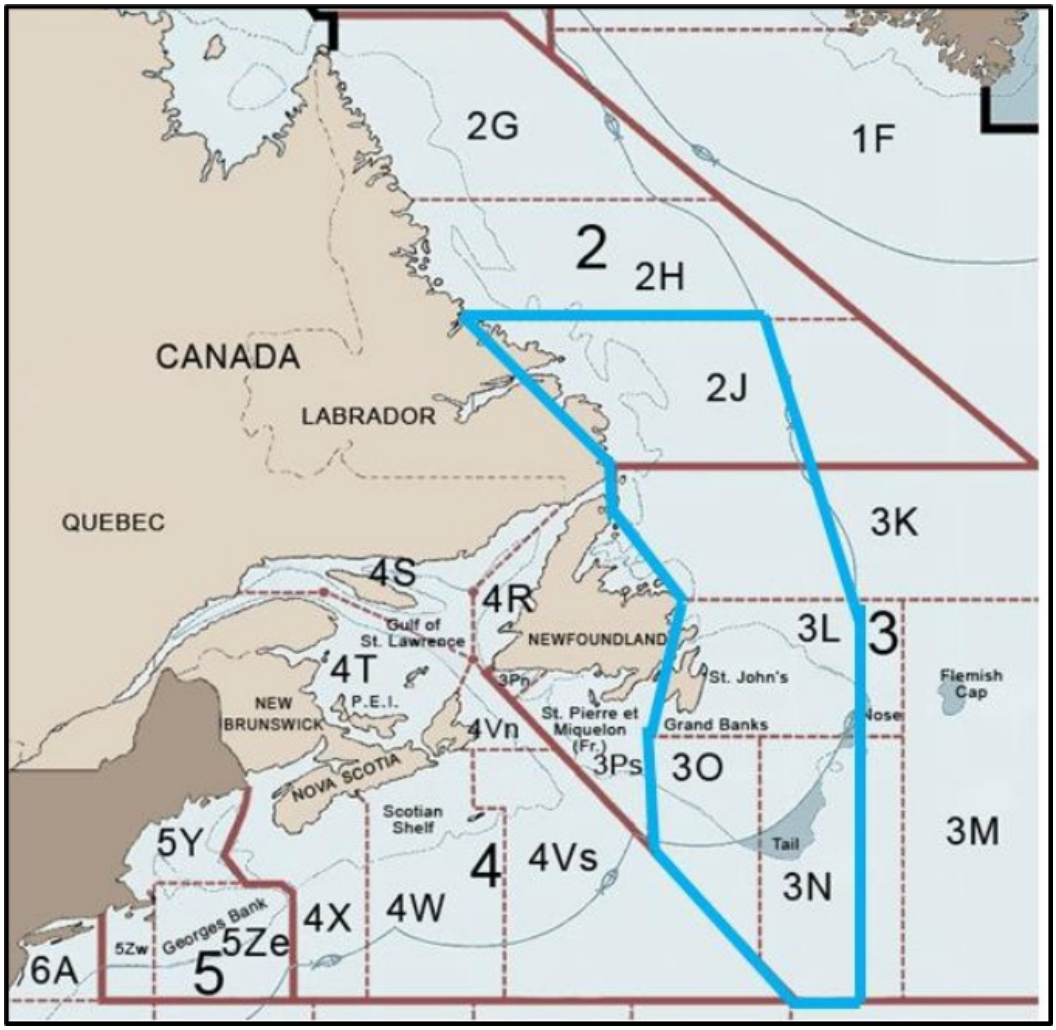

Figure 10: Model area of the model developed for the Northwest Atlantic (Canada) by Tam and Bundy (2019) as indicated by the solid blue line. Image copied from Tam and Bundy (2019).

Northern Gulf of St. Lawrence, Canada

Morisette et al. (2003) developed a food web model for the northern Gulf of St. Lawrence. This gulf is in the Northwest Atlantic Ocean and is semi-enclosed by the Canadian mainland in the north, west, and south, and by Newfoundland in the east (Figure 11). The total area of this gulf is about 200,000 km^2, ranging from approximately 51.4° to 47.4° N. and 67.3° to 56.9° W., with almost half this area exhibiting deep channels (see Figure 11). Its waters are connected to the Atlantic Ocean by the Cabot Strait in the south and the Strait of Belle-Isle in the north, through which it is supplied with relatively warm water and cold water, respectively. in addition, a vast amount of freshwater enters through several large rivers, including the St. Lawrence River. The modeled area covered a total area of 103,812 km^2, excluding the shallow water zone. The northern Gulf of St. Lawrence's ecosystem is characterized by phytoplankton, a low diversity of large zooplankton species, a relatively low abundance of fish (mainly cod, herring, and redfish), and a high abundance of juvenile fish (primarily capelin, *Mallotus villosus*) (de Lafontaine et al., 1991). Morisette et al. (2003) developed this model to assess trophic flows of this ecosystem during the mid-1980s before the groundfish stock collapses. Diet

data from this period relevant to the region were used for functional groups in the model where possible.

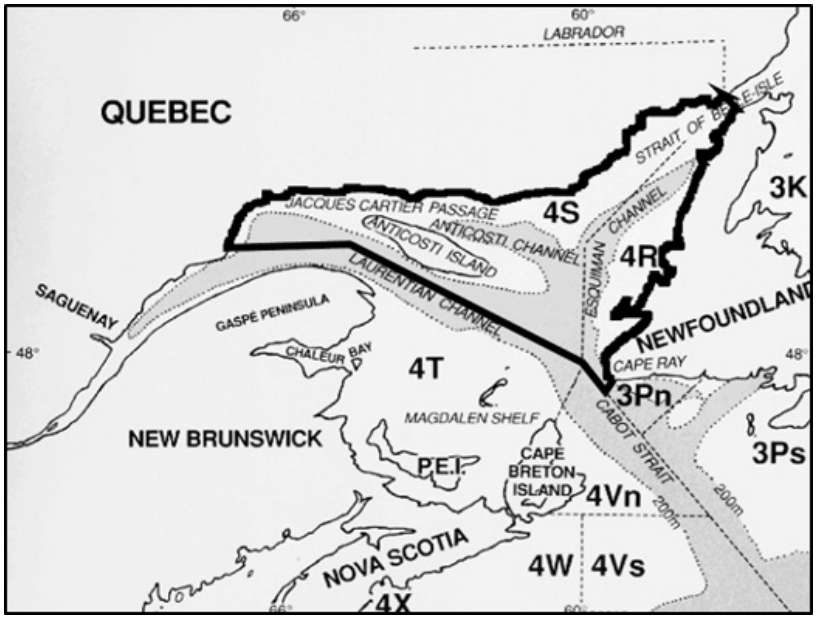

Figure 11: The model area of the northern part of the Gulf of St. Lawrence (NAFO zones 4RS, bold black outline) as considered in the food web model by Morisette et al. (2003). Also shown are the deep channels, with depths over 200 m in grey, and the straits. Image copied from Morisette et al. (2003).

Results

Capelin meets the Seafood Watch definition of forage species in both the Northwest Atlantic and Gulf of St. Lawrence ecoregions. In the Northwest Atlantic, capelin was modeled as part of a guild alongside other planktivorous fish.

Table 3

Ecosystem Model	Model Group Name	Scientific Name	Connectance	SURF	Energy
Northwest Atlantic, Canada	Herring	*Clupea harengus*	KEY		
	Other planktivorous fish (including capelin)		KEY	KEY	KEY
Gulf of St. Lawrence, Canada	Capelin	*Mallotus villosus*	KEY	KEY	KEY

Appendix B: Catch Composition in Canadian Capelin Fisheries

Year	Area	Gear	Species	Obs Kept Weight (kg)	Obs Discard Weight (kg)	Obs Total Caught (kg)	% of Kept Capelin	Recorded Landings (mt)	% Obs	Extrapolation (mt)	Extrap. Catch Comp (%)
2011	4R	Purse Seine	Capelin (Kept only)	233,145	n/a	233,145	100	10,033	3.78	10,033	89.09
2011	4R	Purse Seine	Capelin (Discards only)	n/a	100	100	0.04	Not Recorded	3.78	4.013	0.04
2011	4R	Purse Seine	Herring (Kept only)	27,265	n/a	27,265	11.69	Not Recorded	3.78	1172.858	10.41
2011	4R	Purse Seine	Herring (Discards only)	n/a	10	10	0.004	Not Recorded	3.78	0.401	Negligible
2011	4R	Purse Seine	Cod	0	1,180	1,180	0.51	Not Recorded	3.78	51.167	0.45
2011	4R	Purse Seine	Salmon	0	5	5	0.002	Not Recorded	3.78	0.201	Negligible
Total										11,262	100
2011	3K	Purse Seine	Capelin (Kept only)	35,588	n/a	35,588	100.00	8,139	0.97	8,139	99.57
2011	3K	Purse Seine	Capelin (Discards only)	n/a	115	115	0.32	Not Recorded	0.97	26.045	0.32
2011	3K	Purse Seine	Herring	0	37	37	0.10	Not Recorded	0.97	8.139	0.10
2011	3K	Purse Seine	Cod	0	5	5	0.01	Not Recorded	0.97	0.814	0.01
Total										8,174	100
2011	3L	Purse Seine	Capelin	119,283	n/a	119,283	100.00	11,966	3.22	11,966	99.46
2011	3L	Purse Seine	Capelin (Discards only)	n/a	426	426	0.36	Not Recorded	3.22	43.08	0.36
2011	3L	Purse Seine	Herring	0	189	189	0.16	Not Recorded	3.22	19.146	0.16
2011	3L	Purse Seine	Cod	0	27	27	0.02	Not Recorded	3.22	2.393	0.02
Total										12,031	100

Figure 12: 2011 catch composition report (DFO 2014)(SFW 2014).