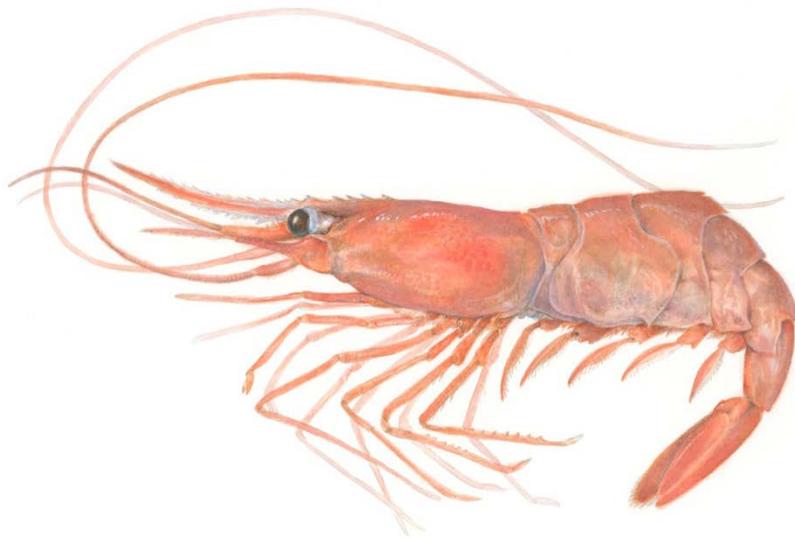


Monterey Bay Aquarium Seafood Watch®

Northern shrimp

Pandalus borealis



©Monterey Bay Aquarium

Nova Scotia, Canada

Trap

February 3, 2016

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About Seafood Watch®

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

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

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished¹ or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

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

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

Each criterion includes:

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

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and the Safina Center's online guide:

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

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

Avoid/Red: Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

ry scored as a Very High Concern for either factor under Management (Criterion 3).

¹ "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates.

Summary

This report assesses the sustainability of the northern shrimp (*Pandalus borealis*) trap fishery of Chedabucto Bay, Nova Scotia, Canada (within SFA-15). A larger trawl fishery also exists for this species throughout the Scotian Shelf (SFAs 13-15); however, the mobile fleet is not included in this report.

The northern shrimp is the only shrimp of commercial importance on the Scotian Shelf. This species inhabits waters ranging from 2-6 °C, and prefers a bottom habitat of mud and high organic content. Northern shrimp are protandroushermaphrodites, maturing first as males (around two years of age) and switching sexes to become female after a couple years (DFO 2015). The maximum age for this species is believed to be eight years, and northern shrimp remain reproductively active throughout their lives.

Trawling for shrimp has occurred on the Scotian Shelf since the 1960s. Trapping for shrimp in Chedabucto Bay began in the mid-1990s, and shrimp caught by this fleet are primarily exported to Maine, US. There are 14 trap licences in total (with specific spatial restrictions within the Bay) with fishers permitted a total of 100 traps each. Currently, the trap fishery is allocated 8% of the TAC for SFAs 13-15 (i.e., 360 t for 2015) and this quota is fished competitively. In 2014, the trap fishery landed 250 t (70% of their TAC for that year).

The northern shrimp in SFAs 13-15 are managed as one stock. At present, this stock is not overfished and no overfishing is currently occurring. The annual stock assessment is based on data from a variety of sources (i.e., an annual DFO/ industry trawl survey, CPUE indices derived from commercial fishing log data, and catch samples collected by the fishery), and the TAC is revised annually in response to stock size as well as environmental conditions and biological indicators. Due to the specific design of the traps used in Chedabucto Bay, bycatch in this fishery is negligible. Shrimp are a prey species for snow crabs and occasionally these larger crustaceans are attracted to the trapped shrimp and hauled up on the outside. However, all incidentally caught animals are returned to the ocean alive.

The current management plan for Scotian Shelf northern shrimp is highly precautionary and aims to ensure proper monitoring and long-term sustainability of the shrimp population fished by the trap fishery (and the more extensive trawl fishery). Specific strengths of management include regular stock assessments, a precautionary harvest strategy, and the involvement of several stakeholders that provide regular input and recommendations for the fishery. Given that the fishing grounds used by trap fleet are very small, there are very few concerns with regard to the fishery's impact on the surrounding ecosystem. Nonetheless, measures are in place to maintain the spatial footprint of this fishery (i.e., zonal restrictions) and over 50% of the fishing region (i.e., SFA 15) is protected from this gear type.

Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Northern pink shrimp - Trap	Green (5.00)	Green (4.75)	Green (5.00)	Green (4.00)	Best Choice (4.668)

Scoring Guide

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

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

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

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

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Introduction

Scope of the analysis and ensuing recommendation

This report assesses the sustainability of the Northern shrimp (*Pandalus borealis*) trap fishery of Chedabucto Bay, Nova Scotia, Canada (SFA-15 on the Scotian Shelf). While a Marine Stewardship Council (MSC) recommendation currently exists for otter trawl-caught shrimp from the region (SFAs 13, 14, and 15 collectively), this assessment pertains exclusively to the much smaller trap fishery, for which no other recommendation currently exists.

Overview of the species and management bodies

The following description of key life history and ecological attributes of the northern shrimp was obtained from the previous Seafood Watch assessment (Lingard 2009).

Shrimp belong to the Class Crustacea, which includes species such as lobsters, crabs, and crayfish. These animals are characterized by a hard outer shell or exoskeleton, jointed legs and, as most crustacean are aquatic, they breathe through gills. The Northern shrimp is pale scarlet when alive (hence its name the “pink” shrimp), has a pair of large compound eyes and can grow as large as 15 to 16 cm, although most are smaller than this. The shell covering the head and thorax, together known as the carapace, is modified into a long, curved, sword-like structure called a rostrum which has numerous spines on both edges. Many shrimp, including the Northern shrimp, are good swimmers. Appendages on the tail (abdomen), called pleopods, act like paddles and enable the animals to move with remarkable agility, both horizontally and vertically, over considerable distances. Sudden flexing of the tail also allows rapid movement over short distances as an emergency mechanism of escape. These shrimp appear to prefer areas where the bottom is soft and muddy.

In the northwest Atlantic, shrimp are most abundant in waters between 2-6°C. In some areas, these temperature requirements restrict their distribution to depths greater than approximately 180 m. There also is a relationship between size and depth, with larger animals generally occurring in greater proportions in deeper water. Migrations are of two types, horizontal and vertical. Horizontal migration is apparently seasonal and occurs when egg-bearing females migrate to shallower water (within the limits, of course, imposed by temperature), where they are often found in dense concentrations. After eggs hatch, distribution is usually less concentrated. Vertical migration occurs on a daily basis as the shrimp tend to leave the ocean floor at night and move upward in the water column, presumably in search of small pelagic crustaceans which form part of their diet.

Shrimp are both hermaphroditic and protandrous. This means that male sex organs develop first and function before the female organs. After functioning as a male, the shrimp goes through a transition period and then spends the remainder of its life as a female. In some areas, early maturing females are found and in these instances the male phase is suppressed or absent.

In the northwest Atlantic, shrimp lay eggs during the late summer and fall. The eggs remain attached to the abdominal appendages of the female until the following spring. An average-sized female carries around 1,700 eggs. These develop over the egg-bearing period and hatch as larvae. The larvae float to waters near the surface where they feed and after several months, they migrate nearer to the ocean floor, and continue their transition to adults. Most shrimp remain immature through the second year and mature as males in the third year, although in some areas where the temperatures are lower, e.g. Scotian Shelf, they mature at 4 yrs. Generally, the transition to the female stage takes place early in the fourth year (depending on the area), followed by ripening of the ovaries, mating and spawning. Females may spawn in one or more successive years and live to be five years of age and older. In areas where water temperatures are at the lower end of the range of tolerance, both growth and maturation are retarded such that shrimp spend more time in the male phase, and the life span tends to be longer.

Shrimp, in order to grow, must periodically shed the hard outer shell through a process called moulting (ecdysis). When the shrimp crawls out of the old shell, its body begins to absorb water and increases in size before the new soft shell begins to harden. During the period when the shell is soft, the shrimp are highly vulnerable to predators. Actual growth takes place during the period between moults (intermoult) as the water previously absorbed is replaced by body tissue. Moulting and growth slows down as the shrimp become older. Females can grow only when they are not carrying eggs.

Northern shrimp feed on the bottom during the daytime on various items such as worms, small crustacea, detritus and marine plants. Small pelagic crustacea called copepods and euphausiids (krill) are probably heavily preyed upon at night when the shrimp migrate vertically in the water column. Shrimp themselves serve as food for many species of fish, especially Greenland halibut (turbot) and cod. They also have been found in the stomachs of harp seals.

Production Statistics

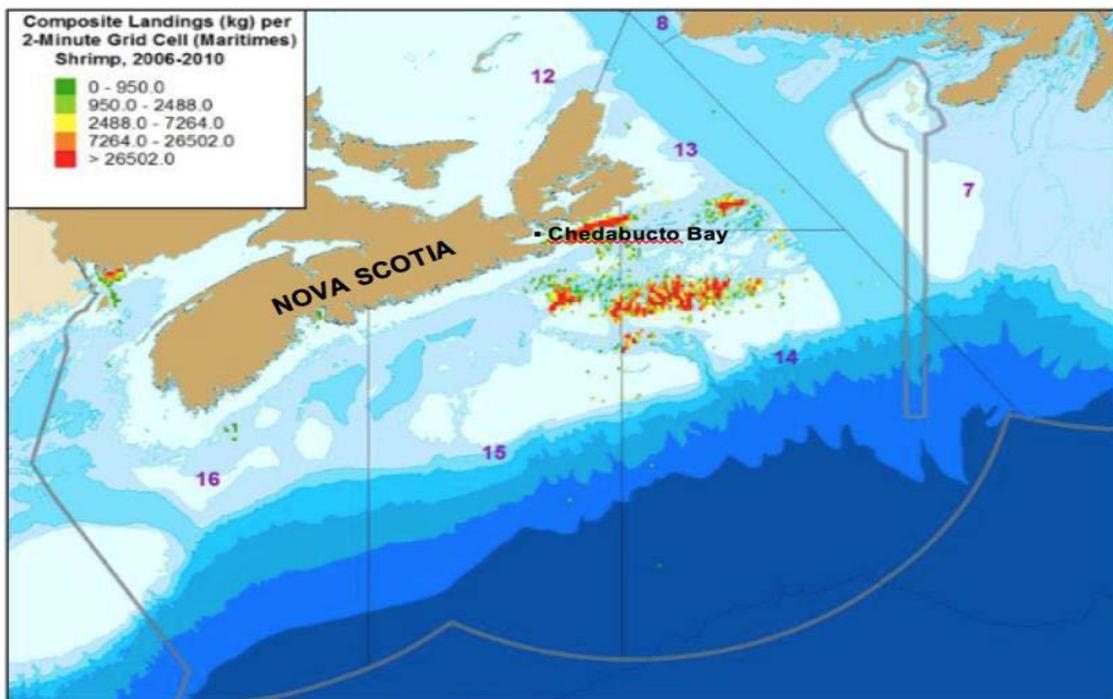
Trawl fishing for shrimp on the Scotian Shelf (SFAs 13-15) began in the 1960s. However, it was not until the invention of the Nordmøre grate in the early 1990s that groundfish bycatch could be mitigated and the fishery was able to expand (DFO 2015). Today, the trawl fishery operates mostly during late spring and early summer in the deep offshore shrimp “holes” (Figure 1). This fleet (~14 active vessels) is divided into two sectors: vessels 65-100' Length Over All (LOA) based in New Brunswick in the DFO Gulf Region, and vessels <65' LOA based in the DFO Maritimes Region (DFO, 2015). In addition to the mobile fleet, a fixed gear (trap) fishery also lands northern shrimp in SFA-15.

Primarily driven by interest and pressure from local fisherman, the shrimp trap fishery was established in 1995 and operates exclusively within Chedabucto Bay, Nova Scotia. As such, it does not overlap in spatial distribution with the mobile fleet. However, in 1998, it was determined that the trappers in Chedabucto Bay were fishing the same stock as the mobile fleet and they were thus allocated 10% of the annual TAC for the region (DFO, 2013). At present, 14 licenses are assigned to this fleet (with 8 active in 2015) and each fisher is permitted 100 traps. The annual TAC for the trap fishery was adjusted in 2005 and is currently set at 8% of the total TAC for SFAs 13-15 (with the other 69.5% for the

Maritimes Region mobile fleet and 22.5% for Gulf Region mobile fleet). The quota for the trap fishery in 2014 and 2015 was 360 t.

The trap quota is fished competitively and, in 2002, the fleet accounted for 9% of the total shrimp landings off the Scotian Shelf. However, this fleet caught significantly less (i.e., ~1 t annually) from 2005-2010. Since 2010, landings have increased annually, with 111 t landed in 2011 (66% of the TAC), 199 t in 2012 (81% of the TAC), 224 t in 2013 (74% of the TAC) and 250 t in 2014 (69% of the TAC). It is believed that the entire allocated quota will be landed for 2015; however, prior to this year, any uncaught quota from the trap fishery could be transferred to the mobile fleet, which operates under an Individual Transferable Quota (ITQ) system (DFO 2015). No compensation has been provided to the trap fleet for this sharing and transfers were made to the trawl fleet collectively, not to specific license holders.

The fishery is co-managed by the Department of Fisheries and Oceans and the Eastern Scotian Shelf Shrimp Committee (ESSSC) through a highly transparent process that involves annual meetings and collaboration with a variety of stakeholders (including fishers groups, processors, local Aboriginal groups, and scientists).



Scotian Shelf Shrimp Fishing Areas and catch of northern shrimp by the mobile fleet in SFAs 13, 14, 15 (2006-2010). The majority of the catch occurs is landed offshore “holes” (i.e., Louisbourg, Misaine and Canso), with only small amounts being taken in inshore waters (including Chedabucto Bay). Annual landings from the trawl fishery between 2006-2010 ranged from 316,000-416,000 t. (Image modified from DFO 2013.)

Importance to the US/North American market

With fisheries extending from the Gulf of Mexico northward along the eastern seaboard of the United States, northern shrimp are a product common in the North American seafood market. However, both landings and value of northern shrimp in the U.S. have declined in recent years and the biomass of this species in the Gulf of Maine reached a record low in 2013 (NFSC 2014).

Canada is the world's largest exporter of coldwater shrimp and these products are the country's fourth most valuable seafood export.^[1] Of the 30 shrimp species found on the Atlantic side of Canada, *P. borealis* represents 97% of commercial landings. With respect to the overall commercial shrimp fishery in the Maritimes Region, the Scotian Shelf shrimp fishery (SFA 13-15) represents <1% of landed value, and only about 15% of regional shrimp landings, as the majority is landed by the offshore fleet (DFO 2013). Landed value for Scotian Shelf shrimp peaked at \$12 million in 2000 and declined steadily through 2010 (\$4.8 million).

Originally, the Japanese sashimi market was the main destination for northern shrimp caught by the Chedabucto Bay trap fishery. However, presently almost all of the catch is retained in North America and exported just south of the Canadian border to Maine (Rob Johnson pers. comm.). In particular, the trap fishery is believed to add an estimated \$700,000 annually to the Nova Scotian town of Canso, the main port from which trap fishers embark. At present, northern shrimp caught by the trap fishery sell for \$1.30/lb (Alen Newell pers. comm.).

[1]From: <http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/shrimp-crevette-eng.htm>

Common and market names

In the US, this species goes by northern shrimp, pink shrimp, salad shrimp, and deepwater prawn (Fish Watch 2014). These appellations apply in Canada as well, where it is additionally known as the deep-sea prawn, great northern prawn, and crevette nordique (Holtuis 1980).

Primary product forms

Northern shrimp from the trap fishery are exported to the United States as frozen product. Given their high quality, they are most commonly steamed or poached and served whole.

Assessment

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

Criterion 1: Stock for which you want a recommendation

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*
Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Criterion 1 Summary

NORTHERN PINK SHRIMP				
Region / Method	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
Nova Scotia Trap	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)

Criterion 1 Assessment

NORTHERN PINK SHRIMP

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*

- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).
Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.*

Nova Scotia , Trap

Medium

Based on the Seafood Watch vulnerability rubric, the northern shrimp (*P. borealis*) has moderate inherent vulnerability (see Figure 2).

Rationale:

Northern shrimp are protandrous hermaphrodites, maturing first as males (around two years of age) and switching sexes to become female a couple years later (DFO 2015). This species is believed to live upward of eight years, remaining reproductively active throughout its life. Northern shrimp are ovigerous and spawning occurs in the fall. Females carry their eggs on their abdomen for about eight months until they hatch in the spring (DFO 2015). Given this life history strategy, northern shrimp would likely exhibit compensatory compensation at low densities.

Attribute	Details	Score	Source
Average age at maturity	All individuals mature as male at age 2; change to female around age 3-4	3	DFO 2015
Average maximum age	Up to 8	3	DFO 2015
Reproductive strategy	Live bearer (brooder)	1	DFO 2015
Density dependence	Likely	1	
Mean score		2	

Life history attributes of northern shrimp (*Pandalus borealis*).

Factor 1.2 - Stock Status

Scoring Guidelines

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*

- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

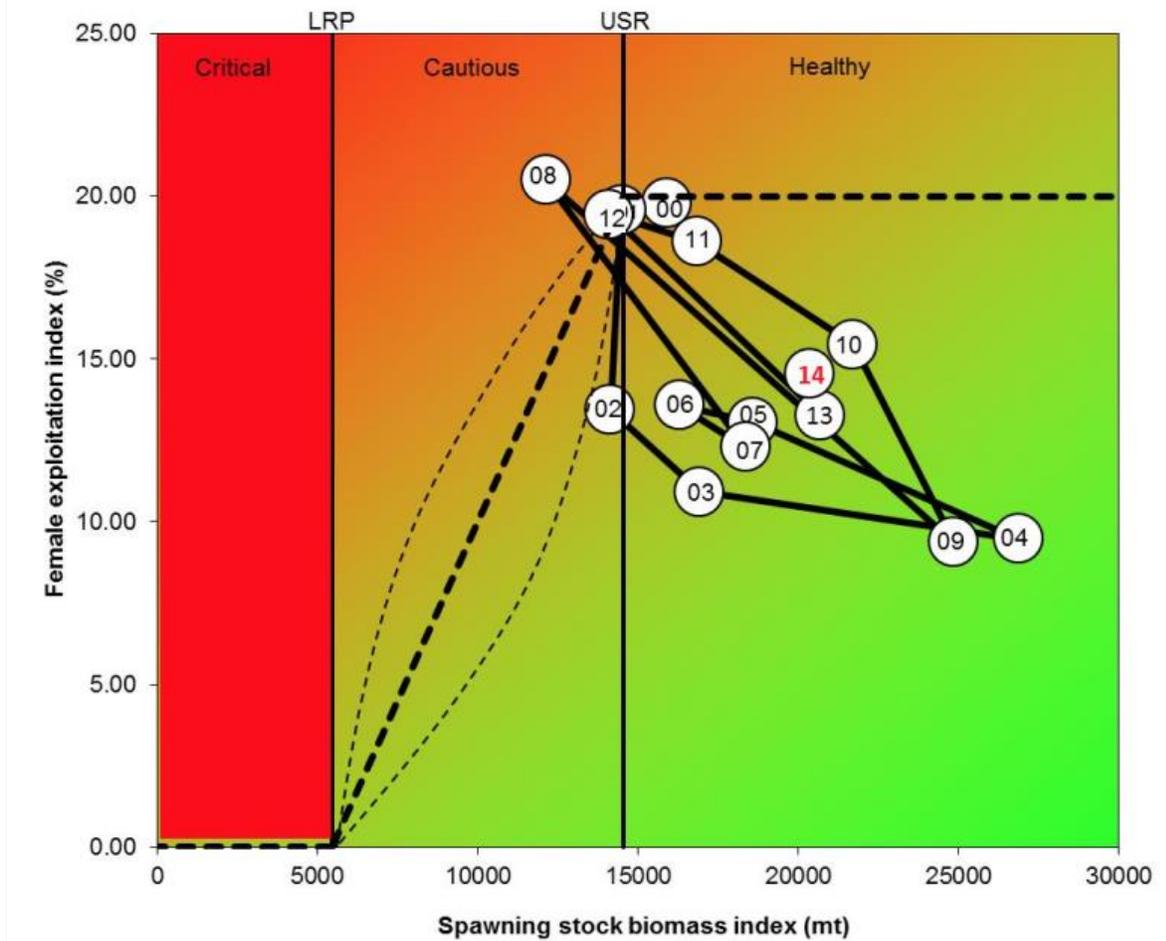
Nova Scotia , Trap

Very Low Concern

The northern shrimp stock in SFAs 13-15 is considered healthy and it is not currently overfished.

Rationale:

Based on the annual DFO trawl survey index, the total biomass estimate for northern shrimp in SFAs 13-15 was 39,381 t. This estimate shows stock stability at a high level with only a 1.5% decrease from 2013 (DFO 2015). This biomass estimate is only 15% lower than the peak in 2009. Furthermore, the spawning stock biomass (i.e., only females) point estimate of 20,359 t remained well above the Upper Stock Reference (USR) point of 15,558 t and has decreased by only 1.5% from the 2013 value (Figure 3). Although there are no quantified confidence limits around the SSB point estimate and there is some uncertainty around this index, the SSB point estimate is well above the USR for 2014 (DFO 2015).



Current (red) and past (black) estimates of spawning stock biomass (SSB) for northern shrimp in SFAs 13-15 (number in circle refers to year). At present, SSB is estimated at 20,359 t and the population is in the healthy zone, above both the Upper Stock and Limit Reference points. (Image from DFO 2015.)

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- 5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible ($\leq 5\%$ of a sustainable level of fishing mortality).
- 3.67 (Low Concern)—Probable ($>50\%$) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing

mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).

- 2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.
- 1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.
- 0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

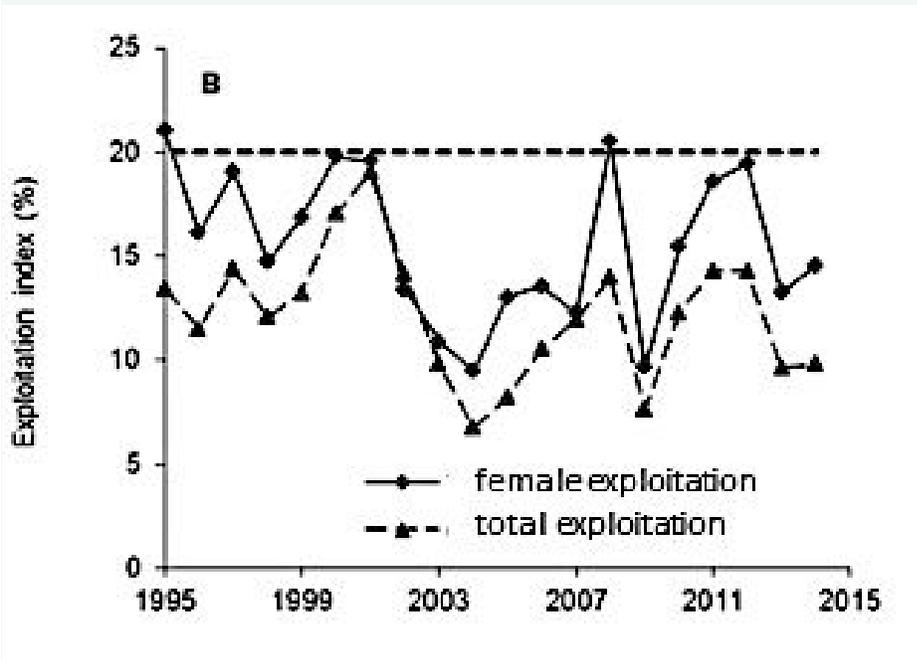
Nova Scotia , Trap

Very Low Concern

There are no concerns of overfishing for the northern shrimp stock in SFAs 13-15.

Rationale:

As of 2014, both the total exploitation and female exploitation indices for the northern shrimp stock on the Scotian Shelf were low and relatively stable at 10% and 15% respectively (DFO 2015). Female exploitation remains below the 0.20SSB removal reference for this stock and there are currently no concerns of overfishing (Figure 4).



Annual exploitation indices for the Eastern Scotian Shelf shrimp fishery (1995-2015). The upper dashed line shows the limit reference point of .20SSB; both overall exploitation and exploitation of females is currently stable and there are no concerns of overfishing at present. (Image from DFO 2015.)

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghostfishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- Score >3.2=Green or Low Concern
 - Score >2.2 and <=3.2=Yellow or Moderate Concern
 - Score <=2.2=Red or High Concern
- Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical.

Criterion 2 Summary

Northern pink shrimp: Nova Scotia , Trap				
Subscore::	5.000	Discard Rate:	0.95	C2 Rate: 4.750
Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NORTHERN PINK SHRIMP	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000

Concerns of bycatch in the Chedabucto Bay trap fishery are negligible since the structure of the traps is designed to make them highly selective for northern shrimp (Koeller et al. 2007; DFO 2013). Specifically, the trap opening consists of a 16" long tapered funnel (from 6" to 1.5" wide) and this prevents any other species from entering the trap (Alen Newell pers. comm.).

On occasion (i.e. <0.01% of hauls), snow crabs are brought up on the outside of the shrimp traps. Since the presence of snow crabs on traps can actually deter shrimp from approaching the traps, fishers have additionally modified the traps to include pieces of plastic on the top of the traps surrounding the funnel entrance. This modification makes the trap exterior slippery and largely prevents snow crabs from gaining a firm grip on the trap or entering the funnel (Alen Newell pers. comm.). All snow crabs brought up are thrown back alive since retention of bycatch is not permitted. Specifically, License Condition 23 for this fishery states that, "all other species of fish that are caught while fishing for shrimp shall be immediately returned to the place from which it was taken and, where it is alive, in a manner that causes it the least harm" (DFO 2013). Given that fishing occurs during the winter, the temperature of the water column is fairly constant and thus post-discards mortality of these snow crabs is unlikely.

Fishers also report that they have also hauled up eels (species unknown), but anecdotal evidence suggests this happens very rarely (i.e., once or twice annually) (Alen Newell pers. comm.) and thus it is not of significant concern.

Criterion 2 Assessment

2.4 - DISCARDS + BAIT / LANDINGS

Nova Scotia , Trap

20-40%

Key Relevant Info:

All trap fishing requires some form of bait to attract and lure the target species. The primary bait used in the trap fishery in Chedabucto Bay is salted herring, a byproduct of a roe fishery (Alen Newell pers. comm.). Each shrimp trap uses around 0.3-0.4 kg herring as bait. While using the herring for bait is a better use than discarding or turning into fishmeal, it could nonetheless be used for direct human consumption. For this reason, we have downgraded the score here from 0-20% to 20-40%.

Criterion 3: Management effectiveness

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

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*
Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
Nova Scotia Trap	5.000	All Species Retained	Green(5.000)

Factor 3.1: Harvest Strategy

Scoring Guidelines

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered.*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*

- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of illegal, unregulated, and unreported fishing occurring.*

Factor 3.1 Summary

Factor 3.1: Management of fishing impacts on retained species							
Region / Method	Strategy	Recovery	Research	Advice	Enforce	Track	Inclusion
Nova Scotia	Highly	N/A	Highly	Highly	Highly	Highly	Highly
Trap	Effective		Effective	Effective	Effective	Effective	Effective

Subfactor 3.1.1 – 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? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Nova Scotia , Trap

Highly Effective

This is a limited entry fishery based on a precautionary approach. Appropriate reference points are set and the annual quota is adjusted accordingly, based on scientific stock assessments. The Integrated Fisheries Management Plan (IFMP) for northern shrimp in SFAs 13-15 IFMP is reviewed annually to ensure that it remains up to date and the objectives, strategies, and tactics remain appropriate (DFO 2013).

Rationale:

As described in detail in DFO (2013), the Scotian Shelf northern shrimp fishery is managed based on five overarching ecological and social goals:1. Productivity: Do not cause an unacceptable reduction in productivity so that all components can play their role in the functioning of the ecosystem;2. Biodiversity: Do not cause an unacceptable reduction in biodiversity in order to preserve the structure and natural resilience of the ecosystem;3. Habitat: Do not cause significant modification to habitat to safeguard both physical and chemical properties of the ecosystem;4. Culture and Sustenance: Respect Aboriginal and treaty rights to fish;5. Prosperity: Create the circumstances for economically prosperous fisheries. In order to accomplish each of these goals, clearly defined, management strategies and measures are in place. This fishery is managed by a limited entry licensing system (42 mobile licenses 14 trap licenses in SFAs 13-15); fleet capacity is currently limited to ensure that a long-term yield of 3,000-5,000 t annually can be achieved (DFO 2015). With regard to overall stock productivity, management bases its approach on the knowledge that shrimp are highly sensitive to environmental conditions (and the associated abundance trends of their predators). As such, the harvest strategy is not set for a fixed MSY. Instead, fleet capacity and fishing pressure are limited through licensing and setting an annual

quota (TAC) of no more than .20SSB. This maximum removal reference is conservative, as the approximate range of natural mortality for this species is 0.25-0.33. Although the stock is currently believed to be in a high-productivity period, fishery reference points are set based on data from 2000-2010 since reference points derived from a shifting average would be less precautionary if biomass was to decline (DFO 2015). Under this strategy the current the Limit Reference Point (LRP) for this fishery is .30SSB (2000-2010) and the Upper Reference Point (URP) is 0.80SSB (2000-2010). When the stock is in the “cautious zone” (i.e., $URP > SSB_{current} < LRP$), the TAC is set to reduce fishing mortality and fishing is restricted when the stock is in the “critical zone” (i.e., $SSB_{current} < LRP$). The TAC for 2014 was set at 4,500 t (up 18% from 3,800 t in 2013) to capitalize on the high fishable biomass of the abundant 2007-2008 year classes, yet female exploitation is maintained at 0.15SSB (DFO 2015).

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery’s impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

Nova Scotia , Trap

N/A

No overfished, depleted or threatened species are targeted by this fishery.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery’s impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Nova Scotia , Trap

Highly Effective

This fishery is based on a precautionary approach, and management incorporates both fishery-dependent and independent data into annual stock assessments, and sets the harvest strategy accordingly. The stock assessment for SFAs 13-15 undergoes a full peer-review every two years (DFO 2013).

Rationale:

Research was not conducted annually on this stock prior to 1994. However, since 1995, ongoing monitoring and sampling of catches from both the trap and trawl fishery has led to improved knowledge of shrimp distribution, abundance, and migration patterns throughout the region. Although fisheries reference points are based on a single abundance and removal index, scientific stock assessments incorporate data from an annual DFO/industry trawl survey, CPUE indices derived from commercial fishing log data, and catch samples collected throughout the fishery. As described in DFO (2013), “indices of shrimp abundance (e.g., indices of resource dispersion), production (e.g., spawning stock biomass, recruitment, year-class strength, shrimp size trends, predation), fishing effects (e.g., exploitation rates, female/ovigerous shrimp harvest) and ecosystem health (e.g., temperature, predator species abundance) are used to provide a broad overview of factors thought to be associated with stock status of Scotian Shelf shrimp”.

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Nova Scotia , Trap**Highly Effective**

There is close collaboration between management and the scientific advisory team.

Rationale:

As noted above, the precautionary approach is applied in the management of this stock. All quotas in recent years have always been set based on stock assessment output data. Given the substantial influence of recruitment on shrimp abundance, recommendations are also based on predicted abundance trends made by tracking the cohorts as they recruit to the fishery. Past management decisions include two considerable decreases in the TAC (30% and 40% reductions) in response to declines in stock health indicators despite continued high catch rates and biomasses (DFO 2015). As a result of poor recruitment from 2009-2012, the stock has begun an anticipated decline and the Advisory Committee (following scientific advice) has reacted accordingly and cut the TAC by 28% for 2016 (David Hardie pers. comm.).

Subfactor 3.1.5 – 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.

Nova Scotia , Trap

Highly Effective

In general, several at-sea and at-port measures are in place to ensure proper fishing behaviour and policies are adhered to. Compliance in the shrimp fishery (both mobile and trap) is achieved through the application of the *Fisheries Act*, the *Fishery (General) Regulations*, the *Atlantic Fishery Regulations* and the *Aboriginal Communal Fishing Licenses Regulations* by Fishery Officers (DFO 2013).

Rationale:

Between 2010-2011, the time dedicated to enforcement of the Scotian Shelf shrimp fishery increased by over 40 hours as a result of additional education and planning activity associated with the trap fishery in Chedabucto Bay. Given that the mobile fleet is substantially larger and takes more of the catch annually, the majority of the time spent on enforcement still pertains to this fleet. Nonetheless, measures employed by DFO's Conservation and Protection Team that are specific to the trap fishery currently include: independent (third-party) license and logbook verification upon landings (20% coverage), electronic vessel monitoring equipment (VMS) monitoring of hailing in and out onboard, and air patrols to ensure compliance with license conditions and area closures. All trap license holders are subject to random at-sea monitoring checks while fishing. Although there has been limited observer coverage for this fishery in recent years, in 2012 there were two violations in the trap fishery for not tending shrimp traps on time (Parsons et al. 2013). Overall, DFO (2013) states that compliance for management measures imposed on the mobile and trap fisheries in SFAs 13-15 has been good. Furthermore, the catch of shrimp by the trap fleet has always been less than their annual TAC. Most recently (i.e., 2011-2014), approximately 72% of trap quota was landed before the remainder was transferred to mobile fleet.

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

Nova Scotia , Trap

Highly Effective

Management's precautionary approach to setting annual catch limits has resulted in the long-term maintenance of northern shrimp biomass at a healthy level.

Rationale:

Despite fluctuations in shrimp recruitment due to environmental factors, management has successfully adjusted the annual TAC in response to these conditions (e.g., 2008 in Figure 2). As such, the stock was allowed to recover for the subsequent year; the current abundance of northern shrimp likely remains above all reference points as a result of this precautionary approach (DFO 2013; 2015).

Subfactor 3.1.7 – 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 and includes stakeholder input.

Nova Scotia , Trap

Highly Effective

The shrimp fishery uses a co-management approach and discussion and decisions occur annually via the Eastern Scotian Shelf Shrimp Advisory Committee (ESSSAC), which is a collective of a various stakeholders and fisheries managers. Through the SSSAC, current fishery management processes are reviewed, including: the performance of the fishery (both in terms of the TAC and its economic viability), current monitoring, surveillance and enforcement activities, stock status from the latest assessment, and new research and scientific advice (DFO 2013).

Rationale:

ESSSAC members include representatives from both the mobile fleet and the trap fleet (represented by a single group: the Chedabucto Bay Shrimp Trappers Association), as well as shrimp processors, provincial governments, and First Nations. Given the size of the ESSSAC, smaller working groups will discuss specific issues before reporting report back to the collective body. The ESSSAC is chaired by the Senior Advisor for shrimp from the Maritimes Region of DFO and annual meetings are scheduled to review current stock research and prepare the fishing plan for the ensuing season. As such, meetings include the presentation of scientific advice, and the TAC is determined at this time. To ensure management transparency, all ESSSAC meetings are open to the public and NGO groups for observational purposes (DFO 2013). Industry has a very high level of participation and confidence in the science completed for this fishery as license holders and DFO biologist complete the survey annually.

Since license holders contribute 100% of the trawl survey cost, the assessment continues to be completed annually and has not been subject to a 3-5 year assessment. This ensures consistent real time data sets and a higher level of confidence when quota advice is requested or supported (Ginny Boudreau pers. comm.).

Bycatch Strategy

Factor 3.2: Management of fishing impacts on bycatch species						
Region / Method	All Kept	Critical	Strategy	Research	Advice	Enforce
Nova Scotia Trap	Yes	N/A	N/A	N/A	N/A	N/A

There are no bycatch concerns in this fishery (see Criterion 2), so no assessment of bycatch management is necessary.

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery’s overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem-based fisheries management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the ecosystem-based fishery management score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*
Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Overall Recomm.
Nova Scotia Trap	3.00:Low Concern	1.00:Strong Mitigation	4.00:Low Concern	Green (4.000)

Justification of Ranking

Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

Scoring Guidelines

- *5 (None)—Fishing gear does not contact the bottom*
- *4 (Very Low)—Vertical line gear*
- *3 (Low)—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. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (*
- *2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand*
- *1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 (Very High)—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.

Nova Scotia , Trap

Low Concern

The trap fishery in Chedabucto Bay occurs in regions of muddy, smooth, bottom habitat (Koeller et al. 2007). This fishery has a much smaller spatial footprint than the trawl fleet and although traps may slide along the seafloor during deployment and retrieval, they likely have a low impact on the surrounding environment.

Rationale:

Neither the trap fishery nor the mobile fishery presents a risk to hydrothermal vents or seamounts, as none are known to exist in the region (DFO 2010)(DFO 2013). The likelihood of the fishery presenting a risk to coldwater corals or sponge-dominated communities is low, as to date these have not been found to overlap with the shrimp fishing grounds. While Chedabucto Bay is believed to have no sensitive seabed, research is ongoing into the environmental impacts of shrimp fishing on the Scotian Shelf. However, due to the more impactful nature of bottom gears, the majority of this research pertains to the mobile trawl fleet. As part of the Marine Stewardship Council (MSC) re-certification for the Scotian Shelf prawn trawl fishery (SFA 13-15) in 2011, the mobile fishery was required to develop and implement a method to better understand and assess the impacts of the fishery on the surrounding environment. Independent research showed that even this gear poses a low risk in damaging the seafloor (Grant 2012 in Parsons et al. 2013). Although not directly related to the trap fishery, the overarching IFMP for this stock in SFA 15 now includes management measures (including area closures) to ensure that no sensitive bottom habitat is damaged (DFO 2013).

Factor 4.2 – Mitigation of Gear Impacts

Scoring Guidelines

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of ‘moderate’ mitigation measures.*
- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.*

- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats.*

Nova Scotia , Trap

Strong Mitigation

The trap fishery occurs within a specifically defined geographic area (i.e., Chedabucto Bay; see Figure 1) and thus at least 50% of the representative habitat is protected from this gear type, both within SFA 15 and also in the greater region of the Scotian Shelf (SFAs 13-15). To ensure the spatial footprint of the fleet in Chedabucto Bay is kept constant, the transfer of tags between license holders in the North (500 traps) and the South (800 traps) regions of the Bay is not permitted (DFO 2013).

Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- *5 (Very Low Concern)—Substantial efforts have been made to protect species’ ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.*
- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

Nova Scotia , Trap

Low Concern

Research to understand the impacts of fishing (multiple fleets) and the interactions between species on

the Scotian Shelf is ongoing. The scope of the studies undertaken appears to be holistic and extensive. However, they are still largely in the planning and development stages of many regional eco-system focused measures.

Rationale:

At the fishing area scale, practical management conservation efforts include coral and sponge area closures in SFAs 13-15; specifically: the Lophelia Coral Conservation Area, the Gully Marine Protected Area (which contains significant coral communities), the Sambro Bank Sponge Conservation Area, and the Emerald Basin Sponge Conservation Area (DFO 2013)(DFO 2014a). While the shrimp trap fishery is not conducted near these regions, ensuring the long-term protection of these fragile species is vital to maintaining the health of the Scotian Shelf ecosystem as a whole.(Bundy et al. 2014) recently conducted a thorough review of the various species and ecosystem interactions in the Scotian Shelf. This report discusses the impacts of terrestrial systems on the coastal environment (in terms of runoff, pollution and human activities), the ecological context for integrated management of fisheries, and presents knowledge gaps and future areas of research to ensure the long-term health and resiliency of the area. By all accounts, knowledge of the role of northern shrimp in the surrounding ecosystem is solid, and (as discussed in Criterion 3), the current IFMP accounts for all available information. At a broader scale, DFO has released a variety of eco-system focused management plans and reports pertaining to the Eastern Scotian Shelf and the Maritime Region as a whole (DFO 2007)(DFO 2010)(DFO 2011). The overarching aim of these documents has been to better understand the impacts of various human activities on the ecosystem (including fishing) and the interplay between different marine resources so that management practices can be improved. In 2014, DFO released another multi-year plan discussing a variety of integrated management strategies for the Scotian Shelf and surrounding areas (DFO 2014b). This document identifies the key concerns and actions being undertaken to improve all aspects of ocean and coastal management in the region.

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

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References

- Alen Newell. 2015. Newell, A. 2015 (personal communication). Trap fisherman, Canso, Nova Scotia.
- Boudreau, Ginny. 2016. Boudreau, G. 2016 (personal communication). Manager, Guysborough County Inshore Fisherman's Association.
- Bundy et al.. 2014. Bundy, A., Themelis, D., Spert, J., and den Heyer, N. 2014. Inshore Scotian Shelf Ecosystem Overview Report: Status and Trends. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/065. xii + 213 p.
- DFO. 2015. DFO. 2015. Assessment of Northern Shrimp on the Eastern Scotian Shelf (SFAs 13-15). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/004. 20 pp.
- DFO. 2014. DFO. 2014a. Offshore Ecologically and Biologically Significant Areas in the Scotian Shelf Bioregion. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/041.
- DFO. 2014. DFO. 2014b. Regional Oceans Plan – Maritimes Region: Background and Program Description. DFO Oceans and Coastal Management Division, Ecosystem Management Branch, Dartmouth, NS. DFO/ 2014-1927. 47 pp.
- DFO. 2013. DFO. 2013. Scotian Shelf Shrimp (*Pandalus borealis*) Integrated Fisheries Management Plan (Version 1.6.1). Department of Fisheries and Oceans Canada. 70 pp.
- DFO. 2012. DFO. 2012. Marine Protected Area Network Planning in the Scotian Shelf Bioregion: Objectives, Data, and Methods. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/064. 19 pp.
- DFO. 2011. DFO. 2011. An outline of the DFO Maritimes Region Framework for an Ecosystem Approach to Management. DFO Maritimes Region, January 28, 2011: 13 pp.
- DFO. 2010. DFO. 2010. Potential impacts of fishing gears (excluding mobile bottom-contacting gears) on marine habitats and communities. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/003. 24 pp.
- DFO. 2007. DFO. 2007. Eastern Scotian Shelf Integrated Management Plan: Strategic Plan. DFO Oceans and Habitat Branch, Dartmouth, NS. DFO/2002-1229. 69 pp.
- Fish Watch . 2014. Fish Watch. 2014. Atlantic Northern Shrimp facts. Available online: <http://www.fishwatch.gov/profiles/atlantic-northern-shrimp>
- Hardie, David. 2016. Hardie, D. 2016 (personal communication). Shrimp biologist, Fisheries and Oceans Canada.
- Holtuis. 1980. Holtuis, L.B. 1980. FAO Catalogue Volume 1 - Shrimps and prawns of the world: An annotated catalogue of species of interest to fisheries. FAO Fisheries Synopsis 125(1). Available online from: <http://www.fao.org/fishery/species/3425/en>

Koeller et al.. 2007. Koeller, P., Covey, M., and King, M. 2007. Biological and environmental requisites for a successful trap fishery of the northern shrimp *Pandalus borealis*. Proceedings of the Nova Scotian Institute of Science, 44: 51-71.

Lingard. 2009. Lingard, D. 2009. Seafood Assessment: Northern Shrimp (*Pandalus borealis*): Atlantic Canada. SeaChoice. 51 p.

NFSC. 2014. NFSC. 2014. 58th Northeast Regional Stock Assessment Workshop (58th SAW) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 14-03; 44 p.

Parsons et al.. 2013. Parsons, D., Powles, H., Bannister, and C., Devitt, S. 2013. Canadian Scotian Shelf Northern Prawn Trawl Fishery Shrimp Fishing Areas 13, 14, 15: Final Certification Report (FCM15 v. 2 rev. 03). Intertek Moody Marine. iii + 299 p.

Rob Johnson. 2015. Johnson, R. 2015 (personal communication). Atlantic Coordinator, SeaChoice.