Snow Crab

Chionoecetes opilio

Canada: Atlantic Coast

Pots

Report ID 802

September 6, 2022

Seafood Watch Standard used in this assessment: Fisheries Standard v3

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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

This report provides analysis and recommendations for the commercial fishery for snow crab (*Chionoecetes opilio*) on the Canadian Atlantic Coast. The fishery harvests snow crab exclusively with traps (pots). Fisheries and Oceans Canada (DFO) manages the fishery. Scores are provided for four fisheries (regions), which together compose the Canada Atlantic snow crab fishery. The fisheries are: Newfoundland and Labrador (NFL), Northern Gulf of St. Lawrence and Estuary (nGSL), Southern Gulf of St. Lawrence (sGSL), and Maritimes (i.e., Eastern Nova Scotia).

Criterion 1 scored Yellow for the NFL and nGSL fisheries, and Green for the sGSL and Maritimes fisheries. Concerns about fisheries that scored lower included uncertainty regarding snow crab abundance, high or uncertain exploitation rates, and a lack of reference points to more confidently determine the stock status.

Criterion 2 includes several species that are captured as by-catch in snow crab traps, used as bait in the fishery, or affected by the fishing gear. Endangered North Atlantic right whale and leatherback sea turtle, as well as a group of highly vulnerable marine mammal species, were included due to a known risk of entanglement in snow crab fishing gear. Depleted stocks of Atlantic herring were also included because they are used as bait in snow crab fisheries. Due to scores from one or more of these species, Criterion 2 was Red for all assessed snow crab fisheries.

Criterion 3 scored Red for all snow crab fisheries. This is primarily due to ineffective by-catch strategies. Data collection regarding by-catch is in need of improvement for most snow crab fisheries, and additional management measures to protect at-risk species are needed. Management measures to protect North Atlantic right whale, in particular, are considered ineffective because the impact of fisheries threatens the population with extinction. Although data collection for snow crab stock assessments is excellent in some fisheries, additional data to support stock assessment models are needed in other snow crab fisheries.

Criterion 4 scored Green for all snow crab fisheries. Snow crab traps present a moderate impact on ocean bottom habitat, but the closure of areas of vulnerable habitats (e.g., corals and sponges) reduces the likelihood of impacts. Harvest levels of snow crab are unlikely to cause large scale impacts to the food web. Management plans are in place for all snow crab fisheries, with some measures in place to protect the ecosystem and snow crab's role.

In summary, all Atlantic Canada snow crab fisheries received an overall recommendation of Avoid (i.e., Red).

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Snow crab | Northwest Atlantic | Pots | Canada | Maritimes Region	4.284	1.000	1.000	3.742	**Avoid (2.001)**
Snow crab | Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence	3.873	1.000	1.000	3.742	**Avoid (1.951)**
Snow crab | Northwest Atlantic | Pots | Canada | Newfoundland and Labrador	2.644	1.000	1.000	3.742	**Avoid (1.774)**
Snow crab | Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary	2.644	1.000	1.000	3.742	**Avoid (1.774)**

Summary

Snow crab caught in the Canadian Atlantic are rated an Avoid, due to the risk of entanglement causing mortality and serious injury to the endangered North Atlantic right whale and for the ineffectiveness of management measures to reduce the impact of fisheries in the region.

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 Concern2, 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

This report covers wild snow crab (*Chionoecetes opilio*) trap/pot fisheries on the Canada Atlantic Coast. The Canadian fishery takes place from Labrador (north) to Nova Scotia (south), and includes the Gulf of St. Lawrence and Estuary. All the snow crab landed on the Canada Atlantic Coast is caught through directed trap fisheries, because no other fisheries are permitted to land snow crab. This report provides recommendations for the four Canadian Snow Crab management regions: Newfoundland and Labrador (NFL), Northern Gulf of St. Lawrence and Estuary (nGSL), Southern Gulf of St. Lawrence (sGSL), and Maritimes (Eastern Nova Scotia). Management of snow crab fisheries within each region is further divided into Crab Fishing Areas (CFAs) or Assessment Divisions (Divisions). Fishery sustainability recommendations were only provided at the regional level. The snow crab management regions in this report include the following CFAs and Divisions:

Region	CFAs or Divisions
Newfoundland and Labrador (including west coast of Newfoundland within Gulf of St. Lawrence)	Divisions 2HJ, 3K, 3L Inshore, 3LNO, 3PS, 4R3Pn
Northern Gulf of St. Lawrence and Estuary (Quebec Province primarily)	CFAs 13–17, 12A, 12B, 12C, 16A
Southern Gulf of St. Lawrence	CFAs 12, 12E, 12F, 19
Maritimes (all areas off Nova Scotia *except* the west coast)	Divisions N-ENS, S-ENS, 4X

Species Overview

Snow crab has a flat, round carapace (shell) and long, slender legs. Younger snow crabs are reddish on top, but crabs appear more greenish or brown as they get older. In the Atlantic Ocean, the southern extent for snow crab is the Gulf of Maine (United States) and it ranges as far north as Greenland (Szuwalski 2019). In the Pacific Ocean, snow crab is found throughout the continental shelf of the Bering, Chukchi, and Beaufort seas, as well as in the Sea of Okhotsk (a subspecies, *Chionoecetes opilio elongates*, exists in the Sea of Japan). The species is also found in the Arctic region (Barents Sea) (Lorentzen et al. 2018). Male snow crabs can grow to a maximum carapace width (CW) of about 150 mm, while females only reach about 90 mm CW (Alunno-Bruscia, M. and B. Sainte-Marie 1998)(FAO 2020a). The Canadian snow crab fishery harvests only crabs equal to or above 95 cm CW, which precludes female crabs from harvest. Snow crabs grow by molting, undergoing several molts before reaching a terminal molt. For males, the terminal molt occurs at approximately 40–150 mm CW and 8–10 years of age (Sainte-Marie et al. 1995). On the Atlantic coast of Canada, molting of males larger than 40 mm CW occurs annually between late winter and early summer, while females molt to maturity from February to April (Sainte-Marie and Hazel 1992)(Sainte-Marie et al. 1995). After molting, crabs have a soft shell for 2–5 months and are called soft-shell crab or white crab, depending on the carapace hardness and other morphological features (Hebert et al. 2019). Physiological maturity in males occurs at approximately 37–39 mm CW, while females mature at approximately 40–74 mm CW and at 5–7 years old (Sainte-Marie et al. 1995)(Alunno-Bruscia, M. and B. Sainte-Marie 1998). An average female produces between 35,000 and 46,000 eggs, but females that carry multiple egg clutches may produce up to 100,000 eggs (Sainte-Marie 1993). Both sexes may live 5–7 years after the terminal molt (Dawe et al. 2012). Snow crab is found at depths from 20 to 1,200 m (in higher densities at 70–280 m in the Atlantic), primarily on mud/silt substrate, and in water temperatures from –1 to 10 °C (Elner 1982)(Tremblay 1997)(FAO 2020a). In addition, colder temperatures during early life history may be linked to increased survival and recruitment (Marcello et al. 2012). Predators of snow crab include Atlantic halibut (*Hippoglossus hippoglossus*), Atlantic wolffish (*Anarhichas lupus*), skate spp.,

Atlantic cod (*Gadus morhua*), seals, American plaice (*Hippoglossoides platessoides*), squids, and crabs, including cannibalism by snow crabs {Lovrich and Sainte-Marie 1997}(DFO 2016).

The Canadian snow crab fishery is managed by Fisheries and Oceans Canada (DFO), which partitions the Atlantic snow crab fishing grounds into 4 management regions and 44 CFAs (Figure 1). DFO conducts stock assessments of snow crab for each region. Some DFO snow crab stock assessments provide information at the CFA level within a region, while others evaluate stocks within Divisions that do not necessarily correspond to Northwest Atlantic Fisheries Organization (NAFO) divisions.

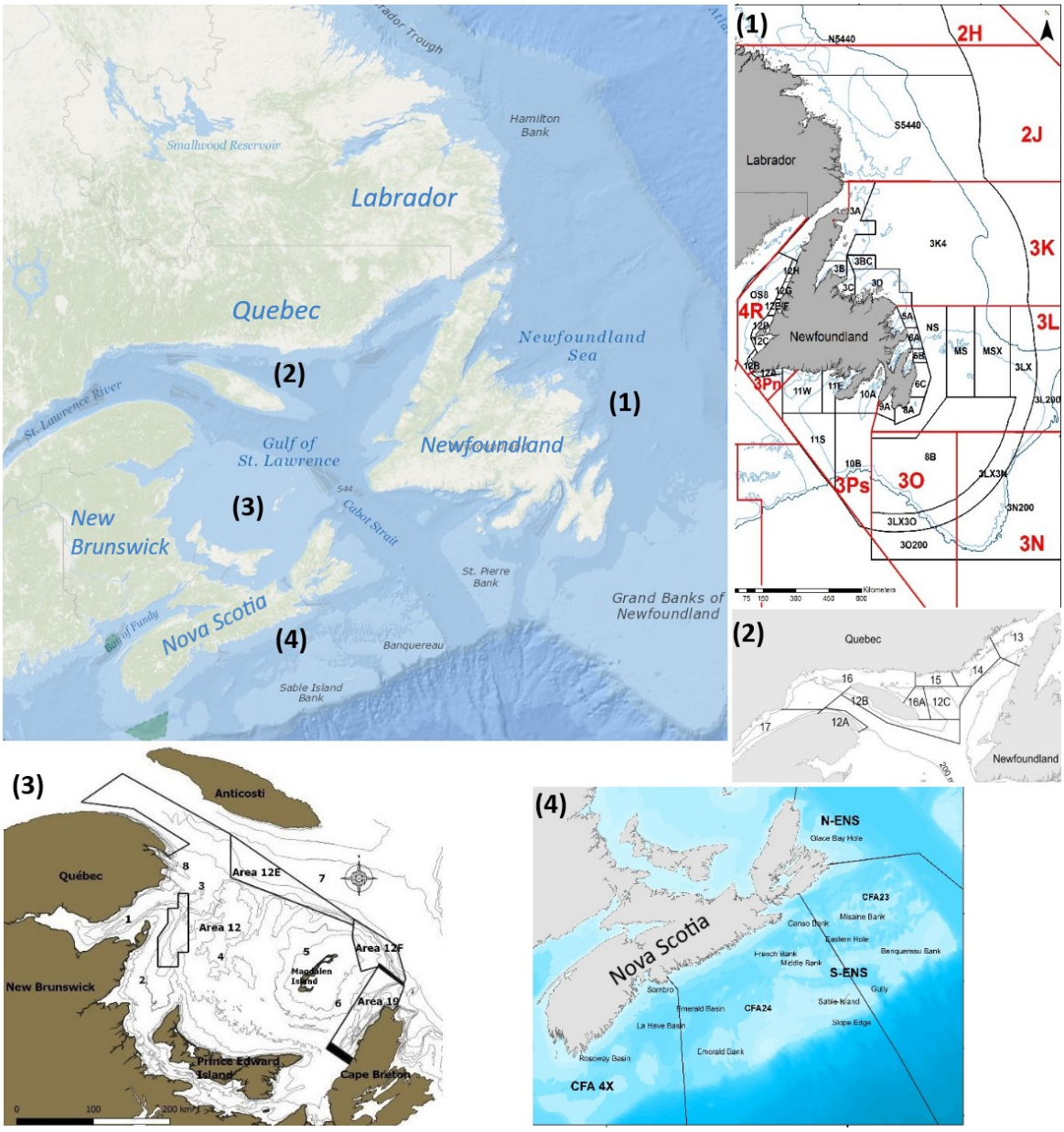

Figure 1: (Top left) Map of eastern Canada with labeled numbers 1–4 corresponding to inset maps of four DFO snow crab fishery management regions, as follows: (1) NFL Region with Divisions labeled and delineated with red font/lines; (2) nGSL Region with eight CFAs labeled; (3) sGSL Region with four CFAs labeled; (4) Maritimes Region with three Divisions labeled in bold font.

In 2019, the Atlantic snow crab fishery was the fourth-largest Canadian fishery by volume and the second-largest in value (CAN 773 million) (DFO 2020a)(DFO 2020b). The targeted commercial market for snow crab expanded in the late 1970s; landings fell in the late 1980s, then increased from approximately 26,000 metric tons (t) in 1990 to a peak of over 100,000 t in 2002 (Figure 2). Landings were consistently high since the late 1990s but decreased notably in 2018. The snow crab fishery in Canada uses baited traps, typically conical shaped, with lines attached to floating buoys.

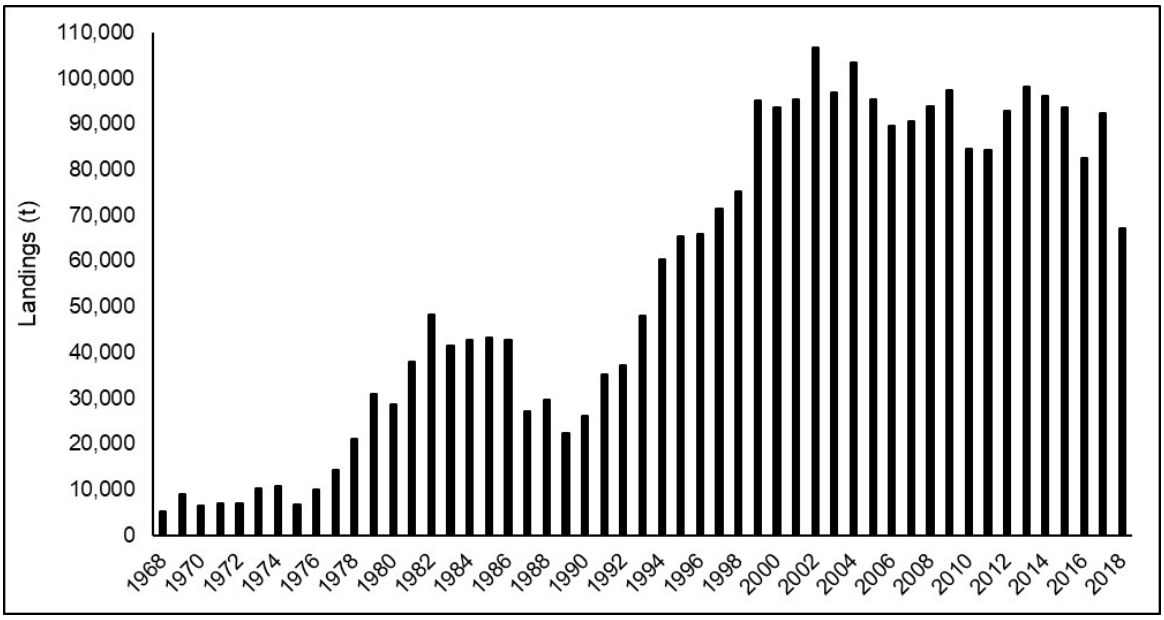

Figure 2: Commercial landings (t) of Canadian snow crab (*C. opilio*), 1968–2018 (FAO 2019).

Production Statistics

Global production has generally increased over time, reaching a peak of over 184,000 t in 1998 (FAO 2019). Global production of snow crab has historically been dominated by Canada with the United States providing substantial production, while in recent years, Russia has contributed to production (Figure 3) (FAO 2019). Some landings of *C. opilio* may also occur in Japan and Korea, but these landings could not be confirmed through FAO statistics. Snow crab production in the U.S. dropped to historic lows during the early 2000s in response to the overfished condition of the stock. U.S. production gradually increased after 2005 but declined again after 2015 (FAO 2019). In contrast to Canada and United States production trends, Russia's production increased in 2018. FAO (2019) reported that the average contributions to global production in 2014–2018 were approximately 76% from Canada, 17% from the United States, and 7% from Russia. Within Atlantic Canada, snow crab landings varied annually among management regions in 2014–2018 (Figure 4); based on data from DFO snow crab stock assessments, landings in 2014–2018 averaged approximately 40,150 t in NFL, 24,550 t in sGSL, 9,725 t in Maritimes, and 8,900 t in nGSL.

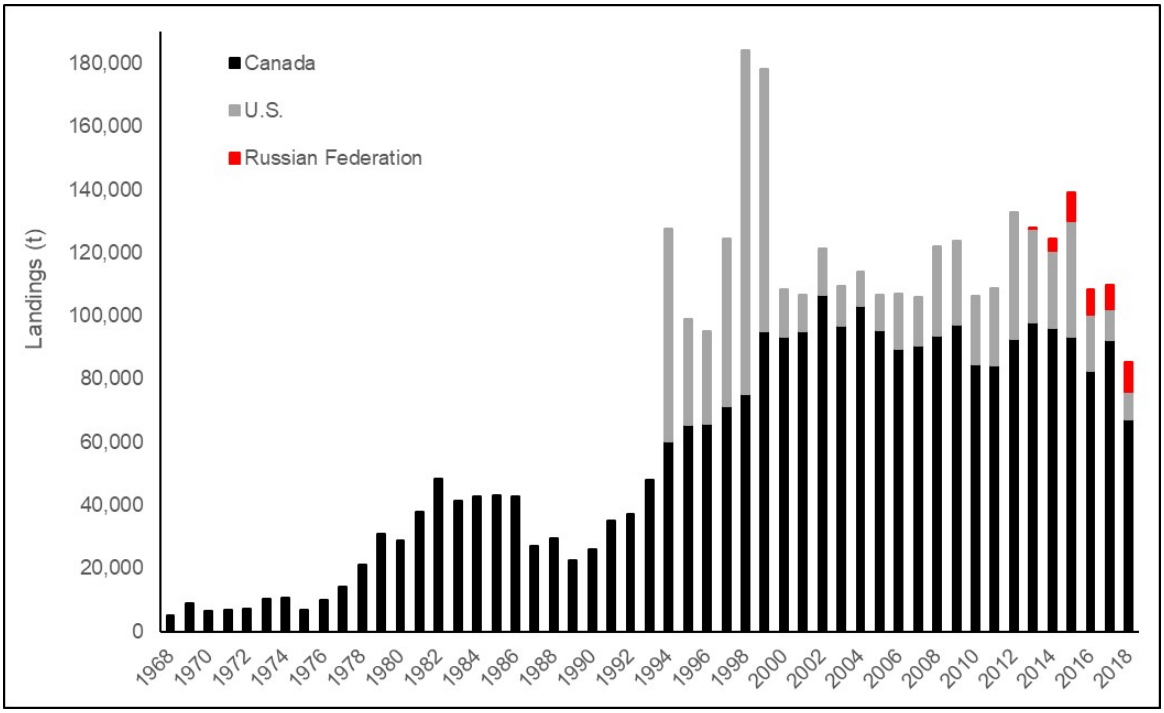

Figure 3: Worldwide snow crab (*C. opilio*) commercial fishery landings (t) by country, 1968–2018 (FAO 2019).

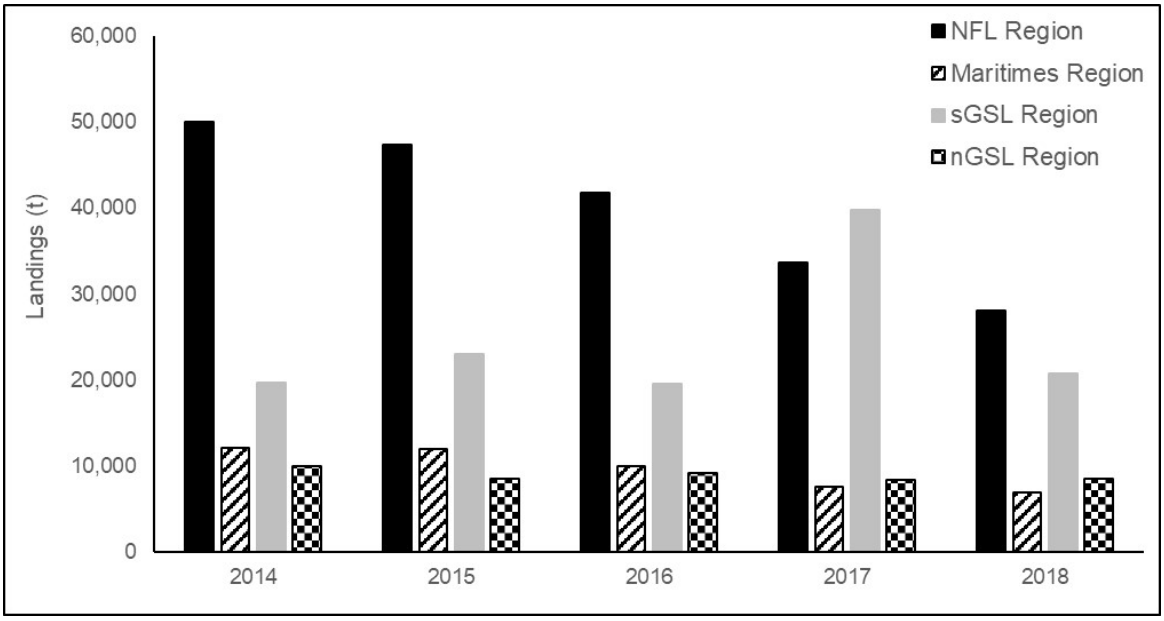

Figure 4: Snow crab landings (t) in Atlantic Canada by DFO management region, 2014–2018 (Data from (DFO 2019a)(DFO 2019b)(DFO 2020c)(DFO 2020d)).

Importance to the US/North American market.

The supply of snow crab in the United States exceeded 49,600 t round weight in 2018, with roughly 88% of this supply being imported (NOAA 2019a)(NOAA 2020a). The 2018 U.S. supply of snow crab was the lowest since 2005 (NOAA 2013). Approximately 66% of snow and tanner crab U.S. imports in 2018 were from Canada and approximately 27% were from Russia (NOAA 2019a). In 2018, approximately 62% of

U.S. snow and tanner crab landings were exported (NOAA 2020a); the majority of exports went to China and Japan (NOAA 2019a). Much of the snow crab exported to China is for meat extraction and subsequent export to Japan (DFO 2016). The supply of snow/tanner crab in the U.S. in 2018 was over three times greater than that of king crab, another high value crab species (NOAA 2020a).

Common and market names.

Snow crab, queen crab, Zuwai-gani (Japan)

Primary product forms

The most common product form of snow crab processed in Canada is frozen leg sections, mainly for export to Japan and the United States, but also available at local Canadian markets (Weston 2011). Extracted meat (typically reprocessed in countries outside Canada) is another common form of snow crab. DFO reports that whole (shelled) cooked crab is another product form that makes up a small percentage of exports to Japan (pers. comm., DFO staff, June 4, 2020).

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

SNOW CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Atlantic | Pots | Canada | Maritimes Region	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence	5.000: Very Low Concern	3.000: Moderate Concern	Green (3.873)
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

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 Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target 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 below 75% 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 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough 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.*

Snow crab

Factor 1.1 - Abundance

Northwest Atlantic | Pots | Canada | Maritimes Region

Low Concern

Abundance reference points were defined in the most recent DFO stock assessment for the Maritimes Region (DFO 2020c). A fishable biomass index was estimated using a lattice-based approach, new to this stock assessment, that models snow crab numerical abundance with environmental factors (depth, substrate, temperature) and biological factors (species composition) as covariates. This index was coupled with a logistic population dynamics fishery model to determine fishable biomass as well as carrying capacity, which was used as the biological reference point for abundance (DFO 2020c). DFO (2020c) indicates that fishable biomass was above the upper stock reference (USR) in the two divisions (N-ENS and S-ENS), with the vast majority (roughly 99%) of the estimated biomass and fishery landings occurring in the Maritimes. Based on the precautionary approach (as defined by DFO), Division N-ENS moved from the cautious zone in 2018 to the healthy zone in 2019, while Division S-ENS was already in the healthy zone before 2019. Fishable biomass was below the USR in Division 4X, but above the limit reference point (LRP), and the stock assessment notes that the biomass estimate for this division is much less certain than for other divisions (DFO 2020c).

For all three divisions, biomass estimates in 2019 were at intermediate levels relative to the time series, which began in 2001 (Figure 5) (DFO 2020c). Snow crab biomass in Divisions N-ENS and S-

ENS increased in the recent few years, while Division 4X showed flat abundance trends. Fishery catch per unit effort (CPUE) was at moderate levels in Divisions N-ENS and S-ENS relative to the time series that began in 2010, while CPUE in 4X was relatively high.

Because biomass was above the USR in the divisions with the majority of the estimated biomass in the Maritimes, but was below the USR and less certain in Division 4X, abundance is considered a low concern.

Justification:
The LRP is 25% of carrying capacity (CC) and the USR is 50% of CC for each division within the Maritimes Region (DFO 2020c). The post-fishery, fishable biomass (segment of the snow crab biomass that is male, mature, and above 95 mm CW) index is calculated using an expanded area trawl survey. The estimate of the CC and the 95% confidence interval (CI) for Division N-ENS in 2019 was 6,770 t (5,340 t, 8,520 t); therefore, the USR was approximately 3,385 t and the LRP was approximately 1,692 t. Fishable biomass was estimated at 4,460 t in Division N-ENS in 2019, above the USR. The estimate of the CC (and 95% CI) for Division S-ENS in 2019 was 76,300 t (64,300 t, 91,300 t); therefore, the USR was approximately 38,150 t and the LRP was approximately 19,075 t. Fishable biomass was estimated at 54,408 t in S-ENS in 2019, above the USR. The estimate of the CC (and 95% CI) for Division 4X in 2019 was 2,120 t (1,570 t, 2,780 t); therefore, the USR was approximately 590 t and the LRP was approximately 290 t. Fishable biomass was estimated at 418 t in 4X in 2019, which is above the LRP but below the USR.

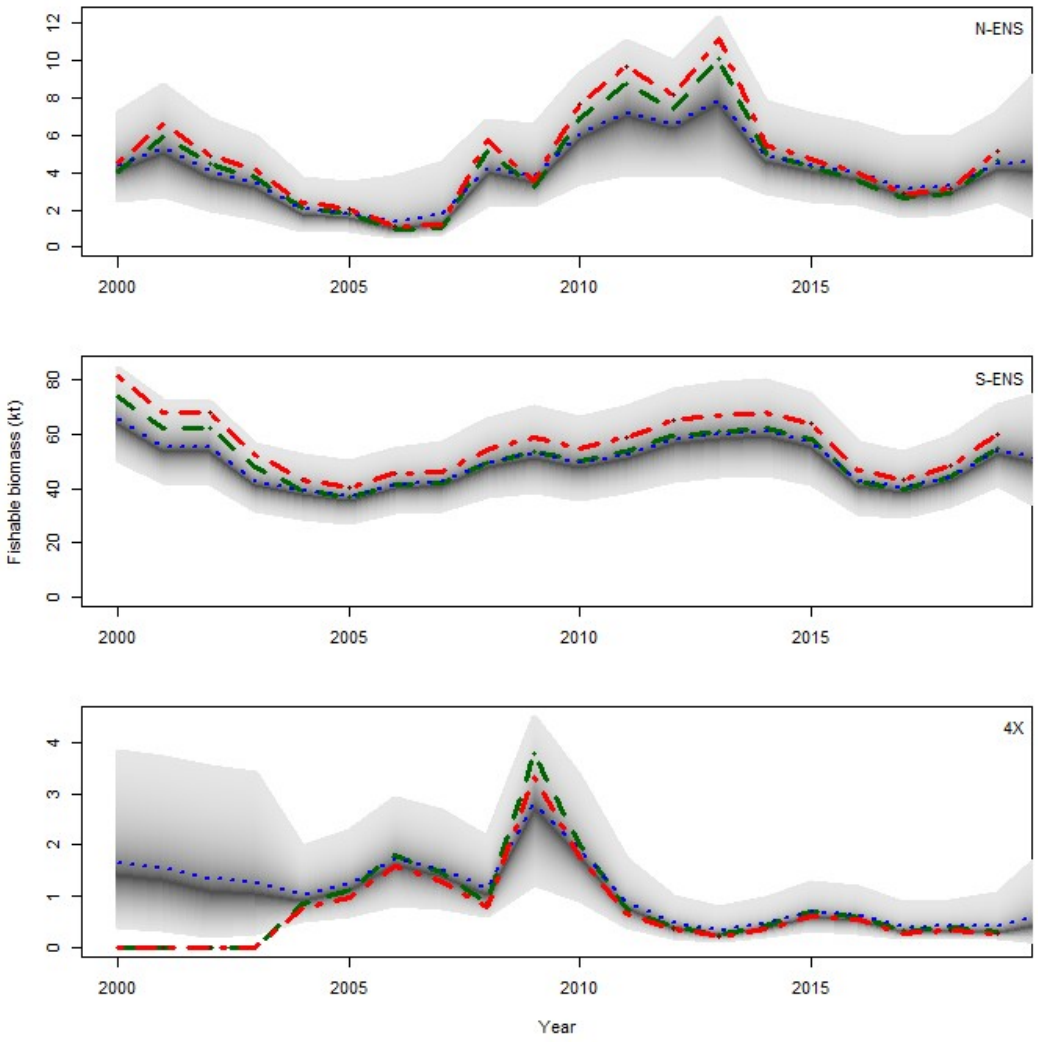

Figure 5: Time series of fishable snow crab biomass in three divisions of the Maritimes region from the logistic population models. The fishable biomass index is shown in red dashed lines. The q-corrected (model catchability coefficient) fishable biomass index is shown in green dashed lines. Posterior mean fishable biomass estimates from the logistic model are shown in blue stippled lines. Density distribution of posterior fishable biomass estimates are presented with 95% confidence interval (grey). From (DFO 2020c).

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

Moderate Concern

Stock status of snow crab in the Newfoundland and Labrador (NFL) region is assessed annually; the most recent assessment was in 2022 (DFO 2022b).

Reference points for snow crab biomass in the Newfoundland and Labrador (NFL) region were used to evaluate stock status in the most recent stock assessment as part of a proposed precautionary approach (PA) framework (DFO 2022b). Limit reference points (LRPs) were developed through a peer-review process for three metrics: fishery catch per unit effort (CPUE), the proportion of female crabs with full egg clutches, and discards (Mullowney et al. 2018). Upper stock reference points

(USR) have been proposed but have not been accepted at this time, and zones (e.g., Healthy, Cautious, Critical) have not been defined (DFO 2022b). The PA framework has not been accepted for use in management of snow crab in NFL; however, DFO Science staff were confident in the peer-reviewed LRPs for assessing stock status in NFL (pers. comm., Julia Pantin September 10, 2020).

Trawl and trap indices of abundance have identified an increase in exploitable biomass during the last 3 years from historical lows, while fishery CPUE increased to or remained near the time-series average in 2020 in all assessment divisions except two, which were near all-time highs (Figures 6, 7, and 8) (DFO 2022b). CPUE and the proportion of egg clutches are above the LRPs in all areas in 2020 (DFO 2022b) (Figure 9). Recruitment prospects for the next 2–4 years are favorable in most assessment divisions, based on pre-recruit abundance and recent climate conditions (DFO 2022b). Because the snow crab stock indicators in NFL were above LRPs in all assessment divisions, but no upper reference point has been determined, abundance is considered a moderate concern.

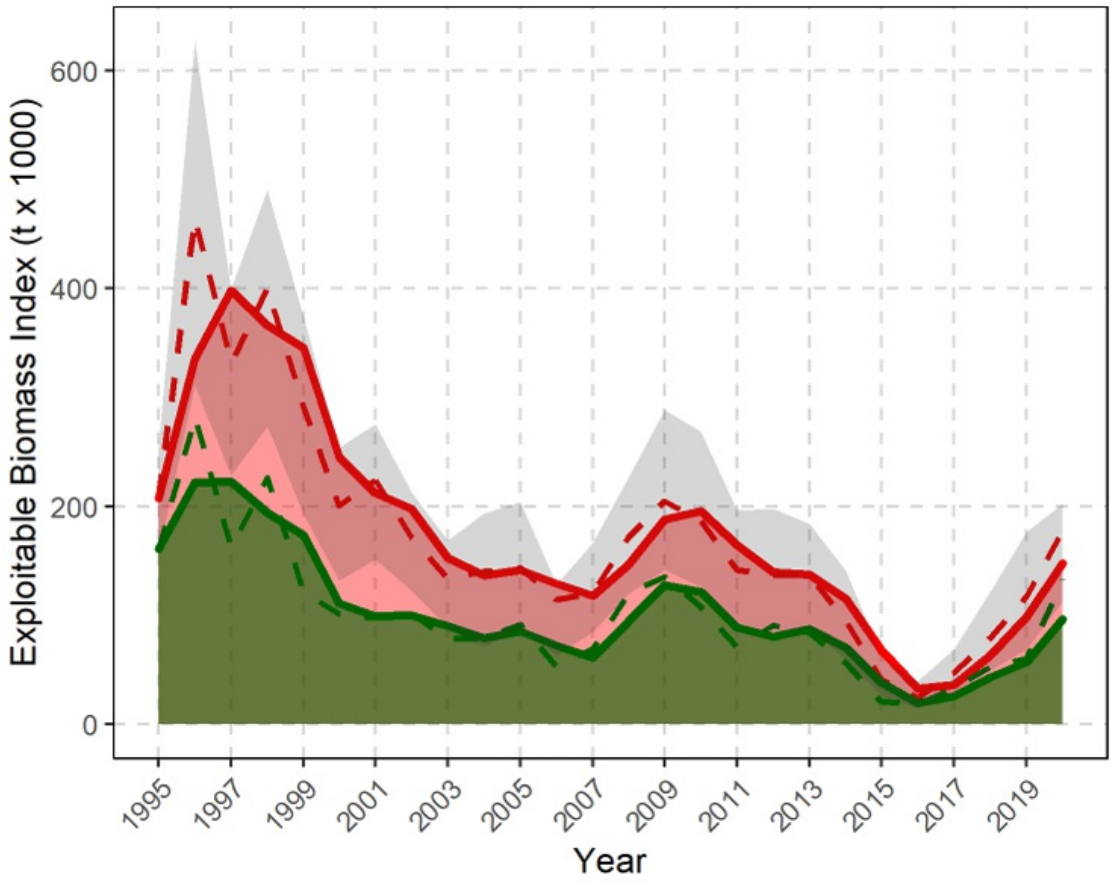

Figure 6: Trawl survey exploitable biomass indices (t × 1000) by shell condition for combined Assessment Divisions. Soft-shell and new-shell crab represent recruitment (green) and intermediate and old-shell crab represent residual biomass (red). Dashed lines shows annual estimates and solid lines are the 2-year moving average estimates. Shaded grey 95% confidence intervals apply to annual estimates. From (DFO 2022b).

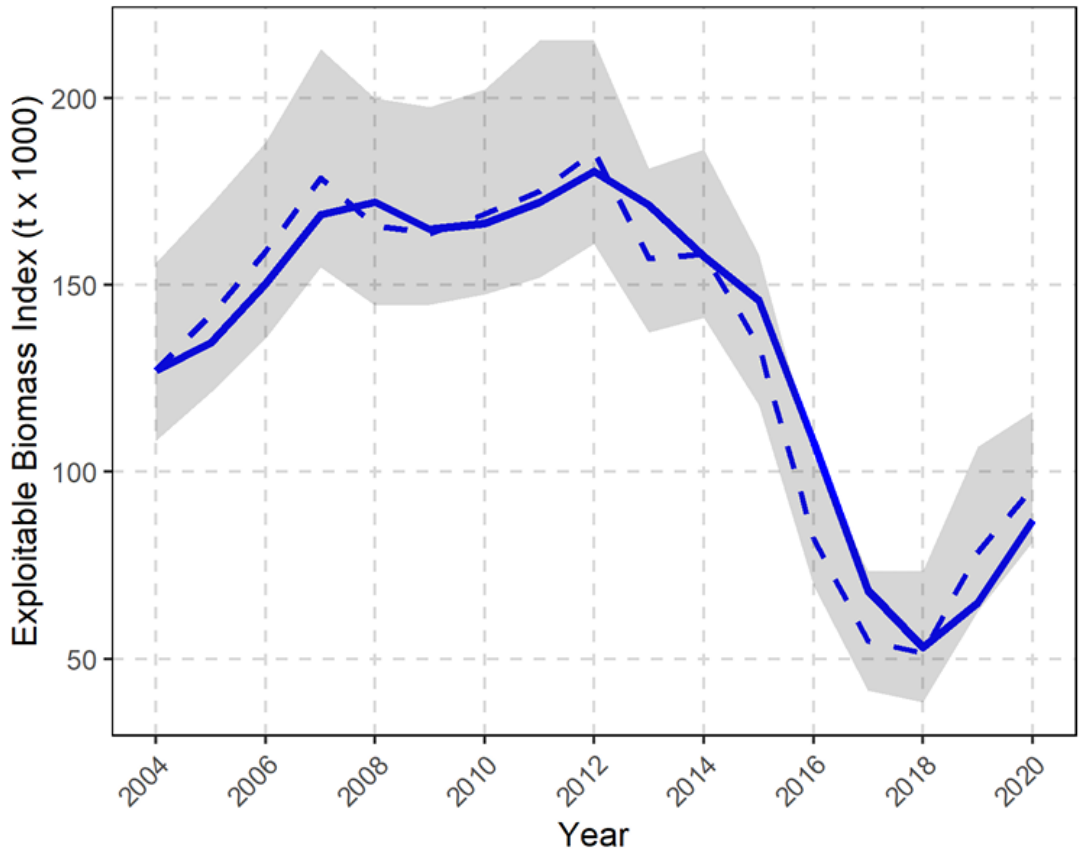

Figure 7: Trap survey exploitable biomass indices (t × 1000) for combined Assessment Divisions. Dashed line shows annual estimate, the shaded area represents the 95% confidence intervals, and the solid line is the 2-year moving average estimate. From (DFO 2022b).

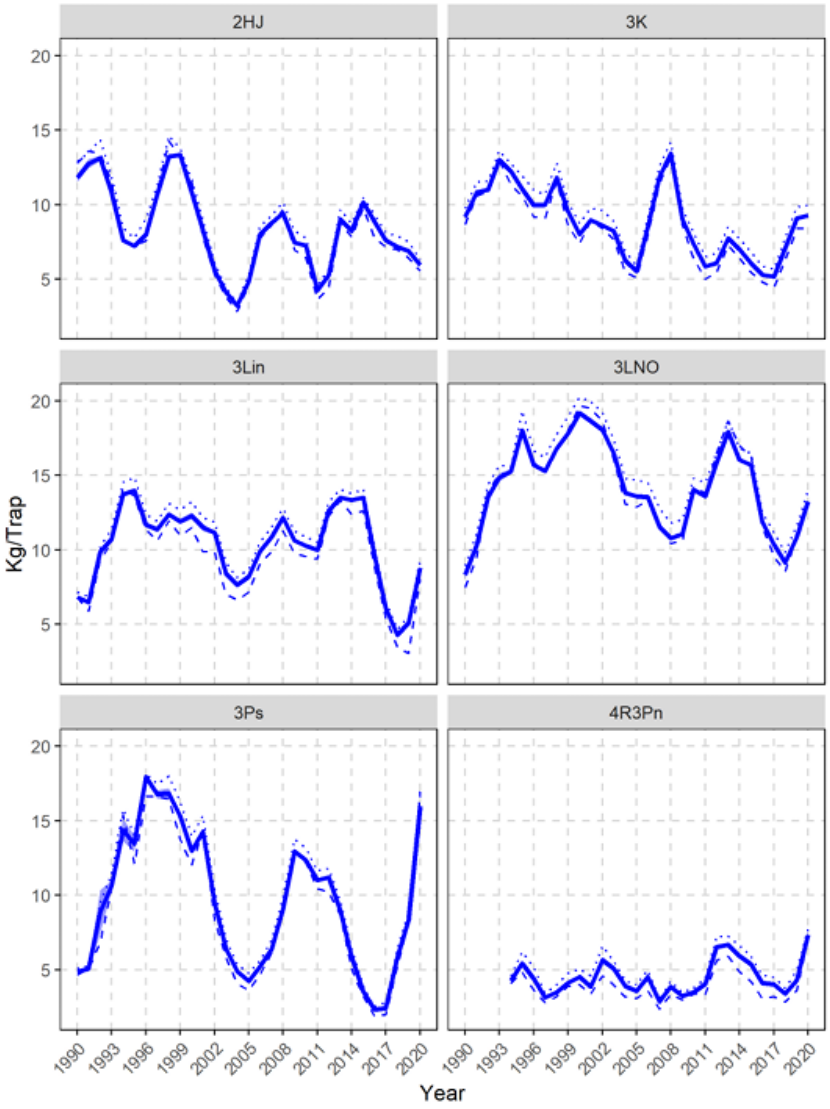

Figure 8: Fishery CPUE (kg/trap) by Assessment Division. Solid line is standardized CPUE and shaded band is 95% confidence interval. Dotted lines are raw means and hashed lines are raw medians. Vertical dashed line represents the beginning of the cod moratorium in most ADs. From (DFO 2021a).

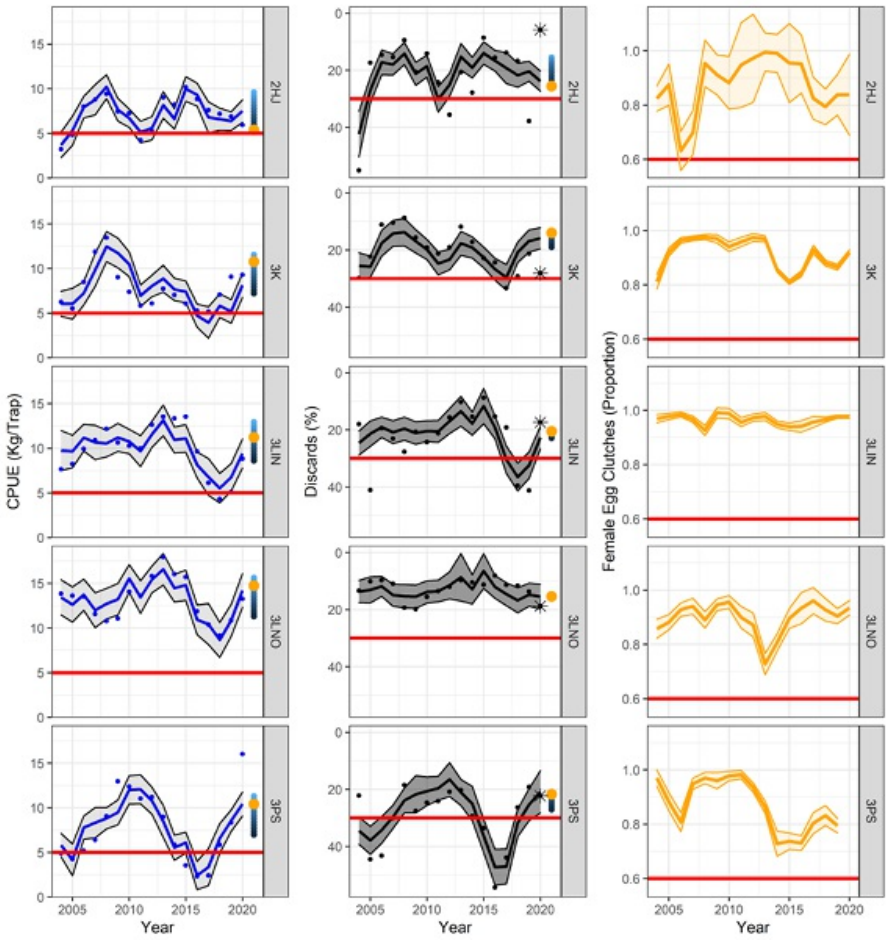

Figure 9: Observed trends in CPUE (left), % discards (middle), and proportion of females with full egg clutch (right) (solid lines) as well as predicted values for CPUE and discards (points) in relation to limit reference points (red horizontal lines) for each metric in the proposed Precautionary Approach Framework, by Assessment Division. Shaded areas represent 95% confidence (egg clutches) or prediction (CPUE and discards) intervals. Orange points represent predicted values under status quo landings in forthcoming fishery. Vertical blue shades in 2020 are the predicted values under varying levels of Exploitation Rate Index (ERI) (light to dark blue: ERI = 0–60%). From (DFO 2022b).

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Moderate Concern

Reference points are not available for snow crab in the nGSL region. Data-limited assessment methods were presented in the 2021 DFO stock assessment for nGSL, and these results were used for evaluating snow crab abundance through 2020 (DFO 2021b). Stock health indices included in the stock assessment for most crab fishing areas (CFAs) suggested mixed stock health trends for exploitable biomass in recent years based on four metrics, summarized below:

1. Numbers per unit effort (NPUE) of snow crab adults and recruits were measured using a post-season, industry-operated, trap survey since the late 1990s or early 2000s in most CFAs. NPUE of adults and recruits generally declined in recent years, especially in 2018. In 2018, NPUE in some CFAs was at or near the lowest point in the respective time series, but all CFAs were below average for adult crab NPUE.
2. Standardized catch per unit effort (CPUE) was reported since the mid-1980s by CFA and showed an increase from 2019 to 2020, but still at around the lowest level in the time series.
3. NPUE for adolescent snow crab was lowest in the time series for small crabs, and slightly below average for larger adolescents, suggesting no increase in recruitment to the exploitable biomass in 2021.
4. Male CW was above average in some areas, while other CFAs had below-average CWs in 2019.

According to the assessors, the combined stock status indicators do not suggest an increase in the biomass available to the fishery in 2021. Because of these mixed results, a productivity-susceptibility analysis (PSA) was conducted for snow crab in Atlantic Canada. Results of the PSA (score = 2.96) suggested that the species in this area has medium vulnerability (Table 1).

Based on the mixed results from the data-limited methods combined with results of the PSA, abundance is determined a moderate concern for snow crab in nGSL.

Justification:
Table 1. Productivity-susceptibility analysis for snow crab in the Northern Gulf of St. Lawrence pot fishery (see Seafood Watch Fisheries Standard Version 3.2 for methodology details).

Productivity (P) Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	7 yrs. (Alunno-Bruscia, M. and B. Sainte-Marie 1998)	2
Average maximum age	15 yrs. (Sainte-Marie et al. 2008)	2
Fecundity	45,000 (Sainte-Marie 1993)	1
Reproductive strategy	Brooder (Sainte-Marie 1993)	2
Trophic level	2.3 (Pauly et al. 2001)	1
Density dependence	No depensatory or compensatory dynamics demonstrated or likely (Marcello et al. 2012)	2
Habitat quality	Moderately altered	2
Total	P = (2 + 2 + 1 + 2 + 2 + 2) ÷ 6	1.71
Susceptibility (S) Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap	Overlap is unknown but likely high due to extent of fishery, with only the areas farthest from shore not targeted.	3
Vertical overlap	Overlap is unknown but likely high, with only the deepest areas of the species' range not targeted.	3
Selectivity	Species is targeted and individuals below legal size limit may escape traps.	2

Post-capture mortality	Published survival rates were not available for snow crab after release from commercial fishery trap gear. A DFO tagging study is underway (2018–2020) but the study is conducted during the fishery-independent trap survey rather than during the commercial season, and only adult males in the year following their terminal molt are tagged. This study estimated 5–10% of released crabs were recaptured the following year, but an estimate of post-capture mortality was not provided (pers. comm., DFO Quebec Region, October 8, 2020). Any estimates of post-capture mortality from this study would only be for adult males and would not reflect handling procedures during the fishery.	3
Total	$S = [(3 \times 3 \times 2 \times 3) - 1/40] + 1$	2.325

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

$V = \sqrt{(3.36 + 5.41)}$

V = 2.89 = Medium vulnerability

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Very Low Concern

The DFO Precautionary Approach describes the use of a limit reference point for biomass (B_{LIM}) for separating the critical and cautious zones and an upper stock reference (USR) to delimit the cautious and healthy zones for assigning stock status (DFO 2014). B_{LIM} was chosen by DFO as the lowest biomass of hard-shelled, commercial-sized adult males that produced good recruitment rates of small male crabs of 34–44 mm CW (DFO 2012). The primary data source for determining commercial biomass was the fishery-independent trawl survey (Figure 10). Based on the most recent DFO stock assessment, commercial biomass in 2021 was 80,950 t, which was above the USR of 41,400 t (Figure 11) (DFO 2022c). Based on this outcome, abundance is a very low concern in the sGSL.

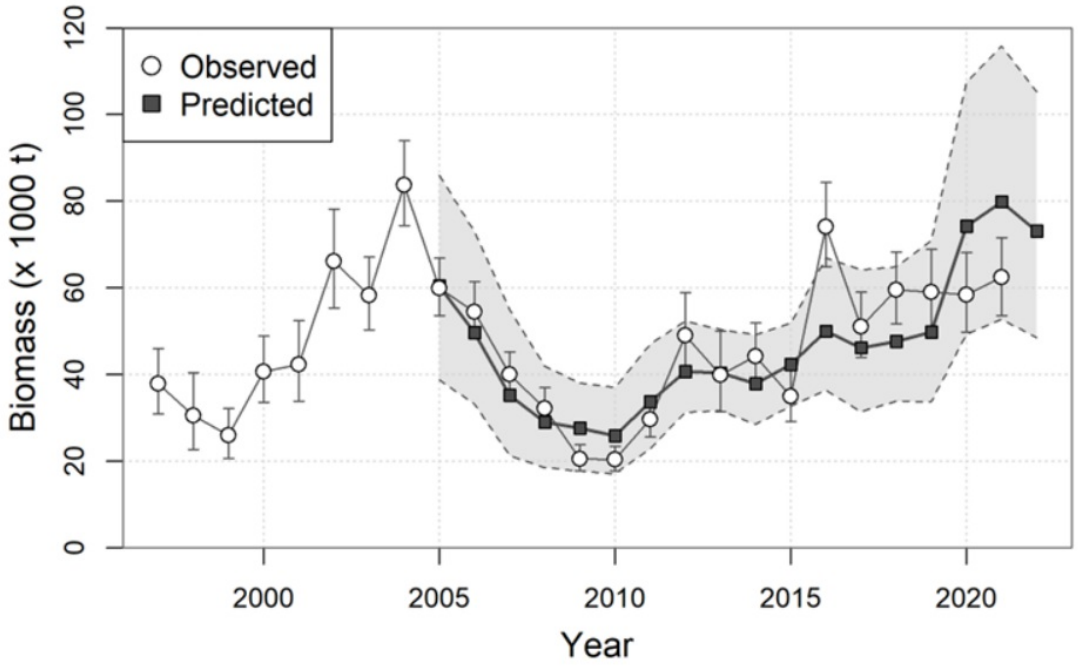

Figure 10: Estimated (open circles are the means with 95% confidence interval vertical bars) and predicted (black squares are the means with the 95% confidence interval bands as dashed lines) biomasses of R-1 (adult male crabs ≥95 mm carapace width of carapace condition 1 and 2) snow crab in the year of the survey, 1997 to 2021. The predicted abundances are based on a relationship to the estimated abundances of R-2 (adolescent male crabs with a carapace width larger than 83 mm) in the previous year. From (DFO 2022c).

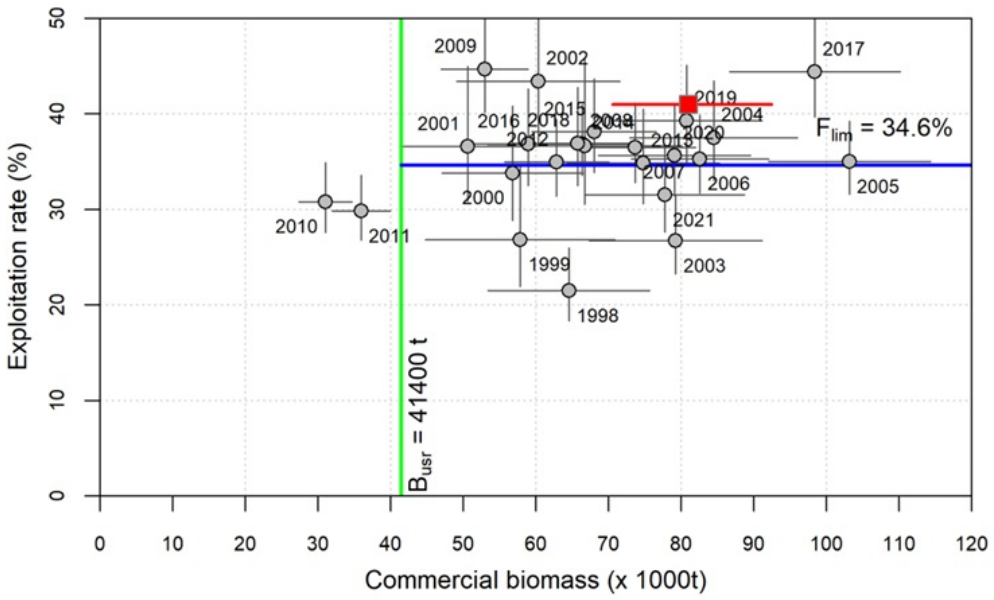

Figure 11: Exploitation rate versus the commercial biomass, with 95% confidence intervals. Year labels represent the fishery year. Colored lines represent reference points: F_{lim} (blue line) is the limit reference point for fishing removal rate, and B_{usr} (green line) is the upper stock reference point for commercial biomass. The red square corresponds to the commercial biomass estimate with the target exploitation rate for the 2022 fishery. From (DFO 2022c).

Factor 1.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Maritimes Region

Low Concern

Fishing mortality rates and reference points were available in the most recent DFO stock assessment for the three divisions in the Maritimes Region (DFO 2020c). The target removal reference is 20% of the fishable biomass in each area, and the removal reference (RR) is not to exceed fishing mortality at maximum sustainable yield (F_{MSY}). The estimate of F_{MSY} (and 95% CI) for Division N-ENS was 0.398 (0.248, 0.572). F was estimated at 0.14 (exploitation rate 0.13) in N-ENS in 2019, which is below F_{MSY}. The estimate of F_{MSY} (and 95% CI) for Division S-ENS was 0.346 (0.224, 0.51). F was estimated at 0.12 (exploitation rate 0.13) in S-ENS in 2019, below F_{MSY}. The estimate of F_{MSY} (and 95% CI) for Division 4X was 0.361 (0.2, 0.543), while F in 2018/2019 was zero because the commercial fishery was closed due to concerns about snow crab stock health. Division 4X contains a much lower density of snow crab, and landings are typically low (roughly 1% of annual regional landings) compared to the other divisions in the Maritimes, likely due partly to 4X being near the southernmost extent of snow crab distribution in the North Atlantic (DFO 2020c).

Seafood Watch generally considers fishing mortality rates below F_{MSY} to be sustainable if there is confidence in the reference point. Fishing mortality was below F_{MSY} in all three divisions, with the only concern in Division 4X, where the fishery was closed to protect the stock. DFO confidence in the methods used in the 2020 stock assessment is higher than for previous years' stock assessments. Therefore, fishing mortality in the Maritimes Region is determined a low concern.

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

Moderate Concern

Reference points were not included in the 2022 DFO stock assessment for NFL (DFO 2022b). Without reference points, the impact of fishing mortality on exploitable biomass and other stock health indicators (e.g., size at maturity) cannot be as clearly understood. But, there is evidence to suggest a high probability that fishing mortality has been a primary cause of the decline of the stock. A recent study proposed that exploitation rates that reach 50% should be considered overfishing for the NFL snow crab stock (Mullowney and Baker 2020). Exploitation rates have declined in all divisions but one to around or below 25%; only one remains around or above 50% (Figure 12) (DFO 2022b). In 2012–2016, male snow crab size at maturity (SaM) declined sharply for male snow crabs in some divisions of the NFL region, but have since started to increase again (Figure 22 in (DFO 2022b)). Size at maturity for female snow crabs (which are not harvested) in the same timeframe did not decline (DFO 2022b). Several potential reasons for the decline in male size at maturity were explored by Mullowney and Baker (2020). The study concluded that colder temperatures likely played a role in the reduced male size at maturity, but the decreased density of adult male snow crab was a significant factor contributing to this change, and that high fishing pressure on male crab in some NFL divisions likely led to the lower density. Divisions of the NFL region with the highest fishing exploitation rates also showed the largest decline in male crab size at maturity, which is evidence that fishing pressure was a driver of this shift (Mullowney and Baker 2020). Mullowney and Baker (2020) suggested that decreased male crab size at maturity can have consequences for the stock health and fishery yield by lowering the reproductive potential and size of male crab. This situation is consistent with growth and recruitment overfishing concepts.

Although total mortality (trends in which generally reflect those of fishing-induced mortality) was high in 2015–17, it has decreased in all Assessment Divisions except 2HJ. The reduced levels of total mortality in AD 3K and AD 3LNO Offshore have been accompanied by the notable recovery of the exploitable biomass, while AD 2HJ has shown little sign of recovery and continues to experience high mortality rates (DFO 2022b). Status quo removals in 2021 were expected to continue the decline in exploitation rate in AD 3K (where it was anticipated to reach time-series lows) and AD 3LNO Offshore, while AD 2HJ would continue to experience high mortality rates (DFO 2022b). Because fishing mortality rates are unknown relative to a sustainable level, but in most areas have decreased and are allowing recovery in exploitable biomass, fishing mortality is scored a moderate concern.

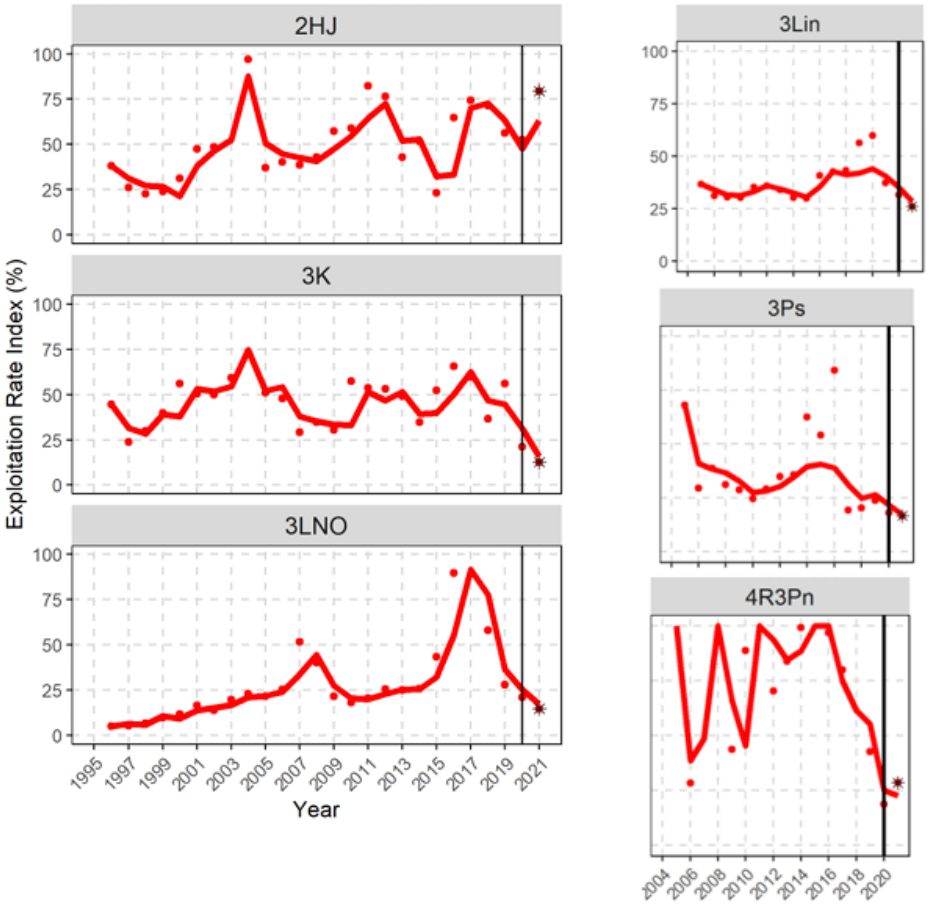

Figure 12: (Left panel) NFL snow crab annual (circles) and 2-year moving average exploitation rate index (solid line) (%) by trawl in 1996–2021 by Division. (Right panel) Trends in the annual (circles) and 2-year moving average trap-based exploitation rate indices (solid line) (%) in 2004–2021 by trap by Division. 2021 stars on both panels depict the annual projected exploitation rate indices under status quo fishery removals. From (DFO 2022b).

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Moderate Concern

Fishing mortality and reference points for evaluating fishing mortality were not estimated in the most recent DFO stock assessment (DFO 2021b). Recent declines in some data-limited abundance indices for most CFAs in nGSL, combined with the relatively unchanged total allowable catches (TAC) for these CFAs, suggest that fishing mortality may be playing a role in these declines but it was not clear whether overfishing is occurring. Because fishing mortality relative to a sustainable level is unknown, it is considered a moderate concern.

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Moderate Concern

The DFO precautionary approach (PA) policy (DFO 2014) states that, when the stock is in the "healthy zone," the removal rate should not exceed the defined removal rate corresponding to F_{MSY}. For the sGSL, F_{MSY} is unknown. Although a removal reference point (F_{LIM}) is given as 34.6% in the most recent DFO stock assessment of snow crab in sGSL (DFO 2022c), the threshold where serious harm could happen to the stock was not assessed (pers. comm., DFO Gulf Region October 8, 2020). DFO set the 2019 preseason exploitation rate at 40.9%, which is above F_{LIM} (DFO 2022c) but consistent with the harvest strategy laid out in the IFMP (DFO 2021c). (See Criterion 3.1 for an assessment of the effectiveness of the harvest strategy and other elements of an effective management system.) In summary, DFO's decision on an acceptable exploitation rate was based on risk analysis indicating that the total allowable catch (TAC) derived from this harvest decision rule would result in a near 100% chance that the biomass in 2022 would be above B_{USR} (DFO 2022c).

Because F_{MSY} is unknown and a suitable proxy reference point (e.g., $F_{35\%}$) was not available, but fishing mortality was not suspected to be above a sustainable level, this factor is considered a moderate concern.

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.

SNOW CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Atlantic | Pots | Canada | Maritimes Region	1.000	1.000: < 100%	Red (1.000)
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence	1.000	1.000: < 100%	Red (1.000)
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador	1.000	1.000: < 100%	Red (1.000)
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary	1.000	1.000: < 100%	Red (1.000)

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.

NORTHWEST ATLANTIC | POTS | CANADA | MARITIMES REGION			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic herring	1.000: High Concern	1.000: High Concern	Red (1.000)
Leatherback turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
North Atlantic right whale	1.000: High Concern	1.000: High Concern	Red (1.000)
Atlantic wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northern wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Spotted wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Humpback whale	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Snow crab	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHWEST ATLANTIC | POTS | CANADA | NEWFOUNDLAND AND LABRADOR			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic herring	1.000: High Concern	1.000: High Concern	Red (1.000)
Leatherback turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
North Atlantic right whale	1.000: High Concern	1.000: High Concern	Red (1.000)
Atlantic wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northern wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Spotted wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Argentine shortfin squid	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Humpback whale	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Snow crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | POTS | CANADA | NORTHERN GULF OF ST LAWRENCE AND ESTUARY			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic herring	1.000: High Concern	1.000: High Concern	Red (1.000)
Mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
North Atlantic right whale	1.000: High Concern	1.000: High Concern	Red (1.000)
Atlantic wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Leatherback turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northern wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Spotted wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Humpback whale	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Snow crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | POTS | CANADA | SOUTHERN GULF OF ST LAWRENCE			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic herring	1.000: High Concern	1.000: High Concern	Red (1.000)
Mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
North Atlantic right whale	1.000: High Concern	1.000: High Concern	Red (1.000)
Atlantic wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Leatherback turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northern wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Spotted wolffish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Humpback whale	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Snow crab	5.000: Very Low Concern	3.000: Moderate Concern	Green (3.873)

Species were included in Criterion 2 if: 1) they represented greater than 5% of total catch from the snow crab fishery in 2014–2018 for a particular management region of Atlantic Canada; 2) they were listed as endangered, threatened or protected (ETP) species and were caught as by-catch in snow crab traps, or there was evidence of snow crab fishing gear causing entanglements that resulted in mortality at above 5% of a sustainable level during 2010–2019 (or the fisheries' impact is unknown); 3) there was evidence of non-ETP species being affected by the snow crab fishery (e.g., caught in traps, entangled in gear), resulting in less than 20% of total fishing mortality during 2010–2019 (or the fishing mortality rate from the snow crab fishery was unknown); or 4) a species used as bait in the snow crab fishery is currently considered an ETP species, overfished, or undergoing overfishing, or bait use was substantial in recent years (over roughly 5% of snow crab catch volume) and potentially unsustainable (e.g., the stock status is uncertain).

By-catch species captured in snow crab traps were determined from independent by-catch studies, at-sea fishery observer data, or fisher logbook data. The only species reported as by-catch in snow crab traps that were included in this assessment were wolffishes (included as ETP species). By-catch of species other than snow crab is only recorded by at-sea observers if there is a special request by DFO staff. Currently, at-sea observers are being asked to record any sightings of North Atlantic right whale as well as other mammals on an Interaction/Observation form. Snow crab harvesters are required by license condition to record in the Species-at-risk logbook any spotted wolffish, northern wolffish, or leatherback sea turtle caught in their traps (pers. comm. Todd Wiliams, DFO technical comments). At-sea observer data summarizing all species captured in snow crab traps were only available for the Maritimes Region, where data indicated that by-catch was primarily of other invertebrate species (e.g., Northern stone crab and American lobster), and that no species was above 5% of the catch (Gavaris et al. 2010)(DFO 2016)(Zisserson et al. 2019).

ETP species were determined based on their status in the following data sources: listed as "Endangered," "Threatened," or "Special Concern" under the Species at Risk Act (SARA) or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), designated as "Endangered" or "Threatened" under the U.S. Endangered Species Act (ESA), or categorized as "Critically Endangered," "Endangered," "Vulnerable," or "Near Threatened" by the International Union for the Conservation of Nature (IUCN). ETP species were

only included if there was evidence that the listed species, stock, or population was caught or entangled in snow crab fishing gear in Atlantic Canada. Five ETP species/stocks were included in this report based on available information: North Atlantic right whale (*Eubalaena glacialis*), leatherback sea turtle (*Dermochelys coriacea*), northern wolffish (*Anarhichas denticulatus*), spotted wolffish (*Anarhichas minor*), and Atlantic wolffish (*Anarhichas lupus*). In addition, some of the species included under the "Mammals" heading are ETP species in Criterion 2. Several additional ETP species were included under the "Mammals" heading in Criterion 2 because they were listed within the National Oceanic and Atmospheric Administration (NOAA) List of Foreign Fisheries (LOFF) as co-occurring or interacting with the snow crab fishery in the respective regions of Canada.

Other non-ETP species were included because they were listed within the NOAA LOFF as co-occurring or interacting with the snow crab fishery in the respective regions of Canada, or based on information on entanglements and mortalities in published literature. These species were included because the contribution of the snow crab fishery to fishing mortality was unknown, but could be above 20% of total fishing mortality for each species. Several non-ETP marine mammal species were included under the "Mammals" heading in Criterion 2. Humpback whale (*Megaptera novaeangliae*), a highly vulnerable species, was evaluated separately in the report (outside the "Mammals" category) because additional information was available about impacts from the snow crab fishery. Some additional information was available indicating entanglements of common minke whale (*Balaenoptera acutorostrata*) in snow crab fishing gear; however, minke whale was not scored in this report because overall impacts to this species from human-induced sources was well below the potential biological removal (PBR) limit as reported by NOAA (NOAA 2019c). Instead, minke whale was included within the "Mammals" category.

Information on bait use in the snow crab fishery is based on DFO staff personal communications and Marine Stewardship Council (MSC) snow crab fishery assessments. These sources indicated that the following species were used as bait: Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), Argentine shortfin squid (*Illex argentinus*), longfin squid (*Loligo pealei*), shortfin squid (*Illex illecebrosus*), and capelin (*Mallotus villosus*). DFO personal communications indicated the possibility that capelin is used as bait, but no data confirmed this or the amount used (if any), so the species was not scored in this assessment. Longfin and shortfin squid were reported as bait species used in the sGSL snow crab fishery (Mateo et al. 2017a); however, neither species was scored in this assessment because the relative amounts of each species used as bait were not available and neither species is considered to be harvested above sustainable levels (Hendrickson 2017)(NOAA 2019b). A small amount of Argentine shortfin squid is reportedly used in the Maritimes snow crab fishery; however, the estimated percentage of snow crab catch was low enough (0.02%) that the species was not assessed for the Maritimes fishery. Atlantic mackerel was not included as a main species in this assessment because the Canadian commercial and bait fisheries for Atlantic mackerel were closed on March 30, 2022 to allow the stock to rebuild (https://www.qc.dfo-mpo.gc.ca/infoceans/en/node/1084).

Four different species/groups limited the scores for Criterion 2:

1. North Atlantic right whale (NARW) limited the scores for all fisheries. NARW is an ETP species, and in each region there was either evidence of entanglements of NARW in snow crab gear or potential for overlap between NARW migrations and snow crab fishery operations, which has caused or is likely to cause mortality of this species above a sustainable level.
2. Leatherback sea turtle limited the scores in the NFL and Maritimes fisheries. Leatherback sea turtle is an ETP species, and evidence from these regions indicated that entanglements of leatherback sea turtle in snow crab gear caused mortality of this species above a sustainable level.
3. The "Mammals" group of species limited the scores for all fisheries. Mammals were scored as high concern using the unknown by-catch matrix (UBM) due to the high vulnerability of the taxon (Factor 2.1) and the high impacts of pot gear on marine mammals in the Northwest Atlantic (Factor 2.2).
4. Atlantic herring (used as bait) limited the scores for all fisheries. Several Canadian herring stocks where bait may be sourced are depleted, and no stocks have reference points that are consistent with guidance from the Lenfest Forage Fish Task Force (Pikitch et al. 2012).

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

Argentine shortfin squid

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

Moderate Concern

Argentine shortfin squid was reportedly the primary bait species used in the snow crab fishery in NFL (≈90% of all bait). Stock abundance of Argentine shortfin squid in the Southwest Atlantic Ocean is unknown because there is currently no comprehensive monitoring of stock status. The IUCN assessed Argentine shortfin squid as "Least Concern" but reports that population trends are unknown and the species experiences high fishing pressure (Barratt, I. and L. Allcock 2014). The productivity-sensitivity analysis (PSA) conducted by Seafood Watch found Argentine shortfin squid to be highly vulnerable (see table in Justification) (Seafood Watch 2020). Most of the available data related to stock biomass are more than 5 years old, which results in high uncertainty, considering the species' short life span and highly variable stock characteristics. A stock assessment using data from 2003 to 2012 indicated that the stock was healthy in the Southwest Atlantic Ocean (Chang et al. 2016). A stock assessment of the winter spawning stock in Argentina and the Falkland Islands found that the 40% escapement goal was met in 2019, but this is just one year of data and does not include high seas biomass (Winter 2019). Abundance of the South Patagonia stock (heavily targeted by China and Taiwan) in 2000 through 2010 was relatively stable and above B_{MSY} (Wang et al. 2018). Landings in Asia have been highly variable but most recently (2016–2017) were low compared to previous years, while landings in South America show a declining trend since 1998 (FAO 2020b). These reductions in squid harvest volume could be the result of biological characteristics, fishing pressure, fishery management, environmental change, or a combination of these factors.

Because of the high vulnerability of the species and the lack of certainty about stock status in recent years, but with some data indicating a relatively healthy population and an IUCN status of "Least Concern," abundance is considered a moderate concern.

Justification:

Table 2. Productivity-sensitivity analysis for Argentine shortfin squid in Southwest Atlantic fisheries (see Seafood Watch Fisheries Standard Version 3.2 for methodology details).

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	<1 year (Haimovici et al. 1998)	1
Average maximum age	1 year (Haimovici et al. 1998)	1
Fecundity	750,000 eggs (Laptikhovsky and Nigmatullin 1993)	1
Average maximum size (fish only)	N/A	
Average size at maturity (fish only)	N/A	
Reproductive strategy	Broadcast spawner (Leta 1992)	1
Trophic level	3.8 (Belleggia et al. 2014)	3
Density dependence (inverts only)	None	2
Habitat quality	Unknown	

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (across all fisheries)	High overlap	3
Vertical overlap (across all fisheries)	High overlap	3
Selectivity of fishery (specific to the fishery under assessment)	Most jigging operations use lights to attract squid, which increases its susceptibility (FAO 2020c)	3
Post-capture mortality (specific to the fishery under assessment)	Retained	3

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

Moderate Concern

The snow crab fishery reportedly uses Argentine shortfin squid as bait in the majority (≈90%) of the snow crab fishery in NFL (Mateo et al. 2018). Mateo et al. (2018) estimated that 6,438 t of squid were used as bait in the NFL snow crab fishery on average in 2014–2016, making up approximately 9.4% of the NFL snow crab catch during the same period. Fishing mortality for this species throughout its range is unknown due to a lack of management and monitoring effort since 2005. Fishing mortality from 2000 to 2010 for China and Taiwan fleets was estimated to be less than $F_{0.1}$ and F_{MSY} (Wang et al. 2018). In the Southwest Atlantic, biomass was estimated at more than two times the annual catch, indicating that the stock was healthy under current fisheries exploitation (Chang et al. 2016). But, both studies were based on regional data more than 5 years

old. The 2019 stock assessment on winter spawning stock in Argentina and the Falkland Islands found that the 40% escapement reference point was met, but this does not include the high seas areas (Winter 2019). Argentine shortfin squid catches, including all fisheries worldwide, were estimated to be 146,700 mt in 2016 (FAO 2020b). Based on the average bait use estimate for 2014–2016, the snow crab fishery in NFL uses roughly 4% of the global harvest of this species. Because fishing mortality is unknown for this species, and bait use by this fishery is considerable, it is scored a moderate concern.

Atlantic herring

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Maritimes Region

High Concern
Based on fisher logbook data supplied by DFO as well as surveys of bait suppliers and fishers, Atlantic herring was used as bait in all four snow crab fisheries (pers. comm., Magalie Hardy February 4, 2020) (Lloyds Register 2020)(Mateo et al. 2017a)(Mateo et al. 2017b)(Mateo et al. 2018). The herring fisheries in Canada do provide bait for domestic fisheries, including the snow crab and lobster fisheries, and this analysis focuses on those. (Herring is also imported by bait suppliers [pers. comm., DFO, during technical review]; further information on this may allow for a more detailed analysis here.) There are 10 herring stocks targeted by Canadian fisheries, all of which were included in relatively recent DFO stock assessments (see Justification below). Only two stocks have both a limit reference point (LRP) and an upper stock reference (USR) (spring and fall spawners in the Southern Gulf of St. Lawrence); one of those is in the Critical zone, and the other is in the Cautious zone and declining. One other stock (SW Nova Scotia and Bay of Fundy) has an LRP, and the latest assessment found current biomass to be at that point. Where they were available, data-limited indicators appear to be mixed (see Justification).

Most Canadian Atlantic herring stocks are at low abundance or declining, or are of unknown status. Therefore, abundance is considered a high concern.

Justification:
Most Atlantic herring fisheries in Canada have only a limit reference point, if they have any reference points. LRPs are usually based on multiyear average spawning stock biomass (SSB) levels for particular years. Although various fishery-independent and fishery-dependent collection methods were used to create these reference points, some data indicators are highly uncertain, due to low data availability for certain years or very low abundance of Atlantic herring.

- West Coast of Newfoundland: spring spawners and fall spawners. Reference points not defined (rejected in 2020) (DFO 2022d).
- East and South Newfoundland and Labrador: Reference points not defined. Stock status

index based on gillnet research survey catch rates declining trend through the 2000s, with a slight increase in 2017 (DFO 2019f).

- Southern Gulf of St. Lawrence: Critical zone for spring spawners since 2002 (77% of the LRP in 2021), Cautious zone for fall spawners since 2017 (171% of the LRP in 2021, SSB declining since 2011) (DFO 2022e).
- Quebec North Shore (Division 4S): Reference points not defined. Acoustic index of the spring spawners increasing since 2018, fall spawners have remained relatively stable (DFO 2021e).
- SW Nova Scotia and Bay of Fundy: Biomass has been relatively stable in recent years (2011 to 2016) but declined to the LRP in 2017 (DFO 2018c).
- Offshore Scotian Shelf: Reference points not defined (DFO 2018c).
- Coastal Nova Scotia: Reference points not defined. Acoustic surveys show biomass increases in recent years in Little Hope and Eastern Shore. Other areas (Glace Bay and Bras d'Or Lakes) have no indicators but are assumed to be low abundance (DFO 2018c).
- SW New Brunswick: Reference points not defined (DFO 2018c).

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Maritimes Region

High Concern

Fishing mortality relative to reference points appropriate for forage species is unknown for all Canadian Atlantic herring stocks. The only stock to have even a provisional harvest decision rule is the Southern Gulf of St. Lawrence stock; the catch has exceeded that level since 1999 for spring spawners and in the 1990s, 2000s, and again in 2020–2021 for fall spawners. This stock (specifically the fall spawners) accounts for a significant portion of the total herring catch. The other stocks have data-limited assessments with mixed outcomes (see table in Justification).

Because fishing mortality is essentially unknown relative to a sustainable level, but the two stocks that are best understood appear to be subject to excessive fishing mortality, and the contribution of the bait fisheries to total mortality across stocks is unknown, we have awarded a high concern score.

Justification:

Atlantic herring is commonly used as bait in snow crab fisheries throughout eastern Canada. Atlantic herring is estimated to make up 10% of the total bait used in NFL (Mateo et al. 2018). Mateo et al. (2018) estimated that herring bait use represented 1% of the NFL snow crab catch volume for 2014–2016. Approximately 900 t of Atlantic herring were estimated to be used as bait in the 2015 sGSL snow crab fishery, making up approximately 3.5% of the sGSL snow crab fishery catch (Mateo et al. 2017a). A survey of bait suppliers found that approximately 527 t of herring was used as bait in the nGSL snow crab fishery in 2019, which was roughly 7% of the snow crab landings in recent years (Lloyds Register 2020). According to a survey of bait sellers and snow crab fishers in the Maritimes Region, herring was the primary species used as bait in snow crab pots, with approximately 540 t used in 2015, which was 4.4% of the Maritimes snow crab catch volume

(Mateo et al. 2017b). Although catches of bait are required to be recorded in harvester logbooks for the Atlantic herring fishery, compliance is reportedly low, so estimates of Atlantic herring harvest for bait were not available (DFO 2018b).

Stock assessment data points and information of relevance to understanding fishing mortality and of the contribution of that mortality from bait catches.

Stock	Information	Reference
West Coast of Newfoundland	TACs and exploitation rates in recent years have declined for both stocks, and 2021 levels were very low (<20% of the TAC had been taken, and <5% based on actual catch due to the presence of too many juveniles). Assessment indicates maintenance of TAC should not pose significant risk to stocks. Total TACs = 20,000 mt. Bait TAC = 50 mt.	(DFO 2022d)
East and South Newfoundland and Labrador	TACs = 12,842 mt, 42% of which was landed in 2017 and 2018. Total estimated bait catch was 1,192 mt in 2017 and 675 mt in 2018.	(DFO 2019f)
Southern Gulf of Saint Lawrence	Fishing mortality has exceeded the provisional harvest decision rule of the PA Framework for the sGOSL since 1999 (spring spawners) and most of the 1990s, early 2000s and 2020–2021 (fall spawners). Total landings were 603/403 mt for 2020/2021 for the spring spawners, and around 10,065/10,834 mt for the fall spawners. Total bait use from the spring spawners is unknown (stock assessment did not specify for fall spawners).	(DFO 2022e)
Quebec North Shore (Division 4S)	Current catch levels are not likely to pose a significant short-term risk to herring stocks. Bait catch not quantified. Total TACs = 4,000 mt, increased to 4,500 mt in 2019. Average catch 2011–2018 was 3,515 mt, decreasing since to 1,482 mt in 2020.	(DFO 2021e)
SW Nova Scotia and Bay of Fundy, Offshore Scotian Shelf, Coastal Nova Scotia, SW New Brunswick	Bait catch not quantified. SW NS and BoF: 2016–2017 TAC = 42,500 mt, total catch = 39,430 mt.	(DFO 2018c)

Atlantic wolffish

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Maritimes Region

High Concern

Atlantic or striped wolffish was caught in small numbers in the snow crab fishery (Garforth et al. 2012a)(DFO 2015)(Zisserson et al. 2019). The most recent DFO wolffish stock assessment was not conclusive on stock status (DFO 2015). Under Seafood Watch criteria, abundance of any species affected by the fishery that is determined to be a stock of concern, vulnerable, endangered, or threatened by a state, national, or international scientific body is considered a high concern. Because Atlantic wolffish is listed as "Special Concern" under the SARA and COSEWIC, abundance is considered a high concern.

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Maritimes Region

Moderate Concern

The DFO 2015 stock assessment indicates that northern wolffish is present throughout all Atlantic Canada snow crab management regions, and observer logbooks indicate that the species is caught in the snow crab fishery (DFO 2015)(Zisserson et al. 2019); however, observer data were insufficient to determine the level of fishery impacts. DFO regulations have prohibited the harvest of wolffish since 2003, so it was assumed that no harvest has occurred since. Survival rates of northern wolffish released from snow crab traps were not available. Northern wolffish is listed as "Threatened" under the SARA. For endangered or threatened aquatic species listed under the SARA, it is considered an offense to kill, harm, harass, capture, or take an individual (DFO 2013). Because fishing mortality is unknown, it is considered a moderate concern.

Humpback whale

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Moderate Concern

The humpback whale is a highly vulnerable species found throughout snow crab fishing areas in Atlantic Canada (Clapham 2009). Although the species ranges worldwide, there are specific feeding areas used by the same whales annually. Three feeding stocks are recognized from eastern Canada: the Gulf of Maine (which includes some animals feeding on the Scotian Shelf), the Gulf of St. Lawrence, and Newfoundland and Labrador (COSEWIC 2003). The Gulf of Maine stock of humpback whale is increasing in abundance and in 2016 was estimated at 1,396 individuals (NOAA 2020b). There were no stock assessments available specifically for the other feeding stocks in Canada; however, within the NOAA Gulf of Maine stock assessment, abundance for 2016 was estimated at 8,439 (CV = 0.49) for the NFL area and 1,854 (CV = 0.40) for the Bay of Fundy/Scotian Shelf/GSL (NOAA 2020b). These estimates do not include most of the at least 135 humpback whales that perished on the Atlantic coast of the United States during the 2016–2020 Unusual Mortality Event (UME), which may change the population trend (NOAA 2020c). The IUCN considers the species a "Least Concern" (Cooke 2018a). COSEWIC designated the Western North Atlantic population of humpback whale as "Not at Risk" (COSEWIC 2003). Because the species is not imperiled worldwide and the Gulf of Maine stock is increasing, but there is an ongoing UME for the Gulf of Maine stock and uncertainty regarding the other eastern Canadian humpback whale feeding stocks, abundance is considered a moderate concern.

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Moderate Concern

The humpback whale is a highly vulnerable species found throughout snow crab management regions in Atlantic Canada (Clapham 2009). There are no recent estimates of fishery impacts available for humpback whale feeding stocks found in these areas; however, the NOAA LOFF indicates there are known interactions between humpback whales and snow crab fishing gear in all Atlantic Canada snow crab fishing regions (NOAA 2020d). During 1992–2008, 150 entanglements of humpbacks were observed in the NFL area, with 25 of those determined to be in snow crab fishing gear (Benjamins et al. 2011). Benjamins et al. (2011) reported that 24% of entangled humpback whales in NFL were found dead, while others may die after release from entanglements, and that entanglements in snow crab fishery gear were increasing as of 2008. More recent entanglement data were not available for the NFL region. Entanglements of humpback whale in the other three snow crab fishery management regions are unknown.

The potential biological removal (PBR) for the Gulf of Maine humpback whale population is currently 22 whales, and the average estimated human-induced mortality rate for 2013–2017 was 12.15 whales per year (NOAA 2020b). Based on this information, PBR was not exceeded for this stock; however, NOAA (2020b) reports that PBR for this stock is likely being exceeded annually due to undetected mortalities. PBR and mortality rates were not published for the Atlantic Canada feeding groups. Further concern about increased trends in human-induced mortality was raised in the recent NOAA Unusual Mortality Event (UME) for humpback whale on the U.S. Atlantic Coast. The UME documents 135 humpback whale mortalities in 2016–2020, many of which were determined to be caused by ship strikes or entanglements in fishing gear (NOAA 2020c).

There are known impacts of the snow crab fishery on humpback whale, but the contributions of the fishery to total mortalities and levels relative to PBR are unknown. Therefore, fishing mortality on humpback whale by the snow crab fishery is considered a moderate concern.

Leatherback turtle

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

High Concern

Leatherback turtle uses habitats within each of the four snow crab management areas, although studies show that the species spends the most time in the Maritimes, NFL, and sGSL regions (DFO 2020e). Leatherback turtle has been reported entangled in snow crab fishing gear in all Atlantic Canada snow crab management regions (except nGSL) by the Canadian Sea Turtle Network (CSTN)

and the Whale Release and Strandings program (WRS) (Hamelin et al. 2017)(DFO 2020f). The majority of entanglements were reported in the Maritimes and NFL, where CSTN and WRS are based. The IUCN categorizes the Northwest Atlantic subpopulation as "Endangered" and declining, based on nest abundance (Northwest Atlantic Leatherback Working Group 2019). The species is also listed as "Endangered" by SARA, COSEWIC, and the U.S. Endangered Species Act (ESA). Based on this listing information, Seafood Watch criteria indicate abundance is a high concern.

Justification:
Leatherback turtle is protected in Canada under SARA. It nests predominantly in Trinidad, French Guiana, and Costa Rica {Stewart et al. 2013}, but migrates to Atlantic Canadian waters to forage. The majority of turtles are present from June to November. The leatherback turtle is a specialist animal that feeds largely on jellyfish {Heaslip et al. 2012} and other soft-bodied invertebrates (Atlantic Leatherback Turtle Recovery Team 2006).

A study in Nova Scotia found that, although there was considerable annual variation, abundance appears stable, but it is unclear if this is representative of other areas of Canada or the North Atlantic population as a whole {Archibald and James 2016}. A recent assessment of the North Atlantic population by the IUCN found nesting numbers to be decreasing, at approximately 23,010 nests/year to 2017, compared to past estimates of approximately 58,000 nests/year {The Northwest Atlantic Leatherback Working Group 2019}(The Northwest Atlantic Leatherback Working Group 2019 Supp).

Recent research using telemetry data has identified that leatherback turtle uses a large geographic area throughout the Canadian Atlantic, with two key areas of important habit identified: 1) Gulf of St. Lawrence, particularly the southeastern Gulf and waters east of Cape Breton Island; and 2) Burin Peninsula, waters to the south and east of the peninsula including parts of Placentia Bay (DFO 2020h). The study also identified seasonal movement in Canadian waters, with a general movement from the southwest to the northeast. Leatherback turtles enter Scotian Shelf waters from June to July, before moving to more northerly foraging areas in the Gulf of St. Lawrence and Placentia Bay by late summer and fall. During September and October, leatherback turtles begin to migrate southward (DFO 2020h).

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Maritimes Region

High Concern
At-sea observer data from the Maritimes Region snow crab fishery suggests very few encounters with leatherback turtle (Criquet et al. 2018)(DFO 2020f). But, databases maintained by the Canadian Sea Turtle Network (CSTN) and the Whale Release Strandings program (WRS) indicate that leatherbacks were found entangled in fishing gear relatively often in the Maritimes (Figure 13), and that snow crab fishing gear was the most common entangling gear (Hamelin et al. 2017). There were 91 entanglements identified due to pot gear (e.g., snow crab, lobster) in Atlantic Canada in 1998–2014 and another 14 were reported in 2015–2017 (DFO 2020f). Reported entanglements are also considered to be only a portion of the actual entanglements that occur, due to reporting biases (Hamelin et al. 2017). At-sea fishery observer coverage is only 5–10% in most areas of this fishery (DFO 2016), and entanglements may occur in ghost gear after the fishery concludes

(Hamelin et al. 2017). In addition, since 2005 DFO has required fishers to report interactions with leatherback turtle, using logbooks; 12 interactions were reported by snow crab fishers through 2017, mostly in the Maritimes Region (DFO 2020f).

The impact of these entanglements on the population's health is not well understood, although it is estimated that the Atlantic population of leatherback turtle could withstand a human-induced mortality rate of 1% per year (DFO 2004). The Northwest Atlantic subpopulation is currently estimated at 20,000 individuals and is in decline (Northwest Atlantic Leatherback Working Group 2019). Also, leatherback turtle is listed as "Endangered" under the SARA, and it is considered an offense to kill, harm, harass, capture, or take an individual that is listed as endangered or threatened (DFO 2013). This information, combined with the endangered status of leatherback turtle, suggests that minimizing impacts from the snow crab fishery should be a high priority.

Trends in entanglements of leatherback turtle are not clear and likely vary across years, related to the timing of the fishery and of the migration of leatherback turtle in the Maritimes. Although snow crab fishers are required to return leatherback turtle to the water if encountered, the post-release survival rate was not available. In addition, Hamelin et al. (2017) reported that ≈15% of entangled leatherback turtles were found dead in fishing gear in Atlantic Canadian fisheries (although this was not specific to the snow crab fishery). The Northwest Atlantic Leatherback Turtle Status Assessment states that Nova Scotia is a potentially important mortality sink that requires continued monitoring and by-catch reduction efforts (Northwest Atlantic Leatherback Working Group 2018). Recent studies also demonstrated that leatherback turtles spent considerable time in the Maritimes Region in 1999–2018, overlapping in time and space with the Maritimes snow crab fishery, which primarily operates from April to August (DFO 2020e)(DFO 2020f).

Available information indicates it is likely that fishing mortality on leatherback turtle in the Maritimes Region is above a sustainable level. Although the Maritimes snow crab fishery's contribution to mortality is unknown, fishing seasons overlap with leatherback turtle's use of the area, and the fishery may be a substantial contributor to mortality. Therefore, based on Seafood Watch criteria, fishing mortality is considered a high concern.

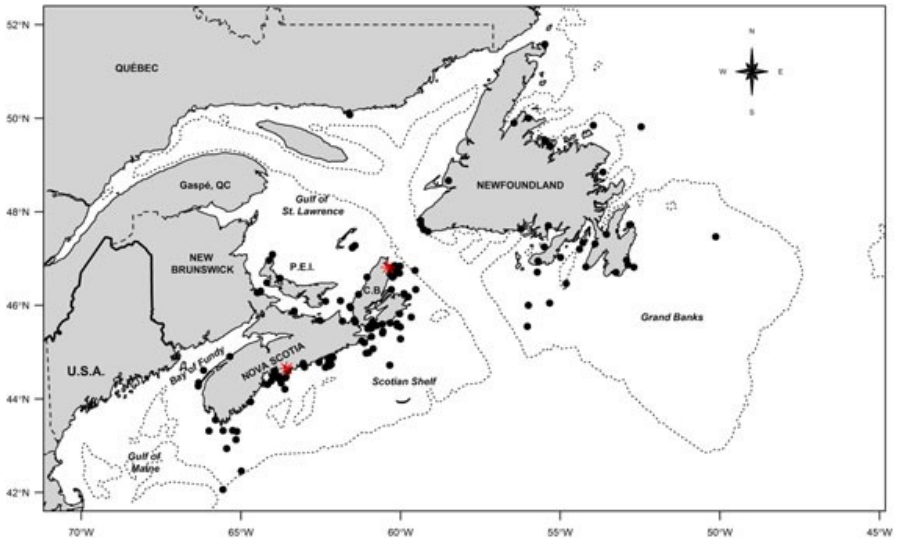

Figure 13: Geographic distribution of reported leatherback sea turtle entanglements (black dots) between 1998 and 2014 in Atlantic Canada (Hamelin et al. 2017). Red stars indicate the locations of Canadian Sea Turtle Network field sites in Halifax, Nova Scotia, and Neil's Harbour, Cape Breton, Nova Scotia. Sites include entanglements with all fishing gears across the time period.

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

High Concern

Limited available at-sea observer data suggest very few encounters with leatherback turtle by the NFL snow crab fishery. But, databases maintained by CSTN and WRS indicate that leatherback turtles were found entangled in fishing gear relatively often in NFL (see Figure 13 in Factor 2.2 for the Maritimes), and that snow crab fishing gear was the most common entangling gear (Hamelin et al. 2017). There were 91 entanglements identified due to pot gear (e.g., snow crab, lobster) in Atlantic Canada in 1998–2014 and another 14 were reported in 2015–2017 (DFO 2020f).
Reported entanglements are also considered to be only a portion of the actual entanglements that occur, due to reporting biases (Hamelin et al. 2017). Fishery observer coverage is reportedly very low for the NFL fishery (DFO 2019a) and entanglements in ghost gear may occur after the fishery concludes (Hamelin et al. 2017). In addition, since 2005 DFO has required fishers to report interactions with leatherback turtles, using logbooks; only one interaction was reported by snow crab fishers in NFL through 2017, but these incidents are believed to be under-reported (DFO 2020f).

The impact of these entanglements on the population's health is not well understood, although the leatherback turtle population in Atlantic waters can only sustain mortality of up to 1% from fishing and other human-induced activities (DFO 2004). The Northwest Atlantic subpopulation is currently estimated at 20,000 individuals and is in decline (Northwest Atlantic Leatherback Working Group 2019). Leatherback sea turtle is listed as "Endangered" under the SARA, and it is considered an offense to kill, harm, harass, capture, or take an individual that is listed as endangered or threatened (DFO 2013). The endangered status of leatherback turtle makes each potential mortality due to

entanglements a concern. Although snow crab fishers are required to return leatherback turtle to the water if encountered, the post-entanglement survival rate of the species is not known. Also, Hamelin et al. (2017) reported that ≈15% of entangled leatherback turtles were dead in fishing gear (not specifically snow crab gear) in Atlantic Canadian fisheries. Recent studies have also demonstrated that leatherback turtles spend considerable time in portions of the NFL region, overlapping in time and space with the NFL snow crab fishery, which primarily operates from April to July (DFO 2020e) (DFO 2020f).

Available information indicates it is likely that fishing mortality on leatherback turtle in the NFL region is above a sustainable level. Although the NFL snow crab fishery's contribution to mortality is unknown, fishing seasons overlap with leatherback turtle use of the area, and the fishery may be a substantial contributor to mortality. Therefore, based on Seafood Watch criteria, fishing mortality is considered a high concern.

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Moderate Concern

At-sea observer data from the snow crab fishery suggests low encounters with leatherback turtle in the nGSL and sGSL regions. Five interactions were observed in sGSL and one in nGSL during 2001–2017 (DFO 2020f). Databases maintained by CSTN and WRS also indicate few interactions in sGSL and nGSL (Figure 13 in Factor 2.2 for the Maritimes) (Hamelin et al. 2017). But, CSTN and WRS are based in the Maritimes and NFL Regions, and Hamelin et al. (2017) suggest that language barriers may have contributed to a lower reporting of entanglements, because leatherback turtle is known to use the Gulf of St. Lawrence. Snow crab gear was generally the most likely source of entanglements in Canadian waters, with 91 entanglements identified due to pot gear (e.g., snow crab, lobster) in Atlantic Canada during 1998–2014 and another 14 reported in 2015–2017 (Hamelin et al. 2017) (DFO 2020f). Observed entanglements are considered to be only a portion of the actual entanglements that occur, due to reporting biases, and it is not clear how much effort is directed to search for leatherback turtle in the GSL (Hamelin et al. 2017).

The impact of these entanglements on the population's health is not well understood, although the leatherback turtle population in Atlantic waters can only sustain mortality of up to 1% from fishing and other human-induced activities (DFO 2004). The Northwest Atlantic subpopulation is currently estimated at 20,000 individuals and is in decline (Northwest Atlantic Leatherback Working Group 2019). Leatherback turtle is listed as "Endangered" under the SARA, and it is considered an offense to kill, harm, harass, capture, or take an individual that is listed as endangered or threatened (DFO 2013). The endangered status of leatherback turtle makes each potential mortality due to entanglements a concern. Although snow crab fishers are required to return leatherback turtle to the water if encountered, the post-release survival rate was not available. Also, Hamelin et al. (2017) reported that ≈15% of entangled leatherback turtles were found dead in fishing gear in Atlantic Canadian fisheries (not specifically snow crab gear).

Recent studies demonstrated that leatherback turtles spend considerable time in portions of the GSL region, especially the sGSL (DFO 2020e)(DFO 2020f). Data from 1999 to 2018 indicate that leatherback turtle primarily uses areas of the sGSL and nGSL in August to October (DFO 2020e).

Although the majority of the snow crab fisheries in these regions conclude before August, seasons for some GSL CFAs extend into August or longer.

Because fishing mortality from the snow crab fishery in these regions is unknown and entanglements are likely underestimated in available literature, and due to overlapping usage of some GSL areas during open snow crab seasons, fishing mortality is considered a moderate concern.

Mammals

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Maritimes Region

High Concern

Besides the marine mammal species already listed in Criterion 2 of this report for the Maritimes snow crab fishery, a large number of species are listed in the 2020 NOAA LOFF as interacting or co-occurring with the Maritimes snow crab fishery, including Atlantic white-sided dolphin, Blainville's beaked whale, blue whale, common bottlenose dolphin, common minke whale, common seal, Cuvier's beaked whale, dwarf sperm whale, fin whale, goose-beaked whale, gray seal, harbor porpoise, harbor seal, harp seal, hooded seal, killer whale, long-finned pilot whale, northern bottlenose whale, pygmy sperm whale, Risso's dolphin, sei whale, short-finned pilot whale, Sowerby's beaked whale, sperm whale, striped dolphin, True's beaked whale, and white-beaked dolphin (NOAA 2020d). Because there was not an available assessment of the Maritimes snow crab fishery's impact on these species, the unknown by-catch matrix (UBM) was used to score the level of concern for this assemblage. Some of these species are listed as endangered, threatened, or special concern under SARA, ESA, and/or IUCN (e.g., blue whale, fin whale, and sei whale), while others have unknown abundance or relatively high abundance. Because of the high vulnerability of all marine mammal species, the UBM provides a score of high concern for abundance of this "Mammals" group.

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

High Concern

Besides the marine mammal species already listed in Criterion 2 of this report for the NFL snow crab fishery, a large number of species are listed in the 2020 NOAA LOFF as interacting or co-occurring with the NFL snow crab fishery, including common minke whale, gray seal, harbor porpoise, harbor seal, harp seal, hooded seal, and ringed seal (NOAA 2020d). Because there was not an available assessment of the NFL snow crab fishery's impact on these species, the unknown by-catch matrix (UBM) was used to score the level of concern for this assemblage. None of these species are listed as endangered under SARA, ESA, and/or IUCN. Some species have unknown abundance while others have relatively high abundance. Because of the high vulnerability of all marine mammal species, the UBM provides a score of high concern for abundance of this "Mammals" group.

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

High Concern

Besides the marine mammal species already listed in Criterion 2 of this report for the nGSL snow crab fishery, a large number of species are listed in the 2020 NOAA LOFF as interacting or co-occurring with the nGSL snow crab fishery, including Atlantic bearded seal, Atlantic white-sided dolphin, beluga whale (Gulf of St. Lawrence population), blue whale, common dolphin, common minke whale, fin whale, gray seal, harbor porpoise, harbor seal, harp seal, hooded seal, killer whale, long-finned pilot whale, ringed seal, Risso's dolphin, sei whale, sperm whale, striped dolphin, and white-beaked dolphin (NOAA 2020d). Because there was not an available assessment of the nGSL snow crab fishery's impact on these species, the unknown by-catch matrix (UBM) was used to score the level of concern for this assemblage. Some of these species are listed as endangered, threatened, or special concern under SARA, ESA, and/or IUCN (e.g., beluga whale, blue whale, fin whale, sei whale), while others have unknown abundance or relatively high abundance. Because of the high vulnerability of all marine mammal species, the UBM provides a score of high concern for abundance of this "Mammals" group.

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

High Concern

Aside from the marine mammal species already listed in Criterion 2 of this report for the sGSL snow crab fishery, a large number of species are listed in the 2020 NOAA List of Foreign Fisheries (LOFF) as interacting or co-occurring with the sGSL snow crab fishery, including Atlantic white-sided dolphin, beluga whale (Gulf of St. Lawrence population), blue whale, common dolphin, common minke whale, Cuvier's beaked whale, fin whale, goose-beaked whale, gray seal, harbor porpoise, harbor seal, harp seal, hooded seal, killer whale, long-finned pilot whale, northern bottlenose whale, Risso's dolphin, sei whale, Sowerby's beaked whale, sperm whale, and white-beaked dolphin (NOAA 2020d). Because there was not an available assessment of the sGSL snow crab fishery's impact on these species, the unknown by-catch matrix (UBM) was used to score the level of concern for this assemblage. Some of these species are listed as endangered, threatened or special concern under SARA, ESA, and/or IUCN (e.g., beluga whale, blue whale, fin whale, sei whale), while others have unknown abundance or relatively high abundance. Because of the high vulnerability of all marine mammal species, the UBM provides a score of high concern for abundance of this "Mammals" group.

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Maritimes Region

High Concern

There is no available assessment of the snow crab fishery's impact on these species. They were included because they were listed as potentially affected by the snow crab fishery in the NOAA LOFF (NOAA 2020d). The unknown by-catch matrix (UBM) was used to score fishing mortality for these species. Based on the UBM, the impacts of pot gear (such as snow crab fishing gear) on marine mammals in the Northwest Atlantic is considered a high concern.

North Atlantic right whale

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

High Concern

North Atlantic right whale (NARW) is a highly vulnerable endangered, threatened, or protected (ETP) species that migrates annually from calving grounds in the southeastern United States to feeding grounds in the northeast United States and southeast Canada during the spring, summer, and fall months (NOAA 2020e)(DFO 2020c). Known feeding grounds include the Gulf of St. Lawrence (GSL) and the Maritimes Region (Figure 14, (NOAA 2020e)). Acoustic data and visual surveys describe an increase in annual North Atlantic right whale presence in the GSL starting in 2015 (Simard et al. 2019)(DFO 2020c)(Bourque et al. 2020). Feeding activities by North Atlantic right whale in the Maritimes Region may have decreased, based on acoustic data (available in 2004–2005 and since 2013) and sightings data (available for 21 years) (Figures 14 and 15) (Bourque et al. 2020)(DFO 2020c). The two figures also show the high density of NARW in the Gulf of St. Lawrence, which typically occurs during the summer months in recent years. Observations of NARW in the Maritimes Region and around Newfoundland are lower than in the Gulf of St. Lawrence; however, observation survey effort (both visual and acoustic) is much lower in these regions. Following the introduction of passive acoustic monitoring in the region, this species has been detected off Newfoundland, particularly Placentia Bay, in 2017, 2018, and 2019 (DFO 2020c). The inclusion of the 10-fathom and 20-fathom contours in the Figure 14 shows that NARW observations are greatly reduced in shallow water. A recent study found that, even though systematic surveys had not identified NARW in waters shallower than 20 fathoms in 2019, the species had been reported in waters that were shallow in 2019 (DFO 2020c). In 2017, at least 17 North Atlantic right whale mortalities occurred (12 in Canadian waters), and in 2018, there were 3 mortalities (all in United States waters) (NOAA 2020f). Fishery entanglements and ship strikes were the two identified causes for these mortalities (Daoust et al. 2017)(NOAA 2020f).

The NARW population has been declining in recent years (Figure 16) (Pettis et al. 2021). Minimum abundance from the most recent stock assessment was estimated at 364 individuals (best estimate 368) (Hayes et al. 2022), while the best estimate of the population from the North Atlantic Whale Consortium was 336 individuals at the end of 2020 {Pettis et al. 2022}. There are fewer reproductive females producing fewer calves each year, with experts estimating that there are 88 or fewer reproductively active females remaining {Pettis et al. 2022}{NOAA 2022c}. In 2020, North Atlantic right whale was downgraded to "Critically Endangered" by the IUCN (Cooke 2020).

Because the North Atlantic right whale is listed as "Endangered" by SARA, COSEWIC, and ESA, and as "Critically Endangered" by the IUCN, abundance is considered a high concern.

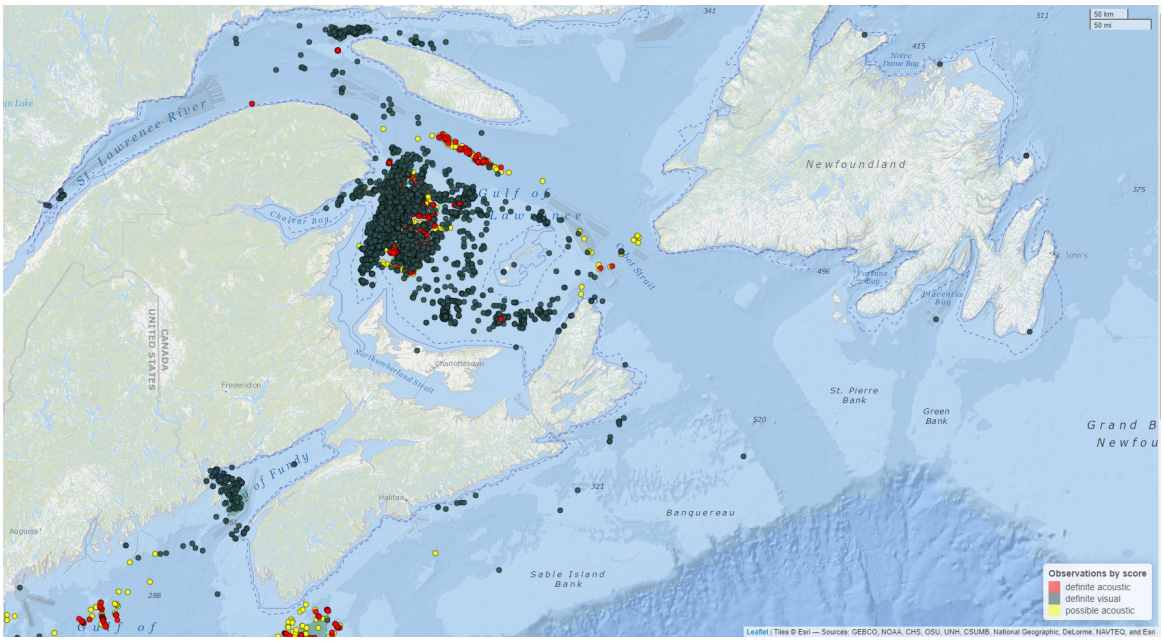

Figure 14: North Atlantic right whale observation in Atlantic Canada from February 1, 2017 to January 31, 2022 as displayed on Whale Map. Definite acoustic (red dots), possible acoustic (yellow dots), and definite visual (green dots) observations are shown, along with the 10-fathom contour (solid line) and 20-fathom contour (dashed line). From https://whalemap.org/WhaleMap/

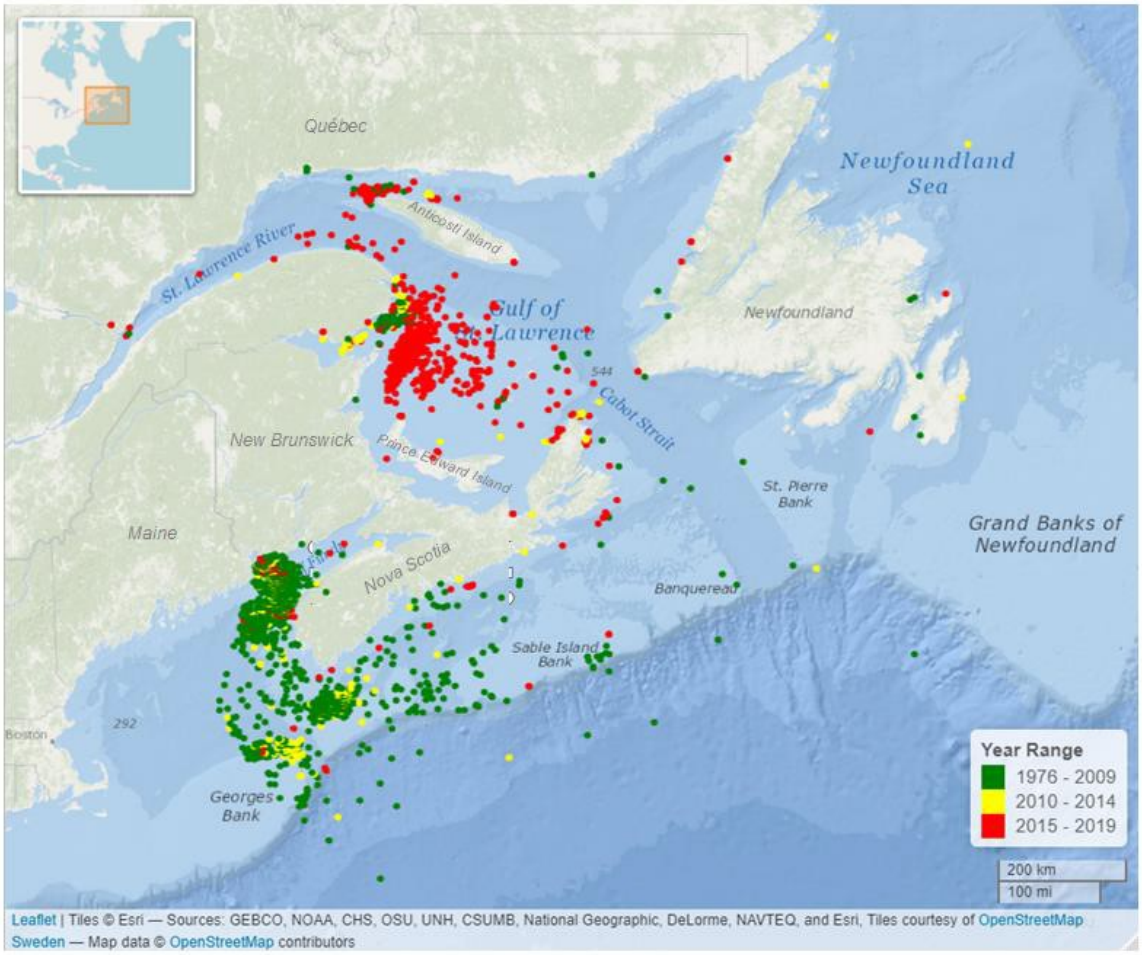

Figure 15: North Atlantic right whale sightings in the Gulf of St. Lawrence and Bay of Fundy from 1976 to 2009 (green dots), 2010 to 2014 (yellow dots), and 2015 to 2019 (red dots) (Bourque et al. 2020). Sightings are based on the North Atlantic Right Whale Consortium Sightings Database 03/04/2020 (Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, MA). Disclaimer: it is not known whether areas of the map without sightings are because of whale absence or lack of surveillance. This map does not include right whale acoustic detections.

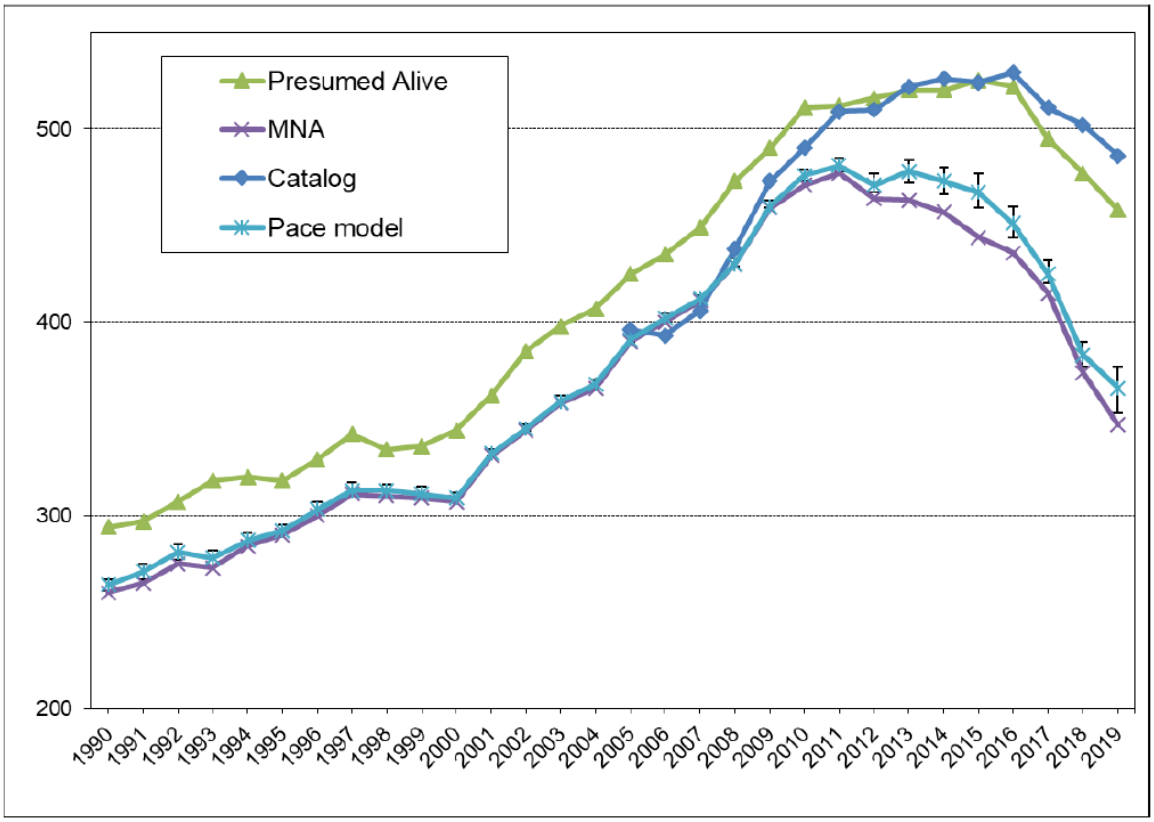

Figure 16: North Atlantic right whale population estimates using four different models, 1990–2019 (Pettis et al. 2021).

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Maritimes Region

High Concern

The western Atlantic stock of the North Atlantic right whale (NARW) is considered a strategic stock because annual serious injury and mortality (SIM) (7.7 from all sources; 5.7 attributed to fisheries entanglement from 2015 to 2019) exceeds the potential biological removal (PBR) (0.7 whales) (Hayes et al. 2022). Due to a lack of information, it is often not possible to assign entanglements to a specific fishery. Documented entanglements from 2015 to 2019 involving pot/trap gear or unidentified gear are all attributed to unknown fisheries, of which the snow crab fishery may be a part. Annual SIMs attributed to entanglements in pot/trap gear in Canadian fisheries were 1.95 (279% of PBR), while none were attributed to pot/trap gear in United States fisheries. Serious injuries and mortalities first seen in the United States but not attributable to country were 2.65 (379% of PBR), and those first seen in Canada but not attributable to country were 1.05 (150% of PBR) (Hayes et al. 2021).

North Atlantic right whale uses annual feeding grounds in southeast Canada, including the Scotian Shelf in the Maritimes Region, during spring, summer and fall (see Figure 14 in Factor 2.1—Abundance) (DFO 2019e)(NOAA 2020e). The NOAA List of Foreign Fisheries (LOFF) indicates that there are known interactions between North Atlantic right whale and snow crab fishing gear in this

region (NOAA 2020d). In 2016–2018, at least five North Atlantic right whales are considered to have died after being entangled in snow crab gear, although most of these were not in the Maritimes Region (DFO 2019e). North Atlantic right whale mortality due to entanglement in fishing gear has been observed in the Maritimes since at least 2010 (Pettis et al. 2010). Within the Maritimes, the following North Atlantic right whale entanglements in fishing gear and mortalities from all sources were observed during 2010–2019: 2010 (one mortality), 2012 (one mortality), 2013 (one entanglement), 2014 (one entanglement), 2015 (three entanglements), 2016 (one entanglement, one mortality), and 2019 (two mortalities) (NARWC 2019). Entanglements were the likely cause of the previously mentioned mortalities in 2010, 2012, and 2016, while the mortalities in 2019 were from an unidentified source (NARWC 2019). The type and origin of fishing gear involved was not identified, except one entanglement in 2015 was attributed to snow crab gear (Pettis and Hamilton 2015). A lack of widespread sufficient gear marking before 2019 to determine the fishery and region responsible for entanglements contributed to the uncertainty about where these interactions initially occurred. NOAA (2020e) set the PBR for North Atlantic right whale at 0.8 whales; therefore, any mortalities from entanglements (or other human-induced causes) would exceed the PBR. In addition, North Atlantic right whale is listed as "Endangered" under the SARA, and it is considered an offense to kill, harm, harass, capture, or take an individual that is listed as endangered or threatened (DFO 2013).

Since 2018, DFO has implemented a suite of management measures to reduce the impact on, and risk to, NARW (these measures are detailed in Factor 3.2). There have been no NARW mortalities linked with Canadian fisheries following the implementation of these measures; however, as previously noted, there were 5 mortalities in 2019 for which the cause of death was not determined (NOAA 2022a). Also, in 2021, NARW #4615 was entangled in the Gulf of St. Lawrence, and this interaction is currently being listed as a serious injury. Unidentified fisheries result in 5.1 SIMs to NARW each year on average (2014–2018), so it is uncertain how much the snow crab fishery contributes to overall fishing impacts on NARW.

Cumulative SIMs far exceed PBR and entanglements due to unknown fisheries are considered a significant contributor. Until there is more specific information available regarding which fisheries are responsible for the unattributed entanglements, Seafood Watch considers that all relevant fisheries that may overlap with NARW pose risks. Based on the available information and the significant risks to NARW, Canadian snow crab fisheries cannot be considered sustainable, and fishing mortality is scored a high concern.

Justification:
North Atlantic right whale mortalities have been observed in eastern Canada since at least 1987 and were highest in 2017 and 2019, while entanglements were reported more consistently since 2011 (Figure 17) (Bourque et al. 2020). Snow crab fishing gear was implicated as the cause of several entanglements and mortalities of North Atlantic right whale in recent years (especially 2017) throughout Atlantic Canada, and is a likely contributing factor to other mortalities (Daoust et al. 2017). There were at least 5 entanglements and 12 mortalities (from all sources) observed in Canadian waters in 2017 (Figure 18). In 2018, zero mortalities were observed in Canadian waters, but one mortality that occurred in U.S. waters was attributed to snow crab fishing gear entanglement (Sharp et al. 2019). In 2019, there were four entanglements and nine mortalities from all sources observed in Canadian waters, according to Bourque et al. (2020) (Figure 19), although

DFO reports three entanglements and eight mortalities in Canadian waters. The 2019 entanglements may have been due to snow crab gear, given the season and proximity to snow crab fishing areas, but the gear was not identified. The proximate cause of the mortalities in 2019 was determined to be ship strikes in four cases and was not determined in the remaining five cases in Canadian waters (Bourque et al. 2020). An additional mortality in 2019 occurred in U.S. waters but was last seen alive entangled in Gulf of St. Lawrence waters (Pettis et al. 2020).

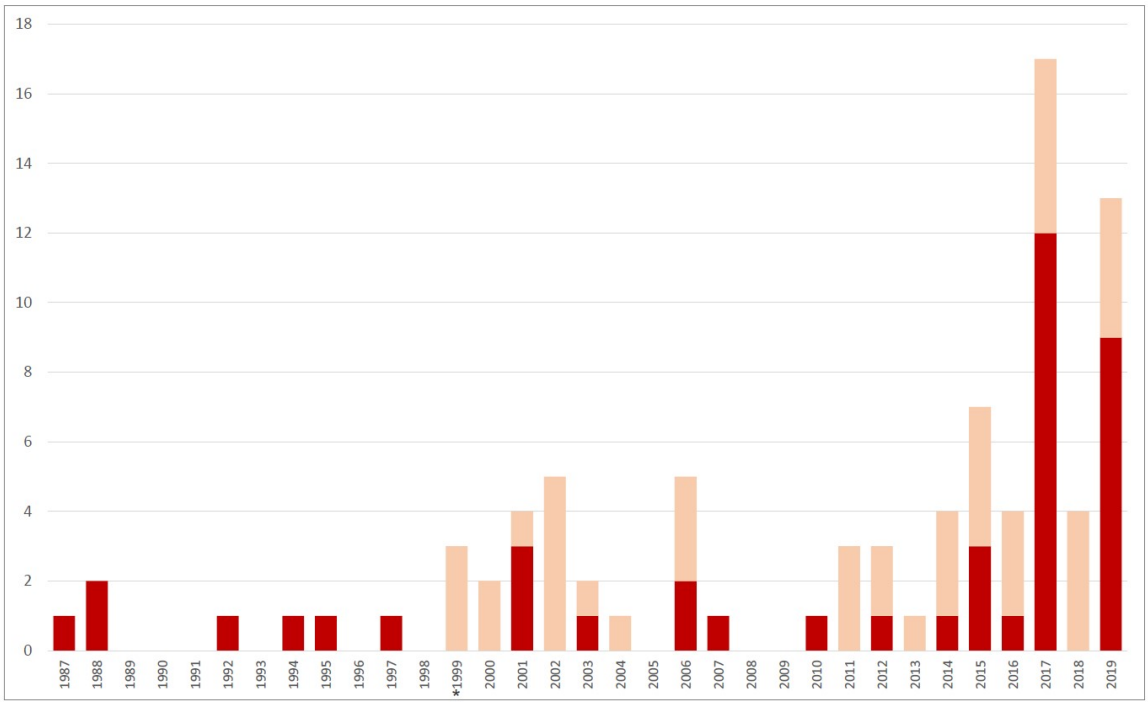

Figure 17: Annual reported NARW mortalities (red) or entanglements/entrapments (pink) in Canadian waters between 1987 and 2019 (Bourque et al. 2020). Note that reports regarding entanglements and entrapments were only available since 1999, and a lack of incidents before 1999 does not indicate that none occurred.

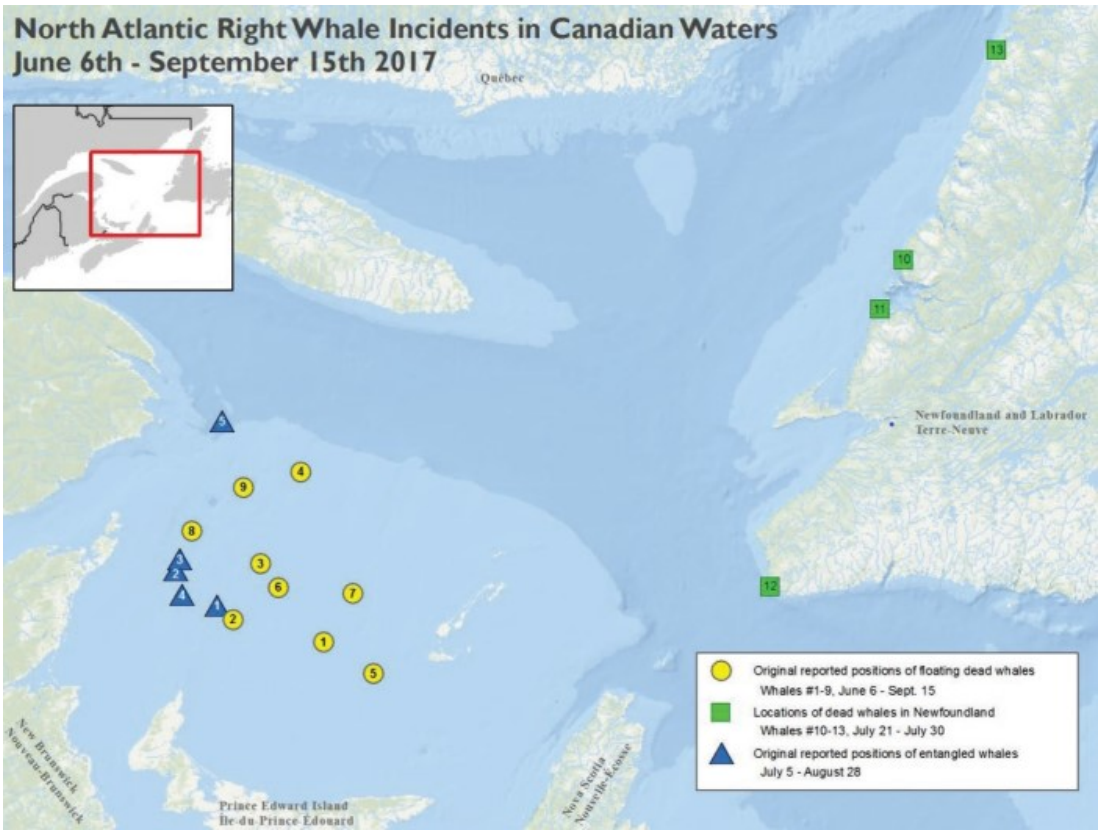

Figure 18: Observed locations of NARW live entanglements (blue markers) and mortalities (yellow and green markers) in Atlantic Canada during 2017 (Daoust et al. 2017).

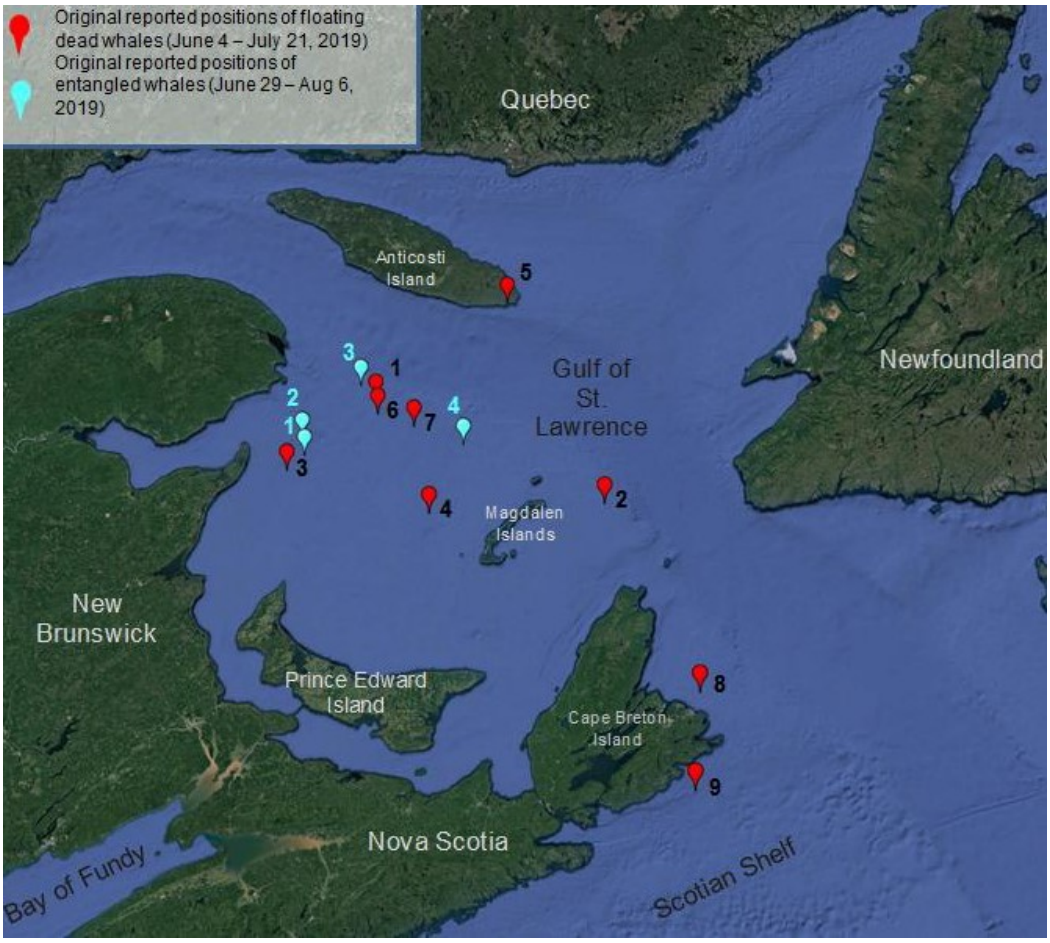

Figure 19: Observed locations of North Atlantic right whale live entanglements (blue markers) and mortalities (red markers) in 2019 in Atlantic Canada (Bourque et al. 2020).

A recent study of individual whales identified in the Gulf of St. Lawrence found that there was a high return rate from year to year, indicating that this is an important feeding area for a specific group of NARW (Crowe et al. 2021). The study also found that, in 2019, a total of 137 individual NARW were estimated to have visited the Gulf of St. Lawrence (Crowe et al. 2021), which was 38% of the estimated 356 NARWs alive at the end of 2019 (Pettis et al. 2021). Although this identifies the Gulf of St. Lawrence as an important foraging area for a significant proportion of the population, it does raise uncertainty regarding the location of the remaining individuals and the concern that they may be in areas that are offered less protection (Crowe et al. 2021).

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

High Concern

The western Atlantic stock of the North Atlantic right whale (NARW) is considered a strategic stock because annual serious injury and mortality (SIM) (7.7 from all sources; 5.7 attributed to fisheries entanglement from 2015 to 2019) exceeds the potential biological removal (PBR) (0.7 whales) (Hayes et al. 2022). Due to a lack of information, it is often not possible to assign entanglements to a specific fishery. Documented entanglements from 2015 to 2019 involving pot/trap gear or unidentified gear are all attributed to unknown fisheries, of which the snow crab fishery may be a part. Annual SIMs attributed to entanglements in pot/trap gear in Canadian fisheries were

1.95 (279% of PBR), while none were attributed to pot/trap gear in United States fisheries. Serious injuries and mortalities first seen in the United States but not attributable to country were 2.65 (379% of PBR), and those first seen in Canada but not attributable to country were 1.05 (150% of PBR) (Hayes et al. 2022).

North Atlantic right whale is occasionally sighted in the Newfoundland and Labrador Region (NFL) and may expand its range to this region in the future (NOAA 2020b)(Kenney 2009). Entanglements of North Atlantic right whale have not been documented in NFL, despite apparent considerable effort by nongovernmental organizations that have found entangled whales of other species in NFL (Benjamins et al. 2011)(WRS 2019). During 2010–2016, there was only one reported mortality (and no entanglements) of North Atlantic right whale in NFL (in 2014), likely due to entanglement in unidentified fishing gear (Pettis and Hamilton 2014). In 2017, four mortalities were observed in a Snow Crab Management Division that is part of the NFL Region but within the Gulf of St. Lawrence (GSL). The area where the mortalities were discovered is a high potential foraging area for North Atlantic right whale; however, live North Atlantic right whales were not observed in the area in 2017–2019 (see Figure 14 in Factor 2.1—Abundance) (Daoust et al. 2017). But, surveys for North Atlantic right whale were rare in the area compared to other areas of the GSL, so the species may be using it more frequently than observations show (Bourque et al. 2020). The cause of the 2019 mortalities is unknown, but snow crab fishing does occur at relatively low levels in this division. There were no reported entanglements or mortalities of North Atlantic right whale in NFL in 2018 or 2019. NOAA Fisheries set the PBR for North Atlantic right whale at 0.8 whales, making any mortality due to entanglements (or other reasons) too many (NOAA 2020b). Also, North Atlantic right whale is listed as "Endangered" under the SARA, and it is considered an offense to kill, harm, harass, capture, or take an individual that is listed as endangered or threatened (DFO 2013).

Since 2018, DFO has implemented a suite of management measures to reduce the impact on, and risk to, NARW (these measures are detailed in Factor 3.2). There have been no NARW mortalities linked with Canadian fisheries following the implementation of these measures; however, as previously noted, there were 5 mortalities in 2019 where the cause of death was not determined (NOAA 2022a). Also, in 2021, NARW #4615 was entangled in the Gulf of St. Lawrence, and this interaction is currently being listed as a serious injury. Unidentified fisheries result in 5.1 SIMs to NARW each year on average (2014–2018), so it is uncertain how much the snow crab fishery contributes to overall fishing impacts on NARW.

Cumulative SIMs far exceed PBR and entanglements due to unknown fisheries are considered a significant contributor. Until there is more specific information available regarding which fisheries are responsible for the unattributed entanglements, Seafood Watch considers that all relevant fisheries that may overlap with NARW pose risks. Based on the available information and the significant risks to NARW, Canadian snow crab fisheries cannot be considered sustainable, and fishing mortality is scored a high concern.

Justification:
North Atlantic right whale mortalities have been observed in eastern Canada since at least 1987 and were highest in 2017 and 2019, while entanglements were reported more consistently since 2011 (see Figure 17 in Factor 2.2 for the Maritimes) (Bourque et al. 2020). Snow crab fishing gear was implicated as the cause of several entanglements and mortalities of North Atlantic right whale in

recent years (especially 2017) throughout Atlantic Canada, and is a likely contributing factor to other mortalities (Daoust et al. 2017). There were at least 5 entanglements and 12 mortalities (from all sources) observed in Canadian waters in 2017 (see Figure 18 in Factor 2.2 for the Maritimes). In 2018, zero mortalities were observed in Canadian waters, but one mortality that was found in United States waters was attributed to snow crab fishing gear entanglement (Sharp et al. 2019). In 2019, there were four entanglements and nine mortalities from all sources observed in Canadian waters, according to Bourque et al. (2020) (see Figure 19 in Factor 2.2 for the Maritimes), although DFO reports three entanglements and eight mortalities in Canadian waters. The 2019 entanglements may have been due to snow crab gear, given the season and proximity to snow crab fishing areas, but the gear was not identified. The proximate cause of the mortalities in 2019 was determined to be ship strikes in four cases and was not determined in the remaining five cases in Canadian waters (Bourque et al. 2020).

A recent study of individual whales identified in the Gulf of St. Lawrence found that there was a high return rate from year to year, indicating that this is an important feeding area for a specific group of NARW (Crowe et al. 2021). The study also found that, in 2019, a total of 137 individual NARW were estimated to have visited the Gulf of St. Lawrence (Crowe et al. 2021), which was 38% of the estimated 356 NARWs alive at the end of 2019 (Pettis et al. 2021). Although this identifies the Gulf of St. Lawrence as an important foraging area for a significant proportion of the population, it does raise uncertainty regarding the location of the remaining individuals and the concern that they may be in areas that are offered less protection (Crowe et al. 2021).

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

High Concern

The western Atlantic stock of the North Atlantic right whale (NARW) is considered a strategic stock because annual serious injury and mortality (SIM) (7.7 from all sources; 5.7 attributed to fisheries entanglement from 2015 to 2019) exceeds the potential biological removal (PBR) (0.7 whales) (Hayes et al. 2022). Due to a lack of information, it is often not possible to assign entanglements to a specific fishery. Documented entanglements from 2015 to 2019 involving pot/trap gear or unidentified gear are all attributed to unknown fisheries, of which the snow crab fishery may be a part. Annual SIMs attributed to entanglements in pot/trap gear in Canadian fisheries were 1.95 (279% of PBR), while none were attributed to pot/trap gear in United States fisheries. Serious injuries and mortalities first seen in the United States but not attributable to country were 2.65 (379% of PBR), and those first seen in Canada but not attributable to country were 1.05 (150% of PBR) (Hayes et al. 2022).

North Atlantic right whale is regularly observed in the GSL during spring through fall, with sightings becoming more common since 2015 (see Figures 14 and 15 in Factor 2.1—Abundance) (DFO 2019e)(NOAA 2020e)(Bourque et al. 2020). In 2016–2018, at least five North Atlantic right whale are considered to have died after being entangled in snow crab gear, including some due to fishing gear from the GSL (DFO 2019e)(Daoust et al. 2017). Within the GSL, the following North Atlantic right whale entanglements in fishing gear and mortalities from all sources were observed during 2015–2019. In 2015, there were three mortalities in the GSL, with the cause of death unknown (Pettis and Hamilton 2015). In 2017, five entangled North Atlantic right whales and nine

mortalities were observed in the sGSL and zero in the nGSL, with four of the entanglements and two of the mortalities attributed to snow crab fishing gear set in the sGSL (see Figure 18 in Factor 2.2 for the Maritimes) (Daoust et al. 2017). In 2018, three entanglements and zero mortalities were observed in the GSL (Pettis et al. 2018). In 2019, four entangled North Atlantic right whales were observed (one of which may have been entangled before entering the GSL) and six mortalities were observed in the sGSL, while one mortality and zero entanglements were observed in the nGSL (see Figure 19 in Factor 2.2 for the Maritimes) (Bourque et al. 2020)(Pettis et al. 2020). An additional mortality in 2019 occurred in U.S. waters but was last seen alive entangled in GSL waters (one of four entanglements in the sGSL) (Pettis et al. 2020).

Although most entanglements and mortalities occurred in the sGSL in 2017–2019, the nGSL (like sGSL) contains high probability North Atlantic right whale foraging areas, and numerous North Atlantic right whales have been observed in the nGSL both during and after snow crab fisheries (see Figure 18 in Factor 2.2 for the Maritimes} (Daoust et al. 2017)(Johnson 2018). In 2017, few surveys by air or sea to search for North Atlantic right whale presence, entanglements, or mortalities were conducted in the nGSL before the first North Atlantic right whale was observed in the region (Figure 20 in Justification following) (Johnson 2018). The species was not observed in the nGSL in 2017–2018 until after the snow crab fishery had concluded, but in 2019, North Atlantic right whale was observed in CFA 16 several weeks before that fishery closed (pers. comm., DFO Quebec Region October 8, 2020). North Atlantic right whale surveys were rare in nGSL CFAs aside from CFA 16; additional surveys in other CFAs in 2019 and other years may have confirmed the species' presence during snow crab fisheries in other portions of the nGSL. A recent study of individual whales identified in the Gulf of St. Lawrence found that there was a high return rate from year to year, indicating that this is an important feeding area for a specific group of NARW (Crowe et al. 2021). The study also found that, in 2019, a total of 137 individual NARW were estimated to have visited the Gulf of St. Lawrence (Crowe et al. 2021), which was 38% of the estimated 356 NARWs alive at the end of 2019 (Pettis et al. 2021). Although this identifies the Gulf of St. Lawrence as an important foraging area for a significant proportion of the population, it does raise uncertainty regarding the location of the remaining individuals and the concern that they may be in areas that are offered less protection (Crowe et al. 2021).

Because of the spatial and temporal overlap between the nGSL snow crab fishery and North Atlantic right whale presence, entanglements were considered an impact on North Atlantic right whale in the nGSL as well as the sGSL. NOAA Fisheries set the potential biological removal (PBR) for North Atlantic right whale at 0.8 whales; therefore, no mortality due to entanglements is acceptable (NOAA 2020b). In addition, North Atlantic right whale is listed as "Endangered" under the SARA, and it is considered an offense to kill, harm, harass, capture, or take an individual that is listed as endangered or threatened (DFO 2013).

Since 2018, DFO has implemented a suite of management measures to reduce the impact on, and risk to, NARW (these measures are detailed in Factor 3.2). There have been no NARW mortalities linked with Canadian fisheries following the implementation of these measures; however, as previously noted, there were five mortalities in 2019 for which the cause of death was not determined (NOAA 2022a). Also, in 2021, NARW #4615 was entangled in the Gulf of St. Lawrence, and this interaction is currently being listed as a serious injury. Unidentified fisheries result in 5.1 SIMs to NARW each year on average (2014–2018), so it is uncertain how much the snow crab

fishery contributes to overall fishing impacts on NARW.

Cumulative SIMs far exceed PBR and entanglements due to unknown fisheries are considered a significant contributor. Until there is more specific information available regarding which fisheries are responsible for the unattributed entanglements, Seafood Watch considers that all relevant fisheries that may overlap with NARW pose risks. Based on the available information and the significant risks to NARW, Canadian snow crab fisheries cannot be considered sustainable, and fishing mortality is scored a high concern.

Justification:
North Atlantic right whale mortalities have been observed in eastern Canada since at least 1987 and were highest in 2017 and 2019, while entanglements were reported more consistently since 2011 (see Figure 17 in Factor 2.2 for the Maritimes) (Bourque et al. 2020). Snow crab fishing gear was implicated as the cause of several entanglements and mortalities in recent years (especially 2017) throughout Atlantic Canada, and is a likely contributing factor to other mortalities (Daoust et al. 2017). There were at least 5 entanglements and 12 mortalities (from all sources) observed in Canadian waters in 2017 (see Figure 18 in Factor 2.2 for the Maritimes). In 2018, zero mortalities were observed in Canadian waters, but one mortality that occurred in U.S. waters was attributed to snow crab fishing gear entanglement (Sharp et al. 2019). In 2019, there were four entanglements and nine mortalities from all sources observed in Canadian waters, according to Bourque et al. (2020) (see the Figure 19 in Factor 2.2 for the Maritimes), although DFO reports three entanglements and eight mortalities in Canadian waters. The 2019 entanglements may have been due to snow crab gear, given the season and proximity to snow crab fishing areas, but the gear was not identified. The proximate cause of the mortalities in 2019 was determined to be ship strikes in four cases and was not determined in the remaining five cases in Canadian waters (Bourque et al. 2020).

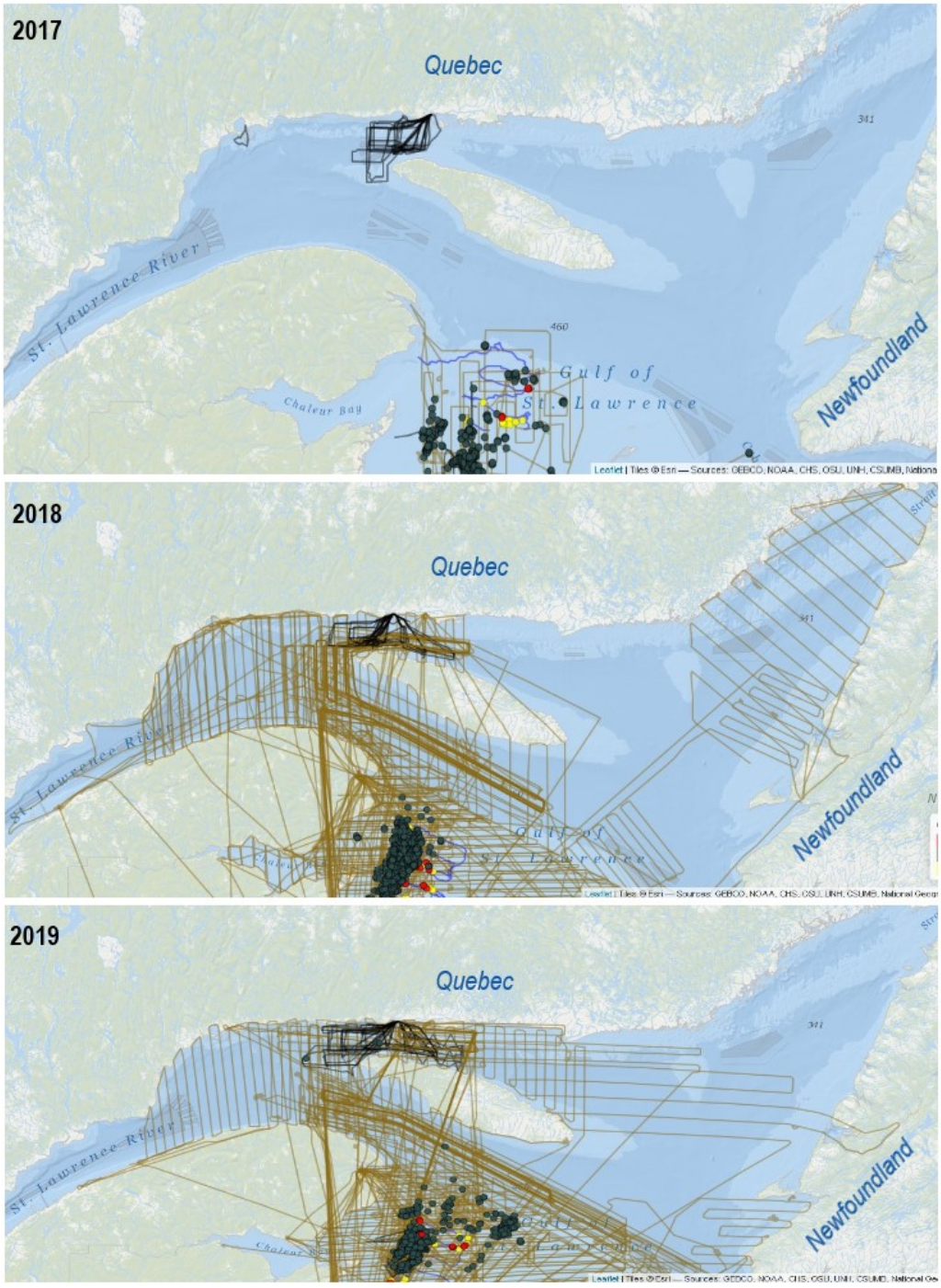

Figure 20: Survey effort for North Atlantic right whale in the nGSL during March 27–July 16 in 2017–2019 (Johnson 2018: https://whalemap.ocean.dal.ca/). Surveillance tracks represent visual (plane and sea vessel) and acoustic (undersea Slocum glider and buoys) observations. Grey circles represent visual North Atlantic right whale observations, whereas yellow and red circles are acoustic observations based on whale vocalizations. March 27 is the typical opening day for snow crab fishing in the nGSL and July 17 was the date of the first North Atlantic right whale observed in the nGSL in 2017. The snow crab fishery in the nGSL closes at different dates, depending on the CFA and year: some CFAs close in late June while others are open through most of August. Note: DFO has indicated that a few survey tracks may be missing from these maps.

Northern wolffish

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

High Concern

Northern wolffish was caught in small numbers in the snow crab fishery (Garforth et al. 2012a)(DFO 2015)(Zisserson et al. 2019). The most recent DFO wolffish stock assessment was not conclusive on stock status (DFO 2015). Under Seafood Watch criteria, abundance of any species affected by the fishery that is determined to be a stock of concern, vulnerable, endangered, or threatened by a state, national, or international scientific body is considered a high concern. Because northern wolffish is listed as "Threatened" under the SARA and COSEWIC, abundance is considered a high concern.

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Moderate Concern

The DFO 2015 stock assessment indicates that northern wolffish is present throughout all Atlantic Canada snow crab management regions, and observer logbooks indicate that the species is caught in the snow crab fishery (DFO 2015)(Zisserson et al. 2019); however, observer data were insufficient to determine the level of fishery impacts. DFO regulations have prohibited the harvest of wolffish since 2003, so it was assumed that no harvest has occurred since. Survival rates of northern wolffish released from snow crab traps were not available. Northern wolffish is listed as "Threatened" under the SARA. For endangered or threatened aquatic species listed under the SARA, it is considered an offense to kill, harm, harass, capture, or take an individual (DFO 2013). Because fishing mortality is unknown, it is considered a moderate concern.

Spotted wolffish

Factor 2.1 - Abundance

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

High Concern

Spotted wolffish was caught in small numbers in the snow crab fishery (Garforth et al. 2012a)(DFO 2015)(Zisserson et al. 2019). The most recent DFO wolffish stock assessment was not conclusive on stock status (DFO 2015). Under Seafood Watch criteria, abundance of any species affected by the

fishery that is determined to be a stock of concern, vulnerable, endangered, or threatened by a state, national, or international scientific body, is considered a high concern. Because spotted wolffish is listed as "Threatened" under the SARA and COSEWIC, abundance is considered a high concern.

Factor 2.2 - Fishing Mortality

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Moderate Concern

The DFO 2015 stock assessment indicates that spotted wolffish is present throughout all Atlantic Canada snow crab management regions, and observer logbooks indicate that the species is caught in the snow crab fishery (DFO 2015)(Zisserson et al. 2019); however, observer data were insufficient to determine the level of fishery impacts. DFO regulations have prohibited harvest of wolffish since 2003, so it was assumed that no harvest has occurred since. Survival rates of spotted wolffish released from snow crab traps were not available. Spotted wolffish is listed as "Threatened" under the SARA. For endangered or threatened aquatic species listed under the SARA, it is considered an offense to kill, harm, harass, capture, or take an individual (DFO 2013). Because fishing mortality is unknown, it is considered a moderate concern.

Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | Pots | Canada | Maritimes Region

< 100%

Information on bait and discards in the Maritimes Region was limited. An estimated 540 t of bait was used in the 2015 snow crab season in the Maritimes, and approximately 12,000 t of snow crab were landed there for 2015 (Mateo et al. 2017b)(DFO 2020c). Based on this one year of information, bait was approximately 4.5% of annual snow crab landings. Discards of snow crab (undersized and soft-shell) were estimated at 1,927 t on average for 2002–2006 (Gavaris et al. 2010). Using landings data from DFO (DFO 2016), snow crab discards in the snow crab fishery were estimated at 21% of snow crab landings (2002–2006 average). Soft-shell discards, a portion of overall snow crab discards, were estimated at <5% in 2019 for the Maritimes snow crab fishery, but discards of undersized crab were not provided (DFO 2020c). An experimental study of survival of snow crab after release from traps in NFL estimated that survival could range from 9.8% to 51.2%,

depending on handling procedures (Grant 2003); in the absence of a study that estimates survival for actual fishery operations in the Maritimes Region, the post-release survival rate was considered unknown for this evaluation. Based on observer data in 2015–2017, 20 other species were reportedly caught and discarded from the Maritimes snow crab fishery, and made up less than 0.02% of snow crab landings in the Maritimes (Zisserson et al. 2019).

Discards of snow crab and other species, combined with bait use, were estimated to make up approximately 25.5% of snow crab landings annually. Even if these percentages are greatly underestimated, it is likely that bait and discards make up less than 100% of snow crab landings in the Maritimes Region.

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

< 100%

Based on estimates of bait from Mateo et al. (2018) and landings from DFO (DFO 2019a), bait was estimated to be ≈15% of snow crab landings in the Newfoundland and Labrador fishery (2014–16 average). Discards of snow crab from the fishery include undersized, unmarketable, or soft-shell snow crab. Estimates of discards of snow crab from this fishery varied among CFAs between approximately 10% and 50% of NFL snow crab landings in 2016–2019 (DFO 2019a). An experimental study of survival of snow crab after release from traps in NFL estimated that survival could range from 9.8% to 51.2%, depending on handling procedures (Grant 2003); in the absence of a study that estimates survival for actual fishery operations in NFL, the post-release survival rate was considered unknown for this evaluation. Few other species are caught and discarded, but there is reportedly quite low at-sea coverage for the NFL snow crab fishery (Mateo et al. 2018)(DFO 2019a). Atlantic cod was the only noncrustacean discard species identified, at less than 0.01% of snow crab landings.

Based on available information on bait and discards in the NFL snow crab fishery, it is highly likely that discards and bait make up less than 100% of snow crab landings.

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

< 100%

Information on bait and discards was limited for the nGSL region. Based primarily on estimates from a 2019 survey of bait suppliers, bait was estimated at approximately 7% of snow crab landings in the nGSL (Lloyds Register 2020). Discards of snow crab from the fishery include undersized, unmarketable, or soft-shell snow crab. Estimates of total snow crab discards were not available for the nGSL; however, DFO provided estimates of released soft-shell crabs, which ranged from 1% to 16% of captured snow crabs among observed CFAs in 2019 (pers. comm., Magalie Hardy February 4, 2020). In the Newfoundland and Labrador Region, estimates of discards of snow crab from this fishery varied among CFAs between approximately 10% and 50% of NFL snow crab landings in 2016–2019 (DFO 2019a). Discards of snow crab in the Maritimes Region were estimated at 21% of fishery landings (2002–2006 average), based on at-sea observer data (Gavaris et al. 2010). An experimental study of survival of snow crab after release from traps in NFL estimated that survival could range from 9.8% to 51.2%, depending on handling procedures (Grant 2003); in the absence of a study that estimates survival for actual fishery operations in the nGSL region, the post-release

survival rate was considered unknown for this evaluation. Available information from the NFL and Maritimes Regions' fisheries indicate that additional by-catch was <1%.

Based on information from the nGSL fishery and neighboring regions' fisheries, it is highly likely that discards and bait make up less than 100% of snow crab landings in the nGSL.

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

< 100%

In 2015, it was estimated that bait use made up 8.4% of snow crab landings in the sGSL (Mateo et al. 2017a). Information on discards was not available for the sGSL. Discards of snow crab from the fishery include undersized, unmarketable, or soft-shell snow crab. In the Newfoundland and Labrador Region, estimates of discards of snow crab from this fishery varied among CFAs between approximately 10% and 50% of NFL snow crab landings in 2016–2019 (DFO 2019a). Discards of snow crab in the Maritimes Region were estimated at 21% of fishery landings (2002–2006 average), based on at-sea observer data (Gavaris et al. 2010). An experimental study of survival of snow crab after release from traps in NFL estimated that survival could range from 9.8% to 51.2%, depending on handling procedures (Grant 2003); in the absence of a study that estimates survival for actual fishery operations in the sGSL region, the post-release survival rate was considered unknown for this evaluation. Available information from the NFL and Maritimes Regions' fisheries indicates that additional by-catch was <1%.

Assuming that discards are not significantly higher in the sGSL than in the NFL or Maritimes, and even if the percentages are underestimated, it is highly likely that discards and bait make up less than 100% of snow crab landings in the sGSL.

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 Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — 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	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Northwest Atlantic | Pots | Canada | Maritimes Region	Highly effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador	Moderately Effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary	Moderately Effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence	Highly effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**

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 follow scientific 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? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, 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: How much 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

Northwest Atlantic | Pots | Canada | Maritimes Region

Highly effective
The snow crab fishery in the Maritimes Region is managed using the DFO precautionary approach (PA) policy (DFO 2016). The PA policy designates the stock as being in the "healthy," "cautious," or

"critical" zone based on the biomass level relative to the limit reference point (LRP) and upper stock reference point (USR) (DFO 2009). Reference points (LRP, USR, target removal [target RR], and removal reference [RR]), as defined in peer-reviewed DFO stock assessments, are used to guide management. Stock assessments are conducted annually for the snow crab fishery in NFL, most recently in 2019. Total allowable catches (TACs) are set by DFO for each CFA, intended to help keep the stock in the "healthy zone." TACs can be modified annually, reportedly based on recommendations provided in the most recent DFO stock assessment and on industry input. Based on results of the 2020 DFO stock assessment, exploitable biomass was at sustainable levels (above the USR) in 2019, except in one of the three assessment divisions (4X) (DFO 2020c). In Division 4X, where the stock was in the "critical zone" (as of the 2019 stock assessment), the fishery was closed for the 2018/2019 season in an attempt to rebuild the stock (DFO 2020c). Division 4X is considered "marginal" habitat for snow crab and has been an issue for management, but the action to close the fishery demonstrates that the situation was taken seriously by managers. Division N-ENS improved from the "cautious zone" to the "healthy zone" in 2019, whereas S-ENS was already in the "healthy zone." Together, N-ENS and S-ENS represent roughly 99% of snow crab abundance and landings for the region. TACs have been adjusted lower in recent years to ensure that stocks in N-ENS and S-ENS are healthy.

It is still unclear whether DFO's strategy to recover Division 4X to a sustainable level for supporting a fishery will be successful, but the majority of the snow crab abundance for the Maritimes Region is within the other two divisions, which are currently considered healthy. Based on the general success of management in the Maritimes Region, management strategy is considered highly effective.

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

Moderately Effective

Stock assessments are conducted by DFO annually for the snow crab fishery in Newfoundland and Labrador, most recently in 2022. Although a precautionary approach (PA) framework for NFL snow crab was developed by DFO Science through a peer-review process in 2018 (Mullowney et al. 2018), including limit reference points (LRP), this framework has not yet been adopted for use in management of the snow crab resource. Some NFL region snow crab fishers involved with the 2020 stock assessment and management processes were not supportive of DFO Science's proposed PA framework for use in decision-making and submitted an alternative PA Framework. The alternative PA framework was peer-reviewed and was not accepted (DFO 2022b). A working group has been established to recommend upper stock reference points (USRs) and harvest control rules (HCRs), but formal recommendations have yet to be made. As a result, limit reference points (LRPs) are used to describe stock status, but a formal precautionary approach has not been implemented (DFO 2022b). Total allowable catches (TACs) are set by DFO for each CFA, intended to help keep the stock in the "healthy zone." TACs can be modified annually, reportedly based on recommendations provided in the most recent DFO stock assessment and on industry input. Previously, there had been some concerns regarding the management approach, because in some CFAs, TACs were set at high levels until well after stock declines began to be detected by trawl and trap survey indices (DFO 2019a). DFO (2019a) indicated that data were insufficient to determine the status of the stock in one CFA, and another CFA was considered to be below the LRP. Sustained high fishing pressure, likely above a sustainable level, was also linked to a recent decline in size-at-maturity of male snow crab in

some NFL Region CFAs (Mullowney and Baker 2020). But the 2022 stock assessment found that exploitable biomass has increased over the last 3 years, and that total mortality on exploitable biomass had reduced in all assessment divisions, and in 2021, all stock indices were above the LRPs for all assessment divisions (DFO 2022b). The current management system appears to have prevented the further decline of the stock and is recovering from time-series lows in abundance. The continued development of a precautionary framework for the fishery should serve to further improve the management of the fishery.

Because management effectiveness is unknown but it is unlikely that the fishery is having serious negative impacts on retained populations, the management strategy is considered moderately effective.

Justification:
The current IFMP for this fishery (DFO 2019i) details several fishery management measures that have been implemented by DFO to reduce the likelihood of overfishing, including the following:

- Snow crab Conservation Exclusion Zones (i.e., closed areas) have been established using a co-management approach.
- The offshore fleets have been directed, through a condition of their license, to immediately sort on deck all crab and release all undersized and soft-shelled crab in a manner causing them the least harm, to reduce handling mortality.
- Since 1995, all license holders have been required to have all snow crab landings weighed and dockside monitored to avoid exceeding the TAC.
- Fishers are required to record information about catch and effort in logbooks, and submit these data to DFO.
- Crab harvesters are required to use traps with a minimum mesh size of 65 mm to allow undersized crab to escape. Any undersized crab that are in the traps must be returned to the sea.
- Earlier and shortened fishing seasons in some years in some CFAs, to reduce capture of soft-shell crabs.

Although these strategies are helpful in management of the NFL snow crab fishery stock, they have not been sufficient to prevent stock declines.

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Moderately Effective
Stock assessments are conducted annually for the snow crab fishery in the nGSL, most recently in 2019. Fishery-dependent and fishery-independent data were available to assess stock health for management purposes through the 2019 DFO stock assessment for nGSL (DFO 2019b).
But, reference points have not yet been developed for the snow crab stock in the nGSL, and this step would greatly increase the likelihood of management success in preventing overfishing. Total allowable catch (TAC) limits have been used by DFO to limit catch since the 1990s in most CFAs, and they are reportedly adjusted each year based on recommendations within the DFO stock assessments for the nGSL and on industry input. But, it is not clear that TACs are always adjusted with enough caution to avoid stock collapses. Recent downward trends in abundance of

exploitable biomass in several CFAs to quite low levels, despite TACs remaining relatively consistent, indicate a potential problem with the management strategy. Although measures (i.e., TACs) are in place that could be effective in limiting declines in exploitable biomass, further precaution in management measures would reduce the likelihood of the biomass declining further. Based on this information, management strategy is considered moderately effective.

Justification:
DFO personnel report confidence in the health of the stock for the region, based on data that indicate at least average numbers of juvenile snow crab in the nGSL and the cyclical nature of exploitable biomass, but note that the current outlook for some CFAs is poor (pers. comm., Cédric Juillet November 22, 2019). A stated goal in the DFO Integrated Fishery Management Plan (IFMP) for the nGSL is to "develop a precautionary approach in collaboration with the industry in the snow crab fishery in the coastal areas of the northern Gulf of St. Lawrence for implementation in 2020" (DFO 2019h). The assumption is that this would include the use of reference points in the stock assessment, and this intention was confirmed by DFO personnel (pers. comm., Cédric Juillet November 22, 2019). Although this is a commendable plan of action to improve management, evaluation of the future management strategies must wait until they have been implemented.

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Highly effective
The snow crab fishery in the sGSL is managed using the DFO precautionary approach (PA) policy (DFO 2009). The PA policy designates the stock in the "healthy," "cautious," or "critical" zone based on the biomass level relative to the limit reference point (LRP) and upper stock reference point (USR). Reference points (LRP, USR, and removal reference [RR]), as defined in peer-reviewed DFO stock assessments, are used to guide management (DFO 2012). Stock assessments are conducted annually for the snow crab fishery in the sGSL, most recently in 2020. Regular monitoring (fishery-dependent and -independent surveys) is undertaken each year to inform stock assessments. Quotas are set by DFO for each CFA, based on the harvest control rules defined in the Integrated Fishery Management Plan (IFMP) and defined to keep the snow crab fishable biomass in the "healthy zone." Quotas are set annually, based on the most up-to-date DFO science biomass estimations and industry input. Success of this management strategy is evidenced by the results of the 2020 DFO stock assessment that exploitable biomass was at sustainable levels (well above the USR) in 2019, and the stock is considered by DFO to be in the "healthy zone" (DFO 2020d). Therefore, the management strategy is considered highly effective.

Factor 3.2 - Bycatch Strategy

Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Ineffective
Evaluation of the by-catch strategy for the Canadian snow crab fisheries includes species caught in snow crab pots and those affected by entanglements in the gear (ropes, buoys, and pots).

Invertebrates and finfish

Only snow crab is allowed to be retained in the Canadian snow crab fisheries. The gear is considered selective, with low by-catch rates:

- Maritimes: 20 other species (mainly invertebrates) caught and released at low levels, comprising some 0.02% of snow crab landings in Divisions N-ENS and S-ENS and 0.4% in 4X (approximately 1.3 t total in 2018), based on averaged annual at-sea observer data (DFO 2020c)
- NFL: less than 0.03% in 2014–2016, based on at-sea observer data (Mateo et al. 2018)
- GSL: No estimate available, but considered low by DFO staff (pers. comm., Cédric Juillet November 22, 2019) (pers. comm., Manon Mallet October 23, 2019)

The restriction on retained catch includes undersized and soft-shelled crabs, and all regions have a minimum 5.25-inch mesh size to reduce the number of sub-legal snow crabs caught (as well as other small organisms) (DFO 2016)(DFO 2019i)(DFO 2019h). Nonetheless, discards of sub-legal crabs can be relatively high. Examples include approximately 10% and 50% of snow crab landings across NFL Crab Fishing Areas (CFAs) in 2016–2019 (DFO 2019a) and approximately 21% of snow crab landings in the Maritimes in the past (2002–2006 average) (Gavaris et al. 2010). Snow crab discards may be a problem if the post-release survival is low. No recent information on post-release mortality was found, but early studies suggest it to be relatively low (in the range of 2% to 16%, depending on handling practices and exposure to air (Dufour et al. 1997)(Grant 2003)).

Protocols are in place to close CFAs when the proportion of soft-shell snow crab observed at sea exceeds a certain threshold (for example, 15% or 20% in NFL (depending on the CFA) of total snow crab catch, and 20% in the GSL). In NFL, DFO (2019a) raised concerns that the soft-shell protocol is ineffective in controlling wastage and mortality in the fishery, due to small grid sizes coupled with low levels of observer coverage (an estimated 0.1–0.3% of the snow crab fishery catch was observed in recent years in NFL (Mullowney et al. 2019)). A quantitative analysis examining appropriate grid sizes and observer coverage levels to implement a precautionary monitoring program is planned for the next 1 to 3 years (DFO 2019i). Other management measures are also used to reduce the catch of sub-legal crab, such as a 2019 shift in the Maritimes N-ENS CFA from separate spring and summer seasons to a single continuous season from April to August, to encourage a shift in fishing effort to earlier in the season when the incidence of soft crab is lower. This was in direct response to the higher incidence of soft crab observed in 2018 (DFO 2020c) (pers. comm. DFO through technical review).

Wolfishes are among the finfish caught in the Maritimes (Zisserson et al. 2019), NFL (DFO 2015), and GSL (pers. comm., Magalie Hardy February 4, 2020). These are listed on the Species at Risk Act (SARA), and must be recorded on SARA logbooks along with any other SARA-listed species. Like the other noncrab species, they are caught in relatively low numbers. Wolffish landings have been prohibited in Canada since 2003, which likely minimizes impacts from the snow crab fishery, assuming that post-release mortality is low. According to Mateo et al. (2018), reports of live releases of wolffishes are between 74% and 96%, based on at-sea observer data in NFL, although the years and reporting rates were not mentioned. Post-release survival rates of wolffishes were not available.

Turtles

Entangled leatherback turtles have been reported in snow crab gear throughout Atlantic Canada in recent years, with some of these events resulting in mortalities (Hamelin et al. 2017)(DFO 2020f). No known snow crab fishery management measures have been implemented specifically to reduce leatherback turtle entanglements in Canadian snow crab fisheries. An action plan for leatherback turtle was released by DFO in 2020. It states that entanglement in fishing gear is considered the most significant of the identified threats to leatherback turtle (DFO 2020h). A recent DFO report focused on fishery interactions with leatherback turtle, but data gaps still exist, and interactions in the GSL are likely underestimated (DFO 2020f). The action plan identifies steps to document and reduce entanglements of leatherback turtle, but implementation is uncertain and success in addressing this concern cannot be evaluated yet.

Mammals

In response to the increase in the observed North Atlantic right whale (NARW) entanglements noted in Criterion 2, DFO has implemented a suite of measures since 2018 (see Justification below for a list of measures and maps of closures). These have been designed to:

- Improve understanding of impacts to improve mitigation strategies (e.g., increased surveillance via aircraft, drones, and underwater gliders and acoustic devices; reporting of lost gear and marine mammal interactions by fishers; gear marking).
- Reduce entanglement risk and impacts (e.g., static and dynamic closures in the GSL snow crab fishery in 2018, later expanded to all snow crab and other fixed gear fisheries; funding and permitting ropeless gears and weak links; funding disentanglement efforts). In 2021, the total closure coverage was nearly 75,000 km^2 (pers. comm., DFO during technical review) (see Figure 21 and text in Justification).

Few analyses have been conducted on the effectiveness of these measures to reduce fishing mortality to below PBR. A NOAA study concluded that the closures in place in United States and Canadian fisheries by the end of 2018 were expected to be effective regionally but may not be sufficient to allow recovery of NARW {Hayes et al. 2018a}. A recent publication by {Cole et al. 2021} found these same closures in the GSL snow crab fishery led to displacement of effort to areas outside the closed areas, producing a higher threat of entanglement in these new areas. The authors note that, although there was a lower quota and reduced trap limit in 2018 than in 2017, fishing effort did not change. Most recently, a risk analysis commissioned by DFO (Cole and Brillant 2021) found an entanglement risk reduction of 61.3% in the GSL snow crab fishery from 2018 to 2021. The authors concluded that, though the efforts and accomplishments to date are commendable, they are not enough to ensure the survival of North Atlantic right whale. The authors are currently working on a more comprehensive risk analysis of the GSL snow crab fishery, which will likely result in different risk reduction values than in the published report. They are also planning to expand the assessment to other fixed gear fisheries in the future (pers. comm., Alexandra Cole July 29 2022).

In the meantime, there continue to be entanglements in Canadian fisheries (e.g., NARW #4615, which was entangled in the Gulf of St. Lawrence in 2021 and is currently listed as a serious injury) (NOAA 2022a), and mortalities due to entanglements in unidentified fisheries that could originate in either Canadian or U.S. waters (e.g., NARW #1226, "Snake Eyes," which was seen entangled in the Gulf of St. Lawrence and later found dead off Long Island, NY in 2019) (NOAA 2022a). Currently, an average of 5.1 NARW are known to be seriously injured or killed each year by unidentified fisheries (Hayes et al. 2021). Until it becomes clear which fisheries are responsible, all fisheries that overlap with North Atlantic right whale migrations and are known to entangle the species are potential sources of entanglements, which may result in mortalities.

Ghost gear

DFO has implemented a number of measures and efforts to mitigate the impacts of lost ("ghost") gear, as part of a broader government commitment to reduce the impacts of plastics in the oceans (see Justification). Many of these are applicable to snow crab, lobster, and Atlantic crab fisheries, including requiring biodegradable panels, requiring that lost gear is reported, and conducting and funding efforts to reduce gear loss and retrieve gear when it is lost.

Because the by-catch management measures for avoiding entanglements of species of concern (mainly North Atlantic right whale) are insufficient, given the potential impacts of the fishery, the by-catch management strategy for Canadian snow crab fisheries is considered ineffective.

Justification:
Measures to protect North Atlantic right whale by year (taken verbatim from (DFO 2022))

2018

- Introduced static and dynamic fishery area closures
- Introduced case-by-case measures to address sightings of three or more whales or a mother and calf anywhere in Atlantic Canada and Quebec
- Introduced new mandatory requirements for harvesters to report lost gear and all marine mammal interactions
- Introduced new measures to reduce rope and to better track buoys
- Introduced new gear marking requirements for harvesters in Crab Fishing Area 12
- Changed the Marine Mammal Regulations to ensure vessels stay at least 100 m from whales
- Invested in new whale detection technologies and new acoustic technologies, through the Oceans Protection Plan
- Supported industry-led pilot projects on new gear modifications to prevent entanglements
- Invested $1 million per year (permanent) to support marine mammal response activities
- Logged 2,500 flight hours

2019

- Amended the static fishery closure area to cover an area where 90% of right whales were spotted in 2017

- Expanded the dynamic fishery closure area to cover the entire Gulf of St. Laurence
- Introduced new temporary fishery closure restrictions in shallow waters (less than 20 fathoms)
- Organized a gear retrieval operation in the Gulf of St. Lawrence, which removed over 100 traps and almost 10 km (6 miles) of rope
- Invested an additional $1.2 million over four years to support Marine Mammal Response activities
- Increased surveillance via aircraft, drones, and underwater gliders and acoustic devices.
- Logged 3,000 flight hours

2020

- Introduced a new season-long closure area protocol
- Expanded the dynamic fishery closure area into the Bay of Fundy
- Introduced mandatory gear markings for all fixed gear fisheries in Eastern Canada
- Authorizing ropeless gear trials in closed areas
- Created a $8.3 million Ghost Gear Fund, to assist in the retrieval and recycling of harmful ghost gear from the oceans. This program helped facilitate the removal of 63 tonnes of ghost gear in Atlantic Canada.
- Logged over 2,500 flight hours

2021

- Modified closure protocols for greater certainty on the continued presence of whales in closed areas
- Established a new technical working group for harvesters, right whale experts, and departmental officials
- Invested an additional $8.4 million in the Ghost Gear Fund, with a focus on ghost gear retrieval in the Gulf of St. Lawrence
- Invested an additional $8 million over 2 years through Nature Legacy to increase capacity to detect North Atlantic right whales in near real-time
- Launched the $20 million Whale Safe Gear Adoption Fund to help harvesters transition to whale-safe gear (i.e., weak breaking points or links) by 2023. This fund also supports ropeless/rope-on-demand technologies.
- Logged over 2,800 flight hours

2022

- Maintaining 2021 closure protocols
- Working with harvesters, fishery by fishery, to implement mandatory whale-safe gear requirements by 2023
- Increasing the number of near-real-time acoustic devices for monitoring and detection

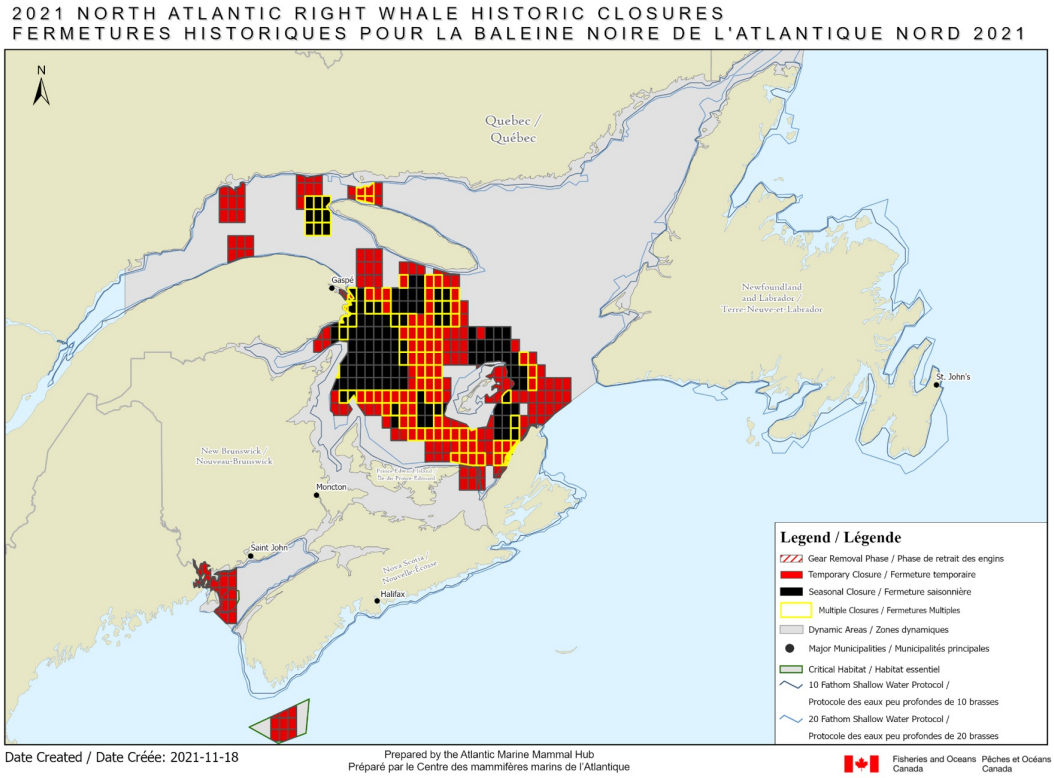

Figure 21: 2021 North Atlantic right whale closures in Canadian waters (pers. comm., DFO during technical review)

Canadian measures to reduce the impact of ghost gear (unless otherwise cited, the information below is from the DFO Ghost gear website (DFO 2020j))

- All snow crab, lobster and Jonah/Atlantic crab traps must use biodegradable twine in some portion of the pots' netting to reduce crab mortality in ghost gear (based on a review of all the available IFMPs for these fisheries)
- In 2018, the Canadian government joined the Global Ghost Gear Initiative
- In 2019, the Canadian Coast Guard conducted a 3-day ghost gear retrieval operation in the GSL. The goal was to help prevent entanglements with marine mammals and increase the sustainability of Canada's Atlantic fisheries. During this operation, 100 snow crab traps and 9 km of rope were removed (DFO 2020j); however, reports from participants in this effort indicate that DFO did not permit all observed ghost gear to be collected upon request, and a North Atlantic right whale was entangled in the area shortly thereafter (pers. comm., Amy Knowlton September 21, 2020).
- In 2019, DFO created the Canadian Ghost Gear Program, which runs from 2020 to 2022. To date, the program has funded 49 projects, for a total of CAN 16.7 million. Of these, 45 were located in Canada and 4 were international. A number of them focused on gear loss prevention and gear retrieval in crab and lobster fisheries in Atlantic Canada. As of April 2022, DFO reports 7,342 units of gear with a total weight of 1,295 tonnes were

retrieved from Canada's waters (east and west coast combined), in addition to 153 km of rope.

- Since 2020, reporting of lost and retrieval of previously reported lost gear has been mandatory in all Canadian commercial fisheries. Fish harvesters and authorized retrievers can report lost gear by using PDF forms or an online Fishing Gear Reporting System.
- In 2020, DFO hosted a Gear Innovation Summit with the aim of exploring whale-safe fishing technologies and strategies as well as methods designed to reduce and mitigate the risk of abandoned, lost, and discarded fishing gear (DFO 2020l). The summit was about raising awareness, and did not attempt to focus on solutions or recommendations.

Factor 3.3 - Scientific Research And Monitoring

Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

N/A

In cases where either Factor 3.1 or 3.2 scores ineffective, Factor 3.3 is not scored because the overall score for Criterion 3 is a very high concern (1), regardless of how a fishery performs against Factor 3.3.

Factor 3.4 - Enforcement Of Management Regulations

Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

N/A

In cases where either Factor 3.1 or 3.2 scores ineffective, Factor 3.4 is not scored because the overall score for Criterion 3 is a very high concern (1), regardless of how a fishery performs against Factor 3.4.

Factor 3.5 - Stakeholder Inclusion

Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

N/A

In cases where either Factor 3.1 or 3.2 scores ineffective, Factor 3.5 is not scored because the overall score for Criterion 3 is a very high concern (1), regardless of how a fishery performs against Factor 3.5.

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	SCORE
Northwest Atlantic | Pots | Canada | Maritimes Region	Score: 3	+.5	Low Concern	**Green (3.742)**
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador	Score: 3	+.5	Low Concern	**Green (3.742)**
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary	Score: 3	+.5	Low Concern	**Green (3.742)**
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence	Score: 3	+.5	Low Concern	**Green (3.742)**

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 - Impact of Fishing Gear on the Habitat/Substrate

Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Score: 3

Snow crab fishery traps (pots) typically rest on the seafloor; therefore, they may cause some substrate damage. Traps can affect biogenic structures (e.g., sponges, corals) through crushing or entanglement (DFO 2010). Also, crushing and scouring effects can result if traps are dragged across the bottom during retrieval or during periods of strong storms or tides. DFO (2010) also indicates that the potential impact of traps on marine habitats depends on a variety of factors, including substrate type, depth, construction of traps, retrieval methods, weather conditions, trap soak time, and type and length of rope (floatlines are less likely to entangle bottom structures). Typical snow crab trap operations occur on mud/sand substrate (DFO 2016)(DFO 2019h). There may be occasions where trap operations occur on more sensitive substrates (e.g., corals or sponges); however, this was assumed to be rare due to implementation of closed areas to protect sensitive seafloor habitats in all regions.

Because snow crab pots contact the seafloor but have a low likelihood of impacting corals in this fishery, a score of 3 was given.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northwest Atlantic | Pots | Canada | Maritimes Region

Score: +.5

In the Eastern Nova Scotia and 4X Snow Crab IFMP (covering the Maritimes Region), three conservation areas are mentioned: the Gully MPA (established 2004), the Lophelia Coral Conservation Area, and the Northeast Channel Coral Conservation Area (DFO 2016). Also, St. Anns Bank MPA (established 2017) protects an area off northeast Nova Scotia from activities that would remove or damage marine organisms (DFO 2019m). All these areas aim to protect unique habitats. It was not clear if these areas include at least 50% of representative habitat (i.e., corals and sponges), but it is likely these measures protect a substantial portion of the representative habitat. Based on this information, 0.5 point was awarded for mitigation of gear impacts.

Justification:

The Gully MPA is over 2,000 km^2 and was established in 2004. It includes a portion of the Gully, the largest underwater canyon in the western North Atlantic, which is an important habitat for at least 15 species of whales and dolphins, including the endangered Scotian Shelf population of northern bottlenose dolphin. A variety of fish and invertebrates use the MPA, including snow crabs and approximately 30 species of cold-water corals.

St. Anns Bank MPA is 4,364 km^2 and was established in 2017. It has the greatest annual sea surface temperature range on the Scotian Shelf, and provides important habitat for commercial and noncommercial species, such as Atlantic cod, redfish, white hake, witch flounder, and a variety of sponges, corals, and sea pens. Scientific surveys have recorded more than 100 species in this area, including ETP species, such as leatherback turtle and Atlantic wolffish. This MPA is part of an important migration corridor for fish and marine mammals, including whales, moving in and out of the GSL (DFO 2019m).

Northwest Atlantic | Pots | Canada | Newfoundland and Labrador

Score: +.5

To protect coral and sponge habitats, 13 areas were closed by the Northwest Atlantic Fisheries Organization (NAFO) to bottom-contacting fishing gear (including snow crab traps) in NFL between 2007 and 2010 (DFO 2017b). A 14th area was closed voluntarily by the fishing industry off Labrador to protect coral and sponge habitats. It is not clear if these closed areas include at least 50% of representative habitat (i.e., corals and sponges), but these closures do likely protect a substantial portion of the representative habitat. Based on this information, 0.5 point was awarded for mitigation of gear impacts.

Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Score: +.5

In 2017, 11 fishery closures were implemented in the nGSL by DFO as part of the Coral and Sponge Conservation Strategy for Eastern Canada (DFO 2019h). The purpose was to protect cold-water coral and sponge species, communities, and habitats. The use of bottom-contacting fishing gear (including snow crab traps) was prohibited as of December 15, 2017 in these areas. It was not clear if these areas include at least 50% of representative habitat (i.e., corals and sponges), but these measures likely protect a substantial portion of the representative habitat. Based on this information, 0.5 point was awarded for mitigation of gear impacts.

Justification:

DFO is also evaluating the St. Lawrence Estuary (within the nGSL region) as a 6,000 km^2 Area of Interest for potential development into a conservation area, with the goal of adding protections for several priority marine species.

Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence

Score: +.5

The American Bank Marine Protected Area (MPA) was designated in 2019 and is located in a snow crab fishing area in the sGSL, but it is managed by the Quebec (nGSL) region (DFO 2019l). There are also scallop buffer zones and coral conservation areas (Magdalen shallow slope and Gulf East), marine refuges, and two crab fishing buffer zones, which include snow crab habitat and limit fishing (Hebert et al. 2019). It was not clear if these areas include at least 50% of representative habitat (i.e., corals and sponges), but these measures likely protect a substantial portion of the representative habitat. Based on this information, 0.5 point was awarded for mitigation of gear impacts.

Justification:

The Banc-des-Américains (American Bank) MPA, established in 2019, is located in the sGSL off Cape Gaspé and is 1,000 km^2 (DFO 2019l). The area supports an extraordinary range of marine habitats and species, including an abundance of commercially fished species. Approximately 15 cetacean species are observed every year in the region, which is a feeding ground and an essential migration route to and from the St. Lawrence Estuary. The leatherback turtle, an endangered species, has been observed in the area. Wolffish species are also found in the MPA. The MPA is an important feeding, spawning, shelter, and migration area for many of these species.

Factor 4.3 - Ecosystem-based Fisheries Management

Northwest Atlantic | Pots | Canada | Maritimes Region
Northwest Atlantic | Pots | Canada | Southern Gulf of St Lawrence
Northwest Atlantic | Pots | Canada | Newfoundland and Labrador
Northwest Atlantic | Pots | Canada | Northern Gulf of St Lawrence and Estuary

Low Concern

Through the Snow Crab IFMP specific to each management region, DFO describes policies and objectives meant to study and protect ecosystem functioning related to snow crab and potential fishery impacts (DFO 2014)(DFO 2016)(DFO 2019h)(DFO 2019i); however, evidence of the effectiveness of these plans is not yet clear. Spatial management is used to protect vulnerable habitats (see Factor 4.2 for each fishery), and several MPAs and marine refuges have already been established and others are being considered (see Factor 4.2 for each fishery). Several closed areas for snow crab conservation were also established in NFL through a collaborative approach with fishing fleet committees (DFO 2019i).

A fishery closure area within the sGSL was established during the snow crab fishing season to reduce entanglements of North Atlantic right whale, but the size of this area was reduced in 2019 and then eliminated in 2020 in favor of seasonal closure areas based on North Atlantic right whale presence (DFO 2020m). Areas within the nGSL and the Maritimes Region are also subject to temporary closures based on North Atlantic right whale presence.

Although there are several known predators on snow crab, no predator species are known to be completely dependent on snow crab for survival (DFO 2016). This information, combined with the snow crab's food-web role as an opportunistic omnivore, suggests that recent fishery removals of snow crab have likely not caused major detrimental impacts to the food web. No other species, aside from snow crab, is retained in this fishery.

Overall, policies are in place to protect ecosystem functioning and account for capture species' ecological roles, but have not yet proved to be effective. Spatial management is used to protect ecosystem functioning, and detrimental food web impacts are unlikely. Therefore, ecosystem-based fisheries management is considered a low concern.

Justification:
The nGSL Snow Crab IFMP includes the following objectives intended to assess the impacts of fishing on the habitat and ecosystem of snow crab (information on progress toward meeting objectives was not available):

- Contribute to research projects and knowledge on biotic and abiotic ecosystem changes.
- Report aquatic invasive species observed during fishing and scientific activities.
- Conduct research projects on the interactions of other fishing activities with snow crab.
- Provide scientific and management information for studies on other human activities or environmental incidents.
- Provide scientific and management information specific to snow crab on the ecological monitoring of MPAs.
- Contribute to species-at-risk recovery strategies by maintaining, and adjusting as necessary, conservation measures to reduce the impacts of the snow crab fishery on species at risk.
- Maintain, and adjust if necessary, conservation measures to reduce the impacts of the snow crab fishery in marine and coastal protected areas.
- Ensure compliance with the prohibition of fishing in closure areas for the protection of the corals and sponges.
- Document and reduce the amount of fishing gear lost or left at sea.

The sGSL Snow Crab IFMP includes the following objectives that are meant to fulfill the goal of assessing impacts of fishing on the habitat and ecosystem of snow crab:

- Ensure that any potential collateral effects that the fishery has on other species or habitats are mitigated.
- Continue to minimize by-catch of other species by configuring fishing gear to minimize their capture and maximize their escapement.
- Minimize impacts on sensitive benthic areas.

DFO (2016) reports that the Maritimes Snow Crab IFMP was developed according to a framework for an ecosystem approach to management. This framework requires that fisheries management decisions reflect the impact of the fishery not only on the target species, but also on nontarget species, habitats, and the ecosystems of which these species are a part. It also requires that decisions account for the cumulative effect of various ocean uses on the ecosystem.

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