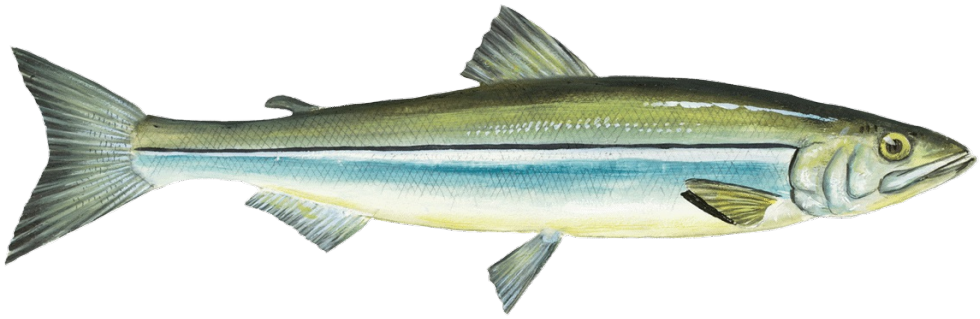
The Safina Center
at Stony Brook University

AND

Monterey Bay Aquarium
Seafood Watch®

# Rainbow smelt

*Osmerus mordax*





## Canada - Gulf of St. Lawrence

## Stationary uncovered pound nets

*June 6, 2019*

*Safina Center Consulting Researcher*

## Disclaimer

Seafood Watch and The Safina Center strive to ensure that all our Seafood Reports and recommendations contained therein are accurate and reflect the most up-to-date evidence available at the time of publication. All our reports are peer-reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science or aquaculture.Scientific review, however, does not constitute an endorsement of the Seafood Watch program or of The Safina Center or their recommendations on the part of the reviewing scientists.Seafood Watch and The Safina Center are solely responsible for the conclusions reached in this report. We always welcome additional or updated data that can be used for the next revision. Seafood Watch and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation and other funders.

Seafood Watch Standard used in this assessment: Standard for Fisheries vF3

# Table of Contents

# About The Safina Center

The Safina Center (formerly Blue Ocean Institute) translates scientific information into language people can understand and serves as a unique voice of hope, guidance, and encouragement. The Safina Center (TSC) works through science, art, and literature to inspire solutions and a deeper connection with nature, especially the sea. Our mission is to inspire more people to actively engage as well-informed and highly motivated constituents for conservation.

Led by conservation pioneer and MacArthur fellow, Dr. Carl Safina, we show how nature, community, the economy and prospects for peace are all intertwined. Through Safina's books, essays, public speaking, PBS television series, our Fellows program and Sustainable Seafood program, we seek to inspire people to make better choices.

The Safina Center was founded in 2003 by Dr. Carl Safina and was built on three decades of research, writing and policy work by Dr. Safina.

**The Safina Center's Sustainable Seafood Program**
The Center's founders created the first seafood guide in 1998. Our online seafood guide now encompasses over 160-wild-caught species. All peer-reviewed seafood reports are transparent, authoritative, easy to understand and use. Seafood ratings and full reports are available on our website under Seafood choices. tsc's sustainable seafood program helps consumers, retailers, chefs and health professionals discover the connection between human health, a healthy ocean, fishing and sustainable seafood.

- Our online guide to sustainable seafood is based on scientific ratings for more than 160 wild-caught seafood species and provides simple guidelines. Through our expanded partnership with the Monterey Bay Aquarium, our guide now includes seafood ratings from both The Safina Center and the Seafood Watch® program.
- We partner with Whole Foods Market (WFM) to help educate their seafood suppliers and staff, and provide our scientific seafood ratings for WFM stores in the US and UK.
- Through our partnership with Chefs Collaborative, we created Green Chefs/Blue Ocean, a free, interactive, online sustainable seafood course for chefs and culinary professionals.
- Our website features tutorials, videos, blogs, links and discussions of the key issues such as mercury in seafood, bycatch, overfishing, etc.

Check out our Fellows Program, learn more about our Sustainable Seafood Program and Carl Safina's current work at www.safinacenter.org .

The Safina Center is a 501 (c) (3) nonprofit organization based in the School of Marine & Atmospheric Sciences at Stony Brook University, Long Island, NY. www.safinacenter.org admin@safinacenter.org | 631.632.3763

# 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 Watch Assessment. Each assessment 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." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, 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 assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

# Guiding Principles

The Safina Center and Seafood Watch define 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 and the Safina Center have 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

# Summary

This report is for rainbow smelt caught with stationary uncovered pound nets (bag nets and box nets) in the Gulf of St. Lawrence in New Brunswick, Canada. Recommendations are separated by season because incidentally encountered species varies between the winter and autumn fisheries.

There have been no recent stock assessments for rainbow smelt in Canadian waters and accurate fishing mortality estimates are not available. Historically, the species was found as far south as the Chesapeake Bay, but its range has truncated over the last century. Rainbow smelt occur naturally in freshwater lakes in parts of Canada and the Northeastern U.S., but have been introduced further inland. Landings from marine/estuarine waters in New Brunswick have declined over the last two decades. Rainbow smelt is an important forage species, local depletion is possible, and management of fishing mortality is not considered precautionary enough.

Historically, the pound net fishery had high bycatch levels of striped bass, winter flounder, white hake, and Atlantic tomcod. Atlantic salmon may also be incidentally caught in this fishery, but bycatch of salmon has not been quantified. There have been no updates to the amount of bycatch since bycatch mitigation measures (seasonal restrictions) were implemented; therefore, bycatch is assessed according to historical research. The autumn smelt fishery catches white hake, which is considered a "Endangered" species in the southern Gulf of St. Lawrence. White hake is not encountered in the winter (ice) fishery. Impacts to non-target species in the autumn fishery are of "high" concern, while impacts in the winter fishery are of "moderate" concern.

There is no current management plan in place for rainbow smelt, though one is in preparation. There are some management measures that may reduce bycatch. However, little data is collected to monitor the health of rainbow smelt stocks, landing data is considered unreliable, and the fisheries score ineffective for research and monitoring.

Trap nets and box nets have minimal contact with bottom habitats, so ecosystem impacts from fishing gear is not of concern. However, as an important forage species, rainbow smelt require precautionary policies that account for the needs of predators. Some ecosystem-based management is in place, but stronger measures are needed.

The autumn and winter rainbow smelt fisheries in New Brunswick is rated "red" or "avoid."

# Final Seafood Recommendations

| SPECIES/FISHERY | CRITERION 1: IMPACTS ON THE SPECIES | CRITERION 2: IMPACTS ON OTHER SPECIES | CRITERION 3: MANAGEMENT EFFECTIVENESS | CRITERION 4: HABITAT AND ECOSYSTEM | OVERALL RECOMMENDATION |
|---|---|---|---|---|---|
| Rainbow smelt Canada Gulf of St. Lawrence, Stationary uncovered pound nets | Red (1.526) | Red (0.750) | Red (2.000) | Yellow (3.000) | **Avoid (1.618)** |
| Rainbow smelt Canada Gulf of St. Lawrence, Stationary uncovered pound nets, Winter fishery | Red (1.526) | Yellow (2.236) | Red (2.000) | Yellow (3.000) | **Avoid (2.127)** |

### 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 either Criterion 1 or Criterion 3 (or both) is Green, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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

# Introduction

## Scope of the analysis and ensuing recommendation

This report covers the rainbow smelt (*Osmerus mordax*) fishery in New Brunswick, Canada. Although Prince Edward Island and Nova Scotia have recorded landings of this species in the past, the vast majority of landings come from New Brunswick (DFO 2018b). Most of the commercial effort is concentrated in the southern Gulf of St. Lawrence, where fishers employ bag nets and trap nets to target rainbow smelt (DFO 2007). Fishers target smelt in an open water fishery and in a winter ice fishery, with more landings occurring in the winter fishery (DFO 2007). Because bycatch composition differs by season, we have split this report into two recommendations: the autumn smelt fishery and the winter smelt fishery.

The rainbow smelt fishery provides supplementary income to fishers, is dependent on market demands, and there are limited resources to perform research on the fishery. The species is of low priority for research because it's no longer considered a major fishery by DFO (D. Fillion, personal communication 2018). The smelt fishery also incidentally catches striped bass, Atlantic tomcod, white hake, and winter flounder (Bradford et al. 1997), though some mitigation measures have been implemented (DFO 2007). Multiple smelt stocks are likely within the Gulf of St. Lawrence (DFO 2007). Fishers in the Maine and New Brunswick target different stocks, and only smelt in New Brunswick is assessed in this report.

## Species Overview

Rainbow smelt is primarily an inshore anadromous fish found along the coasts of eastern North America from eastern Labrador, Canada south to Buzzards Bay, Massachusetts. Historically, the species was found as far south as the Chesapeake Bay, but its range has truncated over the last century (Enterline et al. 2012) (Figure 1). Possible explanations of the range truncation include climate change (Limburg and Waldman 2009), obstructed spawning access via dams or culverts (Hall et al. 2012), and pollution (Chase 2006). Rainbow smelt also inhabit coastal waters in Alaska, British Columbia, and Northwest Territories (NatureServe 2013). These smelt occur naturally in freshwater lakes in parts of Canada and the Northeast US, but were introduced further inland (Enterline et al. 2012). Since smelt spawn in their natal streams, there is likely little exchange between different watercourses, which has been confirmed in tagging studies in Canada (Coulson et al. 2006) (DFO 2007). In Maine, rainbow smelt are not likely part of a coast-wide stock, but rather consist of distinct stocks for some rivers (Kovach et al. 2013). Studies in other parts of the smelt range suggest that some smelt may stray among spawning sites (Murawski et al. 1980) (Marcotte and Tremblay 1948). Understanding stock structure is critical to calculating population estimates and understanding fishing mortality; some researchers suggest managing smelt stocks at the bay-level. (Kovach et al. 2013).

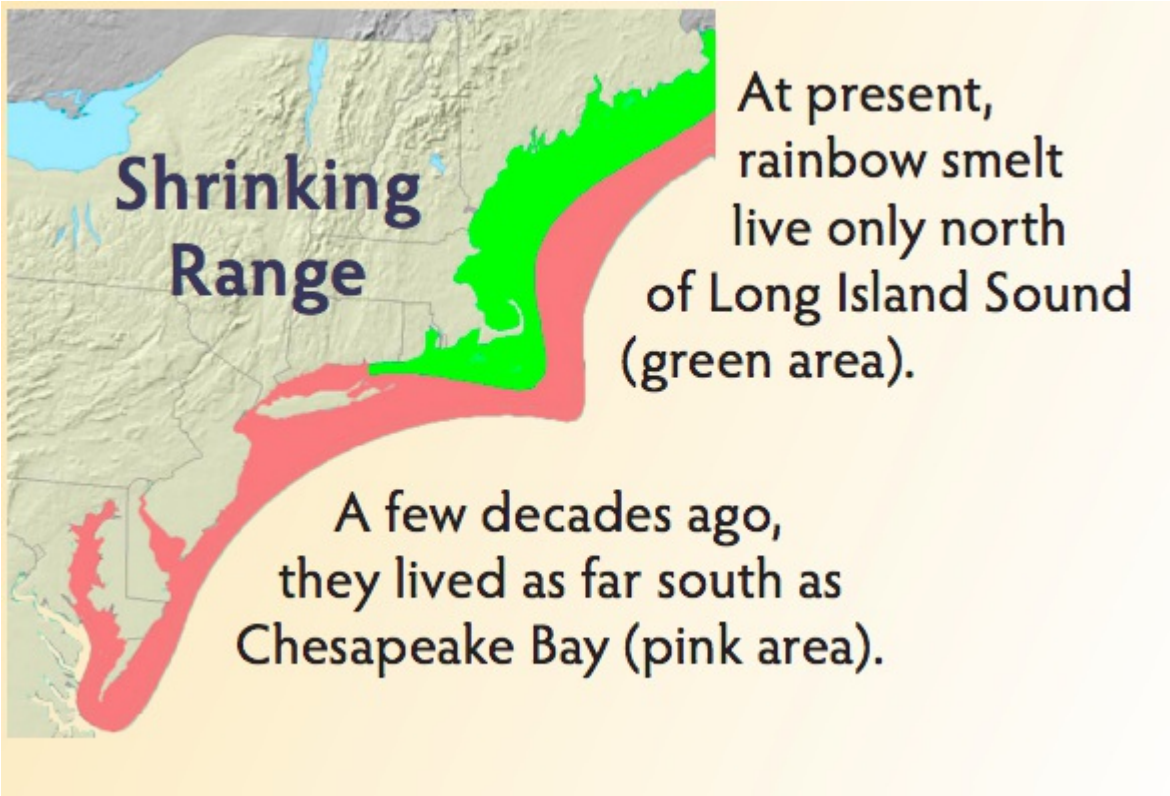


Figure 1 Current (green) and historic (pink) range of rainbow smelt along the eastern seaboard of the U.S.. Figure from Maine DMR.

The maximum size of rainbow smelt is 27 cm and fish rarely exceed five years of age (Enterline et al. 2012). This species is fully mature by age two, but age one individuals are present in spawning aggregations in the US (Enterline et al. 2012). Females can produce up to 33,000 eggs at age two and fecundity increases with age (Clayton 1976). Mature smelt gather in harbors and brackish waters each autumn to overwinter, and then spawn in freshwater in early spring. Though general habitat use in marine waters is unknown, surveys have encountered rainbow smelt as far as 60 km offshore at depths of 77 m (Enterline et al. 2012).

Commercial and recreational fishing for rainbow smelt have long been important to the region. Landings in Maine alone exceeded one million pounds in the 1880s, and recreational ice fishing remains an important part of Maine culture today (Enterline et al. 2012). Commercial landings are only a fraction of historical accounts, with fishers in Maine now targeting rainbow smelt in tidal rivers with dip nets, gill nets, and bag nets. The Maine fishery is not included in this report because of declining populations and confidential data (because too few fishers participate in the commercial fishery).

The Department of Fisheries and Oceans Canada (DFO) manages the rainbow smelt fishery, the previous management plan expired in 2011, and DFO and is currently updating the Integrated Smelt Fishery Management Plan (D. Fillion, personal communication 2018). Primary commercial gears are gill nets, bag nets, and trap nets (DFO 2007), though only the latter two are scored in this report. Landings have been declining in coastal New Brunswick over the last two decades, and landings in Nova Scotia and Prince Edward Island have declined to negligible levels (DFO 2018b).

## Production Statistics

The New Brunswick commercial fleet landed 246 metric tonnes (MT) in 2016, which had a value of $277,000 CAD. No more than 4 MT was landed in other areas of the Canadian maritimes (data suppressed in Nova Scotia

and Prince Edward Island for confidentiality requirements) (DFO 2018b). Prior to the mid part of the 20th century, 99% of Canadian landings came from the Atlantic Coast, with New Brunswick averaging 3,700 MT per year (DFO 2007). The Great Lakes fishery rapidly increased in the 1950s, with a record of 12,399 t landed in 1978. Today, landings fluctuate with market demands, but the anadromous smelt are considered to be of higher quality than the variety in inland lakes (DFO 2007), though production from inland lakes greatly exceeds marine fisheries (DFO 2018b).

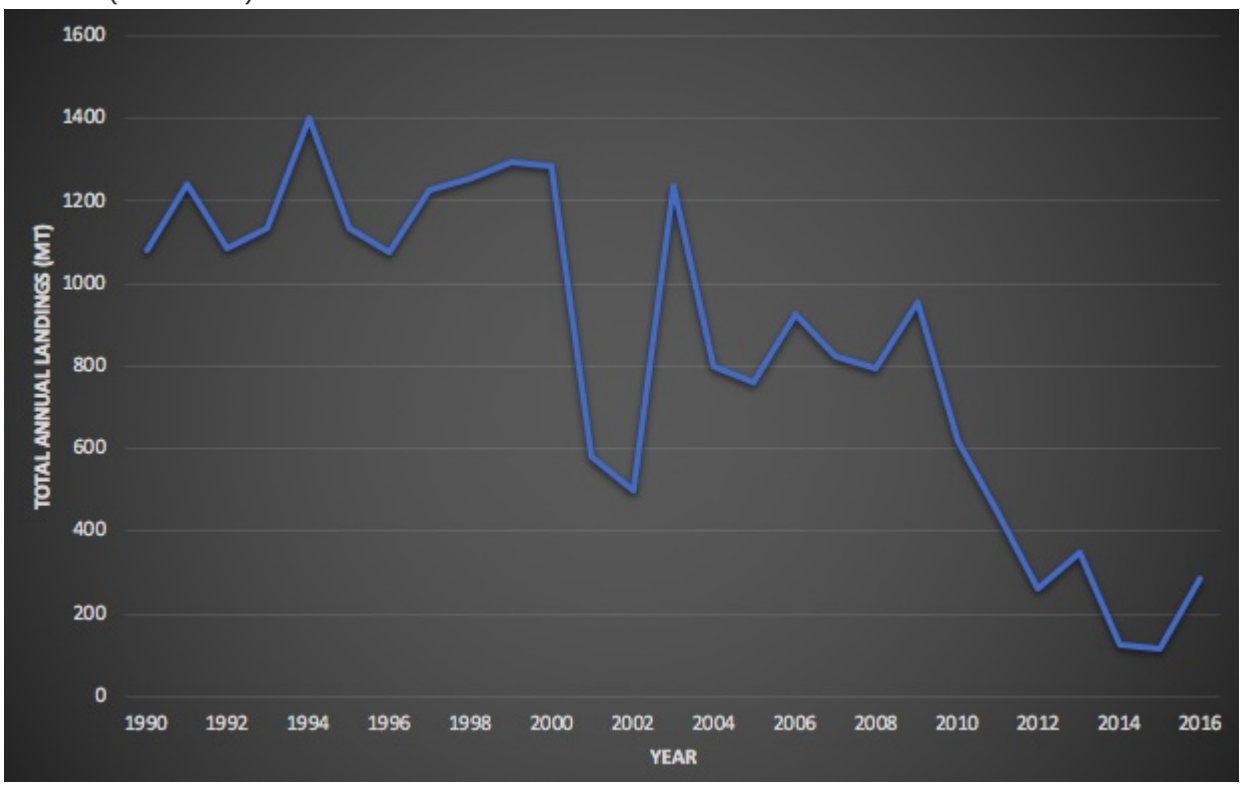



Figure 2 Total annual commercial landings of rainbow smelt (Osmerus mordax) in Eastern New Brunswick, Nova Scotia, and Prince Edward Island from 1990 to 2016. Data from Fisheries and Oceans Canada.

## Importance to the US/North American market.

Worldwide, there are multiple species of smelt within the family Osmeridae, and further, many similar fishes are marketed and sold as "smelt" in the international market. US smelt imports are not recorded to the species level. The US imported 2,833 MT of smelt in 2017, 66% of which came from Canada and were valued at USD 9.55 million (NOAA 2017). The 195 MT of imported smelt from Canada in 2017 were defined as "smelts sea frozen" while the other 1,674 MT was defined as "smelts not specifically provided for (NSPF) fresh or frozen." Canada and Peru have historically provided the lion's share of smelt to US markets, while smelt imports from Trinidad and Tobago have increased over the last five years.

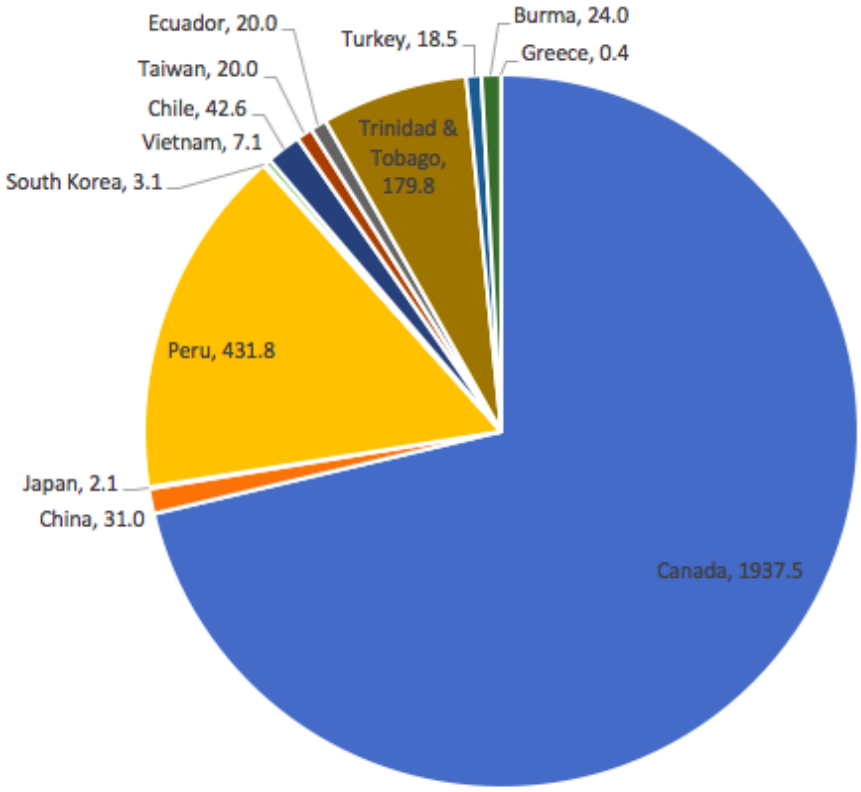



Figure 3 Average annual U.S. imports of smelts (NSPF fresh, NSPF frozen, and Sea frozen combined) from 2013 to 2017 in metric tons per year. Data from NMFS Fisheries Statistics and Economic Division.

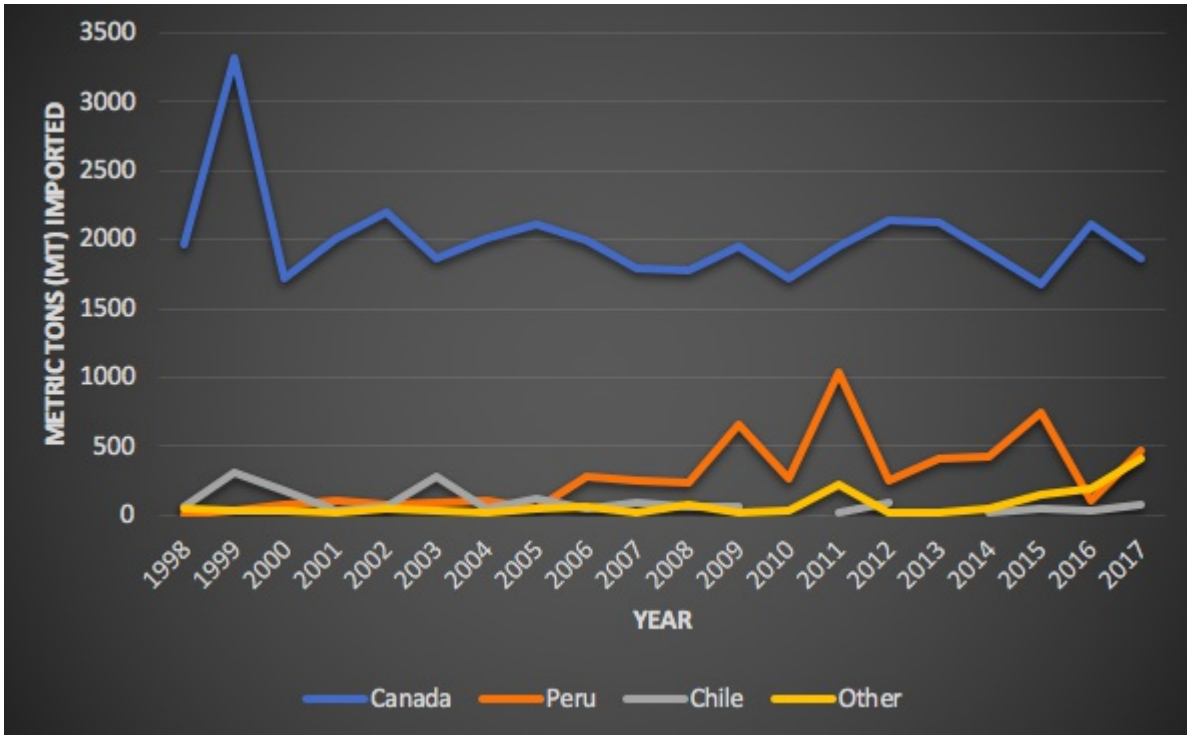



Figure 4 U.S. imports of smelts (NSPF frozen, NSPF fresh, and sea frozen) from Canada, Peru, Chile and all other countries combined (other) from 1998 to 2017. Data from NMFS Fisheries Statistics and Economic Division

## Common and market names.

Rainbow smelt is also known as smelt, freshwater smelt, and American smelt.

## Primary product forms

Rainbow smelts are scaled and gutted and often served fried, but is also poached, baked, or pickled. Smelts are also available to zoos and aquariums as feed for captive animals, but catches may come from the Great Lakes (see the Seafood Watch report for Great Lakes Rainbow Smelt).

# Assessment

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

# Criterion 1: Impacts on the Species Under Assessment

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

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

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

### Criterion 1 Summary

| RAINBOW SMELT | | | |
|---|---|---|---|
| **Region \| Method** | **Abundance** | **Fishing Mortality** | **Score** |
| Canada/Gulf of St. Lawrence \| Stationary uncovered pound nets | 2.33: Moderate Concern | 1.00: High Concern | Red (1.526) |
| Canada/Gulf of St. Lawrence \| Stationary uncovered pound nets \| Winter fishery | 2.33: Moderate Concern | 1.00: High Concern | Red (1.526) |

### Criterion 1 Assessment

SCORING GUIDELINES

### Factor 1.1 - Abundance

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

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

## Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

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

RAINBOW SMELT

## Factor 1.1 - Abundance

CANADA/GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**Moderate Concern**

Abundance in the Gulf of St. Lawrence is not well understood, but the region has not experienced as dramatic a decline as observed in US waters (Enterline et al. 2012). The last stock assessment was conducted in 1996, which suggested that the Miramichi Bay fishery was not likely over-exploiting the stock at that time, but that stocks in smaller bays may have had higher, unsustainable exploitation levels (Chaput and LeBlanc 1996). There is little information on the dynamics of populations in the southern part of the Gulf of St. Lawrence and there are no recent estimates of abundance; declines in landings may be attributed to habitat degradation (DFO 2007). Though little information is available on population trends over the last 10 years, the International Union for Conservation of Nature (IUCN) has rated rainbow smelt as a species of "Least Concern" because of a wide distribution and large number of subpopulations (NatureServe 2013). With limited information on abundance, we award a score of "moderate" concern based on the IUCN rating.

## Factor 1.2 - Fishing Mortality

CANADA/GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**High Concern**

The sustainability of fishing mortality for rainbow smelt in Canada is not known because no reference points have been established, age structure data and mortality rates are not collected, and Fisheries and Oceans Canada (DFO) doesn't assess the relative trend of the impact of the fishery (e.g., catch per unit effort) (DFO 2007). Rainbow smelt is considered a forage species according to Lenfest Forage Fish Task Force (LFFTF) guidelines (Pikitch et al. 2012). Species that feed on rainbow smelt include striped bass, grey seals, Atlantic salmon, tomcod, cod, mink, otters, and various seabirds (DFO 2007) (Enterline et al. 2012), but it is unknown if these species are dependent on smelt. Temperature and water levels have been shown to affect smelt recruitment (Mingelbier et al. 2001), increasing predator populations may contribute to higher natural mortality (Enterline et al. 2012), and fishery landings may be underreported (DFO 2007). This species falls between the LFFTF Low and Intermediate Information Tiers, fishing occurs before smelt spawn, local depletion is possible, and management may not be precautionary enough to ensure the needs of dependent predators are met. We therefore award a score of "high" concern.

**Justification:**

Landings of rainbow smelt in Canada have been variable through time. The average commercial catch between the 1920s and 1980s was between 40 to 60 MT per year, followed by a decline in catch due to habitat degradation, pollution, and reduced fishing activity (Mingelbier et al. 2001). Landings between 1993

and 1998 were stable, followed by a decline in the early 2000s due to lack of markets (DFO 2007); landings have further declined since 2009 (DFO 2018b), but the accuracy of landings data is uncertain since the logbook program ended in 2006 (DFO 2007).

Rainbow smelt have an extensive native distribution and have been introduced to inland ecosystems (Rooney and Paterson 2006). However, they do not migrate far from natal streams, populations in individual bays may be unique (Frechet et al. 1983) (Kovach et al. 2013), and several distinct populations likely inhabit the St. Lawrence Estuary, which is where the fishery primarily occurs (Mingelbier et al. 2001) (Lecomte and Dodson 2004). High concentrations of fishing pressure could decimate distinct populations that may not be recolonized.

Fishing for smelt primarily occurs in winter prior to spawning (DFO 2007). Fisheries that target spawning aggregations are particularly susceptible to overfishing and require a precautionary approach to management that requires specific information at appropriate spatial scales (Sadovy de Mitcheson 2016). Management measures (e.g., spawning closures and escapement goals) will vary among species and the effectiveness of these measures depends on the complexity of the spawning system, the vulnerability of spawning habitat and the level of aggregation during spawning (van Overzee and Rijnsdorp 2015). Because rainbow smelt is not considered a priority fishery, few precautionary measures are in place that may be required for this species and fishery. Also, smelt mortality in other fisheries is not well understood, but bycatch is known to occur in at least five fisheries in the Gulf of Maine (Enterline et al. 2012).

RAINBOW SMELT

## Factor 1.1 - Abundance

CANADA/GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderate Concern**

Abundance in the Gulf of St. Lawrence is not well understood, but the region has not experienced as dramatic a decline as observed in US waters (Enterline et al. 2012). The last stock assessment was conducted in 1996, which suggested that the Miramichi Bay fishery was not likely over-exploiting the stock at that time, but that stocks in smaller bays may have had higher, unsustainable exploitation levels (Chaput and LeBlanc 1996). There is little information on the dynamics of populations in the southern part of the Gulf of St. Lawrence and there are no recent estimates of abundance; declines in landings may be attributed to habitat degradation (DFO 2007). Though little information is available on population trends over the last 10 years, the International Union for Conservation of Nature (IUCN) has rated rainbow smelt as a species of "Least Concern" because of a wide distribution and large number of subpopulations (NatureServe 2013). With limited information on abundance, we award a score of "moderate" concern based on the IUCN rating.

## Factor 1.2 - Fishing Mortality

CANADA/GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**High Concern**

The sustainability of fishing mortality for rainbow smelt in Canada is not known because no reference points have been established, age structure data and mortality rates are not collected, and Fisheries and Oceans Canada (DFO) doesn't assess the relative trend of the impact of the fishery (e.g., catch per unit effort) (DFO 2007). Rainbow smelt is considered a forage species according to Lenfest Forage Fish Task Force (LFFTF) guidelines (Pikitch et al. 2012). Species that feed on rainbow smelt include striped bass, grey seals, Atlantic salmon, tomcod, cod, mink, otters, and various seabirds (DFO 2007) (Enterline et al. 2012), but it is unknown

if these species are dependent on smelt. Temperature and water levels have been shown to affect smelt recruitment (Mingelbier et al. 2001), increasing predator populations may contribute to higher natural mortality (Enterline et al. 2012), and fishery landings may be underreported (DFO 2007). This species falls between the LFFTF Low and Intermediate Information Tiers, fishing occurs before smelt spawn, local depletion is possible, and management may not be precautionary enough to ensure the needs of dependent predators are met. We therefore award a score of "high" concern.

**Justification:**

Landings of rainbow smelt in Canada have been variable through time. The average commercial catch between the 1920s and 1980s was between 40 to 60 MT per year, followed by a decline in catch due to habitat degradation, pollution, and reduced fishing activity (Mingelbier et al. 2001). Landings between 1993 and 1998 were stable, followed by a decline in the early 2000s due to lack of markets (DFO 2007); landings have further declined since 2009 (DFO 2018b), but the accuracy of landings data is uncertain since the logbook program ended in 2006 (DFO 2007).

Rainbow smelt have an extensive native distribution and have been introduced to inland ecosystems (Rooney and Paterson 2006). However, they do not migrate far from natal streams, populations in individual bays may be unique (Frechet et al. 1983) (Kovach et al. 2013), and several distinct populations likely inhabit the St. Lawrence Estuary, which is where the fishery primarily occurs (Mingelbier et al. 2001) (Lecomte and Dodson 2004). High concentrations of fishing pressure could decimate distinct populations that may not be recolonized.

Fishing for smelt primarily occurs in winter prior to spawning (DFO 2007). Fisheries that target spawning aggregations are particularly susceptible to overfishing and require a precautionary approach to management that requires specific information at appropriate spatial scales (Sadovy de Mitcheson 2016). Management measures (e.g., spawning closures and escapement goals) will vary among species and the effectiveness of these measures depends on the complexity of the spawning system, the vulnerability of spawning habitat and the level of aggregation during spawning (van Overzee and Rijnsdorp 2015). Because rainbow smelt is not considered a priority fishery, few precautionary measures are in place that may be required for this species and fishery. Also, smelt mortality in other fisheries is not well understood, but bycatch is known to occur in at least five fisheries in the Gulf of Maine (Enterline et al. 2012).

# Criterion 2: Impacts on Other Species

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

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

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

### Guiding Principles

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

### Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

| RAINBOW SMELT - CANADA/GULF OF ST. LAWRENCE - STATIONARY UNCOVERED POUND NETS | | | | | |
|---|---|---|---|---|---|
| **Subscore:** | **1.000** | **Discard Rate:** | **0.75** | **C2 Rate:** | **0.750** |
| **Species** | **Abundance** | **Fishing Mortality** | **Subscore** | | |
| White hake | 1.00:High Concern | 1.00:High Concern | Red (1.000) | | |
| Striped bass | 1.00:High Concern | 3.00:Moderate Concern | Red (1.732) | | |
| Winter flounder | 1.00:High Concern | 5.00:Low Concern | Yellow (2.236) | | |
| Atlantic tomcod | 2.33:Moderate Concern | 3.00:Moderate Concern | Yellow (2.644) | | |

| RAINBOW SMELT - CANADA/GULF OF ST. LAWRENCE - STATIONARY UNCOVERED POUND NETS - WINTER FISHERY | | | | | |
|---|---|---|---|---|---|
| **Subscore:** | **2.236** | **Discard Rate:** | **1.00** | **C2 Rate:** | **2.236** |
| **Species** | **Abundance** | **Fishing Mortality** | **Subscore** | | |
| Winter flounder | 1.00:High Concern | 5.00:Low Concern | Yellow (2.236) | | |
| Atlantic tomcod | 2.33:Moderate Concern | 3.00:Moderate Concern | Yellow (2.644) | | |

Historically, the autumn smelt fishery had high incidences of bycatch of white hake, winter flounder, striped bass, and Atlantic tomcod. Atlantic salmon may also interact with this fishery. Bradford et al. (1997) estimated the following catch in smelt nets during 1994: 12 MT of smelt, 30 MT of tomcod, 20 to 40 MT of white hake, 3 to 4 MT of winter flounder, and 100,000 to 500,000 juvenile striped bass in the Miramichi River Estuary fishery. The catch rate (measured in kilograms catch per unit effort) of white hake was comparable to the catch rate of smelt and tomcod, while the flounder catch rate was about half of smelt; an estimated 30 striped bass were caught per kg of smelt landed (Bradford et al. 1997). Bycatch data is not available for the winter fishery, but it is likely considerably lower than the autumn fishery because some species (white hake and striped bass) migrate out of the fishing area during the winter. Any incidentally caught species (with the exception of Atlantic tomcod) in rainbow smelt fisheries must immediately be returned to the water (DFO 2007). Although Fisheries and Oceans Canada (DFO) took steps to reduce bycatch in the smelt fishery (DFO 2007), there is no current information on levels of bycatch following management measures. These measures are detailed in Criterion 3 of this report.

Harbor seals are known to drown in trap-nets in nearby Prince Edward Island, while grey seals are large enough to break through netting and escape alive (Cairns et al. 2000). No information is available regarding incidences of seal bycatch in fisheries in the Gulf of St. Lawrence. Since the majority of smelt landings occurs in this area, harbor seals are not included as a main species.

We score fishing mortality as "high" concern for white hake because directed fisheries for white hake are prohibited (COSEWIC 2013), the smelt fishery may be a main source of fishing mortality (Bradford et al. 1997), and the sustainability of fishing mortality is not known. We score fishing mortality "low" concern for winter flounder because catch in the smelt fishery is only minor (i.e., not a substantial contributor to fishing mortality) in comparison to the catch in the directed winter flounder fishery (Bradford et al. 1997) (DFO 2017a). White hake limits the score in the autumn fishery because its population in the southern Gulf of St. Lawrence has declined drastically and is considered an "Endangered" species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Striped bass also limit the score for the autumn fishery because the stock encountered by the smelt fishery is currently listed as a stock of "Special Concern." Winter flounder limits the score in the winter fishery because the stock is overfished.

## Criterion 2 Assessment

SCORING GUIDELINES

### Factor 2.1 - Abundance
*(same as Factor 1.1 above)*

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

WINTER FLOUNDER

### Factor 2.1 - Abundance

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**High Concern**

Winter flounder (*Pseudopleuronectes americanus*) is a flatfish species found from Labrador to Georgia; the southern Gulf of St. Lawrence stock (NAFO Div. 4T) is likely to interact with the rainbow smelt fishery (DFO 2017a). The last stock assessment for winter flounder in the southern Gulf of St. Lawrence was conducted in

2016 using a length-based age structure model with data from multi-species bottom trawl surveys and otter trawl surveys (DFO 2017a). The limit reference point (LRP) is proxy for biomass at maximum sustainable yield (40% $B_{MSY}$) determined by the spawning stock biomass (SSB) during a productive period between 1973 and 1994 (DFO 2017a). The stock has been below the LRP of 147.8 thousand MT since 2006 and spawning stock biomass (SSB) is currently estimated to be 54% of LRP (DFO 2017). Despite decreased fishing effort in recent years, there is no evidence from surveys to suggest a rebound in abundance (Morin et al. 2012) and commercial biomass remains at record low levels (DFO 2016). It is likely (76% chance) that stock is below the LRP (DFO 2017a) and we award a score of "high" concern.

**Justification:**

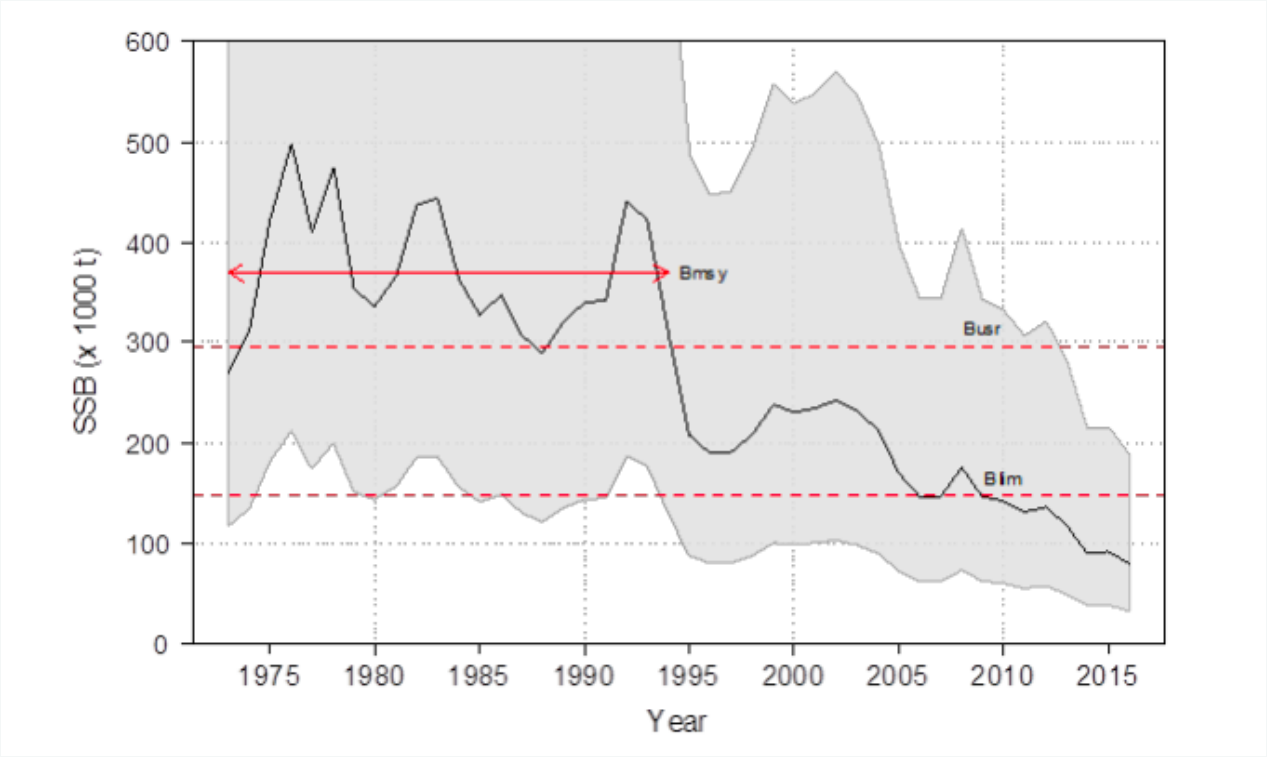



Figure 5 Upper stock reference point (80% of Bmsy) and limit reference point (40% of Bmsy) for winter flounder in the southern Gulf of St. Lawrence (DFO 2017).

## Factor 2.2 - Fishing Mortality

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Low Concern**

The directed fishery for winter flounder has landed between 190 and 320 MT on average over the last 10 years and instantaneous fishing mortality (F) is estimated to be very low compared to natural mortality (M) (DFO 2017a). F has been less than 0.001 for fish 2 to 4 years of age and highest for fish age 7 and 8 at 0.049 and 0.051 respectively, while M has ranged between 0.90 and 1.25 over the last decade (DFO 2017a). Landings have decreased since the 1960s and a total allowable catch has been 330 MT since 2012. Bycatch in the ice smelt fishery has not been well quantified (Morin et al. 2012), but estimates from the smelt fishery overall were 3 to 4 MT of winter flounder bycatch annually (Bradford et al. 1997). Mortality from the smelt fishery is not a substantial contributor to total fishing mortality, and natural mortality is considered to the dominating factor affecting abundance (DFO 2017a). We therefore award a score of "low" concern.

**Justification:**

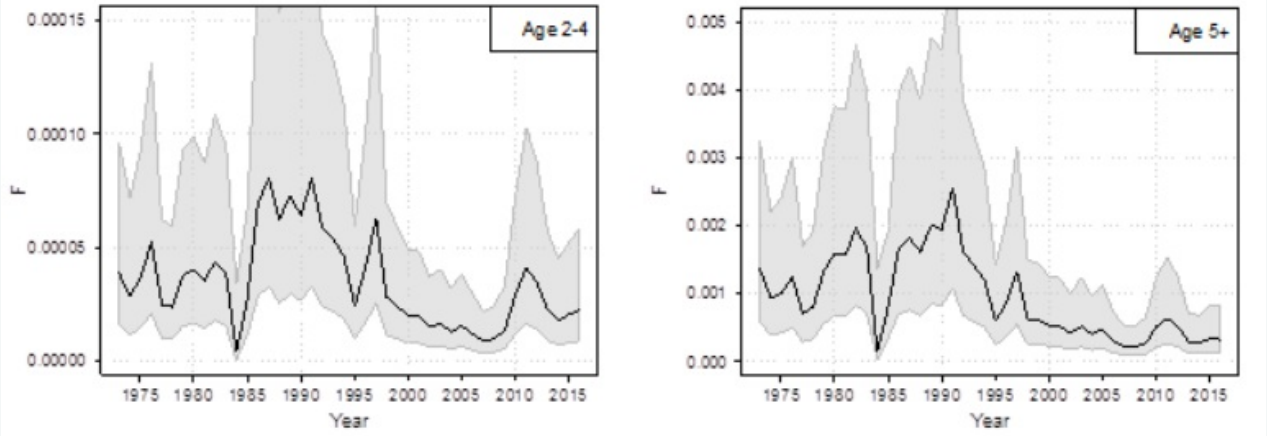



Figure 6 Model estimated F for winter flounder age 2 to 4 (left) and ages 5+ (right) in the Southern Gulf of St. Lawrence from 1973 to 2016. From DFO 2017.

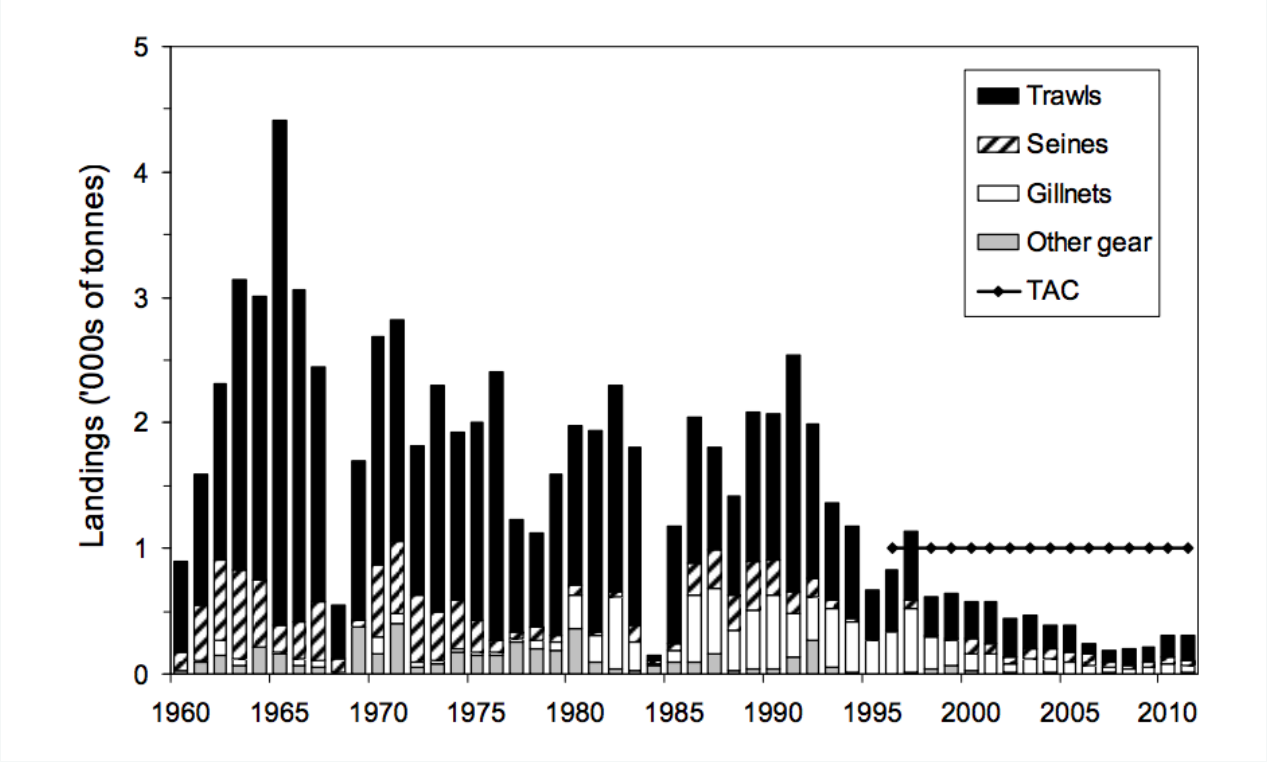



Figure 7 Landings of winter flounder between 1960-2011 in the Southern Gulf of St. Lawrence. 1,000 mt annual quota has been in place since 1996 (Morin et al. 2012).

## Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

| RATIO OF BAIT + DISCARDS/LANDINGS | FACTOR 2.3 SCORE |
|---|---|
| <100% | 1 |
| >=100 | 0.75 |

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**≥ 100%**

With the exception of Atlantic tomcod, all incidentally caught species are discarded and released fish are assumed to survive, but there is little information on actual survivability (D. Fillion, personal communication 2018). Survivability may vary seasonally for some species (DFO 2011b). For example, young-of-the-year striped bass mortality can be very high in the open water smelt fishery because of the difficulty of culling large numbers of small bass from smelt catches (DFO 2011b), whereas annual mortality of medium- and large-sized bass may be 23% (COSEWIC 2012).

Landings of smelt and tomcod in the open water bag fishery in Miramichi in 1994 were 12 MT and 30 MT (Bradford et al. 1997). Incidental catches of hake and flounder were 40 MT and 3 MT respectively, and striped bass bycatch was over 100,000 age-0 fish and less than 1000 each of age-1 and age >2 fish (Bradford et al. 1997). In the 1995 survey, 20 MT of smelt and 30 MT of tomcod were landed, compared to incidental catches of 20 MT hake, 4 MT flounder, and 400,000 age 0, and more than 1000 age 1 and age >2 striped bass fish (Bradford et al. 1997). The discard to landings ratio for weight of fish encountered in 1994 was 1.02, but 0.48 in 1995. However, this does not include the weight of discards of striped bass (131,000 fish in 1994; 501,000 fish in 1995—mostly juveniles) or any other encountered species. The smelt fishing season now starts later to reduce bycatch of striped bass and fewer bass are incidentally captured in the ice fishery (DFO 2011b). There is no data available on the discard rate following bycatch mitigation measures. Without evidence contrary to research from Bradford et al. (1997) discards are assumed to exceed landings.

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**< 100%**

With the exception of Atlantic tomcod, all incidentally caught species are discarded and released fish are assumed to survive, but there is little information on actual survivability (D. Fillion, personal communication 2018), which may vary seasonally for some species (DFO 2011b). Bycatch data used in this report is from Bradford et al. (1997), which only covers the open water (autumn) fishery. Historically, the open water fishery accounted for around 20% of the annual smelt catch (Bradford et al. 1997). There is no equivalent quantitative information for bycatch in the winter (ice) fishery, but white hake and striped bass are largely absent from waters where smelt are caught in the winter (DFO 2011). Since the winter fishery is unlikely to encounter white hake and striped bass, total bycatch in the winter fishery is likely lower than the autumn fishery and the discard ratio is likely <100%.

WHITE HAKE

## Factor 2.1 - Abundance

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**High Concern**

With a recent decrease in adult abundance of 91%, white hake is listed as "Threatened" in the Atlantic and

northern Gulf of St. Lawrence and "Endangered" in the southern Gulf of St. Lawrence by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2013). The southern stock is more likely to interact with rainbow smelt fisheries. Because white hake is an "Endangered" species, we award a score of "high" concern.

**Justification:**

White hake abundance has declined in the northern Gulf of St. Lawrence since the late 1980s; the adult population has declined by 70% over the past three generations, but has since stabilized (COSEWIC 2013). Abundance in the southern Gulf experienced a steep decline in the late 1980s before leveling out by the mid 1990s; the overall decline rate has been 91% over the last three generations (COSEWIC 2013).

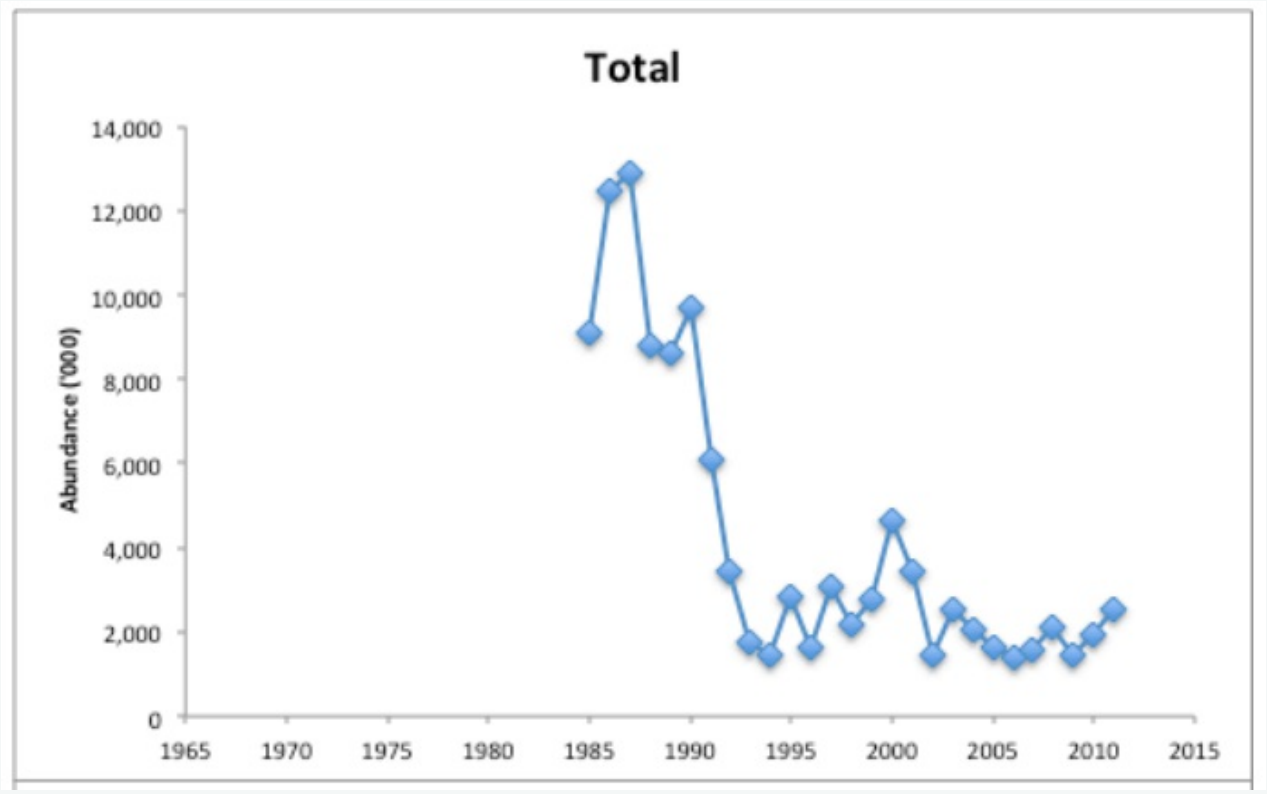



Figure 8 White hake abundance in the Northern Gulf of St. Lawrence (COSEWIC 2013).

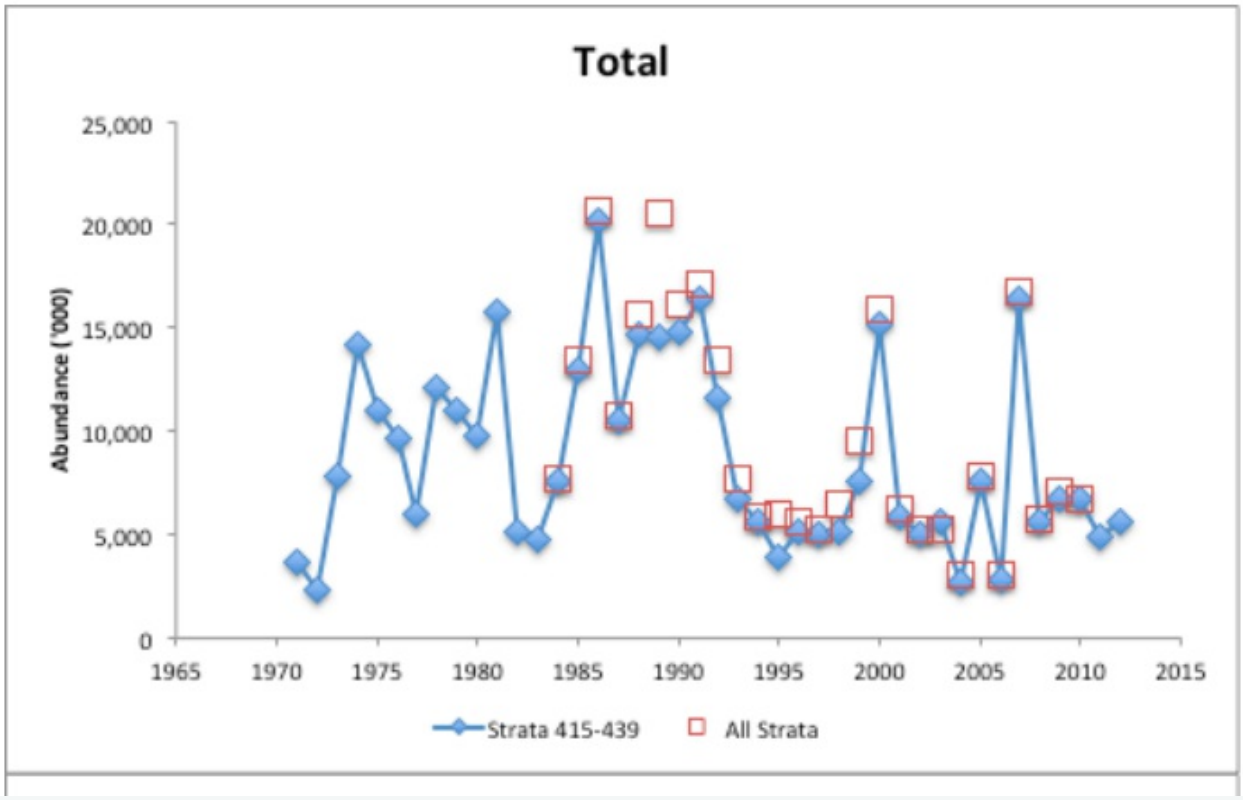



Figure 9 White hake abundance in the Southern Gulf of St. Lawrence (COSWIC 2013).

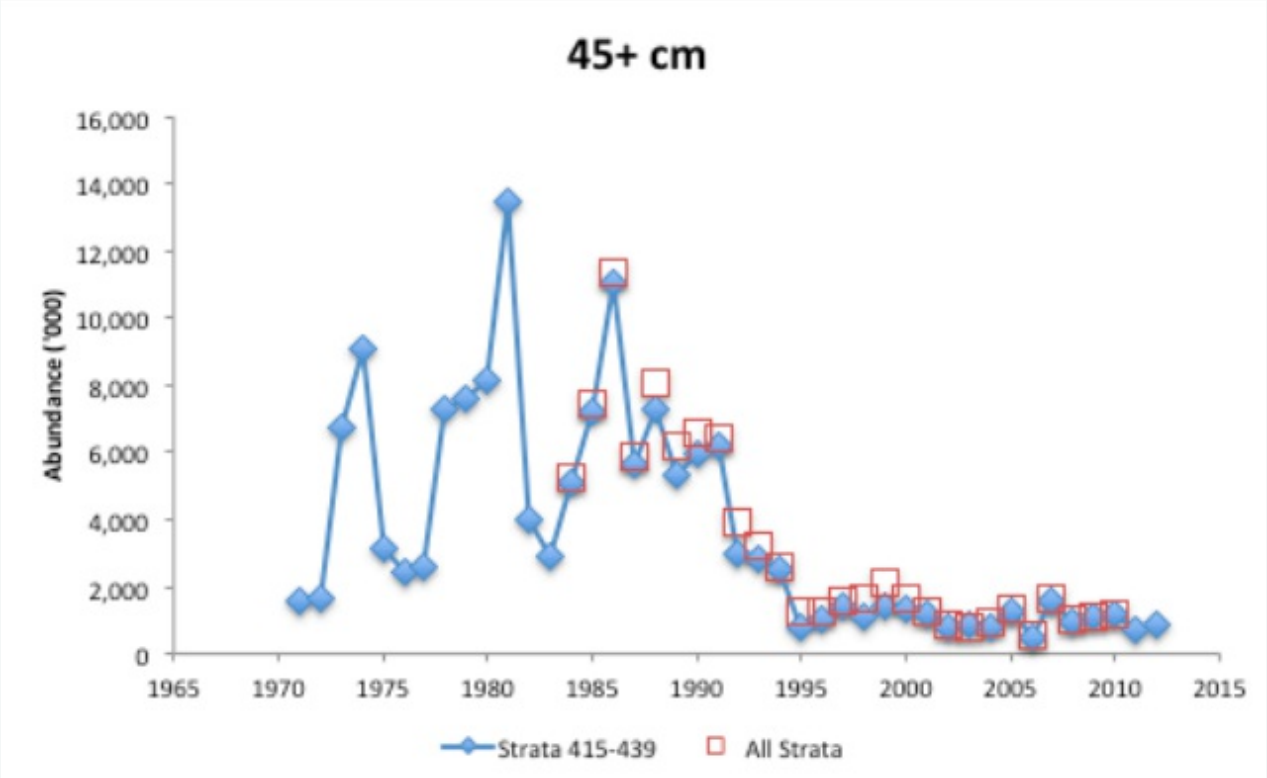



Figure 10 Adult white hake abundance (45+ cm) estimates in the Southern Gulf of St. Lawrence (COSEWIC 2013).

## Factor 2.2 - Fishing Mortality

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**High Concern**

White hake declined in the face of overfishing in the late 1980s and early 1990s (COSEWIC 2013). A directed fishing moratorium has been in place since 1995 in the southern Gulf of St. Lawrence, but the population has not recovered, and has a 20% probability of extirpation within 30 years under current rates of natural mortality and bycatch (COSEWIC 2013). The lack of white hake recovery in the Gulf of St. Lawrence since the 1995 fishing moratorium is thought to be due almost entirely to natural mortality, as *reported* fishing mortality declined to nearly zero (COSEWIC 2013). Recent modeled natural mortality rates (M) increased for all ages classes; M estimates are 1.36, 2.05, and 1.51 for ages 2–3 years, 4–5, and 6+, respectively (Swain et al. 2016) (Figure 11).

This species was historically caught in large quantities in the smelt fishery (estimated 40 MT in 1994) (Bradford et al. 1997), and there is no updated information on whether this trend continues today. Hake caught in smelt nets must be released (DFO 2007), but post-release survival may be poor (e.g., gull predation on discarded hake can be substantial) (Bradford et al. 1997). There has been no update on bycatch in the smelt fishery since 1997, so the fishery's contribution to mortality is unknown. Additionally, the logbook program for the smelt fishery was discontinued in 2006 so we cannot determine the extent of fishing mortality from the smelt fishery (DFO 2007). It is probable that fishing mortality is not sustainable because of the status of the stock (i.e., any level of fishing mortality is unsustainable). Therefore, we award a score of "high" concern.

**Justification:**

M remains high for adult white hake, and some research suggests an indirect link between increasing grey seal abundance and increasing levels of M; other explanations for elevated M include unreported catch, environmental stressors, and fisheries-induced life-history change (Benoit et al. 2011). If non-fishing mortality remains high, the population is unlikely to recover (COSEWIC 2013).

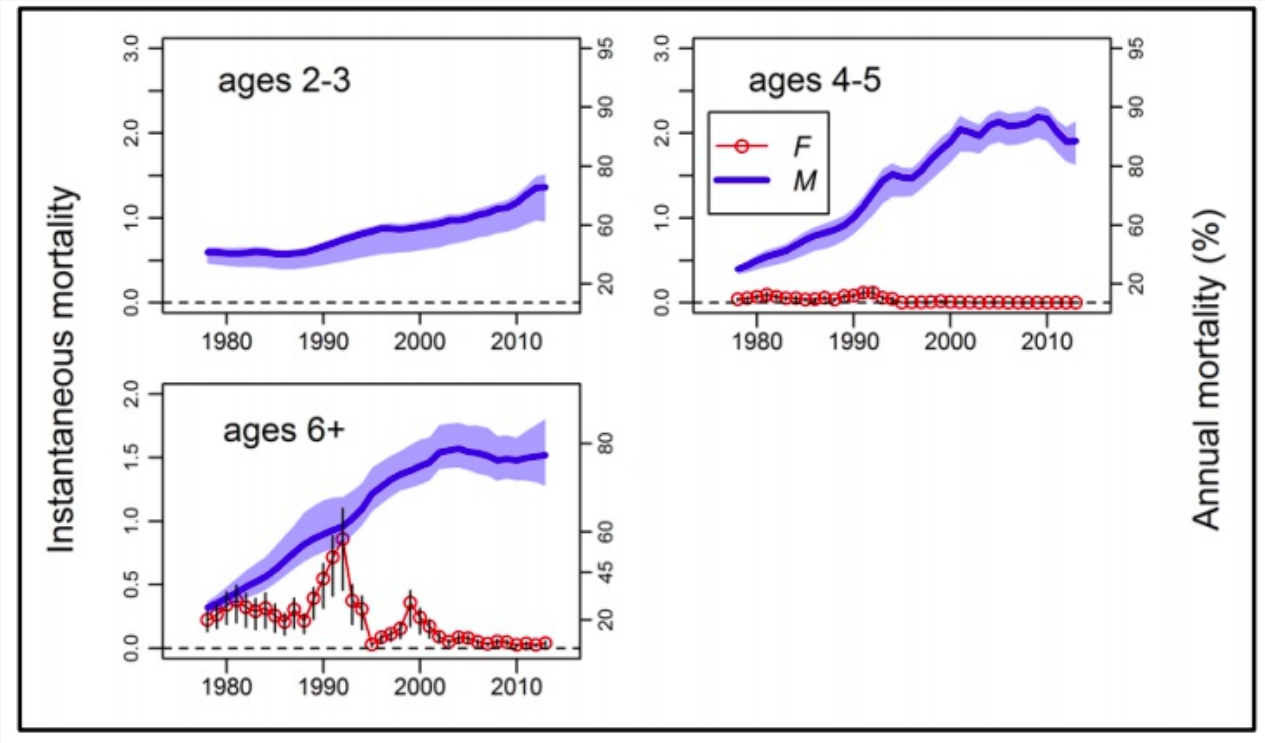



Figure 11 Estimated instantaneous rates of fishing (F) and natural mortality (M) by age group. Blue lines and red circles show the maximum likelihood estimates. Shading and vertical lines show their 95% confidence intervals based on MCMC sampling. The right-hand axis shows the corresponding annual mortality. Average Fs

for ages 2 and 3 are not shown since they were negligible (<0.001 in all years, < 0.00005 since 2000). Figure from Swain et al. 2016.

## Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

| RATIO OF BAIT + DISCARDS/LANDINGS | FACTOR 2.3 SCORE |
|---|---|
| <100% | 1 |
| >=100 | 0.75 |

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**≥ 100%**

With the exception of Atlantic tomcod, all incidentally caught species are discarded and released fish are assumed to survive, but there is little information on actual survivability (D. Fillion, personal communication 2018). Survivability may vary seasonally for some species (DFO 2011b). For example, young-of-the-year striped bass mortality can be very high in the open water smelt fishery because of the difficulty of culling large numbers of small bass from smelt catches (DFO 2011b), whereas annual mortality of medium- and large-sized bass may be 23% (COSEWIC 2012).

Landings of smelt and tomcod in the open water bag fishery in Miramichi in 1994 were 12 MT and 30 MT (Bradford et al. 1997). Incidental catches of hake and flounder were 40 MT and 3 MT respectively, and striped bass bycatch was over 100,000 age-0 fish and less than 1000 each of age-1 and age >2 fish (Bradford et al. 1997). In the 1995 survey, 20 MT of smelt and 30 MT of tomcod were landed, compared to incidental catches of 20 MT hake, 4 MT flounder, and 400,000 age 0, and more than 1000 age 1 and age >2 striped bass fish (Bradford et al. 1997). The discard to landings ratio for weight of fish encountered in 1994 was 1.02, but 0.48 in 1995. However, this does not include the weight of discards of striped bass (131,000 fish in 1994; 501,000 fish in 1995—mostly juveniles) or any other encountered species. The smelt fishing season now starts later to reduce bycatch of striped bass and fewer bass are incidentally captured in the ice fishery (DFO 2011b). There is no data available on the discard rate following bycatch mitigation measures. Without evidence contrary to research from Bradford et al. (1997) discards are assumed to exceed landings.

# Criterion 3: Management Effectiveness

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

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

The Criterion 3 rating is determined as follows:

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

*Rating is Critical if Management Strategy and Implementation is Critical.*

GUIDING PRINCIPLE

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

### Criterion 3 Summary

| Fishery | Management Strategy | Bycatch Strategy | Research and Monitoring | Enforcement | Stakeholder Inclusion | Score |
|---|---|---|---|---|---|---|
| Fishery 1: Canada / Gulf of St. Lawrence \| Stationary uncovered pound nets | Moderately Effective | Moderately Effective | Ineffective | Moderately Effective | Moderately Effective | Red (2.000) |
| Fishery 2: Canada / Gulf of St. Lawrence \| Stationary uncovered pound nets \| Winter fishery | Moderately Effective | Moderately Effective | Ineffective | Moderately Effective | Moderately Effective | Red (2.000) |

### Criterion 3 Assessment

### Factor 3.1 - Management Strategy and Implementation

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

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderately Effective**

The Department of Fisheries and Oceans (DFO) manages the rainbow smelt fishery. The most recent Integrated Smelt Fishery Management Plan covers the Eastern New Brunswick Area fishery from 2007 to 2011 (DFO 2007) and a new plan is currently in draft (D. Fillion, personal communication 2018). Fishing effort is controlled by license requirements, seasonal closures, minimum mesh sizes and location of gear (DFO 2007). No new commercial licenses are currently being issued. There have been no recent stock assessments and no reference points have been defined. This is no longer considered a major fishery by DFO and is thus a low priority for management and research, and DFO lacks the ability to advise on a level of sustainable catches (DFO 2007). Although DFO has outlined long-term management objectives, it is unclear what actions are actually being implemented because the management plan is not current. Additionally, there is uncertainty around landings because the logbook program ended in 2006 with no clear replacement. The effectiveness of the management strategy is unknown, a new management plan is being written, and it is unlikely that the fishery is having a serious negative impact on rainbow smelt in the Gulf of St. Lawrence. Therefore, we award a score of "moderately effective."

## Factor 3.2 - Bycatch Strategy

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

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderately Effective**

Smelt fishing in Miramichi Bay and the Richibouctou River with box nets results in bycatch of Atlantic tomcod, striped bass, winter flounder, and white hake, along with occasional bycatch of 32 other fish species, including endangered Atlantic salmon (Bradford et al. 1997). In response to a 1997 study on bycatch in this fishery, DFO reduced the season in these areas to minimize interactions with striped bass, will delay seasons in other watersheds if bycatch remains high, and will relocate gear if bycatch continues after that (DFO 2007). Additionally, DFO decreased the number of commercial smelt licenses since 1991 by 38%, reduced gill net fishing effort, and reduced the concentration of gears in upstream section of rivers to avoid bycatch of trout (D. Fillion, personal communication 2018). Incidentally caught species are released alive, but post-release survival has not been studied. DFO increased the minimum mesh size to 31 mm to reduce catch of juvenile smelt (DFO 2007). The fishery has demonstrated some bycatch mitigation measures, but there are no updates on the effectiveness of these measures. The effectiveness of mitigation is uncertain and we award a score of "moderately effective."

**Justification:**

Species were recorded during bycatch sampling in the Miramichi open water smelt fishery in the fall of 1994 and 1995; the weight of the unsorted catch was estimated, then subsampled for species composition (Bradford et al. 1997). The only species of interest (striped bass, white hake, and winter flounder) were counted, measured and weighted; other species were recorded but not quantified (Bradford et al. 1997).

| Species | Common Name | Species | Common Name |
|---|---|---|---|
| **Petromyzontidae** | | **Gasterosteidae** | |
| *Petromyzon marinus* | Sea lamprey | Various species | Stickleback(s) |
| **Anguillidae** | | **Percichthyidae** | |
| *Anguilla rostrata* | American eel | *Morone americana* | White perch |
| | | *Morone saxatilis* | Striped bass |
| **Clupeidae** | | *Morone* hybrids | Hybrid perch/bass ✓ |
| *Alosa aestivalis* | Blueback herring | | |
| *Alosa pseudoharengus* | Alewife | **Labridae** | |
| *Alosa sapidissima* | American shad | *Tautogolabrus adspersus* | Cunner |
| *Clupea harengus* | Atlantic herring | | |
| | | **Pholidae** | |
| **Salmonidae** | | *Pholis gunnelis* | Rock gunnel |
| *Salmo salar* | Atlantic salmon | | |
| *Salvelinus fontinalis* | Brook char | **Ammodytidae** | |
| | | *Ammodytes americanus* | American sand lance |
| **Osmeridae** | | | |
| *Osmerus mordax* | Rainbow smelt | **Scombridae** | |
| | | *Scomber scombrus* | Atlantic mackerel |
| **Gadidae** | | | |
| *Enchelyopus cimbrius* | Fourbeard rockling | **Stromateidae** | |
| *Gadus morhua* | Atlantic cod | *Peprilus tricanthus* | Butterfish |
| *Gadus ogac* | Greenland cod | | |
| *Microgadus tomcod* | Atlantic tomcod | **Cottidae** | |
| *Urophycis tenuis* | White hake | *Hemitripterus americanus* | Sea raven |
| | | *Myoxocephalus octodecemspinosus* | Longhorn sculpin |
| **Zoarcidae** | | *Myoxocephalus scorpius* | Shorthorn sculpin |
| *Macrozoarces americanus* | Ocean pout | | |
| | | **Agonidae** | |
| **Cyprinidontidae** | | *Aspidophoroides monopterygius* | Alligatorfish ✓ |
| *Fundulus diaphanus* | Banded killifish | | |
| *Fundulus heteroclitus* | Mummichog | **Bothidae** | |
| | | *Scopthalmus aquosus* | Windowpane |
| **Atherinidae** | | | |
| *Menidia menidia* | Atlantic silverside | **Pleuronectidae** | |
| | | *Hippoglossoides platessoides* | American plaice |
| | | *Pleuronectes americanus* | Winter flounder |
| | | *Pleuronectes ferrugineus* | Yellowtail flounder |
| | | *Pleuronectes putnami* | Smooth flounder |

Figure 13 Species identified during fall sampling of Miramichi open water smelt fishery in 1994 and 1995 (Bradford et al. 1997)

## Factor 3.3 - Scientific Research and Monitoring

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

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Ineffective**

With the exception for a portion of the Miramichi River, there is very little research into rainbow smelt in New Brunswick, and actual landings are not fully known (DFO 2007). Studies on bycatch in this fishery were conducted in the 1990s (Bradford et al. 1997), but no recent research has occurred. The Canadian

government conducted a stock assessment in Chaleur Bay in 1996 (Chaput and LeBlanc 1996), but no assessments have been done since. The fishery historically had a logbook program, but due to poor participation, it was discontinued in 2006 (DFO 2007). An advisory committee meeting takes place every three years with industry partners to discuss updates on landings and fishing effort (D. Fillion, personal communication 2018). Little data is collected, and that which is collected is considered unreliable, resulting in a score of "ineffective."

**Justification:**

No data or very minimal data are collected or analyzed; appropriate data-limited assessment and management methods are not used (see Appendix 7 of the Seafood Watch Standard). There is generally a lack of scientific and biological information collected for this fishery that prohibits a basic understanding of individual stocks, fishing and natural mortality, and current interactions with other species.

## Factor 3.4 - Enforcement of Management Regulations

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

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderately Effective**

Previous reporting systems resulted in completely inaccurate landings data, and each advisory committee had indicated that landings were far higher than reported (DFO 2007). As of 2007, landings are required to be reported where the catch takes place, and regulations are enforced by the Conservation and Protection Branch (DFO 2007). DFO also actively enforces the seasonal closures. The Conservation and Protection Branch oversees compliance with the management plan, enforces gear regulations (mesh size, space between gears, gear labeling, and net length), ensures that all gear is removed during the closed season, and monitors bycatch (DFO 2007). However, the effectiveness of reporting measures and bycatch monitoring is uncertain. Therefore, we award a score of "moderate concern."

## Factor 3.5 - Stakeholder Inclusion

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

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderately Effective**

The following information is provided in the Integrated Smelt Fishery Management Plan (DFO 2007). The Smelt Fishery Advisory Committee provides management recommendations and provides information on the status of the fishery in different areas. The Committee consists of representatives from the commercial fisheries, Aboriginal groups, government and fish processors. Each committee member is required to consult with stakeholders within their area before recommendations are made to Fisheries and Oceans (DFO). Although fishery interests are appropriately represented and the management process is transparent, it's unclear if all user groups (i.e., conservation groups) are included in management and we award a score of "moderately effective."

# Criterion 4: Impacts on the Habitat and Ecosystem

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

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

*Rating cannot be Critical for Criterion 4.*

### Criterion 4 Summary

| Region / Method | Gear Type and Substrate | Mitigation of Gear Impacts | EBFM | Score |
|---|---|---|---|---|
| Canada / Gulf of St. Lawrence / Stationary uncovered pound nets | 3 | 0 | Moderate Concern | Yellow (3.000) |
| Canada / Gulf of St. Lawrence / Stationary uncovered pound nets / Winter fishery | 3 | 0 | Moderate Concern | Yellow (3.000) |

### Criterion 4 Assessment

SCORING GUIDELINES

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

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

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

## Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

## Factor 4.3 - Ecosystem-Based Fisheries Management

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

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

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

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**3**

The naming of gear types is inconsistent within the fishery, and it's an issue that DFO addressed in the Integrated Smelt Fishery Management Plan (DFO 2007). DFO defines a trap net (which includes box nets) as a "net that is set to enclose a stretch of water into which the fish is guided by means of one or several leaders with one or several openings," and a bag net "is affixed to stakes or to buoys and consists of a bag that floats with the tide or currents." Nets that are attached to stakes have contact with the bottom since the stake is weighted with sandbags or other weights (Peppar and Blair 1977). Box nets are typically anchored to the ice

and do not have contact with the bottom (Peppar and Blair 1977). Bag, box, and trap nets are all included in the score of "3" because the gear has minimal contact with the bottom.

## Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**0**

There are seasonal closures (DFO 2007) and reductions in the concentration of gear in some areas (D. Fillion, personal communication 2018), but gear modifications or other measures are not sufficient to meet the criteria for mitigation credits.

## Factor 4.3 - Ecosystem-Based Fisheries Management

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderate Concern**

Under the Integrated Smelt FMP, DFO calls for management based on all species within a watershed or other marine environment, rather than a species-based approach (DFO 2007). Specific examples include limiting gears in the Miramichi watershed, varying seasons based on encounters with protected species, closure of some smelt fisheries, discontinuing license reallocation in Kouchibouguac National Park, and others (DFO 2007). Distinct smelt populations inhabit individual bays (DFO 2007); stronger policies are needed at various scales to protect those populations.

Rainbow smelt is an important forage species with predators including cod, tomcod, Atlantic salmon, seals, otters and various bird species. Detrimental food web impacts are possible and stronger policies may be warranted; the fishery receives a score of "moderate concern."

**Justification:**

Rainbow smelt do not migrate far from their native steams, individual bays may hold distinct populations (Chaput and LeBlanc 1996) and degradation of spawning habitat and estuaries is thought to contribute to a decline in smelt landings (DFO 2007). Smelt benefit from habitat improvement projects aimed at restoring Atlantic salmon populations, and as anadromous fish populations have declined, some improvements in land management have occured in recent years. For example, forestry practices (e.g., road construction, stream crossings, and riparian vegetation removal) have greatly improved, and pollution from industry and municipalities has declined (MREAC and ACAP 2007). DFO identified management measures related to smelt habitat, e.g., identify causes of smelt habitat degradation and develop action plans; take smelt habitats into account when evaluating major projects; promote the guiding principle of no net loss of habitat productive capacity; assist local groups with watercourse rehabilitation, and offer advice on fish passage (DFO 2007). However, the management plan has expired and it is unclear which, if any, of those measures were implemented.

# Acknowledgements

*Scientific review does not constitute an endorsement of The Safina Center or Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. The Safina Center and Seafood Watch® are solely responsible for the conclusions reached in this report.*

*Seafood Watch would like to thank the consulting researcher and author of this report as well as several anonymous reviewers for graciously reviewing this report for scientific accuracy.*

# References

ASMFC. 2013. Stock assessment overview: Atlantic striped bass. Atlantic States Marine Fisheries Commission. October 2013.

Benoit, H.P., Swain, D.P., Bowen, W.D., Breed, G.A., Hammill, M.O., and Harvey, V. 2011. A risk analysis of the potential effects of selective and non-selective reductions in grey seal abundance on the population status of two species at risk of extirpation, white hake and winter skate in the southern Gulf of St. Lawrence. CSAS Res. Doc, 2011/033.

Bradford, R.G., Chaput, G., Hurlbut, T. and Morin, R. 1997. Bycatch of striped bass, white hake, winter flounder, and Atlantic tomcod in the autumn "open water" smelt fishery of the Miramichi River estuary. Canadian Technical Report of Fisheries and Aquatic Sciences 2195. 43 p.

Cairns, D.K., Keen, D.M., Daoust, P.Y., Gillis, D.J., and Hammill, M.O. 2000. Conflicts between seals and fishing gear on Prince Edward Island. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2333.

Chaput, G., LeBlanc, C. 1996. Anadromous rainbow smelt (Osmerus mordax Mitchill) from the Gulf of St. Lawrence - update of fishery and preliminary status of stock, Atlantic Fisheries Research Document 1996/109.

Chaput, G.J. 1995. Temporal distribution, spatial distribution, and abundance of diadromous fish in the Miramichi River watershed. p. 121-139. In E.M.P.. Chadwick [editor]. Water, science, and the public: the Miramichi ecosystem.

Chase, B.C. 2006. Rainbow smelt (Osmerus mordax) spawning habitat on the Gulf of Maine coast of Massachusetts. Massachusetts Division of Marine Fisheries Technical Report Series TR-30.

Chase, B.C. and Childs, A.R. 2001. Rainbow smelt (Osmerus mordax) spawning habitat in the Weymouth Fore River. Massachusetts Division of Marine Fisheries Technical Report TR-5.

Clayton, G.R. 1976. Reproduction, first year growth, and distribution of anadromous rainbow smelt, Osmerus mordax, in the Parker River and Plum Island Sound estuary, Massachusetts. Master's Thesis. University of Massachusetts, Amherst, Massachusetts.

COSEWIC. 2012. COSEWIC assessment and status report on the Striped Bass Morone saxatilis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 82 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

COSEWIC. 2013. COSEWIC assessment and status report on the White Hake Urophycis tenuis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxii 45p.

Coulson, M.W., Bradbury, I.R., and Bentzen, P. 2006. Temporal genetic differentiation: continuous v. discontinuous spawning runs in anadromous rainbow smelt Osmerus mordax (Mitchill). Journal of Fish Biology 69: 209-216.

Fisheries and Oceans Canada (DFO). 2001. Status of Striped Bass (Morone saxatilis) in the Southern Gulf of St. Lawrence in 1999 and 2000. Canadian Science Advisory Secretariat Research Document 2001/058.

Fisheries and Oceans Canada (DFO). 2007. Integrated Smelt Fishery Management Plan, Eastern New Brunswick Area, Gulf Region, 2007-2011.

DFO. 2011. Allowable harm assessment of Striped Bass (Morone saxatilis) in the southern Gulf of St. Lawrence. DFO Canadian Science Advisory Secretariat Science Advisory Report 2011/014.

Fisheries and Oceans Canada (DFO). 2012. Assessment of winter flounder (Pseudopleuronectes americanus) in the southern Gulf of St. Lawrence (NAFO Div. 4T). Canadian Science Advisory Secretariat Science Advisory Report 2012/016.

DFO. 2017a. Stock assessment of winter flounder (Pseudopleuronectes americanus) of the southern Gulf of St. Lawrence (NAFO Div. 4T) to 2016. Canadian Science Advisory Secretariat Science Advisory Report 2017/022.

Fisheries and Oceans Canada (DFO). 2018c. Gulf Region Recreational Fisheries. Frequently asked questions about striped bass. Accessed on May 17, 2018.

Fisheries and Oceans Canada (DFO). 2016. Updated indices of abundance to 2015 for stocks of six groundfish species assessed by DFO Gulf Region. Canadian Science Advisory Secretariat Science Response 2016/016.

Enterline, C.L., Chase, B.C., Carloni, J.M. and Mills, K.E.. 2012. A regional conservation plan for anadromous rainbow smelt in the U.S. Gulf of Maine. In A multi-state collaborative to develop and implement a conservation plan for three anadromous finfish species of concern in the Gulf of Maine; NOAA Award#: NA06NMF4720249.

FishBase 2018a. Microgadus tomcod. Available at https://www.fishbase.de/summary/Microgadus-tomcod.html

FishBase 2018b. Urophycis tenuis. FishBase. http://www.fishbase.org/Summary/SpeciesSummary.php?ID=313&AT=White+hake

Fisheries and Oceans Canada (DFO). 2017b. Fishery Openings and Closures. Variation Order MAR-VAR-2017-019. Retrieved on April 6, 2018.

Fisheries and Oceans Canada (DFO). 2018b. Seafisheries landings data retrieved April 3, 2018.

Fisheries and Oceans Canada (DFO). 2018. Spawner abundance and biological characteristics of Striped Bass (Morone saxatilis) in the southern Gulf of St. Lawrence in 2017. DFO Canadian Science Advisory Secretariat Science Response 2018/016.

Frechet, A., Dodson, J.J., and Powles, H. 1983. use of variation in biological characters for the classification of anadromous rainbow smelt (Osmerus mordax) groups. Canadian Journal of Fisheries Aquatic Sciences 40: 718-727

Hall, C.J., Jordaan, A., and Frisk, M.G. 2012. Centuries of anadromous forage fish loss: consequences for ecosystem connectivity and productivity. BioScience 62(8): 723-731.

Hare, J.A. Morrison, W.E., Nelson, M.W., Stachura, M.M., Teeters, E.J., Griffis, R.B., Alexander, M.A., Scott, J.D., Alade, L., Bell, R.J., Chute, A.S., Curti, K.L., Curtis, T.H., Kircheis, D., Kocik, J.F., Lucey, S.M., McCandless, C.T., Milke, L.M., Richardson, D.E., Robillard, E., Walsh, H.J., McManus, M.C., Marancik, K.E., and Griswold, C.A. 2016. A vulnerability assessment of fish and invertebrates to climate change on the Northeast U.S. Continental Shelf. PLoS ONE 11(2): e0146756. https://doi.org/10.1371/journal.pone.0146756

Klauda, R.K., Moos, R.E., and Schmidt, R.E. 1988. Life history of Atlantic tomcod, Microgadus tomcod, in the Hudson River Estuary, with emphasis on spatio-temporal distribution and movements. Fisheries Research in the Hudson River. 219-251.

Kovach, A.I., Breton, T.S., Enterline, C. and D.L. Berlinsky. 2013. Identifying the spatial scale of population structure in anadromous rainbow smelt (Osmerus mordax). Fisheries Research 141: 95-106.

Lawton, R., Brady, P. Sheehan, C., Correia, S., and M. Borgatti, M. 1990. Final report on spawning sea-run rainbow smelt (Osmerus mordax) in the Jones River and impact assessment of Pilgrim Station on the population, 1979-1981. Pilgrim Nuclear Power Station Marine Environmental Monitoring Program, Report Series No. 4, 72 pp.

Lecomte, F., and J.J. Dodson. 2004. Role of early life-history constraints and resource polymorphism in the segregation of sympatric populations of an estuarine fish. Evolutionary Ecology Research 6: 631-658

Limburg, K.E. and Waldman, J.R. 2009. Dramatic declines in North Atlantic diadromous fishes. BioScience 59(11): 955-965

Marcotte, A. and J.L. Tremblay. 1948. Notes A and JL Tremblay. 1948. Notes sur la biologie biologie dur l'éperlan (Osmerus mordax Osmerus mordax Mitchell) de la Province de Qu Mitchell) de la Province de Québec. Sta. Biol. Saint bec. Sta. Biol. Saint-Laurent, Que. Contrib. 18: 107 pp. Laurent, Que. Contrib. 18: 107 pp.

McKenzie, R.A. 1964. Smelt life history and fishery in the Miramichi River, New Brunswick. Fisheries Research Board of Canada, No. 144.

MDMR. 2017. Maine Department of Marine Resources Regulations. Chapter 40 - Smelts. Retrieved on April 6, 2018.

Miller, B.S. and Kendall A.W. 2009. Early Life History of Marine Fishes. University of California Press. Retrieved from http://www.jstor.org/stable/10.1525/j.ctt1pnqjv

Mingelbier, M., Lecomte, F., and Dodson, J.J. 2001. Climate change and abundance cycles of two sympatric populations of smelt (Osmerus mordax) in the middle estuary of the St. Lawrence River, Canada. Canadian Journal of Fisheries and Aquatic Sciences 58: 2048-2058.

Minister of Justice 2011. Maritime Provinces Fishery Regulations. Current to March 18, 2018.

Morin, R., Swain, D.P., and LeBlanc, S.G. 2012. The status of NAFO Division 4T winter flounder (Pseudopleuronectes americanus), February 2012. DFO Canadian Science Advisory Secretariat Research Document 2012/053. 60p.

Miramichi River Environmental Assessment Committee (MREAC) and the Atlantic Coastal Action Program (ACAP). 2007. State of the Environment Report for the Miramichi Watershed - 2007.

Murawski, S. A., and C. F. Cole. 1978. Population dynamics of anadromous rainbow smelt Osmerus mordax, in a Massachusetts river system. Transactions of the American Fisheries Society 107: 535–542.

NatureServe. 2013. Osmerus mordax. The IUCN Red List of Threatened Species 2013: e.T202413A18229730. Downloaded on April 2, 2018.

NatureServe. 2013. Microgadus tomcod. The IUCN Red List of Threatened Species 2013: e.T202405A18236770. Downloaded on May 16, 2018.

NHF&G. 2015. Wildlife Action Plan, Appendix A: Fish, Rainbow Smelt (Osmerus mordax). Retrieved on April 6, 2018.

NOAA. 2016. Northeast Fish and Shellfish Climate Vulnerability Assessment: Vulnerability to CLimate Related Changes in Abundance. Retrieved on April 6, 2018.

NOAA. 2017. Commercial Fisheries Statistics - Imports and Exports of Fishery Products Annual Summary, 2016. Retrieved on April 3, 2018.

NOAA. 2018a. Commercial Fisheries Statistics. Annual Commercial Landing Statistics. Retrieved on April 3, 2018.

Peppar, J.L. and Blair, R.S. 1977. Types of commercial smelt fishing gear, Restigouche River Estuary, Chaleur Bay, New Brunswick, 1974. Information Publication No. MAR/N-77-1.

Personal communication. 2018. Diana Fillion. Resource Management, Fisheries and Oceans Canada. November 16, 2018.

Pikitch, E., Boersma, P.D., Boyd, I.L., Conover, D.O., Cury, P., Essington, T., Heppell, S.S., Houde, E.D., Mangel, M., Pauly, D., Plagányi, É., Sainsbury, K., and Steneck, R.S. 2012. Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs. Lenfest Ocean Program. Washington, DC. 108 pp.

Robinson, M. and Courtenay, S.C. 1999. Genetic investigations on striped bass (Morone saxatilis) in the Canadian Maritime Provinces. Canadian Stock Assessment Secretariat Research Document 99/06.

Rooney, R.C. and Paterson, M.J. 2006. Ecosystem effects of rainbow smelt (Osmerus mordax) invasions in inland lakes: a literature review. Canadian Technical Report of Fisheries and Aquatic Sciences 2845. 33 p.

Y. Sadovy de Mitcheson. 2016. Mainstreaming fish spawning aggregations into fishery management calls for a precautionary approach. BioScience 66(4): 295-306.

Stewart, L.L. and Auster, P.J. 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) -- Atlantic tomcod. U.S. Fish and Wildlife Service Biological Report 82(11.76). U.S. Army Corps of Engineers, TR EL-82-4. 8p.

Swain, D.P., Hurlbut, T.R., and Benoit, H.P. 2012. Pre-COSEWIC review of variation in the abundance, distribution and productivity of white hake (Urophycis tenuis) in the southern Gulf of St. Lawrence, 1971-2010. Canadian Science Advisory Secretariat Research Document 2012/066.

Swain, D.P., Savoie, L., and Cox, S.P. 2016. Recovery potential assessment of the Southern Gulf of St. Lawrence Designatable Unit of White Hake (Urophycis tenuis Mitchill), January 2015. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/045. vii + 109 p.

van Overzee, H.M.J. and Rijnsdorp, A.D. 2015. Effects of fishing during the spawning period: implications for sustainable management. Reviews in Fish Biology and Fisheries 25(1): 65-83

# Appendix A: Extra By Catch Species

ATLANTIC TOMCOD

## Factor 2.1 - Abundance

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderate Concern**

Atlantic tomcod (*Microgadus tomcod*) is an inshore anadromous fish inhabiting the northwest Atlantic from the Chesapeake Bay to Labrador (Stewart and Auster 1987). There is little information on Atlantic tomcod, but with numerous subpopulations and few threats, the abundance of species is thought to be stable (NatureServe 2013b ). The global population is classified by the IUCN as "Least Concern" (NatureServe 2013b) and we therefore award a score of "moderate" concern.

## Factor 2.2 - Fishing Mortality

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS
CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**Moderate Concern**

Atlantic tomcod is not typically targeted by commercial fisheries and no commercial landings have been reported in the last three years for this species (DFO 2018b). However, tomcod is retained when captured in the smelt fishery and it was estimated that 30 MT of tomcod were landed annually in 1994 and 1995 (Bradford et al. 1997). The season for smelt has changed since that publication and there is no updated data on Atlantic tomcod mortality in the smelt fishery or from other sources. Since fishing mortality is largely unknown, we award a score of "moderate" concern.

## Factor 2.3 - Discard Rate

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**≥ 100%**

With the exception of Atlantic tomcod, all incidentally caught species are discarded and released fish are assumed to survive, but there is little information on actual survivability (D. Fillion, personal communication 2018). Survivability may vary seasonally for some species (DFO 2011b). For example, young-of-the-year striped bass mortality can be very high in the open water smelt fishery because of the difficulty of culling large numbers of small bass from smelt catches (DFO 2011b), whereas annual mortality of medium- and large-sized bass may be 23% (COSEWIC 2012).

Landings of smelt and tomcod in the open water bag fishery in Miramichi in 1994 were 12 MT and 30 MT (Bradford et al. 1997). Incidental catches of hake and flounder were 40 MT and 3 MT respectively, and striped bass bycatch was over 100,000 age-0 fish and less than 1000 each of age-1 and age >2 fish (Bradford et al. 1997). In the 1995 survey, 20 MT of smelt and 30 MT of tomcod were landed, compared to incidental catches of 20 MT hake, 4 MT flounder, and 400,000 age 0, and more than 1000 age 1 and age >2 striped bass fish (Bradford et al. 1997). The discard to landings ratio for weight of fish encountered in 1994 was 1.02, but 0.48 in 1995. However, this does not include the weight of discards of striped bass (131,000 fish in 1994; 501,000 fish in 1995—mostly juveniles) or any other encountered species. The smelt fishing season now starts later to reduce bycatch of striped bass and fewer bass are incidentally captured in the ice fishery

(DFO 2011b). There is no data available on the discard rate following bycatch mitigation measures. Without evidence contrary to research from Bradford et al. (1997) discards are assumed to exceed landings.

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS, WINTER FISHERY

**< 100%**

With the exception of Atlantic tomcod, all incidentally caught species are discarded and released fish are assumed to survive, but there is little information on actual survivability (D. Fillion, personal communication 2018), which may vary seasonally for some species (DFO 2011b). Bycatch data used in this report is from Bradford et al. (1997), which only covers the open water (autumn) fishery. Historically, the open water fishery accounted for around 20% of the annual smelt catch (Bradford et al. 1997). There is no equivalent quantitative information for bycatch in the winter (ice) fishery, but white hake and striped bass are largely absent from waters where smelt are caught in the winter (DFO 2011). Since the winter fishery is unlikely to encounter white hake and striped bass, total bycatch in the winter fishery is likely lower than the autumn fishery and the discard ratio is likely <100%.

STRIPED BASS

## Factor 2.1 - Abundance

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**High Concern**

Striped bass (*Morone saxatilis*) spawner abundance was roughly 300,000 in 2016 and 994,000 in 2017 (with a high level of uncertainty) and objectives in the Recovery Potential Assessment for this population were met for the seventh straight year for the Gulf of St. Lawrence stock (DFO 2018). The recovery limit—as established in the context of the Species at Risk Act—for this stock is 21,600 spawners, and the recovery target for fisheries access is when there are >31,200 spawners in three of six consecutive years (DFO 2018). However, this access only applies to First Nations for food, social, and ceremonial purposes. Other abundance indicators (e.g., high catch rates in fisheries, surveys, and range expansion) are consistent with spawner abundance estimates and show an increase in abundance of more than 100 fold since the 1990s (DFO 2018). This stock has met the recovery target for seven consecutive years, but there is considerable uncertainty in spawning population. Striped bass are currently considered a species of special concern by the Committee of the Status of Endangered Wildlife in Canada (COSEWIC) because they are susceptible to high rates of fishing-related mortality, and the population in the southern Gulf of St. Lawrence depend on a single spawning location (COSEWIC 2012). Because of the COSEWIC status, we award a score of "high" concern.

**Justification:**

Coastal migratory striped bass range from North Carolina to the St. Lawrence River in Canada (ASMFC 2013), but the Canadian populations are likely distinct stocks (Robinson and Courtenay 1999). The Bay of Fundy, Southern Gulf of St. Lawrence, and St. Lawrence Estuary are the three known Canadian stock units (COSEWIC 2012). Striped bass from the Southern Gulf of St. Lawrence stock are most likely to be encountered in the smelt fishery, primarily in the fisheries in Miramichi Bay and Richibouctou River (DFO 2011).

In the Gulf of St. Lawrence, striped bass abundance drastically declined during the 1990s, reaching less than 5,000 spawners and prompting a fisheries closure (DFO 2001). The species was listed as "Threatened" in 2004 by the Committee on the Status of Endangered Wildlife in Canada, and downgraded to "Special Concern" in 2012 (DFO 2018).

(DFO 2018)

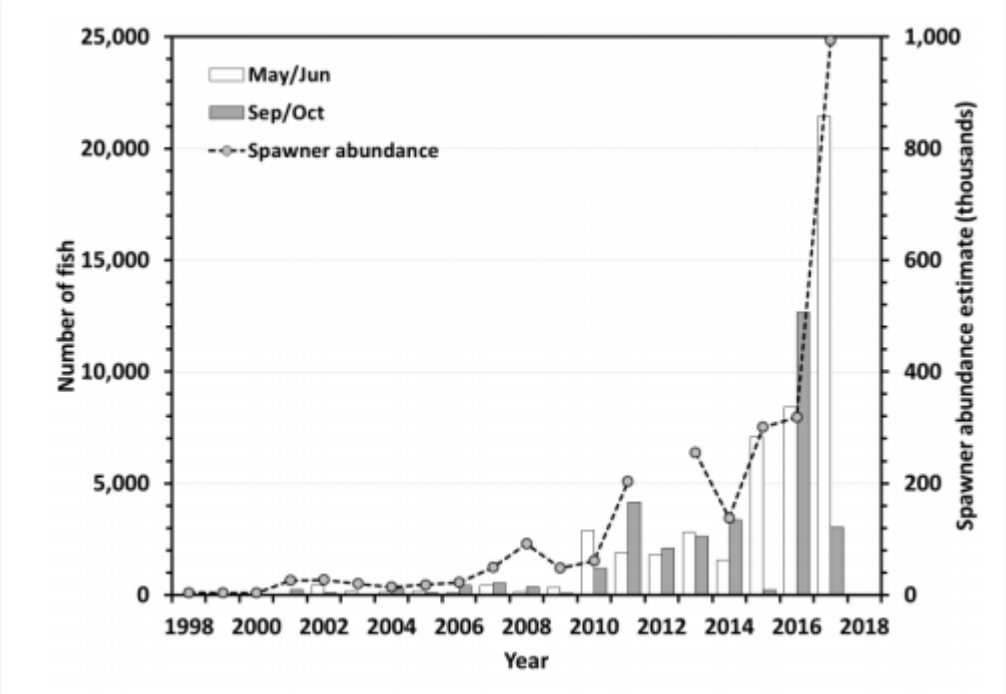



Figure 12 Striped bass abundance from index trapnets in the Miramichi River system in New Brunswick, and spawner abundance estimates (DFO 2018).

## Factor 2.2 - Fishing Mortality

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**Moderate Concern**

Sources of current fishing mortality on striped bass include illegal fishing, bycatch in other fisheries (including the rainbow smelt fishery), and recreational and aboriginal fisheries (COSEWIC 2012) (DFO 2018). Illegal fishing accounts for over half of adult bass mortality (DFO 2011b). It is unknown whether current levels of fishing mortality are sustainable, but the population of striped bass in the southern Gulf of St. Lawrence continues to improve. Given the uncertainty in fishing mortality, we award a score of "moderate" concern.

**Justification:**

The targeted commercial fishery for striped bass in the Gulf of St. Lawrence was permanently closed in 1996 and the recreational and aboriginal fisheries were closed in 2000 (DFO 2001). Aboriginal and recreational fisheries reopened in 2012 and 2013 respectively (DFO 2018). In terms of bycatch in other fisheries, post-release mortality estimates vary by fishery, but an estimated 61,700 medium and large-sized striped bass are thought to be killed each year in the southern Gulf of St. Lawrence fisheries targeting shad, smelt, eel, salmon, and others (DFO 2011b). Striped bass caught in smelt fisheries are overwhelmingly juvenile fish.

## Factor 2.3 - Discard Rate

CANADA / GULF OF ST. LAWRENCE, STATIONARY UNCOVERED POUND NETS

**≥ 100%**

With the exception of Atlantic tomcod, all incidentally caught species are discarded and released fish are assumed to survive, but there is little information on actual survivability (D. Fillion, personal communication

2018). Survivability may vary seasonally for some species (DFO 2011b). For example, young-of-the-year striped bass mortality can be very high in the open water smelt fishery because of the difficulty of culling large numbers of small bass from smelt catches (DFO 2011b), whereas annual mortality of medium- and large-sized bass may be 23% (COSEWIC 2012).

Landings of smelt and tomcod in the open water bag fishery in Miramichi in 1994 were 12 MT and 30 MT (Bradford et al. 1997). Incidental catches of hake and flounder were 40 MT and 3 MT respectively, and striped bass bycatch was over 100,000 age-0 fish and less than 1000 each of age-1 and age >2 fish (Bradford et al. 1997). In the 1995 survey, 20 MT of smelt and 30 MT of tomcod were landed, compared to incidental catches of 20 MT hake, 4 MT flounder, and 400,000 age 0, and more than 1000 age 1 and age >2 striped bass fish (Bradford et al. 1997). The discard to landings ratio for weight of fish encountered in 1994 was 1.02, but 0.48 in 1995. However, this does not include the weight of discards of striped bass (131,000 fish in 1994; 501,000 fish in 1995—mostly juveniles) or any other encountered species. The smelt fishing season now starts later to reduce bycatch of striped bass and fewer bass are incidentally captured in the ice fishery (DFO 2011b). There is no data available on the discard rate following bycatch mitigation measures. Without evidence contrary to research from Bradford et al. (1997) discards are assumed to exceed landings.