Atlantic Cod, Atlantic Pollock

Gadus morhua, Pollachius virens

Image © Monterey Bay Aquarium

Northwest Atlantic
Canada

Bottom Trawl, Bottom Longline, Gillnet

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About Seafood Watch®

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological 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. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. 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.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

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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.

Based on this principle, Seafood Watch had developed four sustainability **criteria** for evaluating wild-catch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

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, we develop an overall recommendation. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide and the Safina Center's online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

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

Avoid/Red: Take a pass on these for now. These items are overfished or caught 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.

Executive Summary

There are many commercially important groundfish species caught in the Northwest Atlantic by Canadian and U.S. fleets. This report focuses on two gadoid species landed and sold in the U.S. and Canadian markets. The scope of the analysis and ensuing recommendations includes Atlantic cod (*Gadus morhua*) and Atlantic pollock (*Pollachius virens*) fisheries in the Canadian Northwest Atlantic. Both species are harvested mainly with gillnets, longlines, and bottom trawl gears: for cod, in the Gulf of St. Lawrence, and Newfoundland and Labrador Grand Banks; and for pollock, in the Scotian Shelf, eastern Georges Bank, and Bay of Fundy. This report centers on cod stocks 3Ps and 3Pn4RS and pollock stock 4VWX +5 (primarily the Western Component) because these fisheries are the most active of the cod and pollock commercial fisheries. Although there are small, commercial fisheries for cod in areas 2J3KL and 4X5Y, their contribution to the market is minor.

In general, gadoids have a medium to high vulnerability to fishing pressure. Due to heavy fishing pressure, these fish have experienced a decrease in size and age at maturity, which may be adversely impacting recruitment and natural mortality. In addition, heavy exploitation and poor management led to the catastrophic collapse of cod stocks and severe depletion of pollock stocks (along with other commercially important groundfish species) in the early 1990s, leading to various fishery moratoria on different stocks throughout the 1990s and into the 2000s. Despite extensive efforts in management and science, the cod stocks are seeing little to no recovery (although recent assessments of cod in the 3Ps management area suggest that abundance is increasing off southern Newfoundland). Cod has been determined to be Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Pollock abundance relative to reference points is unknown and no status determination has been completed by COSEWIC.

Retained and bycatch species that are analyzed in this assessment have been chosen based on either their contribution of catch in the cod- and pollock-directed groundfish fisheries or their conservation status (e.g., endangered, threatened, overfished). Cod and pollock are targeted mainly by Bottom trawls, longlines, or gillnets—all of which are considered highly unselective gears (with respect to species caught). Bottom trawls and gillnets in particular are not very discriminating gears, so their impacts on habitat and their bycatch are significant. The quantity of bycatch that is frequently caught and discarded is significant, but the more pressing concern is the number of at-risk species that could be and frequently are incidentally captured in these fisheries. The endangered and threatened species and species of special concern that have interactions with at least two of the three gear types include harbor porpoises (*Phocoena phocoena*), North Atlantic right whales (*Eubalaena glacialis*), leatherback turtles (*Dermochyles coriacea*), three species of wolffish (*Anarchias minor*, *Anarchias lupus*, and *Anarchias denticulatus*), thorny skates (*Amblyraja radiata*), winter skates (*Leucoraja ocellata*), barndoor skates (*Dipturus laevis*), cusk (*Brosme brosme*), and dogfish *(Squalus acanthias*). Because cod is one of the most common bycatch species in groundfish fisheries, there are technological and managerial mitigation efforts to reduce cod bycatch. It is mandatory to land all groundfish unless they are below a minimum size and they have a Small Fish Protocol in place. But there is

little information on discard and mortality rates in these fisheries, which makes it difficult to assess the magnitude of the problem.

Canada's Department of Fisheries and Oceans (DFO) is responsible for managing the cod and pollock stocks in Canadian waters. DFO manages fisheries through the implementation of Integrated Fisheries Management Plans (IFMP). The IFMPs are drafted by DFO in collaboration with stakeholders and through consultation processes with the species' Advisory Committees and Regional Advisory Processes (RAPs). Like other groundfish stocks, cod and pollock have experienced severe declines since the 1990s, and dramatic measures have been taken to rebuild the stocks. Because cod is endangered (as determined by COSEWIC) and it has commercial and cultural value, the other groundfish (including pollock) are managed partly to protect and conserve cod stocks. Total allowable catch (TAC) limits set by DFO are intended to follow the Precautionary Approach and Sustainable Fisheries Framework; however, even under this framework, directed fishing continues on cod stocks that are below the precautionary Limit Reference Point (i.e., in the Critical Zone). Examples include the Northern Cod fishery and the Gulf cod fishery. Despite a precautionary approach to management of the fisheries, some cod and pollock stocks remain severely depleted with little to no projected recovery in the near future.

Cod and pollock are mainly fished with bottom otter trawls, gillnets, and longlines. Several recent studies have shown that, of all the fishing gears available, these three methods have moderate to high impact on benthic habitats. Bottom trawls, like many other trawling gears, can be particularly damaging to bottom habitats because they scrape and gouge the bottom. Gillnets and longlines, though not as damaging as Bottom trawls, have some impact on the ocean floor—especially on structures such as corals, which may become snagged and broken in lines. The extent of the impacts of gillnets and longlines on benthic habitats is not as well-known as those for trawl gear, but it is likely that their impacts are significantly underestimated.

Atlantic cod that are caught by all gears in NAFO management unit 3Pn4RS and 3Ps are given a recommendation of **Avoid.** Atlantic Pollock from 4VWX +5 (both Eastern and Western components) caught by longline and gillnet receive a **Good Alternative** recommendation while those caught by bottom trawl are given a recommendation of **Avoid**.

Stock	**Fishery**	**Impacts on the Stock** Rank (Score)	**Impacts on other Species** Lowest scoring species Rank*, Subscore, Score	**Manage-ment** Rank Score	**Habitat and Ecosystem** Rank Score	**Overall** Recommendation Score
Laurentian North -Cod 3Ps	Newfoundland Atlantic Longline	Red 1.53	Laurentian North-Cod 3Pn4RS Red, 1,0.95	Yellow 3	Yellow 3.12	**AVOID 1.92**
Laurentian North -Cod 3Ps	Newfoundland Otter Trawl	Red 1.53	Deepwater Redfish Red, 1,1	Yellow 3	Yellow 2.6	**AVOID 1.86**
Laurentian North -Cod 3Ps	Newfoundland Atlantic Gillnet	Red 1.53	Leatherback Turtle, Laurentian North-Cod 3Pn4RS, North Atlantic Right Whale Red, 1,0.95	Yellow 3	Yellow 3.12	**AVOID 1.92**
Laurentian North-Cod 3Pn4RS	Newfoundland Atlantic Longline	Red 1	Northern Wolffish Red, 1.53,1.45	Yellow 3	Yellow 3.12	**AVOID 1.92**
Laurentian North-Cod 3Pn4RS	Newfoundland Atlantic Gillnet	Red 1	Leatherback Turtle, Laurentian North-Cod 3Pn4RS, North Atlantic Right Whale Red, 1,0.95	Yellow 3	Yellow 3.12	**AVOID 1.73**
Pollock	Maritimes Longline	Yellow 2.64	Cod, Cusk Red, 1,0.95	Yellow 3	Yellow 3.12	**GOOD ALTERNATIVE 2.201**
Pollock	Maritimes Otter Trawl	Yellow 2.64	Cod Red, 1,1	Yellow 3	Yellow 2.6	**AVOID 2.13**
Pollock	Maritimes Gillnet	Yellow 2.64	Cod, Leatherback Turtle, North Atlantic Right Whale Red, 1,0.95	Yellow 3	Yellow 3.12	**GOOD ALTERNATIVE 2.201**

Scoring Guide

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

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

- **Best Choice/Green** = Final Score >3.2, **and** no Red Criteria, **and** no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, **and** neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern[2], **and** no more than one Red Criterion, **and** no Critical scores
- **Avoid/Red** = Final Score <=2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern **or** two or more Red Criteria, **or** one or more Critical scores.

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

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Introduction

Scope of the analysis and ensuing recommendation

There are many commercially important groundfish species caught in the Northwest Atlantic by Canadian and U.S. fleets. The scope of this analysis and ensuing recommendations includes Atlantic cod (*Gadus morhua*) and Atlantic pollock (*Pollachius virens*) fisheries in the Canadian Northwest Atlantic. Both species are harvested mainly with bottom trawl, gillnet, and longline gears: for cod, in the Gulf of St. Lawrence, and Newfoundland and Labrador (Figure 1); and for pollock, in the Scotian Shelf, eastern Georges Bank, and Bay of Fundy (Figure 2). This report focuses on cod stocks 3Ps and 3Pn4RS and pollock stock 4VWX + 5 (primarily the Western Component). This report will not include analysis of the 2J3KL cod fishery because it has been under moratorium since 1992, except for a small stewardship fishery; or the 4X5Y cod fishery because it is part of a mixed fishery with very small contributions to the market (pers. comm., J. Ryan 2012) (DFO 2009)

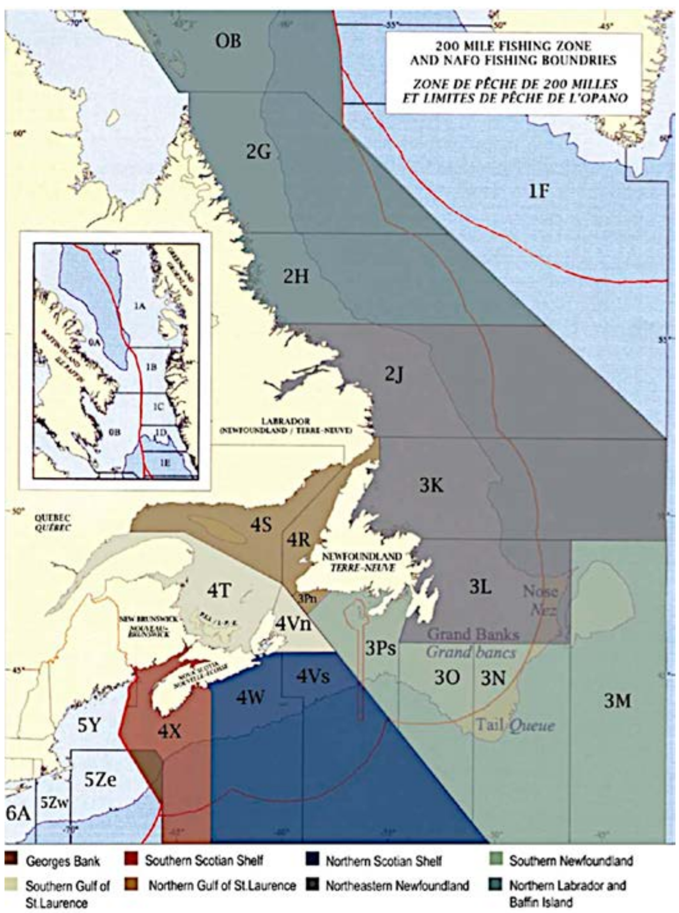


Figure 1. Map of the NAFO management areas. Areas 3Ps, 3Pn, 4RS, 4X, 4V, 4W, 5Y, and 5Z are the areas of focus for Atlantic cod and pollock (DFO 2011; Canadian Fisheries Statistics 2008).

Overview of the species and management bodies

Atlantic cod and pollock are members of the Gadidae family of teleost fishes. They are found in temperate waters on both sides of the Atlantic. In the Northwest Atlantic these species are found from Greenland to North Carolina (DFO 2009c) (DFO 2012e) (DFO 2011d) (Fahay et al. 1999). They are also known as the "true cods" and have been important commercial groundfish species in Canada and the United States for centuries. They are medium-sized fish with three dorsal fins and two anal fins (Nelson 2006). Both species share similar habitat preferences and characteristics. Both are demersal fish that can be found at temperatures from 0° to 10°C (32° to 50˚F) and depths to 400 m. Cod prefer pebble and gravel bottom habitats (Fahay et al. 1999) (DFO 2012a) (DFO 2012e) (DFO 2009d), while pollock exhibit strong schooling behavior and spend more time in the water column rather than on the bottom (DFO 2009d). In past years, the highest densities of cod were found off Newfoundland and Labrador, the Gulf of St. Lawrence, and the Scotian Shelf (Fahay et al. 1999), but all Canadian cod stocks have suffered massive declines due to overexploitation. Currently only the 3Ps and 3Pn4RS cod stocks are commercially significant to the Canadian and U.S. markets. Significant Canadian fisheries for pollock occur on the Scotian Shelf, Eastern Georges Bank, and the Bay of Fundy (4VWX +5) (DFO 2009d). Cod and pollock continue to be important commercial species, but years of exploitation and mismanagement led to major declines in the 1990s to these stocks (especially cod), so the fisheries have been subjected to increased regulation to help rebuild the stocks.

Canada's Department of Fisheries and Oceans (DFO) is responsible for managing the cod and pollock stocks in Canadian waters. DFO manages fisheries through the implementation of Integrated Fisheries Management Plans (IFMP) (Haughton et al. 2006). The IFMPs are drafted by DFO in collaboration with stakeholders and through consultation processes with species Advisory Committees and Regional Advisory Processes (RAPs) (Haughton et al. 2006). The aim of each IFMP is to provide a planning framework for the conservation and sustainable use of fisheries resources and the process by which a given fishery will be managed for a period of time.

Atlantic Canada's groundfish fishery has existed since colonial times and focused originally on cod. Eventually the cod fishery grew to include other groundfish (e.g., haddock and redfish) and most of the fishing grounds in the Northwest Atlantic (Lear 1998). Fishing exploitation became more efficient with the introduction of improved fishing technologies such as longlines and Bottom trawls as well as onboard refrigeration (Lear 1998) (Klein-McPhee 2002). By the 1960s, an exorbitant increase in fishing effort yielded record landings of groundfish that eventually led to rapid declines in most groundfish stocks (Lear 1998) in the 1970s. A slow partial recovery occurred in the 1980s after the Extension of Jurisdiction to 200 nm in 1972 and the reduction in foreign fishing effort. But after 1989, groundfish stocks (especially cod) declined sharply due to overfishing by Canadian fishing fleets, leading the Canadian government to impose a fishing moratorium on 2J3KL cod in 1992 and moratoria on 3Ps and 3Pn4Rs cod stocks in 1994. Moratoria on a number of other groundfish stocks were imposed in 1993. The moratoria were implemented to facilitate stock recovery. In the 20 years since the first implementation of moratoria, some groundfish stocks, especially haddock on the Scotian Shelf, have seen some improvements.

Current fishery characteristics

Atlantic cod: Since the severe declines of the Canadian stocks in the NW Atlantic in the early 1990s, most stocks continue to be under fishing moratoria to facilitate stock recoveries. There are only four stocks under DFO management that support small, directed commercial fisheries: 3Ps in Southern Newfoundland and Labrador, 3Pn4RS in the Northern Gulf of St. Lawrence (Figure 2), 4x5Y on the Southern Scotian Shelf–Bay of Fundy, and 2J3KL on the Grand Bank and Eastern Newfoundland Shelf. The Southern Gulf Cod stock (4TVn) and the Eastern Scotian Shelf cod stock (4VsW) remain under a moratorium on all directed commercial cod fishing, although some bycatch still occurs in other groundfish fisheries.

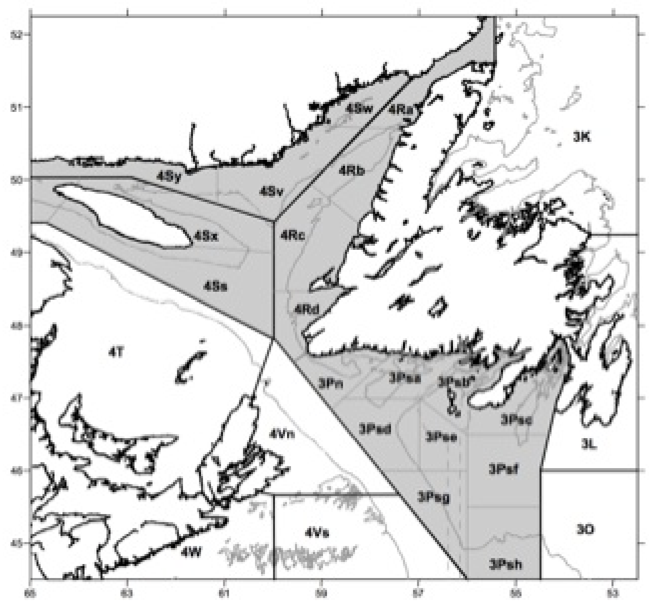


Figure 2: Cod stock management areas 3Ps (Southern Newfoundland and Labrador) and 3Pn4RS (Northern Gulf of St. Lawrence) (DFO 2011).

3Ps cod: The 3Ps cod stock is one of four stocks adjacent to Newfoundland and Labrador that are of vital importance historically, economically, and culturally (DFO 2009b). 3Ps cod are harvested both inshore and offshore with bottom trawls, longlines, and gillnets. The inshore fishery normally uses longlines and gillnets (and some handlines). In recent years there has been an increase in the use of gillnets (DFO 2009b). The offshore sector uses both mobile and fixed gear to harvest cod. Generally, the majority of the landings come from the inshore sector. The majority (85%) of the 3Ps fishery is managed through individual quotas (IQ) (inshore fleet) or enterprise allocation (EA) (midshore and offshore). This was the only cod stock that was not severely depleted when it was placed under moratorium in 1994. The fishery reopened in 1997 with a 10,000 t TAC, but by 1999 the TAC had increased to 30,000 t based on over-optimistic assessments of the recovery, and the stock again declined. Recent stock assessments show an increase in abundance since 2009 (DFO 2012a, 2013).

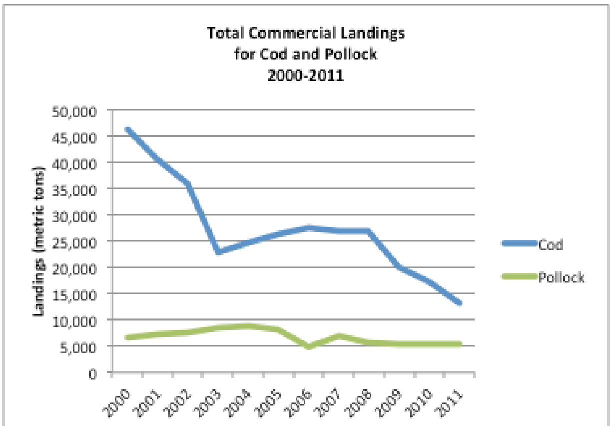
3Pn4RS cod: Prior to the 1994 moratorium, harvesting of cod in 3Pn4RS was conducted primarily with mobile gear during the winter months. Of the total landings from this fishery, 60% were attributed to trawl gear (DFO 2005a). Since 1997, the fishery has shifted to an exclusively fixed-gear fishery, mainly during the summer and fall (DFO 2005a). The Gulf cod fishery is the only Atlantic coast fishery that exclusively uses fixed gear: primarily gillnets and longlines (and some handlines) (DFO 2012f). In 2003, the 3Pn4RS Gulf cod fishery was put under a second moratorium (the first was from 1994 to 1996) but reopened again in 2004 with a much-reduced TAC (3,500 t). In 2005 the TAC was increased to 5,000 t and experienced slow increases up to 7,000 t by 2009. The TAC was reduced in 2011 to its current level of 2000 t. This does not reflect well on the condition and sustainability of this fishery.

Atlantic pollock: Important Canadian fisheries for pollock occur on the Scotian Shelf, eastern Georges Bank (east of the Hague line), and the Bay of Fundy using primarily Bottom trawl and gillnets. The main fisheries for pollock are in the NAFO division 4VWX +5 management unit and are split into the Eastern Component (4VW) and a Western Component (4Xopqrs +5) (DFO 2011b). In 2003, an evaluation of the pollock stock structure in 4VWX +5 indicated the existence of two discrete population components. The Eastern Component is a slower growing population than the Western Component, which is fast growing (DFO 2011b) (Lopuch and Peters-Mason 2010). Since 1993, much of the Eastern Component has been closed to directed cod and haddock fishing, which has contributed to declines in landings in this area (DFO 2011b). Despite reduction in fishing effort, there is little evidence of a concurrent increase in pollock biomass (DFO 2011b). Mobile gears, primarily Bottom trawls, bring in 70% of the landings in the Eastern Component while fixed gears (gillnets) contribute 30% of the catch in this area. Most of the pollock in the Eastern Component is being harvested in the 4Xn area (DFO 2011b).

The Western Component of the pollock fishery contributes 86% of the total pollock landings (DFO 2011b). The smaller, mobile-gear vessels account for most of the landings from the Western Component, followed by the gillnet vessels (DFO 2011b). Since 2000, the gillnet landings in the Western Component have declined while the landings from the smaller mobile-gear sector have increased (DFO 2011b). The proportion of landings by larger trawlers had been declining steadily since the mid 1990s but increased slightly in 2006 and 2010 (DFO 2011b). Landings from longlines and handlines have also declined since the mid-1990s, although in recent years there have been slight increases (DFO 2011b). Most landings from the Western Component come from area 4Xpq because landings from the other areas have declined significantly (DFO 2011b).

Production statistics

With declines in the NW Atlantic groundfish stocks (especially cod) and the moratoria implemented in 1992, 1993, and 2003, the harvest and landed value of cod and pollock have also declined (Figure 4a), although landings values are also affected by other factors (e.g., high volumes of whitefish in the global market (pers. comm., J. Ryan 2012). Since 2000, the total landings for cod have declined from 46,771 mt to 13,301 mt in 2011. Pollock has remained fairly consistent with a time-series average landing of 6,737 mt. In 2011, these two species combined were worth approximately $15,901,000 compared to $73,848,000 in 2000 (Figure 4b) (DFO 2011a).



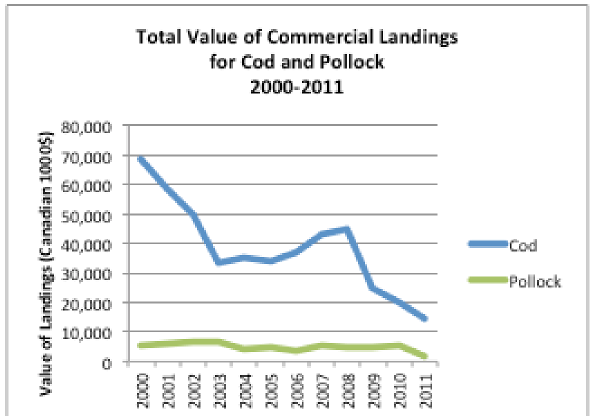


Figure 4a. Total commercial landings for cod and pollock from 2000–2011. Figure 4b. Total value of commercial landings for cod and pollock from 2000–2011 (landings data from DFO statistics).

The TACs for Atlantic cod in the only two significant open fisheries, 3Ps and 3Pn4RS, in 2011 were 13,225 mt and 1,500 mt, respectively (http://www.dfo-mpo.gc.ca/decisions/fm-2014-gp/index-atl-eng.htm; accessed 4/29/15). These quotas include allocations for the Aboriginal fisheries, the Sentinel Survey fishery, and the recreational fisheries. In addition, the TAC for 3Ps is shared with France (St. Pierre and Miquelon); Canada's allocation is 84.4% and France's is 15.6%. The TACs for both 3PS and 3Pn4RS have stayed fairly consistent in the last decade with only small reductions in TAC (Tables 1, 2).

Table 1: Cod landings by management year in NAFO Subdivision 3Ps (000s t) (DFO 2014b).

Management Year	04–05	05–06	06–07	07–08	08–09	09–10	10–11	11–12[1]	12–13[1]	13–14[1, 2]
TAC[3]	15.0	15.0	13.0	13.0	13.0	11.5	11.5	11.5	11.5	11.5
Canada	12.1	11.7	11.3	10.8[4]	10.6[4]	7.5[4]	6.6[4]	4.9[4]	4.0[4]	1.5[4]
France	2.4	2.2	1.9	2.0	2.0	1.5	1.3	1.1	0.8	<0.1
Totals	14.5	13.9	13.2	12.8	12.6	9.0	7.8	6.0	4.8	1.5

1 Provisional
2 Approximate landings to 03 October 2013
3 TAC is shared between Canada (84.4%) and France (St. Pierre and Miquelon; 15.6%).
4 Does not include recreational fisheries.

Table 2. Cod landings and TACs (000s t) in division 3Pn4RS (DFO 2012a).

Year	1999-2002	2003	2004	2005	2006	2007	2008	2009	2020	2011
TAC	7.1[1]	0	3.5	5	5	6	7	7	7	4
Landings	6.8[1,3]	0.4	3.3	4.5	5.7[4]	6.5	6.2[5]	4.7[2,5]	6.3[2,5]	1.7[2,5]

1 Average
2 Preliminary data
3 Includes landings from the recreational fishery: 253 t in 2001 and 34 t in 2002
4 Includes 75 t from the recreational fishery
5 No data from the recreational fishery available

In the Atlantic pollock management area 4VWX +5, the TAC for the 2010-2011 fishing year was 5,900 t (Table 3) while the total landings were lower at 4,926 t. The majority of pollock landings in this fishery (approximately 86%) come from the Western Component, 4Xopqrs5. Since 2000, the Eastern Component of the fishery seems to have experienced slight increases in landings from an average of 600 t (2000–2005) to 1,500 t in 2008, although most of the Eastern Component has been closed to directed fishing for cod since 1993 and thus contributing to catch reductions for pollock. Since 2008, landings from the Eastern Component have remained steady at 1,100 t (Table 3). While the catch in the Eastern Component has seen slight increases, the Western Component landings have declined nearly 42% from an average of 6,600 t (2000–2005) to 3,800 t in 2010 (Table 3) (DFO 2011b). Landings from the Western Component now come mostly from Unit Area 4Xpq and have declined substantially from all other areas, e.g., the Bay of Fundy, Georges Bank (5Zc), and 4XO (DFO 2011b).

Table 3: Landings and TAC (000s t) for Pollock in 4VWX +5 (DFO 2014a).

Year	2000–2005	2006	2007[1]	2008	2009	2010[2]	2011	2012
TAC	9.4	4.5	5	5.8	5.9	5.9	6.7	6.4
TOTAL	7.2	4.3	5.5	5.5	5	4.9	4.8	4.95
East	0.6	0.5	1.1	1.5	1.1	1.1	0.2	0.15
West	6.6	3.8	4.4	3.9	3.9	3.8	4.6	4.8

1 For the 2007/2008 FY, the TAC was from 4X5 only, but there were additional landings from a test fishery in 4W.
2 Landings for 2010 are from April 1, 2010 to March 31, 2011.

Importance to the U.S./North American market

After the decline of the Atlantic cod stocks in 1992, Canada’s commercial fishing industry in the Northwest Atlantic changed significantly. In the 1990s, the groundfish fishery played significant roles in the harvesting and processing sectors of the industry, comprising 50% of landings (DFO 2011a). But by 2008, groundfish represented only 15% of the landings, with cod representing only 3% of the landed value in Atlantic Canada (Figure 4) (DFO 2011a).

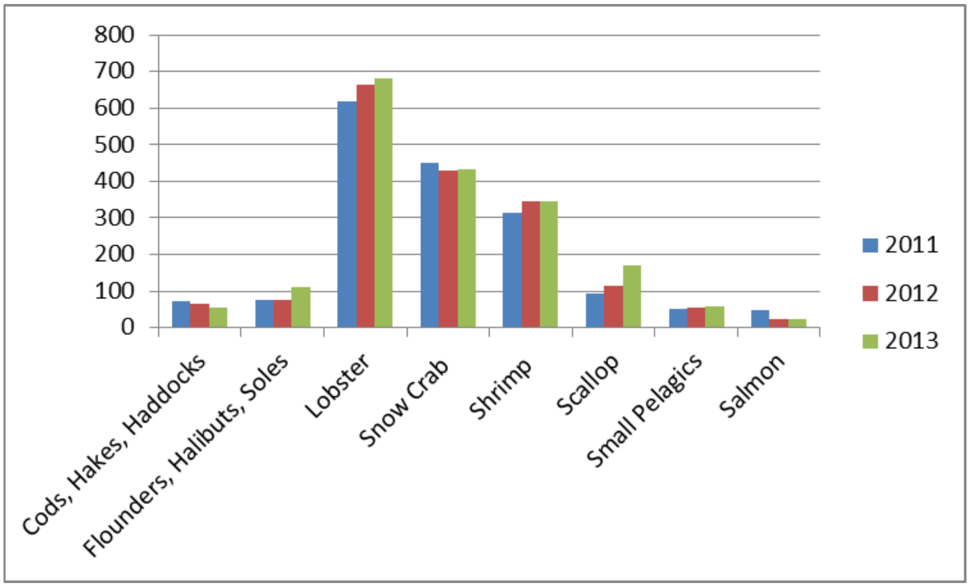
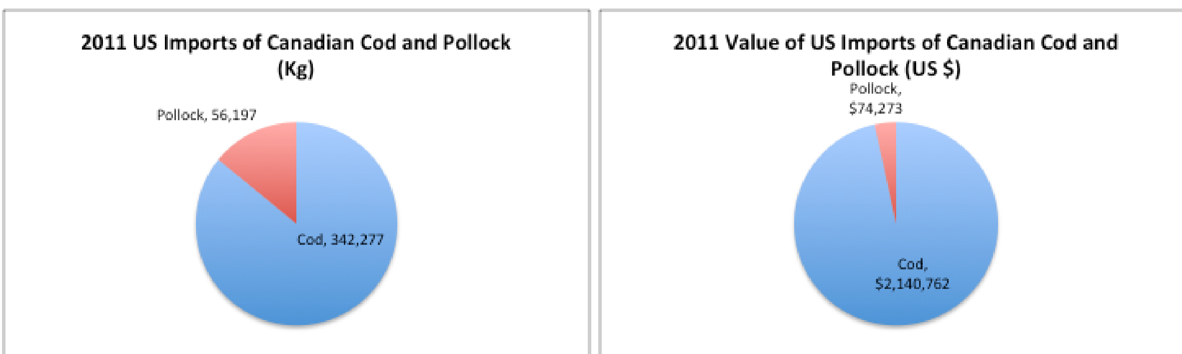


Figure 4: Total landed value (CAN$ millions), main commercial marine species, Canada, 2011–2013 (DFO 2015).

The United States is the largest export market of Canadian fish products, accounting for approximately 54% of Canadian exports in 2011 and 56% in 2012 (DFO 2011a). In 2011, the United States imported 398,474 kg of Canadian cod and pollock products worth $2,215,035 (Figures 5a, b). This makes up approximately 2% of all fish products imported from Canada by the United States (NMFS Landings database).



Figures 5a, b: 2011 U.S. imports in kg (left panel) and 2011 value (in U.S. dollars) of U.S. imports of Canadian cod and pollock (data from NMFS landing database).

Common and market names.

Atlantic cod is also known as true cod, scrod, codfish, or whitefish.

Atlantic pollock is most often referred to as saithe. In New England, pollock is sometimes sold as Boston bluefish, blue cod, or blue snapper, while in Europe it is also known as coalfish or coley.

Primary product forms

Both species are available in a variety of forms including fresh or frozen fillets, breaded fillets, boneless, cooked, dressed, salted, smoked, dried, or canned. Fresh whole fish are also available (Froese and Pauly 2013).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Stock for which you want a recommendation

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. 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.

Criterion 1 Summary

Stock	**Fishery**	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Criterion 1** Rank Score
Laurentian North -Cod 3Ps	Newfoundland Atlantic Longline	High	Very High Concern (1)	Moderate Concern (2.33)	Red 1.53
Laurentian North -Cod 3Ps	Newfoundland Otter Trawl	High	Very High Concern (1)	Moderate Concern (2.33)	Red 1.53
Laurentian North -Cod 3Ps	Newfoundland Atlantic Gillnet	High	Very High Concern (1)	Moderate Concern (2.33)	Red 1.53
Laurentian North-Cod 3Pn4RS	Newfoundland Atlantic Longline	High	Very High Concern (1)	High Concern (1)	Red 1

Laurentian North-Cod 3Pn4RS	Newfoundland Atlantic Gillnet	High	Very High Concern (1)	High Concern (1)	Red 1
Pollock	Maritimes Gillnet	Medium	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Pollock	Maritimes Otter Trawl	Medium	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Pollock	Maritimes Longline	Medium	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64

Synthesis:
In general, gadoids have a medium to high vulnerability to fishing pressure. Due to heavy fishing pressure, these fish have experienced a decrease in size and age at maturity, which may be adversely impacting recruitment and natural mortality. In addition, heavy exploitation and poor management led to the catastrophic collapse of cod stocks and severely depleted pollock stocks (along with other commercially important groundfish species) in the early 1990s, leading to fishery moratoria throughout the 1990s and into the 2000s. Despite stringent efforts in management and science, the cod stocks are seeing little to no recovery and are considered Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Pollock abundance relative to biological reference points is unknown.

Justification of Ranking

Atlantic cod
Laurentian North DU: 3Ps and 3Pn4RS

Factor 1.1 Inherent Vulnerability
Key relevant information: **High Vulnerability**
The FishBase vulnerability score is 67 (Froese and Pauly 2015) indicating that cod are highly vulnerable to fishing. Atlantic cod reaches sexual maturity between 5 and 8 years and at a length of 45–60 cm, although the proportion that mature at 4–6 years is increasing (DFO 2014b). It is a prolific spawner; females can lay several million eggs during each spawning. Within the food chain, mature cod is a high-level predator.

Factor 1.2 Stock status
Key relevant information: **Very High Concern**

Atlantic cod stocks in NAFO subdivisions 3Ps and 3Pn4RS are considered one biological stock and were identified as part of the larger Laurentian North population, which is designated as Endangered by COSEWIC (COSEWIC 2010).

Atlantic cod 3Ps

The most recent assessment of Atlantic cod from 3Ps was conducted in 2015 (DFO 2015d) and indicated that the spawning stock biomass (SSB) has increased to approximately twice the limit reference point (LRP) and is near the time series maximum (1983–2013) (DFO 2015d).

Atlantic cod 3Pn4RS

The most recent stock assessment in 2011 indicated that the spawning stock biomass was considerably below the LRP (14% below B_{LIM}) (DFO 2012f) and, based on updated LRP that were established, the 2012 assessment of this stock indicated that it was well below the LRP of 116,000 t (Duplisea and Frechét 2011). Under the DFO Precautionary Approach Framework, this stock is considered to be in the "Critical Zone" and removals should be kept to the absolute minimum. Additionally, it was recommended that the commercial and recreational cod-directed fisheries be closed and measures to prevent any increase in bycatch be implemented (DFO 2012f). A recent update of indicators of stock status (DFO 2014c) found that indices were comparable to the average of recent years (1990–2013) at a low level, and that the stock remains in the critical zone.

Due to its continued endangered status and because both stocks are part of the greater Laurentian North cod population, Seafood Watch deems stock status as "very high" concern.

<u>Detailed rationale:</u>

For designation purposes, COSEWIC identified six separate "designatable units" (DU) or populations for Atlantic cod in Canada (COSEWIC 2010). Based on genetic studies, there are significant genetic differences between all six DU, including the Laurentian North population (Marcil et al. 2006a b) (Hutchings et al. 2007). Because of the genetic similarities, even though the 3Ps stock appears to be recovering somewhat and the 3Pn4Rs stock is not recovering, these are considered part of the overall Laurentian North population.

Atlantic cod 3Ps

In the most current stock assessment of 3Ps cod, there has been a notable increase and change in trend in the SSB from 2009–2012. In 2008 and 2009, the SSB had been estimated to be below the LRP; however, by 2011, the SSB had increased to 7% above the LRP and, within the span of one year, the SSB increased significantly to 60% above the LRP in 2014 (DFO 2015d).

Because there is no reliable model for determining the true biomass for 3Ps cod, indices based on the research vessel (RV) survey have been used to assess the current status of the stock relative to historic observations and to evaluate growth and sustainability of the stock. A cohort assessment model that gave a measure of relative spawning stock biomass was used for the 2011 stock assessment. The Limit Reference Point (LRP) (the biomass level below which the stock is considered to be in the "Critical Zone") was determined to be $B_{RECOVERY}$. This was defined as the lowest SSB level from which the stock had previously sustained a rapid recovery; in this case, the 1994 SSB value (DFO 2012a) (NAFO 2003). Therefore, if the 2011 SSB were below the LRP, the stock would be in the "Critical Zone" as defined by the DFO's precautionary approach framework, and harvest control rules would have to be redefined to protect the stock further (pers. comm., J. Ryan 2012) (DFO 2012a). Though the stock was assessed to be above the LRP, it was still within the "Cautious Zone"*. It should be noted that the lack of an assessment model incorporating both landings data and the research vessel survey index considerably weakens the assessment of stock status for 3Ps cod. Landings data are currently considered too unreliable and uncertain to be used in the determination of stock status. In the absence of landings data, the assessment provides only a relative index of stock size based on the survey data and cannot be used directly to determine the appropriate TAC level that should be applied.

There is significant uncertainty regarding the appropriateness of the reference point that has been set in the 3Ps region. It is unclear how this reference point relates to biomass at maximum sustainable yield, and setting the LRP at a post-collapse level does not suggest a precautionary management approach. Cod abundance in the 3Ps region was believed to have recovered from the LRP once before in 2003–04; however, this was followed by a further collapse from which the stock is just recovering. This leads to significant uncertainty as to whether the current LRP has been set at an appropriate level.

* The "Cautious Zone," as defined by DFO's Precautionary Approach framework, is when the LRP is between the B_{LIM} and the B_{USR} (upper stock reference) and it guides how to establish harvest control rules to conserve and preserve the stock.

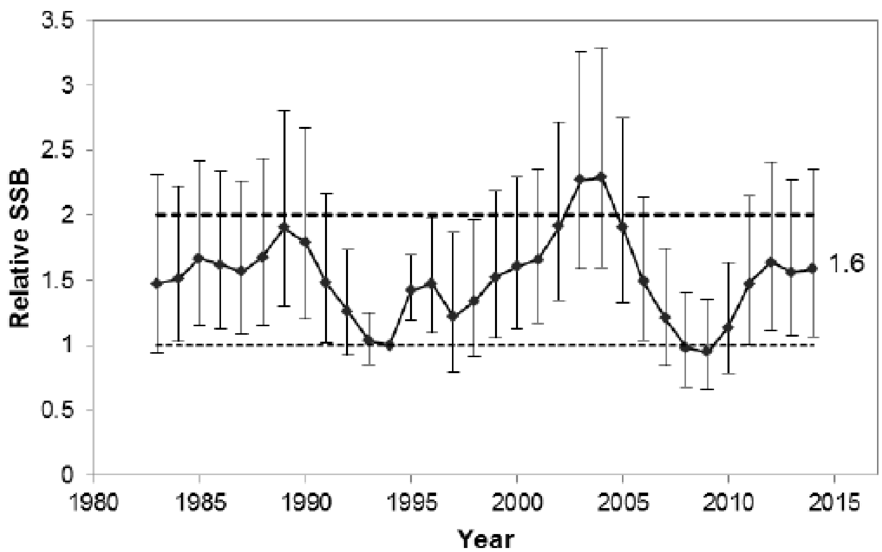


Figure 6: Cohort analysis estimates of Spawning Stock Biomass (SSB), relative to the 1994 value (Limit Reference Point). The thin dashed line at 1 represents the Lower Stock Reference, the thick dashed line at 2 represents the Upper Stock Reference (i.e., 2 x LRP). 1.6 is the 2014 SSB relative to the LRP (DFO 2015d).

Factor 1.3 Fishing mortality

Key relevant information:

Atlantic Cod 3Ps: **Moderate Concern**

There are no estimates for fishing mortality (F) for 3Ps cod, although estimates of total mortality (Z), which include fishing mortality (ages 5–10) between 2011–2013, averaged 0.53 (41%) (DFO 2015d). Total mortality has been increasing since 2011 after a period of decline from 2006–2011 (DFO 2105d). Although there are no reliable estimates of F in the latest stock assessment, it does give an indication of fishing mortality through a tagging-recapture study (DFO 2013b). Over the last decade, many fishing mortality management measures have been implemented to promote the recovery of Atlantic cod in Canada. These measures include Conservation Harvesting Plans, limited entry licenses, seasonal limits and by-catch protocols for other directed fisheries, geographic restrictions, monitoring landings, and protecting small fish and spawning activity (DFO 2005a). There is some uncertainty surrounding the appropriateness of the TAC because current mortality rates are comparable to the time series average and less than half of the TAC is currently being taken (DFO 2015d). If landings were to increase to meet the TAC, then fishing mortality and total mortality might increase to levels that jeopardize the current recovery efforts. Because fishing levels are unknown relative to sustainable levels in 3Ps but management measures are in place to promote the recovery of Atlantic cod, this factor is rated "moderate" concern.

Atlantic Cod 3Pn4RS: **High Concern**
F = 0.4 (DFO 2012f), which is an increase from F = 0.1 in 2004 when the target fishing mortality was F = 0.18 (**http://www.dfo-mpo.gc.ca/fm-gp/initiatives/cod-morue/strategie-qc-eng.htm#a4.2**), therefore overfishing is occurring.

Detailed Rationale:
Atlantic Cod 3Pn4rs
The TAC was set at 1,500 mt for 2013, and 1,250 mt were caught (DFO 2014c). Abundance appears to be stable but in the critical zone and, because there is no sign of recovery for this stock, it is believed that the current TAC is not suitable to allow recovery. Under the DFO Precautionary Approach Framework, catches of cod should be reduced to an absolute minimum, and there have been calls for cod-directed fisheries to be closed and for measures implemented to reduce bycatch to minimal levels (DFO 2012f).

Atlantic pollock

Factor 1.1 Inherent Vulnerability
Key relevant information: **Medium Vulnerability**
The FishBase vulnerability score is 59 (Froese and Pauly 2013) for this species; however, based on life-history characteristics such as maximum age (23 years), maximum length (110 cm), and age and length at maturity (3–4 years, 45–50 cm), this is considered more accurately rated as "medium" vulnerability.

Factor 1.2 Stock status
The last stock assessment for Atlantic pollock in unit area 4VWX +5 was conducted by DFO in 2009 (DFO 2009d). Since then, there have been updates to the assessment as well as development of management measures for the Western Component (4Xopqrs5) (DFO 2011 b)

(DFO 2011 c) (DFO 2015b) and of biological reference points for the Eastern Component (4VW + 4Xmn) (Stone 2012). However, since these additional pieces of information have not yet been used in another formal assessment, the actual status of the stock is unknown.

Atlantic Pollock—Eastern Component 4VW + 4Xmn
Key relevant information: **Moderate Concern**
B_{MSY} is unknown because biological reference points were not defined in the last stock assessment (DFO 2009d). However, the DFO summer research vessel survey biomass indicated an increasing trend in biomass in this area (DFO 2009b).

Detailed rationale:
The biomass index is derived from the DFO research vessel survey. The values for biomass from the RV survey are variable and showed biomass declines in this area from the early 1990s to 2006 (the third-lowest level in the time series) (DFO 2009d). However, the recent RV survey index demonstrates increasing biomass levels close to those from the 1990s (DFO 2009d) (Figure 7). Although these biomass increases reported in the last assessment indicated positive trends, it is difficult to conclude the current status of the fishery. The 2009 assessment recommended that the directed pollock fishery in the Eastern Component proceed with caution (DFO 2009d).

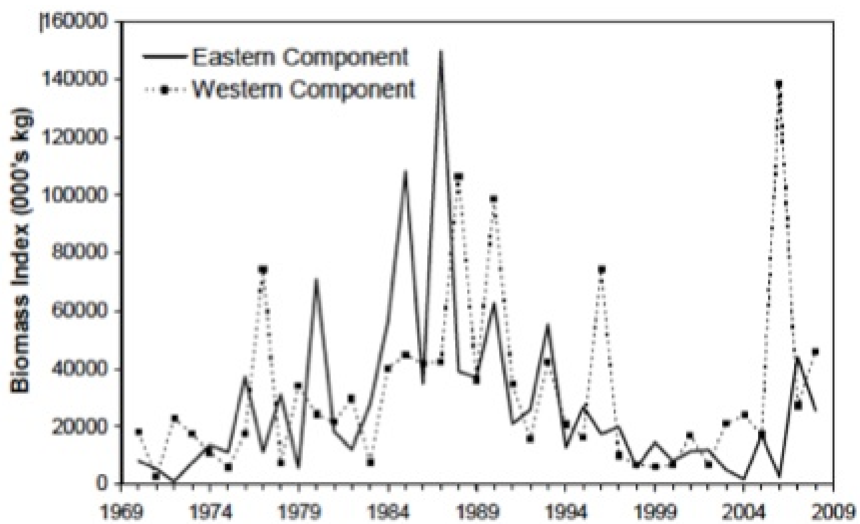


Figure 7: Trends in survey biomass indices for Atlantic pollock from the Eastern and Western Components (DFO 2009d).

In 2012, biological reference points were developed and calculated for the stock, but have not been used in a formal stock assessment context to date. The biological reference points were based on a proxy for B_{MSY}. This proxy was calculated for the summer research surveys from 1970–2011 (Stone 2012). Choosing an arbitrary 10-year period to reflect a period of high productivity (1984–1993) (assuming a constant productivity rate for the last 40 years), the mean total biomass was 50,200 t (Stone 2012). From this, a limit reference point (LRP) (40% of B_{MSY} proxy) was calculated as 20,100 t and the upper stock reference point (USR) (80% of B_{MSY} proxy) was calculated as 40,100 t (Stone 2012) (Figure 9). Based on these calculations, the survey biomass has only been above the LRP five times since 1994, and four of these values occurred since 2006 (Figure 8) (Stone 2012). This suggests that the status of the Eastern Component of the resource is seeing improvements (Stone 2012). But until these reference points are used in a formal assessment, the present status of the stock remains uncertain.

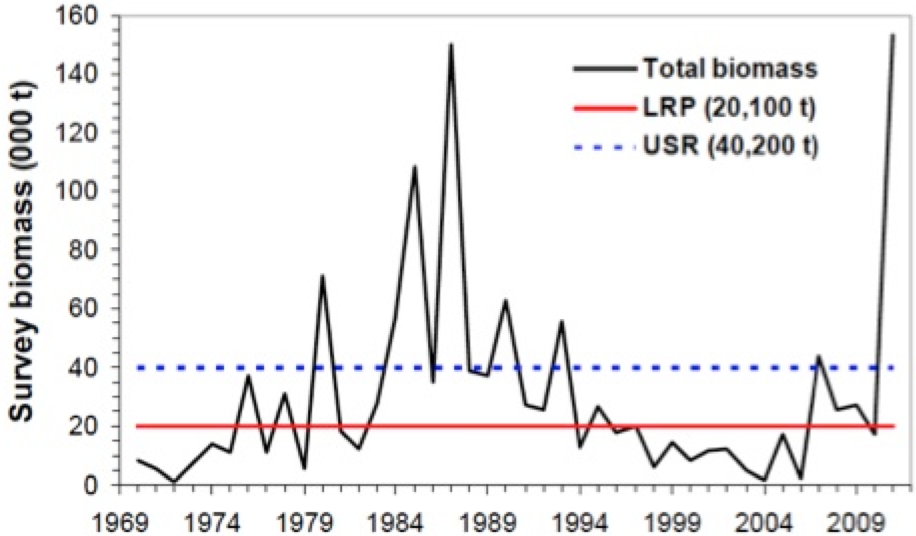


Figure 8: Total biomass (000 t) and calculated LRP and USR values of Eastern Component pollock from the DFO Summer RV surveys (DFO 2012).

Atlantic Pollock—Western Component 4Xopqrs

<u>Key relevant information:</u> **Moderate Concern**

B_{MSY} is unknown because biological reference points were not defined in the last stock assessment (DFO 2009d). Based on an unknown biomass relative to sustainable levels and a medium vulnerability to fishing (see Factor 1.1), the Western Component Atlantic pollock is considered to be a "moderate" conservation concern.

<u>Detailed rationale:</u>

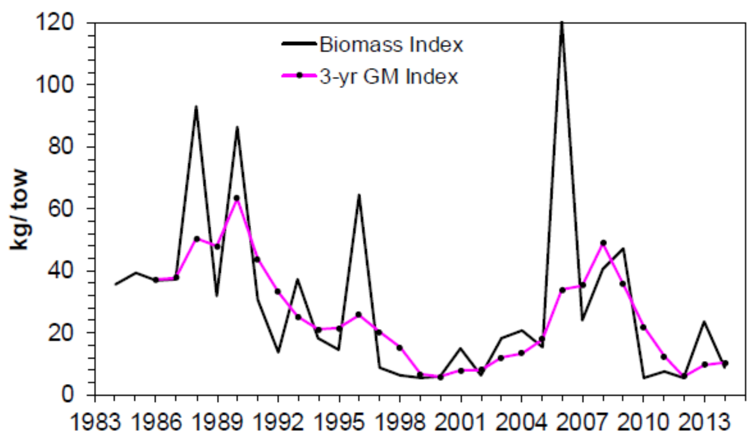


Figure 9: DFO summer Survey Biomass Index (kg/tow) for pollock (DFO 2015b).

As with the Eastern Component, the Western Component stock biomass is assessed from data from the summer DFO RV survey. The latest stock assessment in 2009 showed an increasing trend in biomass from 2002–2009 (DFO 2009d) (Figure 8). In 2010, biomass levels declined sharply, which appears to be inconsistent with the increasing trends observed since 2002 (Figure 9) (DFO 2011b). This trend has continued, as indicated in Figure 9. The fishery is currently being managed using a risk-management approach in an attempt to provide more stable catch limits for the fishery, which takes into account the uncertainties associated with the assessment (DFO 2015b) including the semi-pelagic schooling behavior and varying distribution of pollock within the water column (DFO 2011b).

Factor 1.3 Fishing mortality

Atlantic Pollock—Eastern Component 4VW + 4Xmn
Key relevant information: **Moderate Concern**
F_{MSY} is unknown because biological reference points for fishing mortality have not been defined for this stock, although the 2009 assessment defined a “relative fishing mortality” (landings/survey biomass) as low as 3% and 2% for 2007 and 2008, respectively.

Atlantic Pollock—Western Component 4Xopqrs
Key relevant information: **Moderate Concern**
F_{MSY} is unknown because biological reference points for fishing mortality have not been defined for this stock, although the 2009 assessment reported an F_{REF} = 0.2 for ages 6–9 (DFO 2009d). Fishing mortality in this age group had been below F_{REF} since 2006 (DFO 2009d). In 2011, a new management strategy was implemented for 4Xopqrs pollock (Rademeyer & Butterworth 2011) and the effectiveness of this new management strategy is yet to be determined. In recent years, the catch limit has been decreasing from 6,000 mt in 2011 to a projected 2,781 mt in 2015–16 (DFO 2015b). Without specific reference points, it is unclear whether current fishing mortality is at a sustainable level, and is therefore considered a “moderate” conservation concern.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. 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. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. 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 Critical.

Criterion 2 Summary

Newfoundland & Labrador: Otter Bottom Trawl

Stock	**Inherent Resilience** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Deepwater Redfish	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	1.00	Red
Spotted Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
Northern Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
Laurentian North - Cod 3Ps	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
White Hake	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
Acadian Redfish - Units 1+2	Medium	Endangered or threatened (1)	Moderate (3.67)	1.92	1.92	Red
Thorny Skate	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.16	Red
Atlantic Wolffish	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.16	Red

Newfoundland & Labrador: Otter Bottom Trawl (Continued)

Barndoor Skate	Low	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.64	Yellow
Pollock	Medium	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.64	Yellow
Witch Flounder	Low	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.64	Yellow
Spiny Dogfish	Low	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	3.05	Yellow

Newfoundland & Labrador: Longline

Stock	**Inherent Resilience** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Laurentian North-Cod 3Pn4RS	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
Northern Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Spotted Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Laurentian North - Cod 3Ps	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
White Hake	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Thorny Skate	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Atlantic Wolffish	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Leatherback Turtle	Low	Endangered or threatened (1)	Sustainable (5)	2.24	2.12	Yellow
Barndoor Skate	Low	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.51	Yellow
Pollock	Medium	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.51	Yellow
Spiny Dogfish	Low	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Halibut - 3NOPs4VWX5Zc	Low	Abundant (5)	Sustainable (5)	5.00	4.75	Green

Newfoundland & Labrador: Gillnet

Stock	**Inherent Resilience** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
Leatherback Turtle	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
Laurentian North-Cod 3Pn4RS	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
North Atlantic Right Whale	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
Harbor Porpoise	Low	Overfished, Depleted, or Stock of Concern (2)	Overfishing occurring (1)	1.41	1.34	Red
Spotted Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Northern Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Laurentian North - Cod 3Ps	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
White Hake	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Thorny Skate	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Atlantic Wolffish	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Pollock	Medium	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.51	Yellow
Spiny Dogfish	Low	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Halibut - 3NOPs4VWX5Zc	Low	Abundant (5)	Sustainable (5)	5.00	4.75	Green

Maritimes: Otter Bottom Trawl

Stock	Inherent Resilience Rank	Stock Status Rank (Score)	Fishing Mortality Rank (Score)	Subscore	Score (subscore* discard modifier)	Rank (based on subscore)
Cod	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	1.00	Red
Northern Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
Winter Skate	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
Spotted Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
White Hake	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.53	Red
Cusk	Low	Endangered or threatened (1)	Moderate (3.67)	1.92	1.92	Red
Acadian Redfish - Unit 3	Medium	Endangered or threatened (1)	Moderate (3.67)	1.92	1.92	Red
Thorny Skate	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.16	Red
Atlantic Wolffish	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.16	Red
Pollock	Medium	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.64	Yellow
Spiny Dogfish	Low	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	3.05	Yellow
Atlantic Haddock - 4X5Y	Medium	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	3.05	Yellow
Atlantic Haddock - 5Zjm	Medium	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	3.05	Yellow

Maritimes: Longline

Stock	Inherent Resilience Rank	Stock Status Rank (Score)	Fishing Mortality Rank (Score)	Subscore	Score (subscore* discard modifier)	Rank (based on subscore)
Cod	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
Cusk	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
Winter Skate	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Northern Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Spotted Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
White Hake	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Thorny Skate	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Atlantic Wolffish	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Leatherback Turtle	Low	Endangered or threatened (1)	Sustainable (5)	2.24	2.12	Yellow
Pollock	Medium	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.51	Yellow
Barndoor Skate	Low	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.51	Yellow
Spiny Dogfish	Low	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Haddock - 4X5Y	Medium	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Haddock - 5Zjm	Medium	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Halibut - 4RST	Low	Moderate (4)	Moderate (3.67)	3.83	3.64	Green
Atlantic Halibut - 3NOPs4VWX5Zc	Low	Abundant (5)	Sustainable (5)	5.00	4.75	Green

Maritimes: Gillnet

Stock	Inherent Resilience Rank	Stock Status Rank (Score)	Fishing Mortality Rank (Score)	Subscore	Score (subscore* discard modifier)	Rank (based on subscore)
Cod	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
Leatherback Turtle	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
North Atlantic Right Whale	Low	Endangered or threatened (1)	Overfishing occurring (1)	1.00	0.95	Red
Harbor Porpoise	Low	Overfished, Depleted, or Stock of Concern (2)	Overfishing occurring (1)	1.41	1.34	Red
Spotted Wolffish	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
White Hake	Low	Endangered or threatened (1)	Unknown or Risk of Overfishing (2.33)	1.53	1.45	Red
Thorny Skate	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Atlantic Wolffish	Low	Overfished, Depleted, or Stock of Concern (2)	Unknown or Risk of Overfishing (2.33)	2.16	2.05	Red
Pollock	Medium	Unknown or Risk of Overfished (3)	Unknown or Risk of Overfishing (2.33)	2.64	2.51	Yellow
Spiny Dogfish	Low	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Haddock - 4X5Y	Medium	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Haddock - 5Zjm	Medium	Moderate (4)	Unknown or Risk of Overfishing (2.33)	3.05	2.90	Yellow
Atlantic Halibut - 4RST	Low	Moderate (4)	Moderate (3.67)	3.83	3.64	Green
Atlantic Halibut - 3NOPs4VWX5Zc	Low	Abundant (5)	Sustainable (5)	5.00	4.75	Green

Synthesis:
Retained and bycatch species that are analyzed in this assessment have been chosen based on either their contribution of catch in the cod- and pollock-directed groundfish fisheries or their conservation status (e.g., endangered, threatened, overfished). But for some fisheries, such as 3Ps cod, bycatch data is poor, so data from similar fisheries in the region have been used as a proxy because it is probable that there is a strong correlation between the species that are encountered. Cod and pollock are targeted mainly by bottom trawls, longlines, or gillnets—all of which are considered highly unselective gears (with respect to species caught). Bottom

trawls and gillnets in particular are not very discriminating gears, so their impacts on habitat and their bycatch are significant. The quantity of bycatch that is frequently caught and discarded is significant, but the more pressing concern is the number of at-risk species that could be and frequently are incidentally captured in these fisheries. The endangered and threatened species and species of special concern that have interactions with at least two of the three gear types include harbor porpoises (*Phocoena phocoena*), North Atlantic right whales (*Eubalaena glacialis*), leatherback turtles (*Dermochyles coriacea*), three species of wolffish (*Anarchias minor*, *Anarchias lupus*, and *Anarchias denticulatus*), thorny skates (*Amblyraja radiata*), winter skates (*Leucoraja ocellata*), barndoor skates (*Dipturus laevis*), white hake (*Urophysis tenuis*), cusk (*Brosme brosme*), dogfish (*Squalus acanthias*), Acadian redfish (*Sebastes fasciatus*), and deepwater redfish (*Sebastes mentella*). Several other species, such as American plaice (*Hippoglossoides platessoides*) and witch flounder (*Glyptocephalus cynoglossus*), are bycatch in the multispecies groundfish fisheries and are included in the overall assessment.

Cod is one of the most common bycatch species in Canadian groundfish fisheries, so there are many mitigation efforts, both technological and managerial, to reduce cod bycatch. It is mandatory to land all groundfish unless they are below a minimum size and there is a Small Fish Protocol in place. Additionally, there is little information on discard and mortality rates in these fisheries, which makes it difficult to assess the magnitude of the problem. Although there are fishery observers on some vessels, the coverage is low (particularly on smaller vessels) and the accuracy of the observer reports is unknown.

Justification of Ranking

*Cod (*Gadus morhua*), Maritimes Region*
Factor 2.1 Inherent Vulnerability
<u>Key relevant information:</u> **High Vulnerability**
The FishBase vulnerability score is 67 (Froese and Pauly 2015), indicating that cod are highly vulnerable to fishing. Atlantic cod reaches sexual maturity between 5 and 8 years and at a length of 45–60 cm, although the proportion maturing at 4–6 years is increasing (DFO 2014b). It is a prolific spawner; females can lay several million eggs during each spawning. Within the food chain, mature cod is a high-level predator.

Factor 2.2 Stock Status
<u>Key relevant information:</u> **Very High Concern**
Cod abundance in the Maritimes region (NAFO area 4X5Yb) has been fluctuating at a historically low level since 2010 with little sign of recovery (DFO 2015e). COSEWIC determined cod in the Southern Designatable Unit (DU) to be Endangered in 2010. Seafood Watch considers the abundance of cod in the Maritimes region to be a “very high” concern.

Factor 2.3 Fishing Mortality
<u>Key Relevant Information:</u> **High Concern**

Fishing mortality was considered to be high and above the reference point (F = 0.2) until 2011, when the TAC was reduced to 1,650 mt. This reduction was expected to reduce F to 0.11, approximately 55% of the reference value. It is unclear whether the reference value will enable recovery to take place, because it has been set to allow continued harvest in order to reduce social and economic impacts. As of yet there are no signs of recovery for the Maritimes cod stocks; therefore Seafood Watch considers fishing impacts to be a “high” concern.

Cusk (Brosme brosme), Maritimes Region

Factor 2.1 Inherent Vulnerability

Key relevant information: **High Vulnerability**

The FishBase vulnerability score for cusk is 65 (Froese and Pauly 2015). Cusk can live up to 20 years and grow to over 100 cm long. It reaches sexual maturity at a length of 50 cm (5–6 years old).

Factor 2.2 Stock status

Key relevant information: **Very High Concern**

In May 2003, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed cusk as Threatened; however, as of November 2012, COSEWIC has re-assessed cusk as Endangered (COSEWIC 2012a). Cusk is currently being considered for listing on Schedule 1 of the Species at Risk Act (SARA) (MSC 2010) (DFO 2008) (COSEWIC 2003), although an initial consideration was declined in 2013 (DFO 2015c). Because cusk is considered to be endangered by COSEWIC, Seafood Watch scores this as a “very high” concern.

Detailed rationale:

Cusk abundance has declined since the 1970s and some estimates put the decline at >90% (Harris and Hanke 2010). This has prompted the Canadian government to assess whether cusk should be listed as threatened or endangered. In 2003, COSEWIC determined cusk to be Threatened, and in November 2012 as Endangered. A decision to list cusk under SARA is pending (as of 2012) (Hare et al. 2012) (Harris and Hanke 2010) (COSEWIC 2003). Decreases in the survey indices for cusk have met the criteria for an endangered status under Canadian legislation (>90% declines) and recent evidence suggests that its range has declined appreciably (COSEWIC 2012a). Additionally, average fish sizes have declined.

There is no direct assessment of cusk abundance in Canadian waters; however, an index has been derived and accepted for management purposes from the Industry-DFO Halibut Longline Survey. Using the survey index, an upper reference point (URP) of 26.6 kg/1000 hooks and a limit reference point (LRP) of 13.3 kg/1000 hooks have been established. The 3-year geometric mean index for 2012–2014 was 13.3 kg/1000 hooks, suggesting that biomass is at the LRP (DFO 2015c).

Factor 2.3 Fishing mortality

Key relevant information:

Longline: **High Concern**

Bottom Trawl: **Low Concern**

There is no calculated fishing mortality for this species, which was determined to be Endangered by COSEWIC in 2012 (COSEWIC 2012c). Since 1970, most cusk landings have been dominated by the longline fishery, and it accounts for most cusk landings in the region (COSEWIC 2012c). Because the longline fishery has a more significant impact on cusk abundance, fishing mortality in the longline fishery is ranked "high" concern.

In 2010, cusk landings in trawl gear were calculated at 12 t, compared to 378 t in the longline fishery (COSEWIC 2012c). Although fishing mortality for trawls is unknown relative to reference points, trawls account for a small percentage of the fishing mortality (<5%) (COSEWIC 2012c) and are considered a "low" concern.

Detailed rationale:
Fishing is the only known major source of human-induced mortality on cusk. Cusk is a common bycatch species in longline and trawl fisheries directing for cod, haddock, pollock, and halibut (Harris and Hanke 2010). Since 2004, cusk landings in NAFO regions 4VWX and 5Zc have been below 1,000 mt. Between 2003–2007, cusk closures were implemented, and it is quite likely that unreported fishing mortality due to discarding occurred (DFO 2008).

*Deepwater Redfish (*Sebastes mentella*), Newfoundland Region*

Factor 2.1 Inherent Vulnerability
Key relevant information: **High Vulnerability**
The FishBase vulnerability score for deepwater redfish is 56 (Froese and Pauly 2013). Deepwater redfish reaches 30 years of age and matures at 9–10 years of age, making it more vulnerable to fishing pressure than Acadian redfish.

Factor 2.2 Stock Status
Key relevant information:
Unit 1+2 (Newfoundland & Labrador) Very High Concern
In the last COSEWIC assessment, two designatable units (DU) for the deepwater redfish were identified (COSEWIC 2010c). These were the Gulf of St. Lawrence/Laurentian Channel population (Units 1+2) and the Northern population (Grand Banks to the Labrador sea) (COSEWIC 2010). For the purposes of this report, only the Laurentian channel population of this species (Units 1+2 (NAFO divisions 4RST, parts of 4V and 3P)) is considered.

In 2010, the Gulf of St. Lawrence/Laurentian Channel population of deepwater redfish was designated as Endangered by COSEWIC (COSEWIC 2010). Since 1984, the abundance of mature individuals of *S. mentella* has declined by 98% and is still declining (COSEWIC 2010). Currently, deepwater redfish are taken in the Unit 2 direct fishery (TAC = 8,500 t for redfish spp.) and an index fishery in Unit 1 (TAC = 2,000 t for redfish spp.) (DFO 2012g) (COSEWIC 2010). Presently, the Laurentian Channel population of *S. mentella* is considered to be in a very low biomass state with 0% chance of being above 0.4 (40%) B_{MSY} (McAllister and Duplisea 2011). Based on the endangered designation by COSEWIC and the current low biomass state, stock status for deepwater redfish is scored as “very high” concern.

Factor 2.3 Fishing mortality

Key relevant information: **High Concern**

F_{MSY} for *S. mentella* in Unit 1+2 is 0.03 based on the results of the production model used to determine reference points for the Gulf of St. Lawrence/Laurentian Channel population (DFO 2012g). But there are no estimates for current fishing mortality that can be compared to this benchmark. Based on the latest assessment, this stock continues to be depleted, with little margin for any allowable harm if the goal is to reach 40% B_{MSY} (McAllister and Duplisea 2011). Because of the depleted condition of the stocks and the continued removals in both index and commercial fisheries in Units 1+2, fishing mortality is deemed “high” concern.

Leatherback Turtle (Dermochelys coriacea)

Factor 2.1 Inherent Vulnerability

Key relevant information: **High Vulnerability**

Turtles are considered to be highly vulnerable to fishing activities (SFW Criteria document p. 9).

Factor 2.2 Stock Status

Key relevant information: **Very High Concern**

Leatherback turtles in Canadian waters were determined as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1981, 2001, and most recently in 2012 (DFO 2012b).

Detailed rationale:

Population estimates are currently based on abundance of adult females encountered on nesting beaches. Recent estimates range from 34,000 to 94,000 adults (males and females) in the North Atlantic (COSEWIC 2012). Current data on leatherback sea turtles are insufficient to determine fluctuations and trends in the population in Canadian waters. Most major Western Atlantic nesting populations may be stable or increasing slightly (COSEWIC 2012).

Factor 2.3 Fishing Mortality

Key relevant information:

Maritimes/Newfoundland & Labrador Gillnet: High Concern

Maritimes/Newfoundland & Labrador Longline: Very Low Concern

The only estimates of fishing mortality for leatherback turtles in the groundfish gillnet fishery have been calculated using data from SARA logbook records, which put the encounter mortality* rate at 20%, and from the Whale Release and Stranding Network, which estimates the mortality rate at 23% (DFO 2012b). Only rough estimates of overall mortality due to fixed gear are available (20%–70%) (DFO 2012b). Currently, fishing mortality of leatherback turtles in groundfish gillnet and bottom longlines is unknown and more data are necessary. Due to considerable uncertainty about fishing mortality, the relative low incidence of encounters (for bottom longlines), and the endangered status of this species, fishing mortality is considered a "high" concern for Maritimes/Newfoundland & Labrador gillnet and a "very low" concern for Maritimes/Newfoundland & Labrador longline.

* Encounter mortality is defined as mortalities observed at the time of the encounter.

Detailed rationale:
The leading threat that leatherback turtles in Canadian waters face is the continual interaction with fishing gear. Leatherback turtles are incidentally caught in almost all fisheries in the Northwest Atlantic, especially the pelagic longline fishery. The groundfish longline and gillnet fisheries are also responsible for leatherback turtle bycatch (DFO 2012b). Turtles are especially vulnerable to entanglement in vertical and surface lines from fixed gear as well as mooring lines, trip lines, and monofilament and polypropylene netting (COSEWIC 2012). Entanglement can lead to serious injury, flipper amputation, and drowning. Since the last COSEWIC assessment in 2001, the primary threats to leatherback turtles (fishing, marine pollution, ship strikes, and oil and gas exploration) have not changed much and, in the case of fishing gear interactions, it appears as if they have worsened. Interactions with fishing gear are more significant than previously assessed because of the inconsistency and infrequency of data collection and what data are available. This has contributed to the underreporting of incidents, which has led to an underestimation of the magnitude of the problem (COSEWIC 2012) (DFO 2012b). Additionally, threats to leatherback turtles in Canadian waters not only affect the Canadian populations but, because these are transient animals that return to the beaches where they hatched all along the Western Atlantic, the impacts are magnified (COSEWIC 2012) on the entire Western Atlantic population (COSEWIC 2012).

Much of the data on fisheries interactions with leatherback turtles in past assessments have come from the observer program, which has been in place since 1977. But only recently have protocols been adopted that encounters with leatherbacks be recorded and recorded accurately (DFO 2012b). Even with new protocols in place, records of leatherback turtle encounters are rare in the observer database. Only 1 record was available in Newfoundland & Labrador in 2000, 1 in the Gulf of St. Lawrence in 2008, and 143 off the Scotian Shelf (DFO 2012b). The reliability of the observer records is unknown because there is no independent audit.

Similarly, since 2005, fishery interactions with species listed under SARA are required to be reported by DFO (DFO 2012b). Interactions with SARA-listed species are to be recorded in specially designed SARA logbooks; however, there have been issues with implementation of this requirement due to incomplete fishery coverage, issues with compliance, and confusion on how and when the SARA logbooks need to be completed (DFO 2012b). Despite their problems, the SARA logbooks have provided more records of leatherback interactions since 2005 in areas and fisheries where there are no data available from the observer program (DFO 2012b)—further suggesting that the magnitude of the problem is much worse than previously assessed. There have been 10 encounters off Newfoundland & Labrador (6 in fixed gear and 4 in mobile gear) reported by the Newfoundland & Labrador Region, 19 in the Gulf of St. Lawrence (17 with fixed gear) reported by the Quebec (18) and Gulf (1) regions, and 100 off the Scotian Shelf (99 with pelagic longline, 1 with a lobster trap) reported by the Maritimes Region (DFO 2012b).

Although there are no data available on discard/bycatch rates for leatherback turtles overall, it is important to note that in the groundfish fishery (which includes gillnet, longline, and trawl fisheries for cod, haddock, and pollock), encounters with leatherback turtles are relatively low but they still occur, particularly in the longline and gillnet fisheries. Between 2001 and 2010, 10,000 sets were observed in the groundfish gillnet fishery (from approximately 2% fishery coverage) and no encounters were recorded in the observer program database (DFO 2012b). However, there have been two leatherback turtle entanglements in Newfoundland & Labrador since 2005 (DFO 2012b)—again illustrating the potential underreporting within the observer program. There are no other reports either from SARA logbooks or observers in the Maritimes, Gulf, and Newfoundland & Labrador. Since 1976, of the 75 encounter records from Whale Release and Strandings in Newfoundland & Labrador, the groundfish gillnet fishery is responsible for 44% (33) of the encounters, with 27 of those resulting in a live release (DFO 2012b). These reports suggest that the potential for interaction, and thus mortality, from this fishery may be higher than would be determined from DFO records, especially off Newfoundland & Labrador. Data are insufficient to determine whether the risk of interaction with this fishery is increasing or decreasing (DFO 2012b). In a recent assessment of worldwide fisheries bycatch impacts on sea turtles, net gears (which include gillnets) were determined to have a high impact on leatherback turtles in the Northwest Atlantic (Wallace et al. 2013). Leatherback turtles are protected under Canada's Species At Risk Act (SARA) and a recovery strategy is in place. Because of the potential for high interactions of leatherback turtles in the groundfish gillnet fishery, this factor has been rated "high" concern.

Similarly, for the groundfish longline fishery, there are few records available to ascertain the magnitude of the fishery/leatherback turtle interactions. Observer coverage ranges from 20%–30% depending on the area (3Pn, 3Ps, 4R, 4X, and 5Ze) and no records exist in the observer database after 2001 (DFO 2012b), while three reports are available from the SARA logbooks from Quebec (one in 2006 and two in 2008) (DFO 2012b). Whale Release and Strandings have 10 records of leatherback entanglements, with 4 mortalities, since 1976. Again, these reports suggest that the risk of interaction from this fishery is greater than that indicated by the observer database (DFO 2012b). A recent study on the global impacts of sea turtle bycatch rated longline gear as having a low impact on the Northwest Atlantic leatherback sea turtle population (Wallace et al. 2013). Because longline fisheries overall are having a low impact on leatherback sea turtle populations in the Northwest Atlantic, and bottom longlines are less of a threat to sea turtles than pelagic longlines, this factor is rated "very low" concern.

North Atlantic right whale (*Eubalaena glacialis*)

Factor 2.1 Inherent Vulnerability
Key relevant information: **High Vulnerability**
Marine mammals are highly vulnerable to fishing activities (SFW Criteria document p. 9).

Factor 2.2 Stock Status
Key relevant information: **Very High Concern**
North Atlantic right whales are endangered the world over and the species was listed Endangered under SARA in 2005 (Brown et al. 2009). The population of North Atlantic right whales in Atlantic Canadian waters was estimated in 2003 at 322 animals; however, more recent estimates place the current population at 455 animals (Waring et al. 2014).

Detailed rationale:
According to the last COSEWIC assessment in 2003, the population was estimated at 322 individuals, which was the number of catalogued North Atlantic right whales thought to be alive in 2003 (COSEWIC 2003). Precise estimates have not been calculated for this cetacean species, although more recent abundance estimates suggest 455 animals were alive in 2010 (Waring et al. 2014). The population of North Atlantic right whales declined in the 1990s, and increases in mortality rates in 2004 and 2005 were cause for serious concern (Kraus 2005). It was predicted that these mortality rate increases would likely reduce the right whale population by 10% per year (Kraus et al 2005). Despite these predictions, an examination of the minimum number of alive population index as it existed between 1990 and 2010 suggests that the right whale population is experiencing a positive trend in population size, with a mean crude growth rate of 2.8% in that period (Waring et al. 2014).

Factor 2.3 Fishing Mortality
Key relevant information: **High Concern**
Since whaling of North Atlantic right whales was eliminated in the 1930s, the only other immediate threats to the recovery of this population are ship strikes and entanglement in fishing gear. Between 1970 and January 2007, there have been 75 reliably documented right whale deaths: 11% (8 whales) were attributed to entanglement in fishing gear, 37% (28 whales) were attributed to vessel strikes, 28% (21 whales) died of unknown causes, and 24% (18 whales) were defined as “neonatal mortality” (Brown et al. 2009) (Knowlton and Kraus 2001) (NEAq unpublished data). The average annual rate of mortality and serious injury to right whales due to anthropogenic effects was 4.05 (U.S. waters, 3.1; Canadian waters, 0.95) (Waring et al. 2014). The two main causes were incidental entanglements in fishing gear at 3.25 per year (U.S. waters, 2.3; Canadian waters, 0.95) and ship strikes at 0.8 per year (U.S. waters, 0.8; Canadian waters, 0) (Waring et al. 2014). During 2007–2011, out of 21 records of mortality or serious injury, 17 were attributed to entanglement or fishery interactions (Waring et al. 2014). The actual total deaths attributed to anthropogenic activities are unknown but are likely higher than the observed number because not all carcasses of right whales are found. For example, carcasses of right whales that die as a result of entanglements in fishing gear may be more likely to sink at sea because of the decreased health of the animals and subsequent energetic

losses; thus it has been suggested that up to two-thirds of human-caused right whale deaths may go undetected (Brown et al. 2009).

The fisheries responsible for entanglements in Canadian waters have not been identified because gear was not present or recovered from the observed injuries and mortalities (Waring et al. 2014). Because North Atlantic right whales are known to interact with gillnets in this region and others, this species has been included in this assessment.

The Potential Biological Removal (PBR) of this species is 0.9 (Waring et al. 2014), while the average mortality rate of North Atlantic right whales in Canada is 0.95, which is higher than the PBR. This suggests that mortality due to entanglements in Canadian fisheries is of “high” concern.

Detailed rationale:
There are three identified stocks of right whales (*Eubalaena glacialis*): North Atlantic, North Pacific, and Southern Hemisphere. The North Atlantic stock has two sub-stocks: Eastern North Atlantic and Western North Atlantic (WNA). The WNA stock of right whales has a range from North Florida to the Bay of Fundy (Fujiwara and Caswell, 2001) as well as six major aggregations: 1) Georges Bank/Gulf of Maine, 2) Cape Cod and Massachusetts Bay, 3) Bay of Fundy, 4) Scotian Shelf, 5) coastal waters of Southern United States, and 6) Great South Channel; all these areas, except the southeast, support an active lobster fishery (Waring and Pace et al. 2004). Right whales are the most endangered of all the great whales in the world and their effective population size is approximately 455 individuals (Waring et al. 2014). Due to the limited size of the population, the species may already be functionally extinct because of demographic stochasticity (Fujiwara and Caswell, 2001).

Despite active protection of the species, North Atlantic right whales do not appear to be recovering (NMFS 2005). The NMFS 2005 Recovery Plan stated that there had been no recovery of the population in the last 15 years and suggested that the North Atlantic right whales were actually much rarer and more endangered than previously believed (NMFS, 2005). The reasons for lack of recovery were probably due to decreased birth rates and increased mortality rates. Juvenile right whales appear to be particularly vulnerable to mortality from ship strikes, interaction with fishing gear, and natural causes (NMFS 2005). In a study by Kraus (1990), it was estimated that in the first 4 years of life, North Atlantic right whale mortality rates ranged from 2%–17%, with approximately one-third of mortalities attributed to anthropogenic factors (Kraus 1990).

Although there are no data on North Atlantic right whale discards/bycatch rates *per se* in Canadian waters, there are some quantitative data on encounters with fishing gear, primarily entanglement events. As in United States waters, fishing gear has been a significant threat to right whales and other marine mammals for a long time. Reports of entanglement encounters of right whales date to 1909 in Provincetown Harbor, Massachusetts (Brown et al. 2008). Though it was once believed that interactions with fishing gear by right whales were rare and “exceptional” events (Brown et al. 2008) (Reeves et al. 1978), it is now evident that interactions with fishing gear are major sources of serious injury (maiming, amputation, starvation) and mortality. Fishing gear entanglements are a serious impediment to the recovery of this population (Kraus et al. 2005) due to the sheer volume of fishing gear in the Northwest Atlantic and the precarious state of the population. Recent studies have shown that more than 75% of right whales have scarring attributed to entanglements in fishing gear at some point in their lives, and the rate of scarring increased in the 1990s (Brown et al. 2008) (Knowlton et al. 2005). Juvenile right whales are particularly vulnerable to entanglements (Brown et al. 2008; Knowlton et al. 2005).

It is difficult to definitively attribute one type of fishing gear or its geographical origin because right whales are highly mobile and entangling gear is often unmarked, but there is evidence that vertical and horizontal lines from fixed gear such as gillnets and traps are most often implicated in entanglements in Canadian and U.S. waters (Johnson et al. 2005).

Since 1988, at least two right whale mortalities from entanglement can be attributed to fishing gear traced to Canadian fishing operations (Brown et al. 2008) (Knowlton and Kraus 2001) (NEAq unpublished data). Although the actual number of mortalities attributed to entanglements is not known (Brown et al. 2008), it is likely higher than the number that has been observed in both Canada and the United States (Brown et al. 2008). Analysis of entanglement data from 1980–1999 document eight right whales with potentially fatal entanglements that were last seen alive but were presumed dead (Brown et al. 2008) (Knowlton and Kraus 2001). Recently, due to more comprehensive sighting data, the examination of fishing gear retrieved from entangled right whales, and the emergence of new fixed-gear fisheries that are carried out in the summer and autumn, it is clear that there is a greater risk for right whale entanglement in Canadian waters than previously thought (Brown et al. 2008).

Wolffish
*Atlantic Wolffish (*Anarhichas lupus*)*
*Northern Wolffish (*Anarhichas denticulatus*)*
*Spotted Wolffish (*Anarhichas minor*)*

Factor 2.1 Inherent Vulnerability
Key relevant information: **High Vulnerability**
Wolffish are considered to have high vulnerability to fishing, as indicated by their associated FishBase vulnerability scores (Atlantic 67; northern 78; spotted 80). Wolffish typically live 22–30 years (maturing at ages 4–6) and have relatively low fecundity compared to other teleost fishes, producing 10,000 to 15,000 eggs per spawning (Froese & Pauly 2015).

Factor 2.2 Stock Status
Key relevant information:
Atlantic Wolffish – **High Concern**
Northern and Spotted Wolffish – **Very High Concern**
In 2001, COSEWIC assessed all three wolffish species, while SARA listed Atlantic wolffish as a

species of Special Concern and the northern and spotted wolffish as Threatened. COSEWIC re-assessed the species in 2011 and confirmed each listing in November 2012 (COSEWIC 2012a). Wolffish is found in the highest densities on the northeast Newfoundland and southern Labrador shelves (DFO 2013d). It is rare in the Maritimes region. The abundance of northern and spotted wolffish is ranked "very high" concern. Abundance of Atlantic wolfish is a "high" concern because it is not considered threatened or endangered but as Special Concern (DFO 2013e).

<u>Detailed justification:</u>
There are currently no biological reference points available for these species to accurately determine abundance. The Atlantic wolffish, *Anarhichas lupus*, is considered a species of Special Concern by COSEWIC (Kulka et al. 2007). Both the northern wolffish (*Anarhichas denticulatus*) and the spotted wolffish (*Anarhichas minor*) were determined as Threatened by COSEWIC in 2001 and November 2012 (COSEWIC 2012a). Based on the first determination, these two species were listed ("grandfathered in") under the Canadian Species at Risk Act (SARA) when it was enacted in 2003. COSEWIC indicated that the abundance of these two species had seen a 90% decline over three generations and their range of distribution had also declined (Kulka et al. 2007). A biomass index for Atlantic wolffish for 1997–2001 from NAFO area 2J3Kl was calculated at 4,302 t, while indices for northern wolffish and spotted wolffish in the same NAFO region in the same period were 5,652 t and 4,300 t, respectively (Kulka et al. 2007).

Factor 2.3 Fishing Mortality
<u>Key relevant information:</u>
Atlantic Wolffish – **Moderate Concern**
Northern and Spotted Wolffish – **Moderate Concern**
There is currently no F metric for determining fishing mortality for any of the three species of wolffish. The latest metrics for fishing mortality for these species were based on an exploitation index (catch/relative biomass) from 1995–2002 for each; those were 1% (Atlantic wolffish), 6.3% (northern wolffish), and 2.2% (spotted wolffish) (Kulka et al. 2007). Additionally, in the Recovery Strategy Report, it states that obtaining an accurate estimate of fishing mortality (F) is problematic due to wolffish being captured in a variety of fisheries (Kulka et al. 2007). Therefore, because fishing mortality is unknown and a recovery strategy is in place, we rate this factor for all three wolffish species as "moderate" concern.

<u>Detailed Rationale:</u>
The leading cause of human-induced mortality of the wolffish populations in Canada is incidental capture in a variety of fisheries, especially the cod and pollock longline fishery (Kulka et al. 2007). But the extent to which fishing activities contribute to the total mortality of wolffish is not clear (Kulka et al. 2007). There is no directed fishery for any species of wolffish in Canada; however, their distribution overlaps fishing grounds of many Northwest Atlantic fisheries, including groundfish and lobster fisheries. Thus wolffish are common bycatch in many of these fisheries (Kulka et al. 2007). The 2004 Allowable Harm Assessment for northern and

spotted wolffish determined that the mortality levels for these species had remained fairly stable because of a decrease in fishing efforts in other fisheries due to the groundfish moratoria (DFO 2004d). Because of the relative stability of mortality levels, the Allowable Harm Assessment concluded that these mortality levels did not prohibit recovery of the species (DFO 2004d). Thus, a policy was implemented of mandatory release of northern and spotted wolffish back to the site of capture and in a manner that maximized survival (Kulka et al. 2007) (DFO 2004d). There is no directed fishery for any of the three species of wolffish, but spotted and Atlantic wolffish have commercial value while northern wolffish does not. For this reason, prior to the implementation of the mandatory release policy, about 50% of both spotted and Atlantic wolffish species were retained and 50% discarded, while 100% of northern wolffish was discarded (Kulka et al. 2007). It is not known how well the animals survive once they are released and how well this mandatory release policy is working.

Factor 2.4 Overall discard rate

<u>Key relevant information:</u>
(Gavaris et al. 2010) estimated the discard rates of Canadian fisheries from the limited observer data that are available for these fisheries and established the figures below. Note that there is a level of uncertainty associated with estimates due to the small sample size.

Bottom Trawl: 8.6%
Gillnet: 35%
Bottom Longline: 38.7%

<u>Detailed rationale:</u>
Bottom Trawl:
Discard rates (fish thrown back to sea) for the Newfoundland and Labrador region were not available. In the Maritimes region, some discard data are available from at-sea observer programs. The amount of fishery catches that has been sampled in this region ranged from 5%–17% during 2002–2006. The most recent data is for 2006 (Gavaris et al. 2010), when 17% of the catches were sampled. An estimated 1,410 mt of fish were discarded and 16,359 mt were retained (landed) in the bottom trawl fishery in 2006. The ratio of discards to retained catches/landings is approximately 8.6%.
Gillnet:
Discard rates (fish thrown back to sea) for the Newfoundland and Labrador region were not available. In the Maritimes region, some discard data are available from at-sea observer programs, but the amount of catches sampled is very low (0%–2% during 2002–2006), leading to uncertainties in the data. The most recent data for this fishery are for 2005, and it was estimated that 1,136 mt of fish were discarded and 3,237 mt of fish were retained (landed) in the gillnet groundfish fishery on the southern Scotian Shelf and the Gulf of Maine (Divisions 4X5Y). The ratio of discards to landings was approximately 35%. In 2005, 2% of fishing trips in Divisions 4X5Y were sampled. This is the main area where the Canadian gillnet fishery takes place and the only area in the Maritimes region with observer coverage in 2005 (Gavaris et al.

2010). In Northwest Atlantic U.S. groundfish gillnet fisheries, a similar but higher discard to landings ratio of 46.8% was estimated (NMFS 2011).

Bottom Longline:

Discard rates (fish thrown back to sea) for the Newfoundland and Labrador region were not available. In the Maritimes region, some discard data are available from at-sea observer programs, but the amount of catches sampled is very low (2%–4%), leading to uncertainties in the data. The most recent data are for 2006. The ratio of discards to retained catches (landings) in the Maritimes region was approximately 38.7% for the longline fishery. An estimated 3,845 mt of fish were discarded and 9,944 mt of fish were retained (Gavaris et al. 2010). In previous years (2003–2005), the estimated discard to retained catches ratio was lower, at approximately 15%. In the similar U.S. Northwest Atlantic longline groundfish fishery, the bycatch to landings ratio was 27.7% (NMFS 2011).

Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. 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 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*

  Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Fishery	**Management: Harvest** Rank (Score)	**Management: Bycatch** Rank (Score)	**Criterion 3** Rank Score
Newfoundland Otter Trawl	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
Newfoundland Atlantic	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
Newfoundland Atlantic Gillnet	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
Maritimes Otter Trawl	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
Maritimes Longline	Moderate Concern (3)	Moderate Concern (3)	Yellow 3
Maritimes Gillnet	Moderate Concern (3)	Moderate Concern (3)	Yellow 3

Fishery	Critical?	Mgmt strategy and implement.	Recovery of stocks of concern	Scientific research and monitoring	Scientific advice	Enforce.	Track record	Stakeholder inclusion	**Management of Retained Species** **Rank (Score)**
Newfoundland Otter Trawl	No	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderate (3)
Newfoundland Atlantic Longline	No	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderate (3)
Newfoundland Atlantic Gillnet	No	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderate (3)
Maritimes Otter Trawl	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderate (3)
Maritimes Longline	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderate (3)
Maritimes Gillnet	No	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective	Moderate (3)

Fishery	All Species Retained?	Critical?	Mgmt strategy and implement.	Scientific research and monitoring	Scientific advice	Enforce.	**Management of bycatch species** **Rank (Score)**
Newfoundland Otter Trawl	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderate (3)
Newfoundland Atlantic Longline	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderate (3)
Newfoundland Atlantic Gillnet	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderate (3)
Maritimes Otter Trawl	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderate (3)
Maritimes Longline	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderate (3)
Maritimes Gillnet	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Moderate (3)

Synthesis:

Canada’s Department of Fisheries and Oceans (DFO) is responsible for managing the cod and pollock stocks in Canadian waters. DFO manages fisheries through the implementation of Integrated Fisheries Management Plans (IFMP). The IFMPs are drafted by DFO in collaboration with stakeholders and through consultation processes with the species’ Advisory Committees and Regional Advisory Processes (RAPs). But the IFMPS are not explicit regarding objectives and strategies for achieving objectives. Like other groundfish stocks, cod and pollock have experienced severe declines due to overfishing since the 1960s with collapses in the early 1990s, and dramatic measures have been taken to rebuild the stocks. Because cod is endangered and it has commercial and cultural value, the other groundfish (including pollock) are managed to ultimately protect and conserve cod stocks. Total allowable catch (TAC) limits are set by DFO and follow the Precautionary Approach and Sustainable Fisheries Framework. Despite the precautionary approach to management of the fisheries, cod and pollock remain severely depleted through most of the Canadian Atlantic with no projected recovery in the near future.

Justification of Ranking

Factor 3.1 Management of fishing impacts on retained species

Key relevant information:

Overall, the cod (3Ps, 3Pn4RS) and pollock (4VWX + 5) fisheries are rated as “moderate” with regard to management of retained species. Like other groundfish stocks, cod and pollock have experienced severe declines since the 1990s and dramatic measures have been taken to rebuild the stocks. Both species are managed as part of the mixed groundfish fishery, which is managed to ultimately protect and conserve the cod stocks. This means that bycatch of cod in other groundfish fisheries (such as the pollock fishery) will affect the overall TAC for those fisheries. If the allowable bycatch cod quota is reached in pollock-directed fisheries, then the fishery is closed. In general, the TAC limits for both species are relatively low compared to historical values and are set according to scientific advice, indicating a conservative approach that is in keeping with DFO’s Precautionary Approach and Sustainable Fisheries Frameworks (DFO 2009b) (MSC 2010). Despite implementing harvest strategies for cod and pollock fisheries (regardless of gear), cod stocks in 3Pn4RS (DFO 2011e) have seen slight or no evidence of a recovery, and pollock stocks in 4VWX +5 have not rebounded (DFO 2011b). But a recent stock assessment has demonstrated that the 3Ps cod stock is recovering (DFO 2013b). It is evident that DFO is proceeding with caution in management of all stocks and utilizing a harvest strategy to best ensure recovery of the stocks, but in the case of cod and pollock, significant recovery has not occurred.

Detailed rationale:

Management Strategy and Implementation: Moderately effective

The Canadian Department of Fisheries and Oceans is responsible for the management of cod and pollock stocks in Canadian waters. However, NAFO and TRAC contribute to management of transboundary stocks (e.g., 3NO cod, which is under an NAFO-imposed moratorium). The general DFO harvest strategy for cod and pollock is implemented for each fleet using total allowable catch (TAC) and Conservation Harvest Plans, which include but are not limited to minimum fish size, bycatch restrictions, fishing gear limitations, dockside monitoring, a minimum of 5% at sea observer coverage, VMS coverage, boundary restrictions, discard controls, and seasonal spawning closures (DFO 2009b) (MSC 2010). Only annual quotas are subject to change from year to year (MSC 2010).

DFO uses a recently developed precautionary harvest strategy around stock status and fishing mortality reference points. The Precautionary Approach (PA) in general is about erring on the side of caution when the scientific information is either inadequate, uncertain, or unreliable (DFO 2009a), as has been the case with many of the depleted groundfish stocks, especially cod and pollock. Using a PA as a management tool is a way to avoid serious harm to the resource because of inadequate scientific information (DFO 2009a). In 2004, the Atlantic Fisheries Policy

Review (AFPR), which was led by DFO and driven by declines in groundfish stock in recent decades, requested a comprehensive risk management framework for decision-making that incorporated the Precautionary Approach. In May 2006, DFO Science released a paper outlining the minimal requirements, from a science perspective, for a harvest strategy to be compliant with the Precautionary Approach (DFO 2006a).

The DFO harvest strategy applies to any exploited resource regardless of the nature of the harvesting, e.g., commercial, recreational, or subsistence, and the removal rate pertains to all human-induced mortality, including bycatch, discards, incidental mortality, or other human activities (DFO 2006a). This harvest strategy has been used for cod and pollock stock assessments and includes:

1. A Removal Reference fishing mortality rate to guide harvesting of stocks when their status is "Healthy."
2. An Upper Stock Reference (USR) biomass level that delineates the boundary between a Healthy stock and one in the "Cautious" zone, in which removals must be progressively reduced to avoid reaching the limit reference point. Management priority in the Cautious zone should be to promote stock growth toward the Healthy zone (DFO 2009a).
3. A Limit Reference Point (LRP) of stock status below which serious harm to the stock may occur. Management priority in this “Critical” zone must promote stock growth by keeping all removals to a minimum (MSC 2010) (DFO 2009a) (Figure 12).

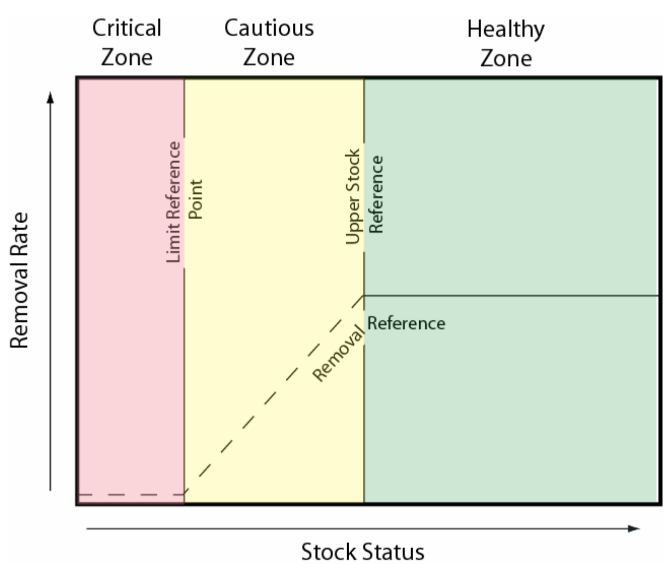


Figure 12: Fisheries Management Framework Consistent with Precautionary Approach (DFO 2006)

Cod and pollock stocks are monitored and regulated, and the recovery and protection of cod stocks is a priority. If the cod bycatch quota is exceeded in any pollock-directed fisheries, then the fishery is closed. In addition, TACs for cod and pollock are adjusted in keeping with the precautionary approach and harvest strategy; i.e., fishing mortality rates have been increased or decreased in response to increases or decreases in stock status estimates (MSC 2010).

Neither of the two focus species of this report has seen significant recovery (although the haddock stocks in the area have seen better recovery rates). The biomass of cod in the 3Ps management region has doubled in recent years and is considered above the limit reference point by DFO (DFO 2014b). But Seafood Watch has concerns with the reference point that is used because it is based on post-collapse abundance, and it is unknown whether it can be seen as a precautionary reference point or how it relates to abundance at maximum sustainable yield.

The pollock stock status has been difficult to evaluate with the standard assessment methods because of the species' midwater schooling behavior. Recently, fisheries management and industry were considering using a risk-management approach for managing pollock in the Western Component (DFO 2011d), and in July 2010, fisheries management initiated a Management Strategy Evaluation (MSE) approach as an alternative to standard stock assessment (DFO 2011b). In the MSE, Management Objectives and Harvest Control Rules (HCRs) are specified up front. Using MSE is a mechanism by which DFO can explicitly consider the uncertainty in stock assessment assumptions and models and compare the likely consequences to Management Objectives (biological, economic, etc.) when a predetermined Management Procedure (MP) incorporating a Harvest Control Rule (HCR) is applied (DFO 2011b). MSE changes the focus from the traditional "best assessment" to identifying a "best procedure," where "best" implies the procedure that most closely meets the desired Management Objectives. The pollock MSE was developed around the following:

1) A 3-year running geometric mean of the summer Research Vessel (RV) Survey Biomass Index provides the measure used in the Harvest Control Rule to establish future catch limits for Western Component pollock.

2) An annual review will determine if the RV Survey Biomass Index has moved outside projected ranges.

3) Exceptional Circumstances provisions are defined and are intended to cover situations outside the range for which the Management Procedure was tested through simulation.

4) Unless an Exceptional Circumstance is triggered, the application of the Management Procedure will provide the catch limit for Western Component pollock.

The expected operating timeframe for this Management Strategy Evaluation is 5 years, after which there will be a thorough review (DFO 2011b). The 2012 fishing season was the first to use the MSE, so a thorough assessment of the efficacy of the MSE in managing pollock has yet to be determined. However, it must be noted that the MSE for pollock is considered conservative and the Exceptional Circumstance functions as a fail-safe that will trigger a review of the MSE in a timely manner to prevent harming the resource before it is too late (DFO 2011b).

Recovery of stocks of concern: Moderately Effective

The purpose of Canada's Species at Risk Act (SARA), enacted in 2003, is to conserve, protect, and recover endangered or threatened species. It also is intended to drive management of species of special concern to prevent them from becoming further at risk (DFO 2005e). SARA commits Canada to preventing the extirpation or extinction of native species and to preserving biodiversity in Canada (DFO 2005e). DFO is one of three governmental departments that oversee that SARA is upheld. DFO is responsible for protection and recovery of aquatic species at risk and for implementing conservation and protection measures (DFO 2005e).

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent body of scientific experts from a variety of fields and governmental agencies whose job is to identify species at risk through scientific processes and data. COSEWIC meets once or twice a year to review reports on species at risk. COSEWIC is not responsible for listing a species under SARA; the Canadian government, with citizen input, is responsible for listing species under SARA. No new commercial marine fish species have been listed since SARA came into effect in 2003. Three species of Atlantic wolffish already had COSEWIC determinations of Threatened or Special Concern accepted by the government before SARA and were not de-listed under SARA.

Currently, no commercially important species have been added to SARA. Theoretically, once a species has gone through the 9-month process of being listed under SARA and has been listed as Threatened or Endangered, recovery strategies and action plans must be created. Recovery strategies are written by recovery teams comprising technical experts from universities, conservation groups, industry, and government. The recovery strategy teams review available information on each species as well as the larger species ecosystem. Recovery strategies outline short-term objectives and long-term goals for protecting and recovering species at risk. These strategies must be completed within one year of a species being listed as endangered, and within two years of a species being listed as threatened or extirpated (extinct in Canada) (**DFO 2008-http://www.dfo-mpo.gc.ca/species-especes/recovery-retablissement-eng.htm**).

Once recovery strategies are complete, action plans are created. Action plans summarize projects and activities that are intended to meet objectives and goals. They include information on habitat, protection measure details, and evaluations of socio-economic impacts (**DFO 2008-http://www.dfo-mpo.gc.ca/species-especes/recovery-retablissement-eng.htm**).

Cod has been determined as endangered by COSEWIC, but has yet to be listed under SARA. The recovery of cod stocks in Canada is uncertain and minimal at best. The two stocks that have been reviewed in this report are examples of the recovery trend of cod, with only 3Ps cod experiencing an increase in SSB and 3Pn4RS not recovering at all. Although the Canadian government has recovery mechanisms in place to aid in the protection and rebuilding of cod stocks, there is minimal evidence of stock recoveries for both cod and pollock. However, it must be noted that the extent to which the Canadian government has gone to protect, conserve and recover cod stocks is an enormous priority for the government. Also, it has and is continuing to assess, implement, and adjust policies, harvest strategies, and quotas and has put certain stocks under moratorium off and on since 1992. Therefore, it is not that there are no mechanisms of recovery in place—they just haven't succeeded, so this factor is deemed only "moderately" effective.

Scientific Research and Monitoring: Moderately effective
There is a comprehensive research program for the cod and pollock fisheries in Atlantic Canada. The Department of Fisheries and Oceans (DFO) has the mandate for the management and conservation of Canadian marine and freshwater aquatic resources and their habitat. This mandate requires that technical knowledge and advice about the conservation requirements for these resources be provided to management and regulatory agencies within DFO and elsewhere. In addition to DFO, a number of other research entities contribute to scientific research of these stocks; some of these include:

The *Regional Advisory Process* (RAP) was established in 1993 to provide peer-reviewed information on the status of the fisheries and marine mammal resources in the Atlantic zone. The RAP addresses issues pertinent to each individual region and provides technical analysis relating to regional habitat and fisheries management. Industry stakeholders as well as scientific experts are involved in the review process (**http://www2.mar.dfo-mpo.gc.ca/science/rap/internet/raphome.htm**).

The *Canadian Science Advisory Secretariat* (CSAS) is responsible for coordinating peer review of scientific issues for DFO. CSAS is also responsible for coordinating and disseminating the information and results from the peer review and advisory process (**http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm**). CSAS readily makes available status reports on fish, invertebrate, and marine mammal stocks; environmental and ecosystem overviews; research documents; and proceedings of peer review meetings (**http://www2.mar.dfo-mpo.gc.ca/science/rap/internet/raphome.htm**).

The *Bedford Institute of Oceanography* (BIO) is the largest center for ocean research in Canada. It was established by the federal government in 1962 and is located on the shores of the Bedford Basin in Dartmouth, Nova Scotia. Under mandate from the Canadian government, BIO performs targeted research to provide peer-reviewed scientific advice on a range of topics, including environmental protection, ocean health, safe and accessible waterways, sustainable natural resources (fisheries, minerals, and oil and gas) as well as the integrated management of large ocean areas (**http://www.bio-iob.gc.ca/general-generales/about-sujet-eng.php**). DFO regional offices also conduct research into stock abundance and other factors critical to the effective management of fish and invertebrate stocks in their respective regions.

Due to the dramatic collapse of the groundfish fisheries in the early 1990s and subsequent moratoria that were implemented, groundfish (especially cod and pollock) are intensively monitored and assessed. Monitoring of these fisheries is done through a multi-pronged process that includes the At-Sea Observer Program, the Dockside Monitoring Program (DMP), and Vessel Monitoring System (VMS). In addition, fishers must fill out logbooks. To avoid biased assessments of stock status because of unreported catch and discards of target and bycatch species, and to ensure that reliable and accurate landings data are recorded, it is crucial that the monitoring system verify the accuracy of a reported catch. This is particularly important in cases where observer coverage is limited or non-existent (MSC 2010). Despite these monitoring measures, there still are unreliable catch data, and they cannot be used in stock assessments of some fisheries, such as 3Ps and 2J3KL (DFO 2013a,b).

DFO's Conservation and Protection Division (CPD) is responsible for promoting and maintaining compliance with legislation, regulations, and fishery management measures (http://www.dfo-mpo.gc.ca/ae-ve/evaluations/10-11/6b142-eng.htm#_Toc283901090). CPD also conducts at-sea surveillance using aircraft, surface patrol vessels, and observers aboard fishing boats, and onshore surveillance using land-based fishery officers.

Management of cod and pollock stocks in eastern Canada uses a variety of measures to collect and analyze up-to-date data (both fishery-independent and fishery-dependent) to generate stock assessments. DFO monitors and assesses the status of the cod stocks every 3 years (annually for 3Ps cod) but does not produce stock assessments for pollock as frequently. Even though the scientific research mechanism is there, there are too many uncertainties in the cod and pollock stock status assessments to get a good handle on the actual abundance and health of the populations. The scientific research component continues to adjust and develop models and different ways to best assess the complex nature of these stocks, and though the data may fit the models better, it appears that the stocks are still severely depleted with little to no recovery. In some cases, projections that include zero fishing mortality still indicate that a recovery is not likely in the future (e.g., Southern Gulf of St. Lawrence Cod).

There is heavy monitoring and assessing of cod and pollock fisheries. All fishers, as a condition of their license, must fill out logbooks and participate in the Dockside Monitoring Program and Vessel Monitoring System (on larger vessels). The at-sea observer program is also an important component in the monitoring measures taken by DFO; however, this program is inherently flawed. Observer coverage is limited and variable, with some fisheries getting significantly more coverage than others. Additionally, the human element of the observer program must be considered, and misreporting and underreporting of species is likely. Due to uncertainties in the data collected and patchy observer coverage, this factor is rated as "moderately effective."

Scientific Advice: Moderately effective

After the collapse of the cod stocks, the Fishery Resource Conservation Council (FRCC) was created to make annual recommendations to the Minister of Fisheries and Oceans on total allowable catches and other management measures related to Atlantic Canada's groundfish stocks (FRCC 2011), until the FRCC was disbanded. Since then, scientific advice and recommendations on Atlantic groundfish stocks come from the CSAS advisory process at either the regional or zonal level or, in the case of some Maritimes stocks, from the Trans-Boundary Management Guidance Committee (TMGC) (MSC 2010). But the Minister of Fisheries has complete discretion to make any decision regardless of scientific advice.

Currently, there is no evidence that DFO scientific advice is not followed when setting catch quotas for cod, haddock, and pollock. But it is believed that, for years after the initial collapse of the groundfish stocks, the TAC recommended by FRCC was consistently too high (Shelton et al. 2007). This seems to be having profound and long-lasting effects on the recovery of many groundfish species, especially cod and pollock. This factor receives a "moderately effective" ranking.

Enforcement: Highly effective

In 2004, FRCC recommended that DFO closely monitor the mixed cod and pollock fisheries in part through increased observer coverage (FRCC 2004). In addition it emphasized that DFO needed to be "diligent in the enforcement and protection" to ensure compliance in the fleet (FRCC 2004). Currently, 100% of groundfish fisheries have dockside observer coverage (DFO 2003a). Regarding compliance in the 2007 cod fishery, CPD (Conservation and Protection Division) reported that, of the 100 ports in 3Pn4RS, 36 had 100% dockside monitoring and 64 had random dockside monitoring. In 3Ps, 63 ports had 100% dockside monitoring while 37 had random dockside monitoring. Overall, 90% of the cod landings were physically verified (http://www.dfo-mpo.gc.ca/fm-gp/initiatives/cod-morue/monitoring-surveillance-eng.htm). In recent years, at-sea observer coverage for the Georges Bank trawl fishery has been the highest of any Atlantic Canadian fishery. Misreporting is assessed by comparing at-sea observed catch to unobserved catches, with any disparity being attributed to discarding and subsequent misreporting. On Georges Bank, any suspected unreported discards are totaled and then counted against the preceding year's quota (Gavaris et al. 2007). Currently, there is a strong enforcement presence in Canadian fisheries: 140 officers (with approximately 40% dedicated to groundfish) of the DFO Conservation and Protection Division monitor fishing operations and enforce regulations using air surveillance, at-sea inspection, and onshore activities (MSC 2010). In Newfoundland & Labrador, 100 fishery officers spent 16,266 hours on enforcement and compliance issues in 2007 (**http://www.dfo-mpo.gc.ca/fm-gp/initiatives/cod-morue/monitoring-surveillance-eng.htm**). Accurate reporting of all forms of catch (commercial, recreational, scientific, food, social, and ceremonial, whether directed or bycatch, retained or non-retained) is essential (FRCC 2011). In 2011, FRCC again recommended that stocks with recovery plans should increase the level of monitoring by ensuring 100% DMP (Dockside Monitoring Program), increasing observer coverage, and accounting for non-retained catch (FRCC 2011). It is recognized that, when stocks are in the critical zone and small quotas are permitted, there could be limitations on bycatch of that stock in other fisheries, thus constraining the catches of those fisheries or leading to discarding (FRCC 2011).

This factor is ranked "highly effective" because regulations are regularly enforced; however, it should be noted that enforcement and monitoring may not be sufficiently effective with respect to observer coverage. At-sea observer coverage is limited and variable, with some fisheries (e.g., cod) receiving more than others (e.g., pollock).

Track Record: Moderately effective

Although many measures and policies have been enacted and implemented in attempts to restore groundfish stocks, many are still depleted and some, such as cod and pollock, are showing little to no signs of recovery. But the haddock fisheries in 4X5Y and 5Zjm seem to be responding and their abundance is improving. The management measures that have been implemented, from gear modifications to area and time closures, are appropriate but appear to be having little effect on cod and pollock populations, with few encouraging signs for the recovery potential in the near future. Therefore the track record is considered “moderately effective.”

Stakeholder inclusion: Moderately effective
The DFO approach to the consultation process provides the opportunity for stakeholders to be involved and facilitates their effective engagement. There are a number of levels of fishery management that allow stakeholder participation in the fishery management process. This is undertaken by regular consultation with the large number of representative organizations and through public meetings (MSC 2010), such as industry consultation meetings held in Clarenville, Newfoundland for the 3Ps management region (pers. comm., J. Ryan 2012). Although a cornerstone of management policy is the consideration of local knowledge, and some policy documents formally acknowledge the importance of this, it appears that there is no formal explanation of how the information and opinions of stakeholders are used or not (MSC 2010).

Factor 3.2 Management of fishing impacts on bycatch species
Key relevant information:
The management of bycatch is fundamental to Canada’s ecosystem-based fishery conservation and management approach, and the Canadian Atlantic groundfish fishery has appropriate strategies and measures to mitigate the fishing impacts on incidentally caught species. But there is not enough evidence and there are not enough data to ascertain how effective the measures are. Bycatch in these fisheries is deemed “moderately effective.”

Detailed rationale:

Management Strategy and Implementation: Moderately effective
Under Canadian regulations, all groundfish must be retained and landed regardless of gear being used. Conservation Harvesting Plans for the different fleet segments and regions stipulate the total bycatch of species that can be taken on each trip as a percentage of the total catch. If this percentage is exceeded, then observer coverage is increased and further action is taken as necessary.

Although all groundfish must be retained, there are exceptions: dogfish, sculpin, lumpfish, skate, and other species defined by license condition may be discarded. In addition, under the “Small Fish Protocol,” the release of undersized fish such as Atlantic halibut (<81 cm), cod, haddock, pollock, white hake (<43 cm), and all flatfish (<30 cm) is required. Under the “Small Fish Protocol,” a fishery can be closed if the volume of fish under the defined size for a species exceeds 15% of the total catch of that species (**http://www.glf.dfompo.gc.ca/Gulf/FAM/Groundfish-Information/Small-Fish-Protocol**). Additionally, these protocols may vary from region to region. Fisheries can also be closed temporarily if established bycatch limits are exceeded. Closures are established on the basis of the catch during a single day and will be in effect for a minimum of 10 days. The measure must be applied in all Atlantic regions for all gear/fleet sectors engaged in directed groundfish fisheries in which a minimum fish size and incidental catch levels have been specified (**http://www.glf.dfo-mpo.gc.ca/Gulf/FAM/Groundfish-Information/Small-Fish-Protocol?is_mobile=1**).

All threatened species (as classified under SARA), such as leatherback turtles, northern wolffish, and spotted wolffish, must be released where they were taken and, when alive, in a manner that causes the least harm (DFO 2009b). Additionally, any catch of northern and spotted wolffish or leatherback turtle must be recorded in the sector logbooks (DFO 2009b).

Recently, some gear modifications have been tested and introduced (and somewhat adopted), including separator panels in trawl nets, acoustic pingers on gillnets, zero-offset circle hooks on longlines, and GPS technology on gillnets. Since 2007, in an attempt to reduce cod bycatch to aid in the recovery of cod populations, all trawlers targeting haddock on Georges Bank have been required to use separator panels as a condition of license. As a result of the implementation of separator panels in trawl nets, the bycatch of cod was reduced to 3.9% of the total catch while haddock was 91% of the total catch in the observed portion of the haddock fishery on Georges Bank in 2007. This likely reflects a combination of higher haddock abundances than cod and the selectivity of the separator trawl (Fuller et al. 2008).

The longline and gillnet fisheries have also taken a few steps to mitigate the effects on habitat and bycatch. In the longline fishery, measures to reduce entanglement and bycatch of sea turtles, including zero-offset circle hooks, the use of fish rather than squid as bait, improved de-hooking protocols, training of practitioners, and fishing in colder water, appear to reduce turtle bycatch and mortality (Baer et al. 2010). To help reduce marine mammal bycatch, net sleeves appear to work well, although the most effective mitigation strategy so far appears to be avoidance of whale concentrations (Baer et al, 2010). Except for avoidance, none of these measures is mandatory.

The impacts of gillnets on habitat are not as extensive as those of mobile gear, but gillnets have dramatic bycatch impacts, especially in regard to marine mammals; in the Northwest Atlantic, harbor porpoises are particularly vulnerable. Several technological innovations have been tested in an effort to reduce interactions and impacts of marine mammal populations. One innovation is acoustic reflective mesh (coated with barium sulfate), in the idea that dolphins and porpoises would be able to echolocate it better than standard, commercial nylon netting. In 2004, Cox and Read (2004) monitored echolocation behavior of harbor porpoises (*Phocoena phocoena*) around normal commercial gillnets and barium sulfate-enhanced gillnets in the Bay of Fundy (Canada). They concluded that porpoises do not respond to the acoustic reflectivity of the modified nets but to other characteristics, such as increased stiffness (Baer et al. 2010). This innovation was further explored by Koschinski et al. (2006) in a fjord on Vancouver Island (Canada). The results showed that the porpoises were able to echolocate the barium sulfate-coated gillnets from at least 4 meters further than standard nylon nets; however, harbor porpoises do not always echolocate and may continue to run into gillnets anyway (Baer et al. 2010).

Because of the uncertain effectiveness of acoustic reflective gillnets, other gear modifications have been suggested, in particular the use of acoustic "pingers" or alarms. These alarms are attached to gillnets and they emit high-frequency sound pulses. Pingers have been shown to be effective deterrents and to alert marine mammals to the presence of gillnets; however, some have suggested that pingers may also create a "dinner bell effect." This effect can increase depredation of and entanglements in the nets (Baer et al. 2010). As long as pingers are maintained and actually used, acoustic alarms are quite effective at reducing mammalian bycatch in gillnets (Baer et al. 2010). Unfortunately, at least in the Gulf of Maine, the unsubstantiated popular perception that pingers may increase depredation or actually attract marine mammals to gillnet causes compliance rates to be quite low for the use of mandatory pingers (Cox et al. 2007). In the lower Bay of Fundy, research was conducted into the use of pingers as an alternative to seasonal area closures for reducing harbor porpoises bycatch. Demersal gillnets fitted with alarms every 100 m along the net floatline reduced the bycatch rates by 77% compared to nets without alarms. Although fewer pollock were caught in alarmed nets during one season, the nets with alarms had no noted effect on catch rates of Atlantic herring, Atlantic cod, and pollock compared to nets without the alarms (Trippel et al. 1999). Study after study have shown that pingers are effective in reducing mammalian bycatch, but participation in the implementation with the fishing fleet is essential for ensuring compliance (Cox et al. 2007) (Baer et al, 2010). Another possible benefit of pingers on gillnets is the potential of deterring sea turtles (Baer et al. 2010). Still, in Canada, the primary mitigation strategy is avoidance of most sensitive areas.

Scientific Research and Monitoring: Moderately Effective
Canada has several programs in place for monitoring and reporting catch and landing information, including bycatch. These programs include the at-sea observer program and dockside monitoring. The at-sea observer program provides independent data on the fishing activities, including fishing efforts and catches and discards at sea. Having observers onboard is beneficial because data that otherwise would not be available are collected, and a more complete picture is possible of the impact of fishing efforts on stocks and habitat. The presence of observers onboard fishing vessels also provides a means to raise awareness about conservation and protection issues, as well as deterrence for any illegal activity that could occur if an observer were not onboard (**http://www.qc.dfo-mpo.gc.ca/peches-fisheries/surveillance/observateur-observer-eng.asp**). Until recently, the cost of the at-sea observer program was shared between DFO (1/3) and industry (2/3); however, this will change in April 2013 when DFO will no longer share the cost and industry will be responsible for the entire cost (**http://www.dfo-mpo.gc.ca/fm-gp/sdc-cps/eng-comm/notices-avis/20121002-eng.htm**).

Although there is a requirement for industry-funded at-sea observer coverage and for dockside monitoring of all groundfish (except lumpfish), there doesn't appear to be adequate and consistent coverage. Thus, this factor is rated "moderately effective." The 2009 Cod Conservation Harvesting Plan (CHP) clearly states that industry-funded observer coverage is required; it gives a target level of 5% of the fleet sector (DFO 2009b). Current levels of at-sea observer coverage for the principal groundfish fisheries such as cod, haddock, and pollock are generally too low and intermittent to have confidence in the data collected (Gavaris et al. 2010). In 2002, the level of observer coverage in the groundfish fixed-gear sector was 5% and for mobile gear it was 10%. In the Maritimes region, the observer coverage for the groundfish bottom trawl and longline fisheries was generally 10% or higher (Gavaris et al. 2010). There is no monitoring of the recreational cod fisheries.

Due to the cost of observer programs, deployment should be done strategically to attain the best value. This means assessing which fisheries have a higher potential of bycatch and directing a higher proportion of observer coverage to those fisheries. The groundfish bottom trawl, longline, and gillnet fisheries are some of the fisheries in which bycatch is common and observer coverage could and should be increased. Insufficient observer coverage in the groundfish fisheries is problematic because even though a general idea can be obtained from the observer database of the bycatch and discard rates, too many gaps exist, especially for species at risk (e.g., leatherback turtle, harbor porpoise, right whale) because of underreporting or misidentification.

Scientific Advice: Moderately effective
Same as for retained species. See “Scientific Advice” under Factor 3.1.

Enforcement: Highly effective
Same as for retained species. See “Enforcement” under Factor 3.1.

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 (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management 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 cannot be Critical for Criterion 4.

Criterion 4 Summary

Fishery	**Impact of gear on the** Rank (Score)	**Mitigation of gear impacts** Rank (Score)	**EBFM** Rank (Score)	**Criterion 4** Rank Score
Newfoundland Otter Trawl	Moderate Concern (2)	Minimal mitigation (0.25)	Moderate Concern (3)	Yellow 2.6
Newfoundland Atlantic	Low Concern (3)	Minimal mitigation (0.25)	Moderate Concern (3)	Yellow 3.12
Newfoundland Atlantic Gillnet	Low Concern (3)	Minimal mitigation (0.25)	Moderate Concern (3)	Yellow 3.12
Maritimes Otter Trawl	Moderate Concern (2)	Minimal mitigation (0.25)	Moderate Concern (3)	Yellow 2.6
Maritimes Longline	Low Concern (3)	Minimal mitigation (0.25)	Moderate Concern (3)	Yellow 3.12
Maritimes Gillnet	Low Concern (3)	Minimal mitigation (0.25)	Moderate Concern (3)	Yellow 3.12

Synthesis:

Cod and pollock are mainly fished with bottom trawls, gillnets, and longlines. Several recent studies have shown that, of all the fishing gears available, these three methods have moderate to high impact on benthic habitats. Bottom trawls, like many other trawling gears, can be particularly damaging to bottom habitats because they scrape and gouge the bottom. Gillnets and longlines, though not as damaging as bottom trawls, have some impact on the ocean floor—especially on structures such as corals, which may become snagged and broken in lines. The extent of the impacts of gillnets and longlines on benthic habitats is not as well known as for trawl gear, but it is likely that their impacts are significantly underestimated.

Justification

Factor 4.1 Impact of the fishing gear on the substrate:
Cod and pollock are part of the mixed groundfish fishery that mainly uses bottom trawls, bottom gillnets, and bottom longlines. These two demersal fish species prefer gravel, smooth rock, and sand substrates, although pollock has a semi-pelagic schooling behavior that keeps it off the bottom. Of 13 gears types reviewed in a recent study, bottom trawls, gillnets, and longlines were among the top gears to have moderate ecological impacts (Figure 13) (Fuller et al. 2008). Both species are caught in all three gear types, either as a result of a directed fishery or as bycatch.

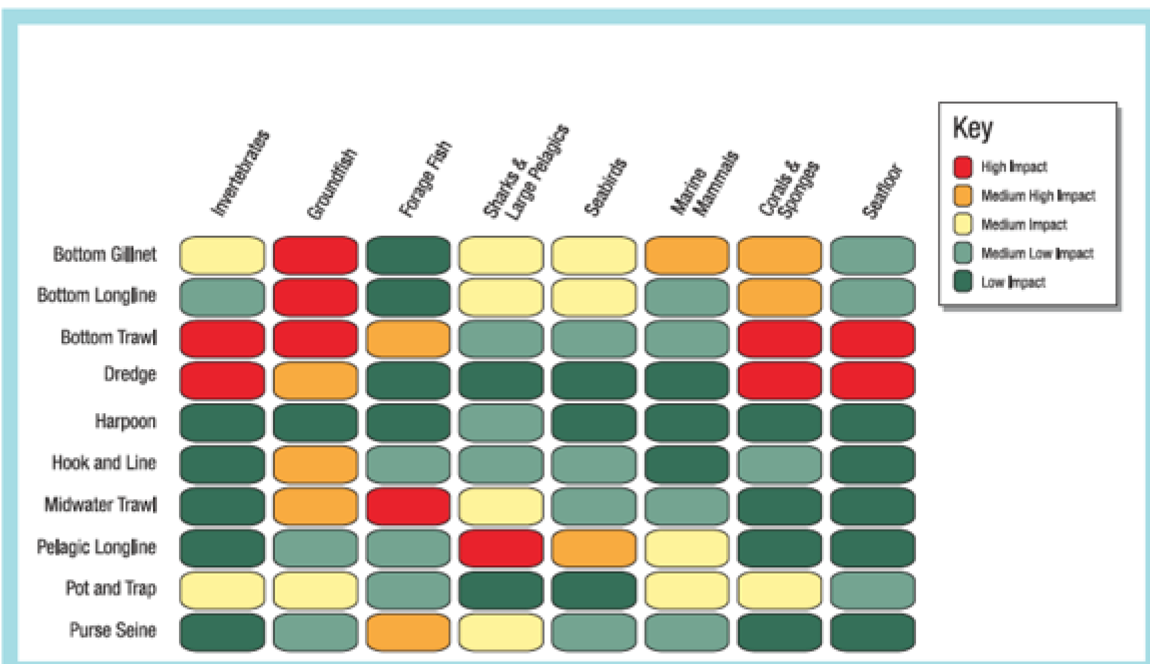


Figure 13: Rating of ecological impacts of fishing gears used on the west and east coasts of Canada. Ratings are based on expert consultations, available DFO data, and reviews of the scientific literature (Fuller 2008).

Bottom Trawls
Key relevant information: **Moderate Concern**
In the areas where Atlantic cod and pollock are normally fished, fishers can encounter a variety of habitats including pebble and gravel substrates as well as some sand, clay, and silt. Though bottom trawls are considered less damaging than other trawls and dredges, this gear still has significant physical and ecological impacts on the seafloor.

Detailed rationale:

DFO has conducted multiyear studies of the impacts of groundfish bottom trawling in the Atlantic (DFO 2006a) that demonstrate short-term disruption of benthic communities, including reduction of biodiversity and of biomass of benthic organisms (Fuller et al. 2008) (DFO 2006a). Schwinghamer et al. (1998) showed that bottom trawl marks on the seafloor were readily visible immediately after trawling and that those marks were still faintly visible a year later. Some previously fished seafloor habitats can demonstrate recovery within one to three years, but frequently trawled habitats remain in an altered state (Fuller 2008). Additionally, certain species are more vulnerable to serious injury or death by bottom trawl. Bottom trawling activities can crush and kill organisms, mix sediment, and increase the mortality of benthic bio-turbating organisms (Park et al. 2011). Consequently, this can disrupt biogeochemical storage and flux from sediment, having implications for nutrient regeneration both in the water column and on the benthos (Park et al. 2011). The degree of impact by bottom trawls is also determined by many factors, most notably the type and weight of gear used, the vulnerability of the benthos, and the frequency of the disturbance (Figure 14). Between 1998 and 2007, bottom trawls were the most commonly used gear type in the Gulf of St. Lawrence and Newfoundland & Labrador regions (Park et al. 2011).

The effects of trawling on various habitat types combined with the substantial amount of fishing effort along Canada's Atlantic continental shelf over the past 50 years indicate that trawling for groundfish has significantly altered or damaged a large portion of the seabed and the ecosystem. An estimate of groundfish trawl gear contact with the benthos on Georges Bank in 2001–2002 revealed that approximately 40% of the bottom was affected (MSC 2010). The effects of these fishing practices on habitats and ecosystems are considered a high conservation concern. The bottom gears used in the cod and pollock fisheries have significant effects on the seafloor, although otter bottom trawls are significantly more damaging than bottom longlines and gillnets, especially in low- and high-energy gravel habitats and hard clay outcroppings (NOAA 2002). Overall, it is likely that repetitive trawling causes substantial and adverse effects to seabed ecosystems along the east coast of Canada and the United States (Stevens 2004).

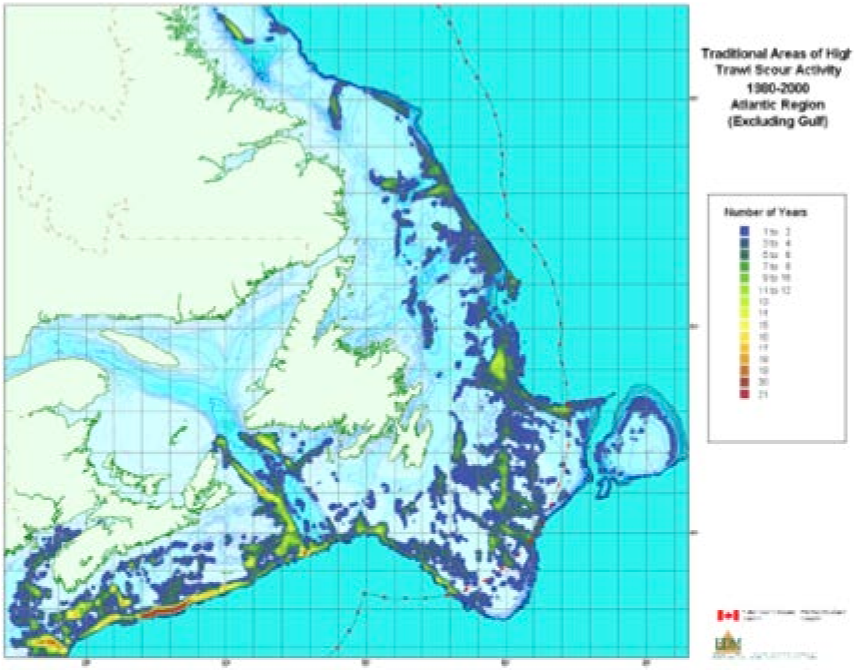


Figure 14: Persistent areas of high intensity trawling in the Atlantic between 1980–2000 (Kulka & Pitcher 2001).

Longline

Key Relevant Information: **Low Concern**

Longlines are used extensively in Newfoundland & Labrador (Park et al. 2011). This gear was responsible for 7% of landings by weight between 1998 and 2007 in this region (Park et al. 2011). Longlines are often deployed deeper than trawls (>500 m) to precisely target rough-bottom ("un-trawlable") areas (Park et al. 2011). The impacts on habitat from bottom longlines are a "low" concern and should require mitigation measures (Chuenpagdee et al. 2003).

Detailed rationale:

Longline capture methods cause far fewer impacts on benthic habitats than bottom trawling does; however, moderate damage can occur from the terminal anchors and by contacting the bottom when hauling in gear (Fuller et al. 2008). Habitat damage from bottom longlines depends on the gear configuration, including weights, number of hooks, type of line, as well as hauling speed and technique (Fuller et al. 2008). While the gear is both fishing and being hauled in, the lines can get entangled in structural components of the habitat. Though the impact of longline gear is less severe than that of bottom trawls, the full extent of the impact is not fully known (Rice 2006). While fishing gear moves over the seafloor, erect features get snagged, boulders are moved, and there is a reduction in the roughness of the seafloor. In evaluating the effects of fishing gear on benthic communities, Rice (2006) noted that habitats that are more complex and have a lower natural disturbance showed greater differences in benthic faunas between areas opened and closed to fishing.

Gillnets

Key Relevant Information: **Low Concern**

Gillnets are vertical walls of mesh, with the mesh openings sized such that target species in the desired size range are caught as they attempt to swim through the webbing, entangling their gills. Bottom gillnets are secured directly to the seafloor by weights and have a high incidence of bycatch (Park et al. 2011). Gillnets are often used in areas where trawls cannot be used. This gear type can affect groundfish biomass through direct removal of directed species as well as bycatch. Studies have shown that gillnets can alter the seafloor (High 1998) and can significantly affect deep-sea coral habitats (Hourigan et al. 2007).

<u>Detailed Rationale:</u>
Similar to longlines, gillnets were rated as having a "medium" impact on habitat (Chuenpagdee et al. 2003). Chuenpagdee et al. (2003) surveyed the opinions of fishers, managers, NGOs, and academics and rated habitat impacts of bottom gillnets as "medium" but recommended "stringent" management policies, including complete prohibitions in ecologically sensitive areas. On the other hand, Fuller et al. (2008) surveyed the opinions of Canadian stakeholders about habitat impacts of more intensive fishing, and ranked the impacts of bottom gillnets as high, behind bottom trawling and only just ahead of dredging. Gillnet capture methods cause far fewer impacts on benthic habitats in comparison to bottom trawling; however, moderate damage can occur from contact with the benthos (Fuller et al. 2008).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts:
<u>Key relevant information:</u> **Minimal Mitigation**
DFO employs a variety of tools to mitigate the impacts of fisheries on habitat. These tools include area closures, marine protected areas (MPAs), and gear restrictions and/or modifications. Besides area closures and some gear restrictions that aim to protect habitat, there are no other mandatory requirements or restrictions on bottom tending gears in Canada. Fisheries management currently does not apply a risk-averse strategy to avoiding ecosystem impacts of fishing. A few existing closures have been put in place and serve to protect two areas on the Scotian Shelf, to protect cold-water corals (Breeze and Fenton 2007 in Fuller et al. 2008) and a coral habitat on the southwest slope of the Grand Banks of Newfoundland & Labrador.

<u>Detailed rationale:</u>
In an effort to reduce the impacts of fishing gear on habitat, but more specifically on bycatch, DFO has implemented a variety of mitigation measures that address either habitat or bycatch or both. These efforts include gear modification, area closures, time closures, and marine protected areas (MPAs); however, few measures (except closures and MPAs) are required or mandatory. In 2005, DFO made steps toward mitigation of fishing gear impacts on marine habitats and conducted a study to assess the impacts of trawl gear on benthic habitats and communities (DFO 2006a). This resulted in the development of the "Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas." But implementation of this policy has been delayed by other priorities (pers. comm., S. Gavaris 24 July 2009 in MSC 2010).

Concern exists both in Canada and globally over abandoned gillnets and longlines. Abandoned gillnets and longlines continue to affect ecosystems and marine life. Reducing the loss and the discarding of gear through improved technology and regulations and through improved awareness of users appears to be the only effective mechanism so far for this problem (Baer et al. 2010). In Canada, the policy was to subsidize the loss of fishing gears; however, that has since been overturned because it fostered the loss of gear. Fishers must now justify and report the loss of gear that is individually tagged and they are responsible for replacing it (Baer et al. 2010). Increased awareness of the impacts of derelict gear and ghost fishing as well as improved GPS technology have led to reduced gear loss rates and higher recovery rates by the fishers (Baer et al. 2010). Regardless of this improvement, sonic tagging of gear is being recommended to further facilitate the recovery of lost gear (Baer et al. 2010).

Factor 4.3 Ecosystem and Food Web Considerations:

Key relevant information: **Moderate Concern**

One of the most productive marine ecosystems and fishing grounds in the world is found on the continental shelf of Atlantic Canada and New England. Food web structure analyses in this area demonstrate a richness in species diversity and abundance along with high complexity and connectivity (Brodziak and Link 2002 cited in Stevens 2004). Unfortunately, as a result of intense fishing pressure in the last 50 years, there has been a dramatic and marked shift in the community.

Detailed rationale:

Due to heavy fishing pressure over the last few centuries, this ecosystem has shifted remarkably from a marine community that was largely a benthic fish community to one that is now mainly a pelagic fish community (Fogarty and Murawski 1998) (Brodziak and Link 2002). This change is believed to be a direct result of the collapse of cod and other commercially exploited groundfish, and it is precisely because of this new ecosystem state that the cod and other groundfish recoveries are impaired (Frank et al. 2005). It is extremely difficult to quantify the effects of this shift, but certain outcomes have been postulated, such as changes in predator-prey interactions and species survival rates, decreases in overall productivity, and perturbation of food web dynamics (Brodziak and Link 2002). One example is the increased predation on groundfish larvae by small pelagic species such as mackerel and herring in Georges Bank, and another is a shift during the 1980s from cod as the dominant fish predator to spiny dogfish (Brodziak and Link 2002). In addition to fishing impacts, natural and anthropogenic environmental impacts (e.g., temperature shifts) may also be resulting in changes to the ecosystem. Separating the effects of fishing and the effects of environmental changes may be close to impossible.

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Appendix A: Main Species Considered in the Assessment

Summary of all the main species considered in the assessment.

*Acadian Redfish (*Sebastes fasciatus*)*

Factor 2.1 Inherent Vulnerability
Key relevant information: **Medium Vulnerability**
The FishBase vulnerability score for Acadian redfish is 44 (Froese and Pauly 2013). Redfish reaches a moderate age of 15 years and matures after 4–5 years. It is an internal live-bearer, which leads it to be more vulnerable to fishing than other species with similar characteristics.

Factor 2.2 Stock Status
Key relevant information:
Atlantic Population
Unit 1+2 (Newfoundland & Labrador) Very High Concern
Unit 3 (Maritimes) Very High Concern
In the last COSEWIC assessment, two designatable units (DU) for the Acadian redfish population were identified by COSEWIC (COSEWIC 2010c). These were the Bonne Bay and the Atlantic populations. This report considers only the Atlantic population, which includes Units 1+2 (Gulf of St. Lawrence and Laurentian Channel, NAFO divisions 4RST, parts of 4V and 3P) and Unit 3 (Scotian Shelf, NAFO divisions 4WX5Y).

In 2010, the Acadian redfish population in Atlantic Canada was determined by COSEWIC to be threatened (COSEWIC 2010). Default reference points based on the Precautionary Approach were used in the most recent recovery potential assessment of the Atlantic Canada Acadian redfish population (Units 1+2, 3). These reference points are an LRP (limit reference point) of 40% B_{MSY} and a URP (upper stock reference point) of 80% B_{MSY} (DFO 2011c). The abundance estimates for the Atlantic Canada population of *S. fasciatus* suggest that biomass has been either stable (Unit 1+2) or increasing (Unit 3) since 2000 (DFO 2011c). The current assessments from the Atlantic population suggest that the stock in Unit 3 is "healthy" while the Unit 1+2 stock is below the LRP but increasing (2012g). However, due to the continued designation as "threatened" by COSEWIC for the larger Atlantic population DU and the significant uncertainty generated from models, the stock status of Acadian redfish in both Unit 1+2 and Unit 3 is considered to be of "very high" concern.

Detailed Rationale:
The estimated biomass in 2010 for Unit 1+2 was 1,876,000 t, with 90% probability intervals ranging from 175,000 t to 8,778,000 t, which is 30%–225% of B_{MSY}. If the catch levels were 9,000 t (which is only slightly more than the 2010 catch), then the stock would have a 99% likelihood of being above 40% B_{MSY} by 2070 (DFO 2011c). In 2010, the estimated mature adult biomass was calculated at 1.88 million t with an 84% likelihood of being above 40% B_{MSY}

(McAllister and Duplisea 2011) and a 64% that the stock was above 80% B_{MSY} and in the healthy zone (McAllister and Duplisea 2011).

The estimated biomass for Unit 3 in 2010 was 2,254,000 t with 90% probability intervals ranging from 325,000 t to 8,642,000 t, which is 150%–230% of B_{MSY} (DFO 2011c). If catch levels were 6,000 t (slightly more than the 2010 catch), then this stock would have a 99% likelihood of being above 40% B_{MSY} by 2070 (DFO 2011c). In 2010, although the estimate of stock size in Unit 3 was imprecise, there was a 99% probability that the stock would be above 80% B_{MSY} and in the healthy zone (DFO 2011c) (McAllister and Duplisea 2011).

Factor 2.3 Fishing mortality

Key relevant information:

Atlantic Population

Unit 1+2 (Newfoundland & Labrador) Low Concern

Unit 3 (Maritimes) Low Concern

F_{MSY} for *S. fasciatus* in Unit 1+2 was 0.06 and it is based on the results of the production model used to determine reference points for the Atlantic Canada population (DFO 2012g). Abundance levels for *S. fasciatus* in Unit 1+2 are currently at very low levels and significantly lower than the 1960 biomass levels. But the population seems to be growing in recent years and it is dependent on a large recruitment event, without which reaching a healthy level will take a long time (DFO 2012g). Therefore, based on current fishing mortality and the recent growth of this population, fishing mortality is rated as "low" concern.

There are no fishing mortality estimates for *S. fasciatus* in Unit 3; however, the population in Unit 3 is increasing, while current fishing levels do not appear to threaten the health of the population and are sustainable (DFO 2011c). Management strategies such as minimum landing size, annual catch limits, and area closures have been set into place to regulate fishing on Acadian redfish (DFO 2000) (DFO 2010f). Fishing mortality in Unit 3 is rated as "low" concern.

*Atlantic Halibut (*Hippoglossus hippoglossus*)*

Factor 2.1 Inherent Vulnerability

Key relevant information: **High Concern**

The FishBase vulnerability score for Atlantic halibut is 88 (Froese and Pauly 2013). Halibut is a slow growing, late-maturing species that can reach over 90 years of age and a length of 470 cm, making it one of the largest bony fish in the world (Froese and Pauly 2013).

Factor 2.2 Stock Status

Atlantic Halibut-3NOPs4VWx5Zc

Key relevant information: **Very Low Concern**

Abundance of Atlantic halibut in 3NOPs4VWX5Zc (Scotian Shelf and Southern Grand Banks) in 2010 was estimated to be 11,000 t compared to B_{MSY} of 4,900 t (Trzincski et al. 2011) (DFO 2012c), and indices from industry surveys indicate a healthy abundance and biomass. Therefore this factor is rated as "very low" concern.

Detailed Rationale:

Based on model projections, 3NOPs4VWX5Zc (Scotian Shelf and Southern Grand Banks) Atlantic halibut is in a productive period due to high recruitment. The spawning stock biomass is expected to increase, and there is little risk in harming the productivity of the stock at harvest levels <4,000 t (DFO 2012c). Based on catch rate analyses and current projections (DFO 2012c), the Scotian Shelf and Southern Grand Banks population has seen steady increases since 2005 with only a slight decline in 2010 (DFO 2011f). The 2010 assessment adopted a new assessment framework using a length based, age-structure, catch-at-length model. This model was fitted to Scotia-Fundy Groundfish RV survey data from 1970–2009 and on the halibut survey data from 1998–2009. The model converts length to ages such that population dynamics become age-based and processes such as recruitment, maturity, fishing, and natural mortality occur at age (DFO 2011f). The results of the model showed that recruitment has been above average since 2002 and all of the age 1 recruits (280,000–480,000) have by now entered the fishery and are contributing to an elevated spawning stock biomass (DFO 2011f).

Atlantic Halibut-4RST

Key relevant information: **Low Concern**

Abundance of the Gulf of St. Lawrence Atlantic halibut stock (4RST) has not been calculated and there are no biological reference points for 4RST, although recent biomass and abundance indicators from various industry surveys indicate a healthy abundance and biomass (DFO 2013c). The latest stock assessment reports that these indicators have seen dramatic increases from 2000 to 2006 and they reached maximum historical values between 2007 and 2010 (DFO 2013c).

Detailed Rationale:

The Gulf of St. Lawrence Atlantic halibut stock (4RST) is also experiencing significant increases in biomass. In the latest assessment for 2009–2010, halibut catches in the Gulf of St. Lawrence have risen sharply during the 2000s and are currently at very high levels compared to levels in the early 1990s (DFO 2013c). Based on DFO survey data biomass and abundance, indices have quadrupled since 2000 and the highest observed values have been seen in the last 5 years (DFO 2013c) However, given that the majority of fish landed are immature, the restoration of the spawning stock remains a concern—especially since the minimum legal catch size and the modal size are far below the size at sexual maturity (L50 of 130 cm) determined for females from the Gulf Atlantic halibut stock (DFO 2011f). The latest assessment recommends continued caution when determining TAC (DFO 2013c).

Factor 2.3 Fishing mortality

Atlantic Halibut-3NOPs4VWx5Zc

Key relevant information: **Very Low Concern**

The F calculated for 3NOPs4VWX5Zc Atlantic Halibut is 0.2, which is below the F_{MSY} = 0.36 (DFO 2011f); therefore, fishing mortality is deemed “very low” concern.

Detailed Rationale:
Based on the most current projections derived from the new assessment framework, the Scotian Shelf and Southern Grand Banks Atlantic halibut population is not experiencing detrimental effects from a high fishing mortality rate. In fact, F = 0.2 and has been below F_{MSY} = 0.36 for the last several years (DFO 2012c). Projections that were made for the next 3 years (2012–2014) indicated that the population would remain in the healthy zone at any harvest level below 4,000 t and at current fishing mortality rates (DFO 2012c). Though there is no calculated F for the Gulf of St. Lawrence stock (4RST), the last assessment indicated that the fishery could support a 20% increase in the TAC over the next several years based on all other indicators (DFO 2011f).

Atlantic Halibut-4RST
Key relevant information: **Low Concern**
There is currently no calculated F for the 4RST population; however, based on the 2011 assessment (DFO 2011f), the majority of indicators are above or comparable to the series average considered, particularly with regard to catch rate (DFO 2011f). The most current stock assessment (DFO 2013c) does not address fishing mortality except to say that it is impossible to determine (DFO 2013c). But based on current scientific opinions, Seafood Watch considers fishing mortality to be "low" concern.

Detailed Rationale:
Though there is no calculated F for the Gulf of St. Lawrence stock (4RST), the last assessment indicated that the fishery could support a 20% increase in the TAC over the next several years based on all other indicators (DFO 2013c).

*Haddock (*Melanogrammus aeglefinus*)*

Factor 2.1 Inherent Vulnerability
Key relevant information: **Medium Vulnerability**
The FishBase vulnerability score is 47 (Froese and Pauly 2015), resulting in a score of "medium" vulnerability. Haddock can live up to 20 years but typically reaches about 10 years, and can reach maturity in 2–3 years (Froese and Pauly 2015).

Factor 2.2 Stock status
Haddock - 4X5Y
Key relevant information: **Low Concern**
The most recent assessment of 4X5Y Atlantic haddock was conducted in 2011 (DFO 2012d). The MSY for 2011 was estimated to be 14,000 t while the SSB_{MSY} was estimated at 52,000 t (DFO 2012d). The biological reference points of 20,800 t (40%) and 41,600 t (80%) of SSB_{MSY} were suggested as the LRP and upper stock reference (USR) for this stock (DFO 2012d) (Figure 11). Although the SSB_{2011} of 47,874 t (based on a survey index) is above the 80% reference point, there are uncertainties in the models used (DFO 2012d).

Detailed rationale:
The Sequential Population Analysis used to determine SSB has been shown to overestimate SSB values (DFO 2012d). Additionally, the model is a poor fit to survey indices (DFO 2012d) and thus could not be used to generate projections for the 2012 and 2013 fishing years (DFO 2012d). But when a retrospective correction of 0.17 (SSB in the past 3 years is reduced by 17% in an effort to account for the overestimates) was applied to the model, hypothetical projections for 2012, 2013, and 2014 were made. If catches were 5,500 t in 2012, 3,254 t in 2013, and 3,326 t in 2014 with an assumed fishing mortality rate of 0.25 for all 3 years, then the SSB was projected to be between the LRP and USR in 2012, 2013, and 2014 (DFO 2012d).

Figure 11: History of SSB for 4X5Y haddock with biological reference points. The upper line is 0.8 of SSB_{MSY} and the upper stock reference (USR). The lower line is 0.4 SSB_{MSY}, which is the limit reference point (LRP) (DFO 2012d).

Haddock - 5Zjm
Key relevant information: **Low Concern**
The latest stock assessment for this stock was conducted in 2011 (TRAC 2012). The adult biomass has seen some fluctuations in recent years. In 2005 it decreased from 81,600 mt to 62,200 mt but by 2009 had increased to 172,700 mt. But at the start of 2012, the adult biomass had decreased again to 70,700 mt (TRAC 2012). The 2010 year class was the largest cohort in the assessment time series, an estimated 589 million age 1 fish (TRAC 2012). The estimate for the 2011 year class was 105 million age 1 fish (TRAC 2012). The probability that the adult biomass will decline from 2013 to 2014 is 0% because of the entry of the outstanding 2010 year class into the age 3+ group (TRAC 2012). The projected adult biomass for 2014 is expected to be a record high 306,200 mt (TRAC 2012).

Factor 2.3 Fishing mortality

Key relevant information: **Moderate Concern**

Latest estimates of fishing mortality are F = 0.25 for 4X5Y (although this is under review) (DFO 2012d) and F = 0.14 for 5Zjm. Fishing mortality was below F_{REF} = 0.26 from 1995 to 2003 and above or near F_{REF} from 2004 to 2006, but has subsequently been below F_{REF} and was 0.14 in 2011 (TRAC 2012). The total allowable catch (TAC) for haddock in the southern Scotian Shelf/Bay of Fundy was 7,000 t from 2006 to 2009, and was lowered to 6,000 t for 2010 and 2011 and to 5,100 t in 2012 (DFO 2012d) (DFO 2014). Catches have been lower than the catch limit, averaging approximately 5,700 t since 2005. Therefore, fishing mortality is considered "unknown" and this factor is ranked "moderate" concern.

*Harbor Porpoise (*Phocoena phocoena*)*

Factor 2.1 Inherent Vulnerability

Key relevant information: **High Vulnerability**

Marine mammals are highly vulnerable to fishing activities (SFW Criteria document p. 9).

Factor 2.2 Stock Status

Key relevant information: **High Concern**

According to the latest COSEWIC assessment in 2006, there are no abundance estimates of harbor porpoises in eastern Canada or the Newfoundland-Labrador population (COSEWIC 2006). The most recent abundance estimate in the Bay of Fundy and the Gulf of Maine was 79,833 individuals (Waring et al. 2014). This species was considered a Special Concern by COSEWIC in 2003.

Detailed rationale:

The harbor porpoise in Atlantic Canada was considered Threatened by COSEWIC in 1991 but the status was downgraded in 2003 to Special Concern (COSEWIC 2006, 2003), and it is protected under the Fisheries Act of Canada. The harbor porpoise is also found in the Gulf of Maine in U.S. waters, and it is protected in the U.S. under the Marine Mammal Protection Act (MMPA) (COSEWIC 2006). Under the MMPA, the Potential Biological Removal (PBR) (the maximum number of porpoises that are allowed to be removed annually) in the Bay of Fundy and Gulf of Maine is 706 (Waring et al. 2014). The main threat to harbor porpoises in Canada and in the United States is incidental capture in fisheries, particularly in those using gillnets, such as the groundfish fishery.

In 1993, the U.S. government proposed listing the harbor porpoise population in the Bay of Fundy and Gulf of Maine as Threatened under the Endangered Species Act because of the lack of adequate regulatory measures in Canada and the United States. But in 1999, based on newly implemented regulations, such as acoustic pingers on groundfish gillnets, other structural modifications of gillnet gear, and time and area closures to gillnet fishing, the National Marine Fisheries Service (NMFS) determined that the new measures were sufficient to ensure the sustainability of the population (COSEWIC 2006).

The sustainability of the harbor porpoise populations in Canada is difficult to assess and there are no real abundance estimates that suggest otherwise. That COSEWIC still listed this species as Special Concern indicates that more data and information is necessary, especially given the dearth of information in the observer database. More information, such as unbiased estimates of abundance and bycatch as well as better understanding of the population structure, is needed particularly for the Gulf of St. Lawrence and Newfoundland & Labrador populations. The harbor porpoise populations in Canada in recent years have likely benefited from the reduced fishing effort in many of the groundfish fisheries, including the groundfish gillnet fishery, even though that aims to conserve and restore groundfish stocks rather than to protect the porpoises (COSEWIC 2006). Because the conservation effort is directed at restoring groundfish stocks, it is more than likely that bycatch rates will increase if and when the groundfish populations rebuild in eastern Canada (COSEWIC 2006). There are no provisions to address harbor porpoise bycatch under the Marine Mammal Regulations of the Fisheries Act of Canada. Nor is there any mechanism for developing scientific advice regarding the sustainability of bycatch levels. The present respite in bycatch mortality provides a unique opportunity to formulate and implement such a mechanism (COSEWIC 2006).

Factor 2.3 Fishing Mortality

Key relevant information: **High Concern**

There is no fishing mortality calculated for harbor porpoises in Canadian waters; however, the biggest source of porpoise mortality is incidental capture in fishing gear, primarily gillnets. In the Gulf of St. Lawrence and in Newfoundland & Labrador, annual mortality in several gillnet fisheries, including the groundfish fishery, is in the thousands (2,000–4,000) (COSEWIC 2006; 2003). But in recent years, due to the closure of several groundfish fisheries (such as cod) and the subsequent decrease in fishing effort, harbor porpoise bycatch mortality has decreased (COSEWIC 2006; 2003). Still, the lack of more recent abundance estimates, observer records, and analyses make it difficult to assess the magnitude of the impact of incidental bycatch on the population.

Detailed rationale:

Incidental capture in commercial fisheries, especially gillnet fisheries, is the most significant threat to harbor porpoises in eastern Canada (COSEWIC 2006; 2003). Most porpoise bycatch occurs in bottom-set gillnets used in the groundfish fishery targeting cod, haddock, and pollock, among others (COSEWIC 2006; 2003). Though this threat has existed since the introduction of the gillnet in 1880 (COSEWIC 2006; 2003), substantial bycatches of harbor porpoises have occurred in the past 20 years both in the United States and Canada. But since the decline of the Canadian groundfish stocks, the threat of bycatch of harbor porpoises has changed as a result of reduced fishing effort (COSEWIC 2006; 2003).

As a result of groundfish closures since 1992, patterns of groundfish gillnet fishing effort have changed significantly; however, the implications on the harbor porpoise populations are not known (COSEWIC 2006; 2003). The most recent stock assessment of harbor porpoises in the Bay of Fundy and the Gulf of Maine by NMFS in 2011 provides more bycatch data on the groundfish gillnet fishery by region (NMFS 2012). The average annual bycatch rate calculated for the Bay of Fundy and Gulf of Maine population between 1997–2001 was 43 animals, but this is inaccurate because there are no data from the DFO observer program since 2002. Between 1986 and 2001, observer coverage on groundfish gillnet boats ranged from 11.3% to 89% and mainly in one region in the Bay of Fundy. However, since no other data were available, the estimate of 43 has been used since 2002 (NMFS 2010, 2012). This assessment did note that the implementation of fishery closures at certain times and in certain areas, the closure of the groundfish fishery due to exceeding catch quotas, and the requirement of acoustic pingers on gillnets did have significant effects on reduction of porpoise bycatch (NMFS 2010, 2012). For example, in 1996, there was a 68% reduction of porpoise bycatch on vessels using gillnets with pingers compared to those that did not, and in 1997, an 85% reduction in porpoise bycatch with gillnets that had pingers (NMFS 2010, 2012).

In the Gulf of St. Lawrence, the porpoise bycatch most often occurred in gillnets targeting cod, herring, and mackerel. Bycatch estimates of 2,215 and 2,394 harbor porpoises were calculated for 2000 and 2001, respectively, although there is uncertainty surrounding these numbers because there was little to no observer coverage representative of the fishing effort (Lesage 2004). In Newfoundland & Labrador, the bycatch estimates in the early 2000s were similar to what was observed in the Gulf of St. Lawrence. Taken together, these estimates were extrapolated for all fisheries and a rough estimate of several thousand porpoises taken annually was calculated (COSEWIC 2006).

In Newfoundland & Labrador and the Gulf of St. Lawrence, due to the decline of the groundfish stocks and the subsequent drastic measures taken to conserve and rebuild the stocks, there have been significant changes in fishing effort in the groundfish gillnet fishery. Similarly, in the Bay of Fundy, several measures have been taken to reduce fishing mortality on several groundfish (e.g., cod), including temporal fish closures (COSEWIC 2006). In 1995, DFO implemented a Harbor Porpoise Conservation Strategy for the Bay of Fundy, in which a cap of 110 harbor porpoises could be incidentally captured, after which the fishery would be closed (COSEWIC 2006). Along with time-area fishery closures for groundfish conservation and pinger-equipped gillnets, fishing effort in these regions has been significantly reduced in both Canada and the United States. In addition, harbor porpoise bycatch is now regulated by two Take Reduction plans. These measures combined appear to have significantly reduced harbor porpoise bycatch, at least in the Bay of Fundy (COSEWIC 2006).

Though technically not discards, incidental catch in fishing gear, especially gillnets, is a major source of mortality for harbor porpoises in the Northwest Atlantic. But it has been mentioned in previous sections that bycatch has likely declined as a consequence of groundfish stock declines. Management measures in the Bay of Fundy have been shown to reduce porpoise bycatch rates in gillnets. However, these measures have not been implemented in much of the species' range, including the Gulf of St. Lawrence and Newfoundland & Labrador, where annual mortality in several gillnet fisheries is still estimated to be in the thousands. There is also some concern that porpoises in the Bay of Fundy and possibly other areas may be excluded from portions of their habitat by acoustic harassment devices associated with aquaculture. Although the population remains abundant, the particular susceptibility of harbor porpoises to bycatch in fishing gear represents an incipient threat. Consequently, the lack of good abundance information in some parts of the range and the lack of porpoise bycatch monitoring and mitigation in many of the relevant fisheries are reasons for concern (COSEWIC 2006).

Skates
*Barndoor Skate (*Dipturus laevis*)*
*Thorny Skate (*Amblyraja radiata*)*
*Winter Skate (*Leucoraja ocellata*)*

Factor 2.1 Inherent Vulnerability
Key relevant information: **High Vulnerability**
The FishBase vulnerability score is 69 for barndoor skate, 59 for thorny skate, and 56 for winter skate (Froese and Pauly 2015). One characteristic common to skates and other elasmobranchs that makes them vulnerable to fishing is a low fecundity. They can also grow to a relatively large size before maturing, increasing the risk that they are caught before spawning.

Factor 2.2 Stock Status
Barndoor Skate
Key relevant information: **Moderate Concern**
There are no biological reference points for this species, although there are estimates of total abundance based on a series of different surveys in different regions. There is evidence indicating that abundance is nearing historical levels in some parts of the range (Cavanaugh and Damon-Randall 2009), which suggests that a low concern score may be appropriate. However, because of the uncertainty across the whole range of the stock, Seafood Watch has given a precautionary score of “moderate” concern for this sub-factor. More data is required across the entire stock to improve the score to low concern.

Detailed Rationale:
The abundance of barndoor skate declined in the mid-1960s to early 1970s; this was likely a result of high fishing effort and bycatch in other fisheries (Cavanaugh and Damon-Randall 2009) (Simon et al. 2002). This was followed by a period of low to zero catches (Simon et al. 2002) (Dulvy 2003). In the southern Scotian Shelf, catch rates of barndoor skates declined 96%–99% between the 1960s and early 1990s (Dulvy 2003). Barndoor skate populations dropped to record lows in the 1980s but the stocks began to rebound in the mid-1990s. Since then, there is evidence of a notable and sustained increase of barndoor skates in commercial and research survey data (Cavanaugh and Damon-Randall 2009), which indicates that abundance is close to historical levels at the center of their distribution and increasing in the east (Cavanaugh and Damon-Randall 2009). It is unknown whether this pattern will ultimately lead to a healthy repopulation of barndoor skate on the eastern Scotian Shelf and the Grand Banks, but barndoor skate is presently not considered at risk (Simon et al. 2009). But given the severe declines of barndoor skate populations in the past, DFO and COSEWIC have suggested that the abundance of barndoor skate should be monitored and should be managed with caution (Simon et al. 2009).

Thorny Skate

Key relevant information: **High Concern**

There are no biological reference points for this species, although there are estimates of total abundance based on a series of different surveys in different regions. However, in November 2012, COSEWIC considered thorny skate to be a species of Special Concern (COSEWIC 2012a).

Detailed Rationale:

The main populations of thorny skate in the Northwest Atlantic are found in the Maritimes and in the Newfoundland & Labrador regions, and the status of the stocks is somewhat different by region, which adds a level of uncertainty to the overall status of thorny skate. The stock in the Maritimes is continuing to decline despite dramatic reductions in fishing effort and evidence of steady recruitment (Simon et al. 2012). In the Newfoundland & Labrador region, the available data to accurately assess abundance contain uncertainty because of many factors, including gaps in life-history knowledge, inaccuracies in landing and observer data, the catchability of the skates in different gear types, and the unusually large inter-annual variability in survey abundance indices; these have led to an underestimation of actual abundance during a period of stock decline (Simon et al. 2012) (Simpson et al. 2011). Despite some evidence suggesting increases in abundance in this region, there is too much uncertainty to make a comprehensive and accurate assessment of the stock.

Winter Skate

Key relevant information: **Very High Concern**

There are no biological reference points for this species although all four populations in Northwest Atlantic Canada are considered either Endangered (Southern Gulf of St. Lawrence), Threatened (Eastern Scotian Shelf), of Special Concern (Georges Bank-Bay of Fundy), or Data Deficient (Newfoundland & Labrador) by COSEWIC (COSEWIC 2005). The Southern Gulf of St. Lawrence and the Eastern Scotian Shelf are the two populations of particular concern and where the numbers of mature winter skate have declined 98% and 90%, respectively, since the early 1970s (COSEWIC 2005). Despite these large abundance declines, the Government of Canada chose not to list this species under the federal Species at Risk Act, primarily due to socioeconomic concerns (Government of Canada 2010). There is no updated information on winter skate abundance. Since the latest scientific information suggests that the Eastern Scotian Shelf population is threatened, this factor is deemed “very high” concern.

Detailed Rationale:

In both the Southern Gulf of St. Lawrence and the Eastern Scotian Shelf, winter skate abundance has been steadily declining since the early 1980s, and the decline continues despite sharp decreases in removals (e.g., discarded bycatch) and drastic reductions in the groundfish fisheries (DFO 2006e). The continued decline may be attributable to an increase in the natural mortality of mature adults (DFO 2006e). But in contrast to the mature population, the decline of the juvenile population since the 1980s appears to be related more to declining spawning stock abundance (DFO 2006e). As of 2006, no recovery was expected for winter skate in the Southern Gulf of St. Lawrence, even in the absence of bycatch in fisheries (DFO 2006d). A stagestructured population model to project population abundance in 10 years was used, and variants of the model considered projections with and without bycatch in the groundfish and shrimp fisheries. All model projections indicated that the population would continue to experience declines regardless of the presence or absence of bycatch (DFO 2006c). Nor is a recovery expected without a significant decrease in the natural mortality of adults (DFO 2006c).

Factor 2.3 Fishing mortality

Barndoor Skate

Key relevant information: **Moderate Concern**

Relative F = 0.2–0.4, but these are calculated only for Divisions 5Zc and 4X because fishing mortality for other divisions is too uncertain due to landing reporting variability (Simon et al. 2009).

Detailed rationale:

There is no directed fishery for barndoor skates in Canada, so the major contribution of human-induced fishing mortality for this species is bycatch (Simon et al. 2009) (Casey and Myers 1998). But information on this is also uncertain due to low observer coverage and the unknown reliability of the observer records. Additionally, there is no requirement to report skate landings by species, so there is uncertainty in the observer reports. Because of the decline in commercial fishing effort for groundfish due to moratoria (e.g., cod), other fishery closures (e.g., grenadier), and reduction in quotas (redfish) (Dulvy 2002), bycatch rates of barndoor skates have been reduced and/or stabilized.

Thorny Skate

Key relevant information: **Moderate Concern**

Relative F = 0.1–1.7 (in 4X and 4VsW) (Simpson et al. 2011) and <5% in 3Ps since 1985 (NAFO 2012). The 2012 TAC of 9,550 t for skates in Div. 3LNOPs (8,500 t in Div. 3LNO; 1,050 t in Subdiv. 3Ps) continues to exceed the average commercial catch during a period when minimal or no rebuilding of this stock has occurred (NAFO 2012). There are no estimates of fishing mortality in the Maritimes region (4VWX5); however, since 2013 all thorny skate must be released (MSC 2013). Due to the uncertainty surrounding abundance as well as unknown fishing mortality estimates, fishing mortality for this species is rated “moderate” concern.

Detailed Rationale:

Because of inadequate reporting of commercial skate landings, such as catch of unspeciated removals by weight, unreported bycatch in groundfish fisheries, unreported discards at sea, and misreporting or misidentification of catch species, it is difficult to assess fishing mortality of thorny skate (Simpson et al. 2011) (Kulka et al. 2006). These missing data are critical to performing a comprehensive assessment of stock status.

Winter Skate

Key relevant information: **Moderate Concern**

There is no fishing mortality calculated for winter skate; however, especially in the southern Gulf of St. Lawrence, the population is in danger of becoming extirpated because of continued bycatch and heavy gray seal predation (Benoît et al. 2011).

Detailed Rationale:
Although bycatch in groundfish, scallop, and shrimp fisheries contributed to the decline of the winter skate populations, especially in the 1970s and 1980s, in the last 20 years bycatch of winter skate in the groundfish fisheries has been relatively low due to moratoria or reduced effort of most groundfish fisheries. (In the Eastern Scotian Shelf, bycatch since 2000 has averaged 74 t annually, and in the Southern Gulf of St. Lawrence 6.5–64.5 t annually (DFO 2006c).) Despite the reduced bycatch, natural mortality rates of winter skate in these regions are high, and even if bycatch were kept to zero, it is likely that no recovery would occur.

*Spiny Dogfish (*Squalus acanthias*)*

Factor 2.1 Inherent Vulnerability
Key relevant information: **High Vulnerability**
The FishBase vulnerability score for spiny dogfish is 69 (Froese and Pauly 2013). Spiny dogfish has an internal fertilization and a gestation period of 18–24 months. It gives birth to an average of 6 pups. In the Atlantic, 50% of females mature at age 16 and a length of 82 cm; males mature at 10 years of age and 63.6 cm (COSEWIC 2010d). The lifespan of a spiny dogfish is 31 years (DFO 2007c). It is a high-level predator species within the food chain.

Factor 2.2 Stock Status
Key relevant information: **Low Concern**
COSEWIC considers spiny dogfish to be a Special Concern (COSEWIC 2010d). A more recent assessment of the Atlantic stock of spiny dogfish (which inhabits waters off Canada and the United States) proposed upper and limit reference points based on the abundance of adult females (SSN) at maximum sustainable yield (MSY) (DFO 2014d). The upper reference (SSN_{MSY}) has been set at 32.8 million individuals, and the limit reference point has been set at 21.3 million individuals. Current abundance is above SSN_{MSY} and is considered by management to be in the "healthy" zone (DFO 2014d). This is aligned with stock assessments of spiny dogfish in the U.S. Atlantic, where biomass is considered to be above biomass at MSY (B/B_{MSY} = 1.35) (NMFS 2015). There is some uncertainty in the Canadian assessment, so Seafood Watch considers abundance to be a "low" conservation concern rather than awarding the highest possible score.

Factor 2.3 Fishing mortality
Key relevant information: **Moderate Concern**
There is no fishing mortality calculated for this species, although a reference point has been developed where $Fssn_{MSY}$ = 0.072 (DFO 2014d). Because fishing mortality relative to a sustainable level is unknown, Seafood Watch considers this factor a "moderate" concern.

Detailed Rationale:
Spiny dogfish are caught in target fisheries and as bycatch in fisheries for groundfish species.

Total allowable catches have been established for spiny dogfish in Canadian waters. On the Atlantic coast, the current total allowable catch is 2,500 t for fixed-gear vessels (e.g., using longlines, gillnets) <45 ft in length, and there are bycatch caps of 5 t for fixed-gear vessels of 45–65 ft and 25 t for mobile-gear vessels <65 ft (MSC 2013). There are no restrictions on discarding spiny dogfish at sea. It has been estimated that discards contribute around 24% of the overall fishing mortality for this species. Fishing in Canadian waters does not appear to be having a detectable impact on the spiny dogfish population (COSEWIC 2010d). But without a formal population assessment, it is hard to determine whether fishing levels are sustainable. For this reason, the fishing mortality factor is ranked "moderate" concern.

*White Hake (*Urophysis tenuis*)*

Factor 2.1 Inherent Vulnerability

Key relevant information: **High Vulnerability**

The FishBase vulnerability score for white hake is 72 (Froese and Pauly 2013), which suggests a high vulnerability to fishing activities. But considering the life-history characteristics, it would appear that white hake is moderately vulnerable to fishing activities. White hake can reach ages of around 20 years at lengths of approximately 135 cm, and it is known to mature at around 42–45 cm at age 4 (DFO 2005b). White hake is a broadcast spawner and can produce several million eggs per spawning. Within the food chain, white hake is a high-level predator, represented by a trophic level of 4.2 (FishBase 2013). Based on the life-history characteristics, Seafood Watch considers white hake to be "highly" vulnerable to fishing activity.

Factor 2.2 Stock Status

Key relevant information: **Very High Concern**

There are no precautionary reference points for white hake. The stocks in Newfoundland & Labrador, Grand Banks, and the Gulf of St. Lawrence have gone through pre-COSEWIC assessments because of concerns that these populations are close to extirpation in these regions; and in November 2013, the Atlantic and Northern Gulf of St. Lawrence population was determined to be Threatened by COSEWIC (COSEWIC 2013). Biomass and abundance indices have been calculated for these regions, but all show significant declines (NAFO 2011). Therefore this factor is rated "very high" concern.

Detailed Rationale:

In the Southern Gulf of St. Lawrence, the last assessment indicated that the abundance of mature adults declined by 90% since 1983 and that since 1995 very little has changed (Swain et al. 2012). Similarly, juvenile abundance declined by 79% between 1983–1995 with little evidence of recovery (Swain et al. 2012). In the Newfoundland & Labrador regions, 1999–2000 saw a large recruitment event, which resulted in significant increases of adults in 2002 and 2004 but did not result in a concurrent increase in juvenile abundance (Simpson et al. 2012). In 2011, there was a small increase in juveniles during the spring survey but the adult abundance saw no change (Simpson et al. 2012). Overall, between 1996 and 2011 the rate of decline in white hake adult abundance in this region was 26% (Simpson et al. 2012). Similarly in the

4VWX/5Y area, white hake abundance has seen a general decline since the early 1990s (MSC 2010).

Factor 2.3 Fishing mortality

Key relevant information: **Moderate Concern**

Fishing mortality is very low (close to zero) for all regions (Swain et al. 2012) (NAFO 2011) (MSC 2010). Although fishing mortality is likely not a predominant contributing factor to the detriment of the population, stock abundance is so low that SFW deems this a “moderate” concern.

Detailed Rationale:

Fishing mortality has been relatively low in all areas since the introduction of catch limits in 1996. Total mortality on the Scotian Shelf is high and its causes are unknown. Total mortality of white hake in the Bay of Fundy is variable without trend (MSC 2010). In the Gulf of St. Lawrence, fishing mortality is now negligible and high natural mortality is the main threat to population persistence. The high natural mortality is hypothesized to result from predation by grey seals (Swain et al. 2012). Swain et al. (2012) report that in this region, estimated total mortality (Z) increased to levels near 2 while F declined to levels near 0, indicating exceedingly high mortality (M) for hake ages 5–7. This very high M has resulted in the near disappearance in the 2000s of hake older than 5 (Swain et al. 2012).

Witch Flounder (Glyptocephalus cynoglossus)

Factor 2.1 Inherent Vulnerability

Key relevant information: **High Vulnerability**

The FishBase vulnerability score for witch flounder is 68 (Froese and Pauly 2013).

Factor 2.2 Stock Status

Key relevant information: **Moderate Concern**

The last population assessment for witch flounder in the 3Ps region by the Department of Fisheries and Oceans Canada (DFO) was completed in 2013 (DFO 2013f). There are no abundance reference points for this population; however, mean abundance during 2008–2013 was estimated at 85% of abundance during the 1983–2013 period. Abundance appears to have remained relatively stable from 1995 onward (DFO 2013f). Therefore, stock status for 3Ps witch flounder is considered “moderate” concern.

Factor 2.3 Fishing mortality

Key relevant information: **Moderate Concern**

Since the early 1970s, annual landings of witch flounder in Subdivision 3Ps generally fluctuated between 300 t and 1,000 t. From 1986–1993, landings were relatively stable, averaging 1,000 t annually. Over the past decade, landings have averaged 375 mt, well below the 1983–1990 average of 1,100 mt and the TAC of 650 mt (DFO 2013f). No fishing mortality reference points/targets have been established for this population. However, it is likely that current fishing levels of witch flounder are not harmful to this population, considering the apparent stability in distribution, survey abundance, and recruitment (DFO 2013f). Since the fishing mortality for witch flounder is unknown, this factor is deemed “moderate” concern.