Atlantic rock crab, Jonah crab

Cancer irroratus, Cancer borealis

Canada Atlantic

Trap

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Disclaimer

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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 fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

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

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

Each criterion includes:

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

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

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

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

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

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

Summary

This report provides analysis and recommendations for Jonah crab (*Cancer borealis*) and Atlantic rock crab (*Cancer irroratus*) in Eastern Canada. Both *Cancer* species are harvested in directed fisheries and as bycatch in the Canadian-American lobster fishery; however, the current dearth of scientific information leaves these species vulnerable to high exploitation and could be a factor in the declines in abundance in recent years. Until the levels of *Cancer* crabs caught in lobster fisheries are fully understood and lobster fishers report all their *Cancer* crab catch (whether it is used directly as bait or sold commercially), accurate assessments of the fisheries that land Jonah and Atlantic rock crabs will be difficult or impossible.

Because there is little information regarding bycatch in the directed *Cancer* crab fisheries, the retained and bycatch species analyzed in this assessment have been chosen based on either the percent of catch in the lobster fishery that they make up or their conservation status (endangered, threatened, overfished, etc.) as a proxy for the *Cancer* crab fisheries. Traps used in the commercial lobster and *Cancer* crab fisheries are highly selective, so bycatch is not considered a large issue. But data are lacking on the nature and quantity of bycatch. The most common types of bycatch found in lobster traps are juvenile lobsters, ovigerous female lobsters, crabs, and some finfish (e.g., wolffish, cod, and cusk).

Bycatch species in lobster/crab traps are relatively few; however, there is evidence of marine mammal interactions and entanglements in lobster gear. Because of the interactions of North Atlantic right whales (*Eubalaena glacialis*) and northern bottlenose whales (*Hyperoodon ampullatus*) (both considered endangered or threatened species) with lobster fishing gear, these species are also analyzed in this assessment. There is little information on discard and mortality rates for the lobster fishery and overall it appears that discard rates of lobster bycatch are low compared to other fisheries.

The Department of Fisheries and Oceans (DFO) Canada manages the Canadian Jonah (*Cancer borealis*) and Atlantic rock crab (*Cancer irroratus*) fisheries. Management of the species is intended to protect the reproductive capacity of the populations. Thus, like some management measures for lobster, regulations have been in place that protect immature animals through minimum size limits and the prohibition of landing females. Since both *Cancer* species are caught using lobster and crab traps, gear restrictions mandate the use of traps with biodegradable panels and escape vents to minimize bycatch. Effort control levels have also been implemented through trap number limits and limited entry into the fisheries, as well as area and season closures. Because the Jonah crab fisheries, and in particular the offshore Jonah crab fisheries, are mainly bycatch and bait fisheries within the directed Canadian lobster fisheries, many management measures in place are established through Integrated Fisheries Management Plans for lobster in the specific management regions. Additionally, both *Cancer* crab fisheries in Atlantic Canada began as experimental/exploratory fisheries in the region and have only been permanent fisheries since 2000, though in the Gulf region some licenses are still exploratory. The *C. borealis* fisheries in the Maritimes region have not fared well; since their inception, catches have continually decreased due to a decrease in abundance and low market demand and price. In the offshore fishery, Jonah crabs are under a total allowable catch (TAC) of 720 t that was set not on a

scientific basis, but on what was set for the lobster fishery. This TAC has since been determined to be unsustainable and was lowered to 540 t in 2010. Since then, the directed fishery for Jonah crab offshore has been inactive, and landings in the region are now mainly from the bycatch and bait fisheries in the lobster fishery.

Cancer irroratus stocks in the Gulf of St. Lawrence and Quebec regions appear to be more cautiously managed, and these fisheries seem to be more stable than the Jonah crab fisheries. This could be attributed to management but also to differences in the biology and resiliency of the two species. The concern with both *Cancer* crab fisheries is the lack of information and data regarding total removals and bait use in the lobster fisheries, because these are often significantly higher than through the directed fisheries. The lack of reporting and limits on removals for such purposes hinder the ability to properly assess the status and the effects of the lobster fishery on these stocks. Recently, efforts to collect these data are being made but the data are still insufficient to determine the scale of removals.

Because *C. borealis* and *C. irroratus* are caught using mainly lobster traps and conical crab traps, the impacts of this type of gear on the ocean floor are generally considered to be moderate to low. The directed crab fisheries in Atlantic Canada are relatively small, with an average of 5 to 8 vessels directing for Jonah crabs and approximately 200 active licenses for Atlantic rock crabs in the Gulf of St. Lawrence region. But the impacts may be underestimated because Jonah and rock crabs are often bycatch in the lobster fishery, which is a more intensive and larger fishery using greater numbers of traps. The "cumulative effect" of thousands of lobster traps being set and recovered on a daily basis could be more damaging to benthic habitats than previously thought; however, little information is available as it pertains to the directed Jonah and Atlantic rock crab fisheries.

Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Atlantic rock crab Gulf Mgmt. region Gulf of St. Lawrence - Trap	Yellow (2.64)	Red (1.37)	Yellow (3.00)	Yellow (3.12)	**Good Alternative (2.415)**
Jonah crab Maritimes Bay of Fundy - Trap	Yellow (2.64)	Red (0.90)	Yellow (3.00)	Yellow (3.12)	**Avoid (2.173)**
Jonah crab Maritimes Gulf of Maine - Trap	Yellow (2.64)	Red (0.90)	Red (1.73)	Yellow (3.12)	**Avoid (1.894)**
Atlantic rock crab Quebec Gulf of St. Lawrence - Trap	Yellow (2.64)	Red (1.37)	Yellow (3.00)	Yellow (3.12)	**Good Alternative (2.415)**

Scoring Guide

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

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

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

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

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

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Introduction

Scope of the analysis and ensuing recommendation

This report provides analysis and recommendations for Jonah crab (*Cancer borealis*) and Atlantic rock crab (*Cancer irroratus*) in the Canadian Northwest Atlantic, in the Scotia-Fundy, Gulf, and Quebec regions. Both species co-occur along much of their range: *C. borealis* is found from Nova Scotia to the Dry Tortugas, FL (Drew 2011) and *C. irroratus* is found from Labrador to Florida (Williams 1984). Both species are landed in direct fisheries and as bycatch in the American lobster fishery, and are exclusively harvested with trap/pot gear (Wilson 2005) (Robichaud and Frail 2006).

Overview of the species and management bodies

The Jonah (*C. borealis*) and Atlantic rock (*C. irroratus*) crab fisheries have existed for a long time in Eastern Canada as bycatch in the American lobster (*Homarus americanus*) fishery but also intermittently in directed, exploratory fisheries. Since the mid-1990s, as a result of increasing abundance and market demand, Jonah and Atlantic rock crabs have emerged as small, commercial fisheries in Eastern Canada (Table 1).

Table 1: Commercial fisheries for Jonah and Atlantic rock crabs in Eastern Canada

REGION/FISHING AREAS	JONAH CRAB	ATLANTIC ROCK CRAB	BODY OF WATER
SCOTIA-FUNDY (LFA 34-38)	directed, bycatch	bycatch	BAY OF FUNDY
OFFSHORE (LFA 41(4X-5Zc))	bycatch	NA	GULF OF MAINE
QUEBEC (ROCK CRAB FISHING AREAS: 12E-Z,12A-C,12D-17,16B,16D)	NA	directed, bycatch	NORTHERN GULF OF ST. LAWRENCE
GULF (LFA 23,24,25,26A,26B)	NA	directed, bait, bycatch	SOUTHERN GULF OF ST. LAWRENCE

Jonah crab and Atlantic rock crab are native to the North Atlantic coast of North America. There is limited information regarding biology, abundance, and distribution of both species. Though physically similar, the two species differ in size and preferred habitats (Reardon 2006). Jonah crabs are larger than Atlantic rock crabs and they are more commonly found at depths of 50–300 m and down to 800 m (Robichaud and Frail 2006). Atlantic rock crabs are smaller and prefer shallower, inshore waters ranging

from 6–456 m (Stehlik et al. 1991) and are most often found at depths of less than 20 m (Krouse 1980) (Robichaud and Frail 2006).

The Jonah and Atlantic rock crab fisheries are managed by Canada's Department of Fisheries and Oceans and are conservatively managed to protect reproductive potential and trophic relationships (DFO 2009b) (DFO 2013e). Currently, the Jonah crab fishery is operating under the 2006–2011 IFMP for American lobster (DFO 2009a) (DFO 2009b), so it is assessed by Lobster Fishing Areas (LFAs) (Figure 1). Both fisheries are managed by input and output controls, including minimum size limits, no take of females, limited entry, fishing area closures, trap limits, and total allowable catch (TAC) (DFO 2009b) (DFO 2013a)(DFO 2013e). The Atlantic rock crab fishery is assessed every 3 years, while the offshore Jonah crab fishery was last assessed in 2009 and the inshore fishery was assessed in 2000. Although the directed crab fisheries are under conservative management, the bait and bycatch crab fishery in the American lobster fishery has few regulations and no reporting requirements. Because of the Atlantic Fisheries Regulation (1985), fishers with a valid lobster license are allowed to land and sell or use as bait male Atlantic rock crabs in all LFAs, and male Jonah crabs are allowed to be landed and sold or used as bait in LFA 34–38 (Robichaud and Frail 2006).

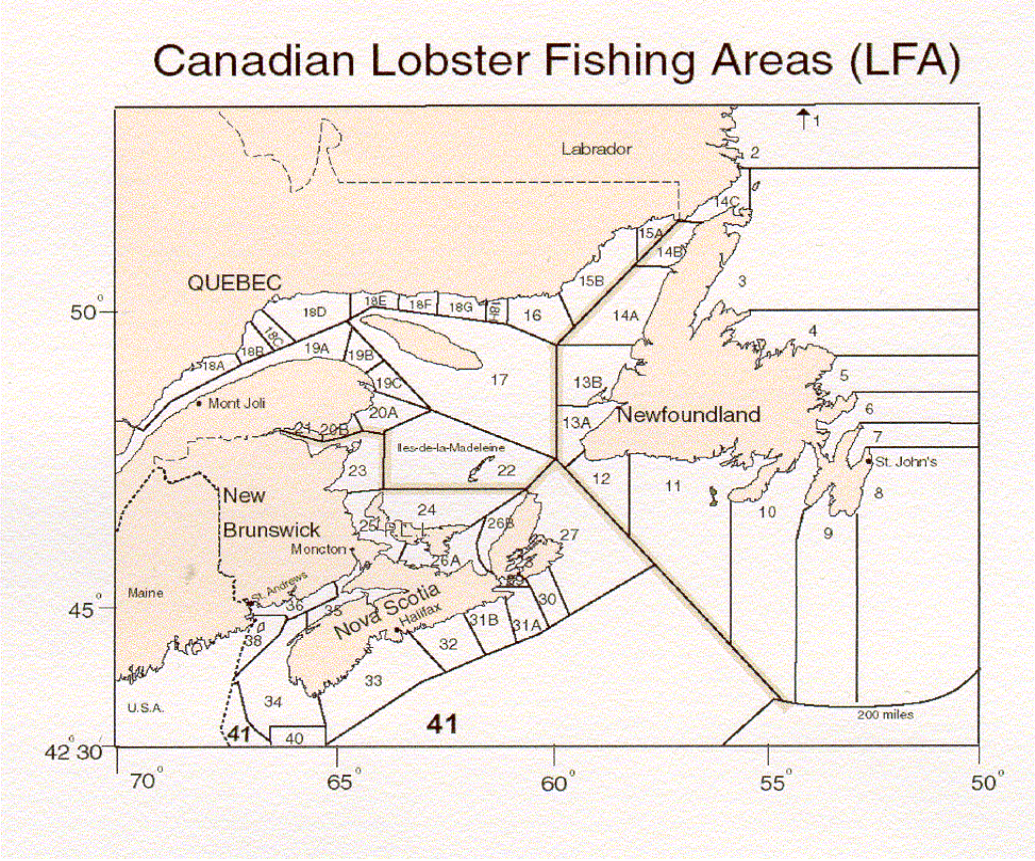

Figure 1: Canadian Lobster Fishing Areas (http://www2.mar.dfo-mpo.gc.ca/fisheries/res/imp/IMAGES%5Clfa41map2.gif)

Production Statistics

C. borealis and *C. irroratus* co-occur in the Northwest Atlantic, from Labrador to Florida. The United States and Canada are the major producers, but these are small fisheries in both countries. There is no known commercially farmed *Cancer* crab production in Eastern Canada. In the mid-1990s, as a result of crab abundance and an increase in market demand, Jonah and Atlantic rock crab experimental fisheries were developed and subsequently became small but permanent commercial fisheries (DFO 2009b) (Robichaud and Frail 2006). Currently, in eastern Canada, despite initial high landings of Jonah crab at the opening of the commercial fisheries, both inshore and offshore Jonah crab landings have declined (DFO 2009b). Since 2010, there has been little to no commercial activity because of low catch and low demand (BIO 2013) (DFO 2009b). The Atlantic rock crab fisheries in the Gulf of St. Lawrence and Quebec regions are faring better but have also seen declines in landings or have not caught the full TAC in the past several years (DFO 2013a) (DFO 2013e).

Jonah crab (*Cancer borealis*)

Jonah crab landing information is difficult to access and the time series data are patchy. Although Jonah crab landings in the Scotia-Fundy region were initially high at the inception of the fishery, landings have been on a continual decline, as seen in Figure 2. The data obtained from DFO show combined total annual landings from 2004 to 2012; however, data could not be accessed for each individual LFA. Jonah crab landings from LFAs 34–38 between 1995 and 2004 show that LFA 34 and LFA 38 had the highest commercial concentration compared to LFA 35 and LFA 36 (Figure 3). Landings in LFA 34 reflect the initial high landings followed by subsequent declines, while the opposite is true in LFA 38. But it is hard to determine the current state of landings in each LFA, due to the lack of data. Figure 4 shows that the offshore Jonah crab fishery was also initially productive but landings declined steadily from their peak of 705 mt in 1999 through 2008, when reported landings were 3 mt. After 2008, landings data are no longer available, likely due to the cessation of the directed crab fishery in this area (DFO 2009).

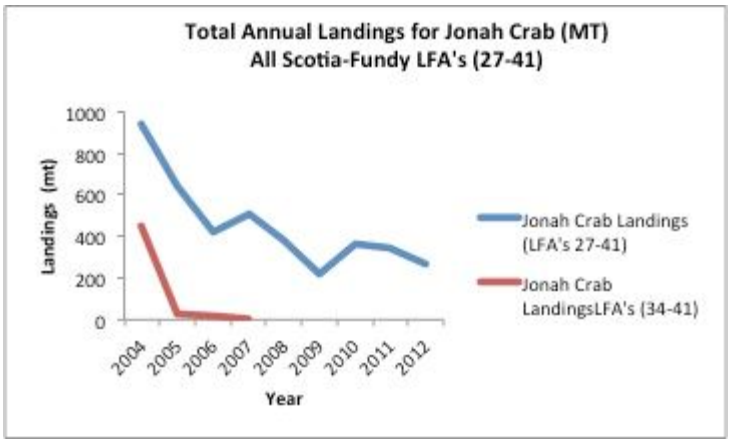

Figure 2: Total annual landings for Jonah crab in Scotia-Fundy Region LFAs 27–41 (data obtained from DFO 2013).

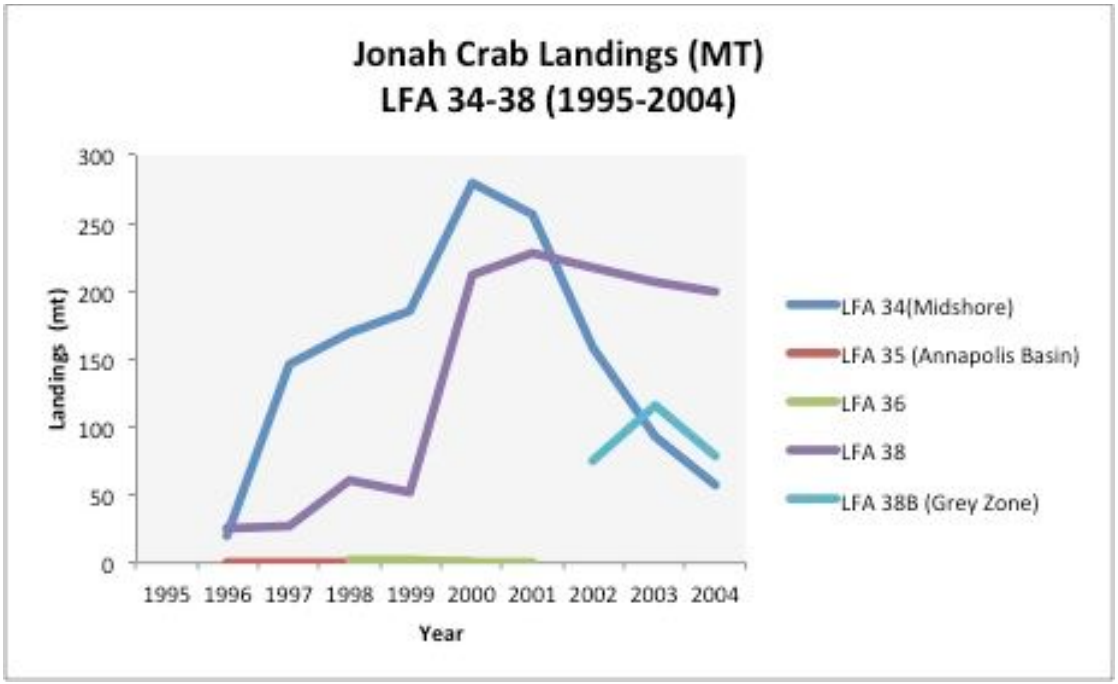

Figure 3: Total annual Jonah crab landings in LFAs 34–38 1995–2004 (Robichaud and Frail 2006).

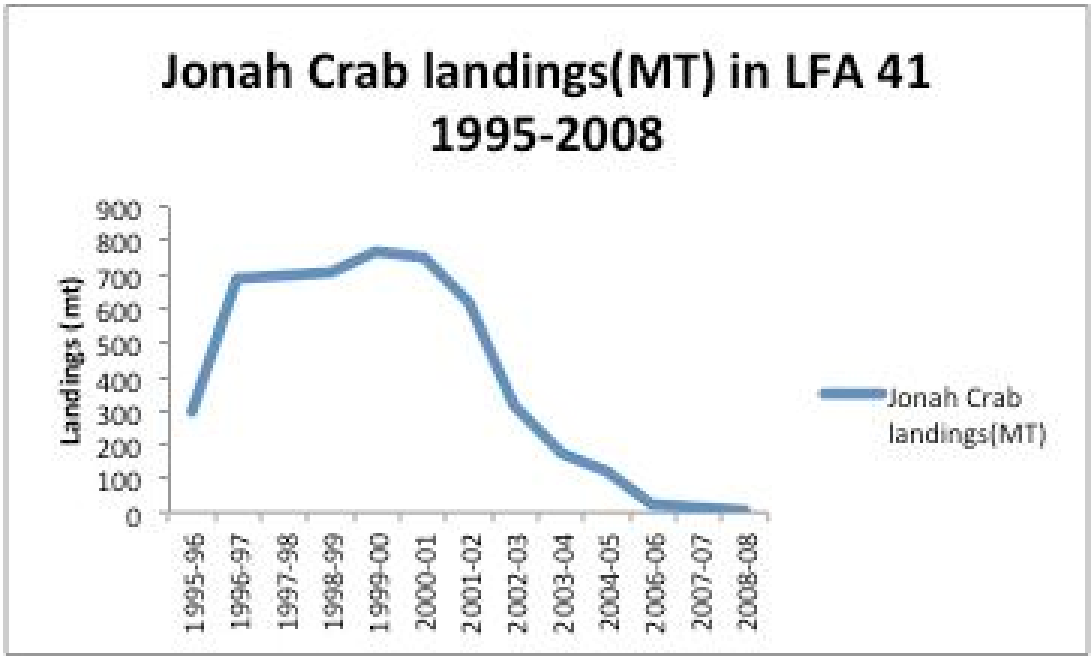

Figure 4: Total annual landings for Jonah crab in LFA 41 1995-2008 (DFO 2009).

Atlantic rock crab (*Cancer irroratus*)

Gulf Region

Total landings from the directed *C. irroratus* fishery in the southern Gulf of St. Lawrence region have

been relatively stable from 2000–2010 (DFO 2013a) with average annual landings of 4,301 mt (Figure 5). Total annual landings in the different LFAs in the Gulf region are varied and show no particular trend other than which LFA contributes the highest percentage of the total landings; in this case, 41% of landings come from LFA 26 (Figure 6) (DFO 2013a). Preliminary data for 2011 indicate a slight decline from the 2000–2010 series average at 4,197 mt (DFO 2013a).

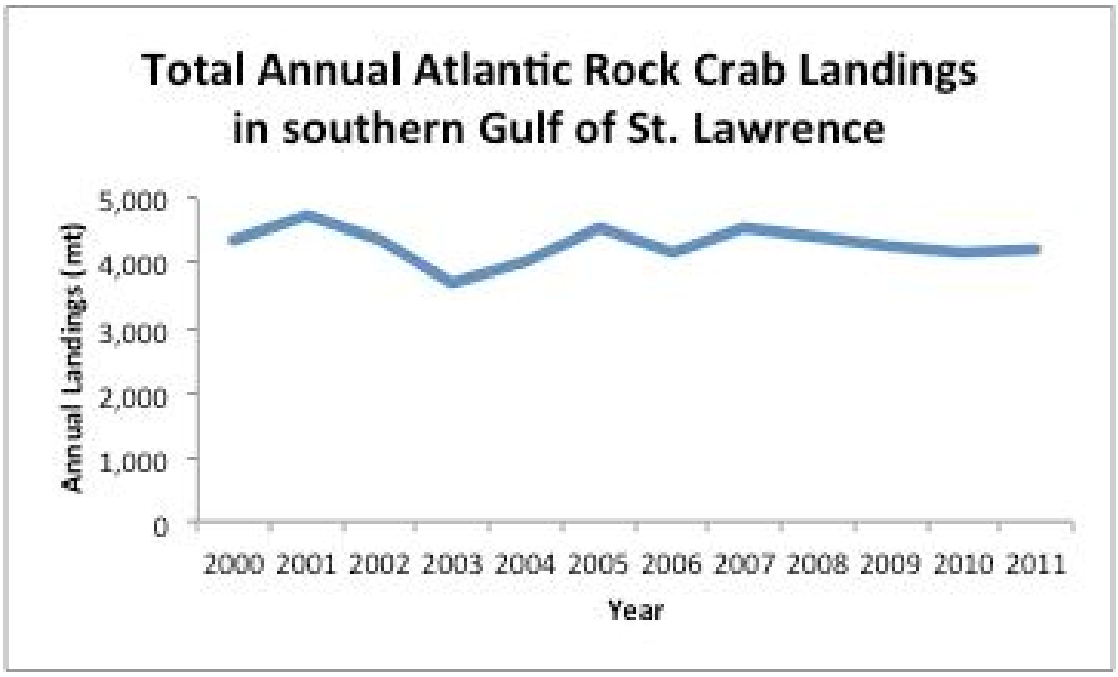

Figure 5: Total annual Atlantic rock crab landings in southern Gulf of St. Lawrence (all LFAs combined) (DFO 2013).

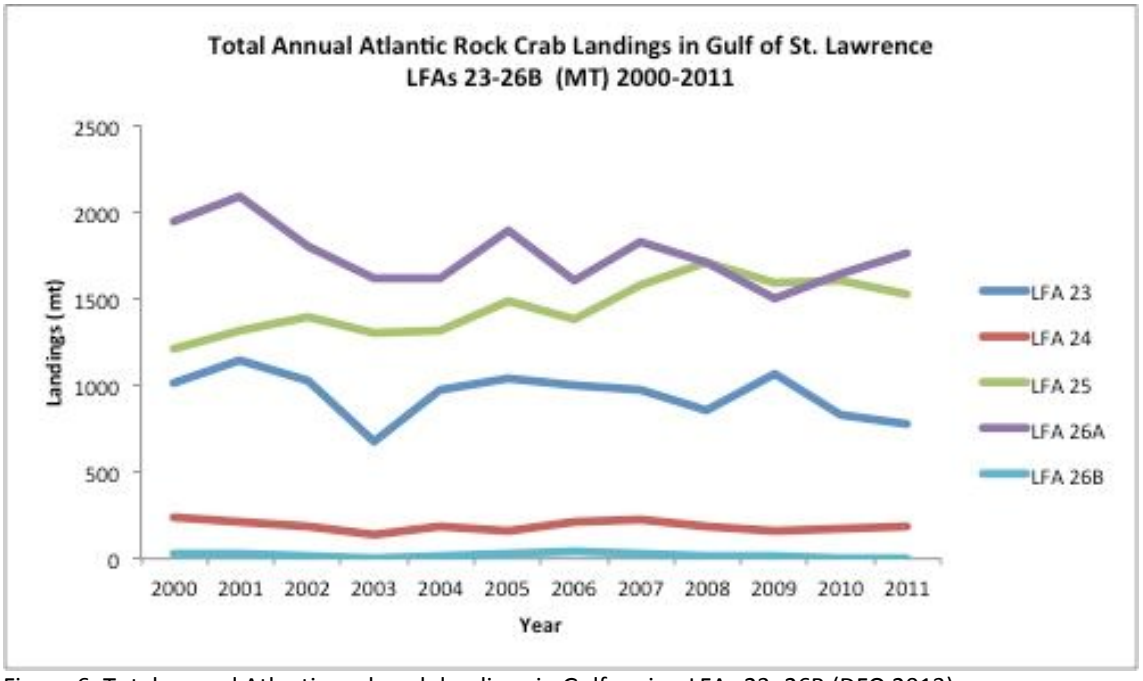

Figure 6: Total annual Atlantic rock crab landings in Gulf region LFAs 23–26B (DFO 2013).

Quebec

The total landings for Atlantic rock crab in the entire Quebec region were 1,581 mt for 2012 (Figure 7) although they were down from 2009 when they totalled 1,777 mt (DFO 2013e). Since 1994, at the start of the fishery, total landings for the region increased steadily from 687 mt to 1,761 mt in 2002 (DFO 2013e) and have been holding steady above 1,500 mt since 2002 (Figure 7) (DFO 2013e). In 2005, landings peaked at 2,004 mt (DFO 2013e). Regionally, most of the rock crab landings tend to come from the Magdalen Islands and from the southern part of the Gaspè Peninsula (Figure 8). In 2012, 35% of landings came from the Magdalen Islands, 29% from South Gaspè, 26% from North Gaspè, and 10% from North Shore (DFO 2013e). Since the mid-2000s, the trend in landings in the Magdalen Islands has seen a decline, thus indicating declines in the population in this region; however, in other regions, such as in the Gaspè Peninsula, landings have remained fairly stable (DFO 2013e).

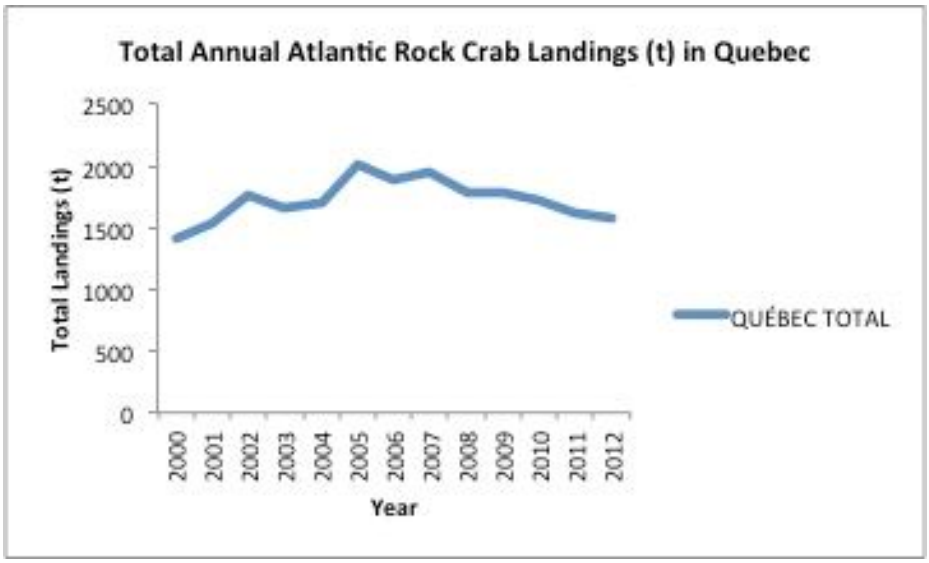

Figure 7: Total annual landings of Atlantic rock crab in Quebec (all regions combined) (DFO 2012).

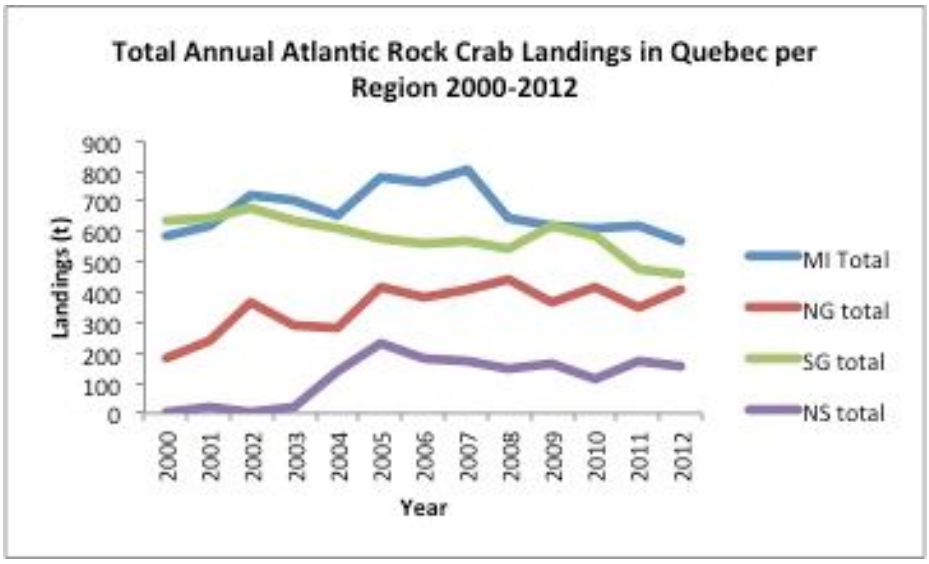

Figure 8: Total Atlantic rock crab landings by region in Quebec (DFO 2012).

Importance to the U.S./North American market

There are no import/export data.

Common and market names

Cancer borealis is also known as: Jonah crab and Atlantic Dungeness crab

Cancer irroratus is also known as: Atlantic rock, peekytoe, sand, quick, and eel grass crab

Primary product forms

For both *Cance*r species: Live, fresh or frozen meat.

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

ATLANTIC ROCK CRAB				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Gulf Mgmt. region Gulf of St. Lawrence Trap	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	**Yellow (2.644)**
Quebec Gulf of St. Lawrence Trap	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	**Yellow (2.644)**

JONAH CRAB				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Maritimes Bay of Fundy Trap	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	**Yellow (2.644)**
Maritimes Gulf of Maine Trap	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	**Yellow (2.644)**

Based on Seafood Watch's inherent vulnerability scoring criteria, Jonah and Atlantic rock crabs appear to have medium to low inherent vulnerability to fishing pressure, respectively. But there is uncertainty surrounding these scores because of the lack of biological, population, and scientific information for both species, so inherent vulnerability is difficult to gauge. As with most crustaceans, determining the age of Jonah and Atlantic rock crabs is problematic because of their molting cycles, but it is generally

believed that both crab species have a maximum age of approximately 8 years, based partly on comparison to their close relative, the Dungeness crab (*Metacarcinus magister*). Both Jonah and Atlantic rock crabs carry their eggs on their abdomen for almost a year before the eggs hatch into planktonic larvae. Although both *Cancer* species are harvested in directed fisheries and as bycatch in the American lobster fishery in Eastern Canada, the overall dearth of scientific information leaves these species vulnerable for high exploitation and could be a factor in the declines in abundance in recent years. Until the levels of *Cancer* crabs caught in lobster fisheries are fully understood and lobster fishers report all their *Cancer* crab catch (whether it is used directly as bait or sold commercially), accurate assessments of the fisheries that land Jonah and Atlantic rock crabs will be difficult or impossible. Overall, Jonah and Atlantic rock crab abundances in Canada have never been adequately assessed, and the only information available is fishery-dependent and based on short-term data sets.

Criterion 1 Assessment

ATLANTIC ROCK CRAB

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 is 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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap Quebec Gulf of St. Lawrence, Trap
Low

The inherent vulnerability score (2.5) for *C. irroratus* is deemed "low."

Rationale:
Atlantic rock crabs are physically similar to Jonah crabs, but they are smaller and are more common inshore and at shallower depths (Reardon 2006). Like most brachyurans, *C. irroratus* exhibits sexual dimporphism between males and females, with female rock crabs rarely reaching carapace widths (CW) of 100 mm (3.9 in) and males reaching CW of 140 mm (5.5 in) (Page 2002) (Bigford 1979). Sexual maturity in Atlantic rock crabs has been estimated at around 60 mm (2.4 in) CW for females (1–3 years) and 70 mm (2.8 in) CW for males (1–4 years) (Page 2002) (Bigford 1979). Similar to *C. borealis,* the maximum age of *C. irroratus* is estimated to be approximately 8 years (Bigford 1979) (Reilly and Saila 1978). Female Atlantic rock crabs can produce 125,000 to 500,000 eggs, depending on size, and they carry the eggs on their abdomen for a year before the eggs hatch (Bigford 1979) (Page 2002). Based on these factors, inherent vulnerabilty for *C. irroratus* is deemed low.

	Atlantic Rock Crab	Score	Source
Average Age at Maturity	1-4 years	3	Page, 2002; Bigford, 1979
Average maximum Age	8 years	3	Bigford, 1979; Reilly & Saila, 1978
Reproductive Strategy	egg brooder	2	Page, 2002; Bigford, 1979
Density Dependence	No depensatory or compensatory dynamics demonstrated or likely	2	Wahle, 2003
Score (mean of factor scores)	2.5		

Table 2: Life-history characteristics of Atlantic rock crab.

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.*

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Moderate Concern

There are no biological reference points for Atlantic rock crab in the southern Gulf of St. Lawrence (sGSL). The most recent stock assessment for *C. irroratus* in the sGSL was conducted in 2011 using mainly fishery-based indicators from fishery-dependent data (DFO 2013a) including Catch Per Unit Effort (CPUE), landings, and the percentage of license holders that reached their individual allocation (DFO 2013a). Due to the incompleteness of the logbook data used and the lack of abundance or biomass estimates, the status of this stock is deemed "moderate" concern.

Rationale:
The most recent assessment (DFO 2013a) gave no estimates of abundance or biomass, but suggested that because landings had remained fairly constant at an annual average of 4,301 t between 2000 and 2011 and because the total individual allocation for all licenses issued of 6,480 t was not reached, the Atlantic rock crab stocks were abundant (DFO 2013a). According to the assessment, in 2011 there was room for increased harvest because only 62% of the total allocation was landed (DFO 2013a).

Quebec Gulf of St. Lawrence, Trap

Moderate Concern

There are no current abundance estimates for the Atlantic rock crab stocks in Québec. The stock is assessed every three years using landings, size structure, and CPUE as proxies for abundance (DFO 2013e). These data are gathered from a review of logbooks; therefore, due to the inherent uncertainty surrounding the quality and completeness of the data, stock status is unknown and Seafood Watch deems *C. irroratus* in Québec to be of "moderate" concern.

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 (≤ 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.*

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Moderate Concern

There are no current fishing mortality (F) reference points or exploitation estimates for the southern Gulf of St. Lawrence (sGSL) Atlantic rock crab stocks, so the appropriateness of current fishing levels is unknown. Additionally, the total removals of Atlantic rock crab used for bait in the lobster fishery is unknown and, although there are data on rock crab landings from the lobster fishery, there is concern that some landings are unreported (DFO 2013a). But bycatch landings of Atlantic rock crab (sold, not for personal use) during the lobster fishery appear to be on a downward trend in recent years, with 295 t landed in 2011 for LFAs 23, 24, 25, 26A, and 26B combined, totalling 7% of the directed fishery landings (DFO 2013a). Seafood Watch deems fishing mortality to be “moderate” concern.

Rationale:
No exploitation or F estimates could be made from the most recent DFO survey data (DFO 2013a). In addition, total *C. irroratus* removals could not be assessed due to the lack of data regarding the amount of crabs used as bait in the American lobster fishery in this region, because there are no reporting requirements within the lobster fishery—lobster license holders are allowed to keep any size male rock crabs without limit (DFO 2013a). In certain areas, Atlantic rock crabs are frequently used as bait and this could represent large catches, especially when access to other traditional baits (e.g., herring and mackerel) is difficult (DFO 2013a). There is concern that market demands for Atlantic rock crab products could drive the lobster fleet to substantially increase fishing pressure for crabs as bycatch, which may not be completely reported (DFO 2013a). Based on the Atlantic Fisheries Regulation (1985), anyone holding a valid lobster license can land and retain any size male *C. irroratus,* and reporting is not required (DFO 2013a) (Atlantic Fisheries Regulations 1985).

Quebec Gulf of St. Lawrence, Trap

Moderate Concern

There are no current fishing mortality (F) reference points or exploitation estimates for Atlantic rock

crab stocks in the Québec region, so the appropriateness of current fishing levels is unknown. Though Atlantic rock crab landings data from the directed fishery are available (DFO 2013e), the total removals of Atlantic rock crab in Québec are uncertain due to the incomplete data pertaining to the number of crabs caught as bycatch and used as bait in the lobster fishery (DFO 2013e). According to the latest assessment, based on CPUE and other "abundance" indicators, current harvest levels from the directed fishery do not seem to be affecting population levels (DFO 2013e). Concern lies in the unknown harvest within the bait and bycatch fisheries in the lobster fishery (DFO 2013e); however, electronic logbooks are being introduced to gather information on bycatch in lobster fisheries and to record bait use, which will improve data collection in the future. Therefore, Seafood Watch deems fishing mortality to be "moderate" concern.

Rationale:
The directed crab fishery in Québec has always been cautiously managed (DFO 2013e). Current landings information from the last assessment indicates that, although landings have remained fairly consistent throughout the region overall, there are certain regions where crab abundance appears to be declining, based on lower catch rates (DFO 2013e). The management effort of keeping harvesting levels low in the directed fishery appears to be successful in certain areas in Québec, but the unknown removals and lack of control of Atlantic rock crabs as bait and bycatch in the lobster fishery are the causes for concern (DFO 2013e) in Québec. The landings data in the most current Atlantic rock crab assessment in Québec do not consider bait levels in the lobster fishery. In certain areas in Québec, these removals could represent significant quantities, especially if the cost of traditional bait sources increases. In addition, because the harvest strategies of lobster fishers are not known, their movements within their fishing areas to maintain good catch rates may be concealing declines in crab abundance (DFO 2013e). Until data on bait and bycatch removals in the lobster industry are collected and reviewed, fishing mortality estimates for *C. irroratus* in Québec will remain unknown, although the current introduction of electronic logbooks should facilitate improved bait and bycatch data collection in the lobster fishery.

JONAH CRAB

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 is 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.*

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Medium

The inherent vulnerability score for *C. borealis* is deemed "medium"; however, there is considerable uncertainty surrounding this score (2.25) because of a lack of life-history and biological data for this species. Many attributes that need to be scored to determine inherent vulnerability are either unknown or extrapolated from data of closely related *Cancer* species such as *Metacarcinas magister* or *Cancer pagurus*.

Rationale:
There is little biological or life-history information for Jonah crab: for example, age at 50% maturity, growth rate, and maximum age are not known. There is sexual dimorphism between males and females with male Jonah crabs growing up to 180 mm (7.1 in) CW and females up to 150 mm (5.9 in). Sexual maturity in Jonah crabs varies with location (DFO 2009b), although in general most females are sexually mature at 89 mm (3.5 in) CW (Cobb et al 1997) and males at 128 mm (5.0 in) (Moriyasu et al. 2002). Although the maximum age in Jonah crabs is not known, age is varied in related species of crabs: for example, *Metacarcinus magister* (Dungeness crab) can live 8–13 years (ADFG 1994), and brown crab (*Cancer pagurus*) (Cobb et al. 1997) typically lives 25–30 years although it reportedly can live up to 100 years (FishOnline 2011). Fecundity for Jonah crabs may be high but there are no estimates; it is known that female Jonah crabs carry eggs once per year during the summer months and it has been reported that they will spawn approximately five times during their life (Cobb et al. 1997). The related brown crab can carry 250,000 to 3,000,000 eggs while Dungeness crabs can produce 250,000 to 1,000,000 eggs (Khatain 2000). The lack of biological information makes determining inherent vulnerability difficult but, based on other life-history characteristics of related *Cancer* species, it is likely that inherent vulnerability is "medium" for Jonah crabs.

Factor	Jonah Crab	Score	Source
Average age at maturity	<5 years*	3	Hankin& Warner, 2001
Average maximum age	~8-13*	2	ADFG, 1994
Reproductive Strategy	egg brooder	2	Cobb et al, 1997
Density Dependence	No depensatory or compensatory dynamics demonstrated or likely	2	Wahle, 2003
Score (mean of factor scores)		2.25	
*data for *Metacarcinus magister* (Dungeness Crab)			

Table 3: Life-history characteristics of Jonah crab

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.*

Maritimes Bay of Fundy, Trap

Moderate Concern

There are no biological reference points or current stock assessments for *C. borealis* in the Maritimes region, including both inshore (LFA 34 & 38) and offshore fisheries (LFA 41). Except for catch data, there are no reliable estimates for abundance and thus no evidence that the stocks are either above or below reference points. Because of a lack of current data and no biological reference points, Jonah crab stock status in the Maritimes is of “moderate” concern.

Rationale:
The most current information on the status of the fishery, which was compiled in 2006 (Robichaud and Frail 2006), was based on catch rates and CPUE, and it suggested that Jonah crab stocks in LFA 34 experienced significant declines beginning in 2000 (Robichaud and Frail 2006). But there are

uncertainties with the CPUE and landings data due to several variables, including environmental changes and market volatility. Additionally, even though the CPUE data showed a significant decline, the Jonah crab directed fishery was new and the stock had been previously unfished, so a decline in CPUE is not unexpected and by itself does not reflect a depleted stock. Therefore, due to the uncertainties in the data, abundance is unknown.

Maritimes Gulf of Maine, Trap

Moderate Concern

There are no biological reference points or current stock assessments for *C. borealis* in the Maritimes region offshore fisheries (LFA 41). Except for catch data, there are no reliable estimates for abundance and thus no evidence that the stocks are either above or below reference points. Therefore, because of a lack of current data and no biological reference points, Jonah crab stock status in the Maritimes is of "moderate" concern.

Rationale:
The stock status of *C. borealis* in Maritimes Canada (both inshore and offshore) is unknown. Little biological and fisheries data are available to adequately and accurately assess the current stock status of Jonah crabs in Canada. Although some biological information has been collected from bottom trawl surveys, these data may not accurately indicate abundance and population because trawls cannot sample certain habitats and Jonah crabs could be avoiding them (Reardon 2006). The only proxy for abundance used in assessing Jonah crab stocks is catch data. The offshore Jonah crab populations were last assessed in 2009 (DFO 2009b). The offshore Jonah crab fishery is the only one with a total allowable catch (TAC). Due to industry concerns about the catch declines, the TAC (which is not science based) was lowered from 720 t to 540 t in 2010 (DFO 2010b) (DFO 2008a). The fishery was last assessed by DFO in 2009 (DFO 2009b) (Pezzack et al. 2009) and there is no additional current information. Standardized and non-standardized CPUE has been used as a proxy for abundance and has indicated that Jonah crab stocks in this area have been declining since the advent of the fishery. The continual decline in abundance of Jonah crabs in LFA 41 is likely due to the fishing down of the biomass that was present at the start of the fishery (1995) (DFO 2009b). Currently, there is no longer a directed Jonah crab fishery in LFA 41 (DFO 2009b) and, although Jonah crabs are caught as bycatch in the American lobster fishery, they are discarded at sea due to low catch rates and low market demand (Bannister et al. 2010). For all intents and purposes, the directed *C. borealis* fishery in LFA 41 is inactive as a result of low catch rates, low effort, and low market demand (Robichaud and Frail 2006) (DFO 2009b) (Bannister et al. 2010).

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 (≤ 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.*

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Moderate Concern

There are no estimates of fishing mortality for Jonah crabs in LFA 34, 38, or LFA 41. However, recent information, especially in LFA 41, suggests that the original TAC (720 t) (which was not science based) that had been implemented until 2010 was not sustainable and that the population declines began at the inception of the Jonah crab fishery in 1995. Though the cause of the population decline of Jonah crab cannot be identified with certainty, it is speculated that the decline is due to the fishing down of the biomass present at the start of the fishery (DFO 2009b). In LFA 41, Jonah crab is no longer being directed for. Fishing mortality for *C. borealis* in LFAs 34, 38, and 41 is considered of “moderate” concern.

Criterion 2: Impacts on Other Species

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

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

Criterion 2 Summary

Atlantic rock crab: Gulf Mgmt. region Gulf of St. Lawrence, Trap

Subscore:: **1.526** **Discard Rate:** **0.90** **C2 Rate:** **1.373**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
ATLANTIC COD	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
LEATHERBACK TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
ATLANTIC ROCK CRAB	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Atlantic rock crab: Quebec Gulf of St. Lawrence, Trap

Subscore:: **1.526** **Discard Rate:** **0.90** **C2 Rate:** **1.373**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
ATLANTIC COD	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
LEATHERBACK TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**

ATLANTIC WOLFFISH	High	2.00: High Concern	2.33: Moderate Concern	**2.159**
ATLANTIC ROCK CRAB	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Jonah crab: Maritimes Bay of Fundy, Trap

Subscore:: **1.000** **Discard Rate:** **0.90** **C2 Rate:** **0.900**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
CUSK	High	1.00: Very High Concern	1.00: High Concern	**1.000**
NORTH ATLANTIC RIGHT WHALE	High	1.00: Very High Concern	1.00: High Concern	**1.000**
ATLANTIC COD	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
LEATHERBACK TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
ATLANTIC WOLFFISH	High	2.00: High Concern	2.33: Moderate Concern	**2.159**
JONAH CRAB	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Jonah crab: Maritimes Gulf of Maine, Trap

Subscore:: **1.000** **Discard Rate:** **0.90** **C2 Rate:** **0.900**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
CUSK	High	1.00: Very High Concern	1.00: High Concern	**1.000**
NORTH ATLANTIC RIGHT WHALE	High	1.00: Very High Concern	1.00: High Concern	**1.000**
NORTHERN BOTTLENOSE WHALE: WESTERN NORTH ATLANTIC	High	1.00: Very High Concern	1.00: High Concern	**1.000**
ATLANTIC COD	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
LEATHERBACK TURTLE	High	1.00: Very High Concern	2.33: Moderate	**1.526**

			Concern	
ATLANTIC WOLFFISH	High	2.00: High Concern	2.33: Moderate Concern	**2.159**
JONAH CRAB	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Retained and bycatch species analyzed in this assessment have been chosen based primarily on the percent of catch they make up in the directed lobster fishery (because Jonah and Atlantic rock crabs are caught as bycatch in the American lobster fishery) or their conservation status (endangered, threatened, or overfished). Traps used in the lobster and directed crab fisheries are highly selective, so bycatch is not generally considered a pressing issue; however, little is known about the nature of bycatch in the directed Jonah and Atlantic rock crab fisheries. Generally, the most common type of bycatch found in traps in the Jonah crab and Atlantic rock crab (and lobster) fisheries are juvenile lobsters, ovigerous female lobsters, crabs, undersized crabs, and some finfish. There is little information on discard and mortality rates for the Jonah and Atlantic rock crab fisheries or pot/trap fisheries in general, although with the size of these fisheries, the rates are likely very low compared to other fisheries. Besides the quantity of bycatch that is caught or discarded in the Jonah and Atlantic rock crab fisheries, the pressing concern is the number of species at risk that can potentially be captured incidentally or have other dangerous interactions with the fisheries. Several endangered species, threatened species, and species of special concern have interactions with trap gear, including North Atlantic right whales (*Eubalaena glacialis*), leatherback turtles (*Dermochelys coriacea*), Atlantic wolffish (*Anarhichas lupus*), cusk (*Brosme brosme*), and Atlantic cod (*Gadus morhua*). Other finfish species incidentally caught in the lobster fishery include red hake, white hake, shorthorn sculpin, spiny dogfish, haddock, and redfish; however, these species will not be analyzed in this report because the bycatch numbers in the lobster fishery are low. These potential interactions are mainly limited to the inshore and offshore lobster fisheries in the Maritimes region. Little to no bycatch data in the directed Atlantic rock crab fisheries in Quebec exist, but this is likely not considered a problem, especially because the fishery does not overlap temporally in this area. Additionally, there is little information on discard and mortality rates in these fisheries, which makes it difficult to assess the magnitude of the problem.

Criterion 2 Assessment

ATLANTIC COD

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

High

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

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Very High Concern

The Atlantic cod stocks in Eastern Canada have suffered extreme biomass declines since the early 1990s, forcing the implementation of moratoria on many stocks off and on since then. Several of the more viable stocks, such as the 3Ps stock, are seeing small improvements in the health of the stock (DFO 2012c) but, in general, most stocks have yet to see significant rebuilding progress. Atlantic cod in Eastern Canada has been assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2010), and Seafood Watch deems Atlantic cod to be of “very high” concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Moderate Concern

There are no recent calculated F values for all the cod stocks (12) in eastern Canada. Although cod is caught as bycatch in the directed lobster fishery in all regions, the numbers overall appear to be relatively low (Bannister et al. 2010) (Pezzack et al. 2009). The lobster fishery and by extension the Jonah and Atlantic rock crab fisheries do not appear to be a major source of cod fishing mortality. Seafood Watch deems fishing mortality of Atlantic cod as “moderate” concern.

Rationale:
(den Heyer et al. 2010) examined the bycatch of lobster traps in the inshore fishery (LFA 27–33). Of the 2,553 traps sampled, 44 species from 9 phyla were recorded. More than 90% of the bycatch by weight was attributed to lobsters, indicating the high specificity of lobster gear. The majority of the bycatch after lobsters were Atlantic rock and Jonah crabs (23% and 10%, respectively), shorthorn sculpins (7%), and sea urchins (7%), while only 1% of the traps had Atlantic cod as incidental catch (den Heyer et al. 2010). A similar study (Gendron and Duluc 2012) looked at bycatch in the lobster fishery in Quebec and found that Atlantic rock crabs were by far the predominant bycatch in the three regions sampled. On the other hand, cod was only in 3% of the traps and only in the South Gaspè region (2012).

Factor 2.4 - Discard Rate

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

40-60%

There is little information regarding overall discard rates in the directed Jonah and rock crab fisheries. But since both *C. borealis* and *C. irroratus* are bycatch in the directed lobster fisheries, in which male rock and Jonah crabs are allowed to be kept as bait or to sell (DFO 2009a), we are using rates calculated from some recent studies pertaining to bycatch and discards in the lobster fisheries as proxies. Based on data from a recent study (den Heyer et al. 2010) and an assumed post-release mortality rate of 20%, we have calculated a discard rate of 22.95%. However, about 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Additionally, since there is a lack of information on bait use for this fishery, we are using a level of bait use of 20%, based on the level of bait use in other crab fisheries. Discard rate + bait use = 42.95% (DFO 2013c) (den Heyer et al. 2010).

Rationale:
There is very little data on the overall rates of discards and bait use in either the Atlantic rock crab or Jonah crab fisheries in Canada. More information is available for the directed lobster fisheries in the

region, and this data can be used as a proxy since *Cancer* crabs are bycatch in the lobster fisheries. Lobster traps and crab traps are inherently quite specific fishing gears, and the relative amount of bycatch in these fisheries is considered very low compared to other, less discriminating gears. Additionally, in both the United States and Canadian lobster fisheries, all traps are mandated to have devices that will allow sublegal crabs and lobsters to escape. In the U.S., fishers have developed a modified Jonah crab trap that has been shown to be highly successful at reducing incidental catch of lobsters and other non-target species (Reardon 2006). As part of management in the Canadian lobster and crab fisheries, there are legal size limits and no take is allowed of female lobster or crabs. Additionally, it is mandatory to discard almost all non-target incidental bycatch, with a few exceptions, and it is dependent on LFAs. In general, male rock crabs and Jonah crabs are allowed to be kept as bait or to sell, without limits on size or quantity (DFO 2009a). Approximately 15% of the catch is discarded and, although post-release mortality is unknown, it is likely low (other trap fisheries' rates are in the range of 20%). About 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Of more pressing concern is the effect that the lobster fishery has on the *Cancer* crab populations. As mentioned, as part of the lobster management plan and the Fisheries Act (1985), bycatch and retention of male *C. borealis* and *C. irroratus* in the lobster fisheries are allowed, without quantity or size limits (DFO 2013b) (DFO 2009a). Catches and bait use of *Cancer* crabs in the lobster fishery are sometimes more than the landings from the directed crab fisheries themselves (DFO 2013e). It is also not required for lobster fishers to report or track bait use and bycatch of *Cancer* crabs in most regions, although electronic logbooks are becoming mandatory in Quebec. Therefore, until there is better reporting and data collection on the bycatch and bait use of *Cancer* crabs in the lobster fishery throughout Eastern Canada, the potential for uncontrolled overexploitation of Jonah and Atlantic rock crabs is likely, especially as access to traditional bait species becomes more limited or more expensive (DFO 2013e).

ATLANTIC WOLFFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

High

Atlantic wolffish has a FishBase score of 67 (Froese & Pauly 2015) and therefore "high" inherent vulnerability. Wolffish typically lives for 22–30 years, maturing at 4–6 years of age, and has relatively low fecundity compared to other teleost fishes, producing 10,000 to 15,000 eggs per spawning (Froese &

Pauly 2015).

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

High Concern

In 2001, COSEWIC assessed and listed Atlantic wolffish as a species of special concern and a Schedule 1 listing under SARA. COSEWIC re-assessed the species in 2011 and confirmed each listing in November 2012 (COSEWIC 2012a). Seafood Watch deems the stock status of Atlantic wolffish in the Northwest Atlantic to be “high” concern.

Rationale:
There are currently no biological reference points available for Atlantic wolffish to accurately determine abundance. The Atlantic wolffish is determined as a species of special concern by COSEWIC (Kulka et al. 2007) (COSEWIC 2012a). A biomass index for Atlantic Wolffish for 1997–2001 from NAFO area 2J3Kl was calculated at 4,302 t (Kulka et al. 2007). Atlantic wolffish is likely to have interactions with trap gear (especially lobster trap gear) in the Bay of Fundy, where there is a small directed Jonah crab fishery along with the inshore lobster fishery.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Moderate Concern

There is currently no F metric for determining fishing mortality for Atlantic wolffish. The latest metrics for fishing mortality for this species were based on an exploitation index (catch/relative biomass) from 1995–2002, and that was 1% for Atlantic wolffish (Kulka et al. 2007). Additionally, the Recovery Strategy Report (Kulka et al. 2007) states that obtaining an accurate estimate of fishing mortality (F) is

problematic due to wolffish being captured in a variety of fisheries (Kulka et al. 2007). Seafood Watch deems fishing mortality of Atlantic wolffish as “moderate” concern due unknown fishing mortality.

Rationale:
The leading cause of human-induced mortality of the wolffish populations in Canada is incidental capture in a variety of fisheries, including in limited amounts in the offshore fishery (Kulka et al. 2007). But the extent to which fishing activities contribute to the total mortality of wolffish is not clear (Kulka et al. 2007). There is no directed fishery for Atlantic wolffish in Canada; however, its distribution overlaps fishing grounds of many Northwest Atlantic fisheries including lobster fisheries (and by extension Jonah and Atlantic rock crab fisheries), so wolffish is sometimes bycatch in these fisheries (Kulka et al. 2007). Currently, in the Canadian lobster fisheries, all finfish bycatch is released (DFO 2009a), but it is not known how well the released animals survive.

Factor 2.4 - Discard Rate

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

40-60%

There is little information regarding overall discard rates in the directed Jonah and rock crab fisheries. But since both *C. borealis* and *C. irroratus* are caught as bycatch in the directed lobster fisheries in which male rock and Jonah crabs are allowed to be kept as bait or to sell (DFO 2009a), we are using rates calculated from some recent studies pertaining to bycatch and discards in the lobster fisheries as proxies. Based on data from a recent study (den Heyer et al. 2010) and an assumed post-release mortality rate of 20%, we have calculated a discard rate of 22.95%. However, about 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Additionally, since there is a lack of information on bait use for this fishery, we are using a level of bait use of 20%, based on the level of bait use in other crab fisheries. Discard rate + bait use = 42.95% (DFO 2013c) (den Heyer et al. 2010).

Rationale:
There is little data on the overall rates of discards and bait use in either the Atlantic rock crab or Jonah crab fisheries in Canada. More information is available for the directed lobster fisheries in the region, and this data can be used as a proxy since *Cancer* crabs are bycatch in the lobster fisheries. Lobster traps and crab traps are inherently quite specific fishing gears, and the relative amount of bycatch in these fisheries is considered very low compared to other, less discriminating gears. Additionally, in both the United States and Canadian lobster fisheries, all traps are mandated to have devices that will allow sublegal crabs and lobsters to escape. In the U.S., fishers have developed a modified Jonah crab trap that has been shown to be very successful at reducing incidental catch of lobsters and other non-target

species (Reardon 2006). As part of management in the Canadian lobster and crab fisheries, there are legal size limits and no take is allowed of female lobster or crabs. Additionally, it is mandatory to discard almost all non-target incidental bycatch, with a few exceptions, and this is dependent on LFAs. In general, male rock crabs and Jonah crabs are allowed to be kept as bait or to sell, without limits on size or quantity (DFO 2009a). As such, approximately 15% of the catch is discarded and, although post-release mortality is unknown, it is likely low (other trap fisheries' rates are in the range of 20%). About 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Of more pressing concern is the effect that the lobster fishery has on the *Cancer* crab populations. As mentioned, as part of the lobster management plan and the Fisheries Act (1985), bycatch and retention of male *C. borealis* and *C. irroratus* in the lobster fisheries are allowed, without quantity or size limits (DFO 2013b) (DFO 2009a). Catches and bait use of *Cancer* crabs in the lobster fishery are sometimes more than the landings from the directed crab fisheries themselves (DFO 2013e). It is also not required for lobster fishers to report or track bait use and bycatch of *Cancer* crabs in most regions, although electronic logbooks are becoming mandatory in Quebec. Therefore, until there is better reporting and data collection on the bycatch and bait use of *Cancer* crabs in the lobster fishery throughout Eastern Canada, the potential for uncontrolled overexploitation of Jonah and Atlantic rock crabs is likely, especially as access to traditional bait species becomes more limited or more expensive (DFO 2013e).

CUSK

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

High

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

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Very High Concern

In May 2003, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed cusk as threatened; however, as of November 2012, COSEWIC had re-assessed cusk and determined it to be endangered (COSEWIC 2012a). Cusk is currently being considered for listing on Schedule 1 of the Species at Risk Act (SARA) (Bannister et al. 2010) (DFO 2008b) (COSEWIC 2003a). Therefore, Seafood Watch deems the stock status of cusk in the Northwest Atlantic to be “very high” concern.

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

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

High Concern

There are no calculated F values for this species; however, an estimated 20.4 t of cusk were taken as bycatch in the offshore lobster fishery (Pezzack et al. 2009) and discarded. During the 2005–2006 lobster season, the estimated mortality rate of cusk in the offshore lobster fishery was >86% (DFO 2008b) (COSEWIC 2003a). Therefore Seafood Watch considers fishing mortality for cusk to be “high” concern.

Rationale:
Fishing is the only known major source of human-induced mortality for cusk. Cusk is often caught as bycatch in the offshore lobster fishery (Bannister et al. 2010) but it is not kept. In the 2005–2006 lobster season, the estimated mortality rate of cusk in the offshore lobster fishery was >86% (DFO 2008b). An estimated 226 mt of cusk were discarded from LFA 34 in the same season, and 169 mt from LFA 34 in 2006–2007 (Harris and Hanke 2010). et al.(Gavaris et al. 2010) calculated cusk discard rates in the lobster fishery in NAFO Divisions 4VW–5Z at 2%–5%, and this could be significant given the density of lobster gear in Southwest Nova Scotia (Gavaris et al. 2010). This is cause for concern, and DFO has

recommended that this area be prioritized when considering future management (Gavaris et al. 2010).

Factor 2.4 - Discard Rate

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

40-60%

There is little information regarding overall discard rates in the directed Jonah and rock crab fisheries. But since both *C. borealis* and *C. irroratus* are caught as bycatch in the directed lobster fisheries in which male rock and Jonah crabs are allowed to be kept as bait or to sell (DFO 2009a), we are using rates calculated from some recent studies pertaining to bycatch and discards in the lobster fisheries as proxies. Based on data from a recent study (den Heyer et al. 2010) and an assumed post-release mortality rate of 20%, we have calculated a discard rate of 22.95%. However, about 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Additionally, since there is a lack of information on bait use for this fishery, we are using a level of bait use of 20%, based on the level of bait use in other crab fisheries. Discard rate + bait use = 42.95% (DFO 2013c) (den Heyer et al. 2010).

Rationale:
There is very little data on the overall rates of discards and bait use in either the Atlantic rock crab or Jonah crab fisheries in Canada. More information is available for the directed lobster fisheries in the region, and this data can be used as a proxy since *Cancer* crabs are bycatch in the lobster fisheries. Lobster traps and crab traps are inherently quite specific fishing gears, and the relative amount of bycatch in these fisheries is considered very low compared to other, less discriminating gears. Additionally, in both the United States and Canadian lobster fisheries, all traps are mandated to have devices that will allow sublegal crabs and lobsters to escape. In the U.S., fishers have developed a modified Jonah crab trap that has been shown to be highly successful at reducing incidental catch of lobsters and other non-target species (Reardon 2006). As part of management in the Canadian lobster and crab fisheries, there are legal size limits and no take is allowed of female lobster or crabs. Additionally, it is mandatory to discard almost all non-target incidental bycatch, with a few exceptions, and it is dependent on LFAs. In general, male rock crabs and Jonah crabs are allowed to be kept as bait or to sell, without limits on size or quantity (DFO 2009a). Approximately 15% of the catch is discarded and, although post-release mortality is unknown, it is likely low (other trap fisheries' rates are in the range of 20%). About 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Of more pressing concern is the effect that the lobster fishery has on the *Cancer* crab populations. As mentioned, as part of the lobster management plan and the Fisheries Act (1985), bycatch and retention of male *C. borealis* and *C. irroratus* in the lobster fisheries are allowed, without quantity or size limits (DFO 2013b) (DFO 2009a). Catches and bait use of *Cancer* crabs in the lobster fishery are sometimes more than the landings from the directed crab fisheries themselves (DFO 2013e).

It is also not required for lobster fishers to report or track bait use and bycatch of *Cancer* crabs in most regions, although electronic logbooks are becoming mandatory in Quebec. Therefore, until there is better reporting and data collection on the bycatch and bait use of *Cancer* crabs in the lobster fishery throughout Eastern Canada, the potential for uncontrolled overexploitation of Jonah and Atlantic rock crabs is likely, especially as access to traditional bait species becomes more limited or more expensive (DFO 2013e).

LEATHERBACK TURTLE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

High

Leatherback turtles in Atlantic Canada have high inherent vulnerability (SFW Criteria document p. 9).

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Very High Concern

Leatherback turtles in Canadian waters were determined as “endangered” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1981, 2001, and most recently in 2012 (COSEWIC 2012b) (DFO 2012a). Due to the “endangered” classification and the lack of population trends and data, Seafood Watch deems the status of this stock as “very high” concern.

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

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Moderate Concern

The only estimates of fishing mortality for leatherback turtles have been calculated for the groundfish gillnet fishery using data from SARA logbook records, which put the encounter mortality* rate at 20%, and from the Whale Release and Stranding Network, which estimates the mortality rate at 23% (DFO 2012a). But only rough estimates of overall mortality due to fixed gear are available (20%–70%) (DFO 2012a). Based on the endangered status of this species in Canada and globally, but with few if any lobster fishery interactions in the Maritimes, Gulf, and Quebec regions (DFO 2012a) (O'Boyle 2012), Seafood Watch deems fishing mortality for leatherback turtles as “moderate” concern.

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

Rationale:
The leading threat to leatherback turtles in Canadian waters is the continual interaction with fishing gear. Leatherback turtles are incidentally caught in almost all fisheries in the Northwest Atlantic, especially in the pelagic longline fishery (DFO 2012a). Turtles are especially vulnerable to entanglement in vertical and surface lines from fixed gear, as well as mooring lines, trip lines, and monofilament and polypropylene netting (COSEWIC 2012b). Entanglement can lead to serious injury, flipper amputation, and drowning. Since the last COSEWIC assessment in 2001, the primary threats to leatherback turtles—fishing, marine pollution, ship strikes, and oil and gas exploration—have not changed much and, in the case of fishing gear interactions, it appears as if they have worsened. Interactions with fishing gear are more significant than previously assessed because of the inconsistency and infrequency of how data are collected and what data are available. This has contributed to the underreporting of incidents, which has led to an underestimation of the magnitude of the problem (COSEWIC 2012b). Additionally, threats

to leatherback turtles in Canadian waters not only affect the Canadian populations. Because these are transient animals that return to the beaches where they hatched all along the Western Atlantic, the impacts of these threats are magnified (COSEWIC 2012b) on the entire Western Atlantic population (COSEWIC 2012b).

With regard to leatherback turtle encounters within the lobster fishery (as a proxy for the Jonah and Atlantic rock crab fisheries), there have only been two reports in the recent literature (DFO 2012a) (O'Boyle 2012) of leatherback turtles interacting with lobster trap gear: one in the Gulf region and one in the Maritimes region (DFO 2012a) (O'Boyle 2012). Though SARA logs are a requirement for a license in Jonah crab, Atlantic rock crab, and lobster fisheries (among others), compliance is extremely low, which makes data from these sources limited and unreliable. So, even though it may appear as if interactions with leatherback turtles in these fisheries are extremely rare, there is a high likelihood of unreported encounters.

Factor 2.4 - Discard Rate

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

40-60%

There is very little information regarding overall discard rates in the directed Jonah and rock crab fisheries. But since both *C. borealis* and *C. irroratus* are caught as bycatch in the directed lobster fisheries in which male rock and Jonah crabs are allowed to be kept as bait or to sell (DFO 2009a), we are using rates calculated from some recent studies pertaining to bycatch and discards in the lobster fisheries as proxies. Based on data from a recent study (den Heyer et al. 2010) and an assumed post-release mortality rate of 20%, we have calculated a discard rate of 22.95%. However, about 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Additionally, since there is a lack of information on bait use for this fishery, we are using a level of bait use of 20%, based on the level of bait use in other crab fisheries. Discard rate + bait use = 42.95% (DFO 2013c) (den Heyer et al. 2010).

Rationale:
There is very little data on the overall rates of discards and bait use in either the Atlantic rock crab or Jonah crab fisheries in Canada. More information is available for the directed lobster fisheries in the region, and this data can be used as a proxy since *Cancer* crabs are bycatch in the lobster fisheries. Lobster traps and crab traps are inherently quite specific fishing gears, and the relative amount

of bycatch in these fisheries is considered very low compared to other, less discriminating gears. Additionally, in both the United States and Canadian lobster fisheries, all traps are mandated to have devices that will allow sublegal crabs and lobsters to escape. In the U.S., fishers have developed a modified Jonah crab trap that has been shown to be highly successful at reducing incidental catch of lobsters and other non-target species (Reardon 2006). As part of management in the Canadian lobster and crab fisheries, there are legal size limits and no take is allowed of female lobster or crabs. Additionally, it is mandatory to discard almost all non-target incidental bycatch, with a few exceptions, and it is dependent on LFAs. In general, male rock crabs and Jonah crabs are allowed to be kept as bait or to sell, without limits on size or quantity (DFO 2009a). Approximately 15% of the catch is discarded and, although post-release mortality is unknown, it is likely low (other trap fisheries' rates are in the range of 20%). About 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Of more pressing concern is the effect that the lobster fishery has on the *Cancer* crab populations. As mentioned, as part of the lobster management plan and the Fisheries Act (1985), bycatch and retention of male *C. borealis* and *C. irroratus* in the lobster fisheries are allowed, without quantity or size limits (DFO 2013b) (DFO 2009a). Catches and bait use of *Cancer* crabs in the lobster fishery are sometimes more than the landings from the directed crab fisheries themselves (DFO 2013e). It is also not required for lobster fishers to report or track bait use and bycatch of *Cancer* crabs in most regions, although electronic logbooks are becoming mandatory in Quebec. Therefore, until there is better reporting and data collection on the bycatch and bait use of *Cancer* crabs in the lobster fishery throughout Eastern Canada, the potential for uncontrolled overexploitation of Jonah and Atlantic rock crabs is likely, especially as access to traditional bait species becomes more limited or more expensive (DFO 2013e).

NORTH ATLANTIC RIGHT WHALE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

High

North Atlantic right whale has high inherent vulnerability (SFW Criteria document p. 9).

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Very High Concern

North Atlantic right whales are endangered the world over and are classified as endangered by COSEWIC (COSEWIC 2003b) and were listed as endangered under SARA in 2005 (Brown et al. 2009). The population of North Atlantic right whales in Atlantic Canadian waters has most recently been estimated at 346–672 animals (Brown et al. 2009) (Pettis 2012). Due to the extremely low numbers of this population, as well as the endangered status under SARA and COSEWIC, Seafood Watch deems the status of this stock as "very high" concern.

Rationale:
Precise estimates have not been calculated for this species of cetacean; however, abundance estimates indicated 444 animals were believed to be alive in 2009 (Waring et al. 2012), and more recently the population was estimated at 509 individuals (Pettis 2012). The population of North Atlantic right whales declined in the 1990s, and increases in mortality rates in 2004 and 2005 were cause for serious concern (Knowlton et al. 2005). It was predicted that these mortality rate increases would likely reduce the right whale population by 10% per year (Knowlton et al. 2005). Despite these predictions, examination of the minimum number of the alive population index for 1990–2009 suggests that the right whale population is experiencing a positive trend in population size, with a mean crude growth rate of 2.6% in that period (Waring et al. 2012).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

High Concern

Since eliminating whaling as a threat to North Atlantic right whales in the 1930s, the only other immediate threats to the recovery of this population are ship strikes and entanglement in fishing gear. Between 1970 and 2007, there have been 75 reliably documented right whale deaths: 11% (8 whales) were attributed to entanglement in fishing gear, 37% (28 whales) were attributed to vessel strikes, 28% (21 whales) died of unknown causes, and 24% (18 whales) were defined as "neonatal mortality" (Brown et al. 2009) (Knowlton and Kraus 2001). Between 2007 and 2011, the total annual rate of mortality and serious injury to right whales due to anthropogenic effects was an average of 4.05 per year (U.S. waters, 3.1; Canadian waters, 0.95) (Waring et al. 2012). The two main causes were incidental entanglements in fishing gear at 3.25 per year (U.S. waters, 2.3; Canadian waters, 0.95) and ship strikes at 0.8 per year

(U.S. waters, 0.8; Canadian waters, 0) (Waring et al. 2012). During 2007–2011, out of 21 records of mortality or serious injury, 17 were attributed to entanglement or fishery interactions (Waring et al. 2012). The actual total number of deaths attributed to anthropogenic activities is unknown but it is likely higher than the observed number because not all carcasses of right whales are found. For example, carcasses of right whales that die as a result of entanglements in fishing gear may be more likely to sink at sea because of the decreased health of the animals and subsequent energetic losses. Therefore, it has been suggested that up to two-thirds of human-caused right whale deaths may go undetected (Brown et al. 2009). The potential biological removal for North Atlantic right whales is 0.9 whales per year, which is exceeded by cumulative fishing impacts and by Canadian fisheries. The impact of the Canadian crab fisheries is unknown because interactions cannot be attributed to specific fisheries; however, the U.S. lobster fishery is known to have a significant impact on North Atlantic right whale populations and, because the crab fisheries use similar gear, Seafood Watch considers them to be a "high" concern.

Rationale:
Although there are no data on North Atlantic right whale discards/bycatch rates *per se* in Canadian waters, there are some quantitative data on encounters with fishing gear, primarily entanglement events. Though it was once believed that interactions with fishing gear by right whales were rare and "exceptional" events (Brown et al. 2009), it is now evident that interactions with fishing gear are major sources of serious injury (maiming, amputation, starvation) and mortality. Fishing gear entanglements are a serious impediment to the recovery of this population (Kraus et al. 2005) due to the sheer volume in fishing gear in the Northwest Atlantic and the precarious state of the population. Indeed, recent studies have shown that more than 75% of right whales have scarring attributed to entanglements in fishing gear at some point in their life, and the rate of scarring increased in the 1990s (Brown et al. 2009) (Knowlton et al. 2005). Juvenile right whales are particularly vulnerable to entanglements, more so than adults (Brown et al. 2009) (Knowlton et al. 2005). In Atlantic Canada, North Atlantic right whales have two critical habitats, the Grand Manan Basin in the Bay of Fundy and Roseway Basin in Southwest Nova Scotia (Brown et al. 2009). North Atlantic right whales are present on the Scotian Shelf during the summer months, and the mouth of the Bay of Fundy and Roseway Basin are known feeding grounds for these mammals (Pezzack et al. 2009), so interaction with lobster gear during lobster and Jonah crab season is possible (Pezzack et al. 2009). An analysis of the different gear types and fisheries encountered by right whales during the summer in the Scotia-Fundy region indicates that the gears with the greatest entanglement potential are groundfish gillnet, groundfish hook and line, and crab traps (Johnston et al. 2007) (Vanderlaan et al. 2011).

Factor 2.4 - Discard Rate

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

40-60%

There is very little information regarding overall discard rates in the directed Jonah and rock crab fisheries. But since both *C. borealis* and *C. irroratus* are caught as bycatch in the directed lobster fisheries where male rock and Jonah crabs are allowed to be kept as bait or to sell (DFO 2009a), we are using rates calculated from some recent studies pertaining to bycatch and discards in the lobster fisheries as proxies. Based on data from a recent study (den Heyer et al. 2010) and an assumed post-release mortality rate of 20%, we have calculated a discard rate of 22.95%. However, about 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Additionally, since there is a lack of information on bait use for this fishery, we are using a level of bait use of 20%, based on the level of bait use in other crab fisheries. Discard rate + bait use = 42.95% (DFO 2013c) (den Heyer et al. 2010).

Rationale:

There is very little data on the overall rates of discards and bait use in either the Atlantic rock crab or Jonah crab fisheries in Canada. More information is available for the directed lobster fisheries in the region, and this data can be used as a proxy since *Cancer* crabs are bycatch in the lobster fisheries. Lobster traps and crab traps are inherently quite specific fishing gears, and the relative amount of bycatch in these fisheries is considered very low compared to other, less discriminating gears. Additionally, in both the United States and Canadian lobster fisheries, all traps are mandated to have devices that will allow sublegal crabs and lobsters to escape. In the U.S., fishers have developed a modified Jonah crab trap that has been shown to be highly successful at reducing incidental catch of lobsters and other non-target species (Reardon 2006). As part of management in the Canadian lobster and crab fisheries, there are legal size limits and no take is allowed of female lobster or crabs. Additionally, it is mandatory to discard almost all non-target incidental bycatch, with a few exceptions, and it is dependent on LFAs. In general, male rock crabs and Jonah crabs are allowed to be kept as bait or to sell, without limits on size or quantity (DFO 2009a). Approximately 15% of the catch is discarded and, although post-release mortality is unknown, it is likely low (other trap fisheries' rates are in the range of 20%). About 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Of more pressing concern is the effect that the lobster fishery has on the *Cancer* crab populations. As mentioned, as part of the lobster management plan and the Fisheries Act (1985), bycatch and retention of male *C. borealis* and *C. irroratus* in the lobster fisheries are allowed, without quantity or size limits (DFO 2013b) (DFO 2009a). Catches and bait use of *Cancer* crabs in the lobster fishery are sometimes more than the landings from the directed crab fisheries themselves (DFO 2013e). It is also not required for lobster fishers to report or track bait use and bycatch of *Cancer* crabs in most regions, although electronic logbooks are becoming mandatory in Quebec. Therefore, until there is better reporting and data collection on the bycatch and bait use of *Cancer* crabs in the lobster fishery throughout Eastern Canada, the potential of uncontrolled overexploitation of Jonah and Atlantic rock crabs is likely, especially as access to traditional bait species becomes more limited or more expensive (DFO 2013e).

NORTHERN BOTTLENOSE WHALE: WESTERN NORTH ATLANTIC

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Maritimes Gulf of Maine, Trap

High

The Scotian Shelf population of Northern bottlenose whales has high inherent vulnerability (SFW Criteria document p. 9)

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Maritimes Gulf of Maine, Trap

Very High Concern

The Scotian Shelf population of Northern bottlenose whales was determined as endangered by COSEWIC in 2011 (COSEWIC 2011). The population is extremely small, with approximately 93 mature adults and 71 immature animals, and no significant trend in population size has been detected between 1988 and 2009 (COSEWIC 2011) (Wimmer and Whitehead 2004). Based on their endangered status as well as extremely low numbers of mature adults, this population is deemed “very high” concern.

Rationale:
The Northern bottlenose whale is a beaked whale found in the North Atlantic. In Canada, there appear to be two distinct populations: one in the waters of the Scotian Shelf, and another in the Baffin Bay-Davis Strait-Labrador Sea region. These are considered two distinct populations based on habitat and genetics (COSEWIC 2011). The Scotian Shelf population is found in the large submarine canyons, the Gully, Shortland Canyon, and Haldimand Canyon (COSEWIC 2011). Although these deep-diving and rare mammals are not often found in waters overlapping the offshore lobster fishing areas, there have been reports of individuals at the edge of the shelf near the fishery areas (Wimmer and Whitehead 2004). Additionally, entanglement in fishing gear is one of the principle threats to this population (Bannister et al. 2010), with many individuals showing evidence of interactions with fishing gear (COSEWIC 2011), although it is unclear whether the threat of fishing gear is great enough to have population-level effects (COSEWIC 2011)**.**

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Maritimes Gulf of Maine, Trap

High Concern

There are no current fishing mortality estimates for the Scotian Shelf population. The two main anthropogenic threats to Northern bottlenose whales are entanglements/interactions with fishing gear and acoustic disturbance (Harris et al. 2007). The impacts of removing individuals from the population are unknown; although, given the extremely small size of the population and the limited genetic exchange with other populations, any human-induced mortality is cause for concern. The PBR for the Scotian Shelf population was calculated at 0.3 individuals per year (Harris et al. 2007). Due to low numbers in the Scotian Shelf population and its endangered status, fishing mortality is deemed “high” concern.

Rationale:
There is no estimate for the frequency of entanglements or incidental catches in fishing gear (Harris et al. 2007) and, though incidents have been reported, a mortality rate cannot be calculated. Since the early 1980s, eight fishery interactions (entanglements/catches) have been documented by fishery observers, and five of those occurred in the Scotian Shelf area (COSEWIC 2011) (Harris et al. 2007). However, the fishing gears involved were trawl and pelagic longline gears. Another entanglement incident was reported in the Gully, but the fishing line was unidentified. None of the reported incidents implicated the lobster fishery; however, entanglements and bycatch may occur more frequently but go unreported (Harris et al. 2007). Additionally, there is evidence that many of the Scotian Shelf individuals bear signs of fishery interactions, which further supports the underreporting of entanglements (COSEWIC 2011).

Factor 2.4 - Discard Rate

Maritimes Gulf of Maine, Trap

40-60%

There is very little information regarding overall discard rates in the directed Jonah and rock crab fisheries. But since both *C. borealis* and *C. irroratus* are caught as bycatch in the directed lobster fisheries where male rock and Jonah crabs are allowed to be kept as bait or to sell (DFO 2009a), we are using rates calculated from some recent studies pertaining to bycatch and discards in the lobster fisheries as proxies. Based on data from a recent study (den Heyer et al. 2010) and an assumed post-release mortality rate of 20%, we have calculated a discard rate of 22.95%. However, about 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Additionally, since there is

a lack of information on bait use for this fishery, we are using a level of bait use of 20%, based on the level of bait use in other crab fisheries. Discard rate + bait use = 42.95% (DFO 2013c) (den Heyer et al. 2010).

Rationale:

There is very little data on the overall rates of discards and bait use in either the Atlantic rock crab or Jonah crab fisheries in Canada. More information is available for the directed lobster fisheries in the region, and this data can be used as a proxy since *Cancer* crabs are bycatch in the lobster fisheries. Lobster traps and crab traps are inherently quite specific fishing gears, and the relative amount of bycatch in these fisheries is considered very low compared to other, less discriminating gears. Additionally, in both the United States and Canadian lobster fisheries, all traps are mandated to have devices that will allow sublegal crabs and lobsters to escape. In the U.S., fishers have developed a modified Jonah crab trap that has been shown to be highly successful at reducing incidental catch of lobsters and other non-target species (Reardon 2006). As part of management in the Canadian lobster and crab fisheries, there are legal size limits and no take is allowed of female lobster or crabs. Additionally, it is mandatory to discard almost all non-target incidental bycatch, with a few exceptions, and it is dependent on LFAs. In general, male rock crabs and Jonah crabs are allowed to be kept as bait or to sell, without limits on size or quantity (DFO 2009a). Approximately 15% of the catch is discarded and, although post-release mortality is unknown, it is likely low (other trap fisheries' rates are in the range of 20%). About 90% of those discards tend to be sublegal or female lobsters (den Heyer et al. 2010). Of more pressing concern is the effect that the lobster fishery has on the *Cancer* crab populations. As mentioned, as part of the lobster management plan and the Fisheries Act (1985), bycatch and retention of male *C. borealis* and *C. irroratus* in the lobster fisheries are allowed, without quantity or size limits (DFO 2013b) (DFO 2009a). Catches and bait use of *Cancer* crabs in the lobster fishery are sometimes more than the landings from the directed crab fisheries themselves (DFO 2013e). It is also not required for lobster fishers to report or track bait use and bycatch of *Cancer* crabs in most regions, although electronic logbooks are becoming mandatory in Quebec. Therefore, until there is better reporting and data collection on the bycatch and bait use of *Cancer* crabs in the lobster fishery throughout Eastern Canada, the potential for uncontrolled overexploitation of Jonah and Atlantic rock crabs is likely, especially as access to traditional bait species becomes more limited or more expensive (DFO 2013e).

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
Gulf Mgmt. region Gulf of St. Lawrence Trap	3.000	3.000	Yellow(3.000)
Maritimes Bay of Fundy Trap	3.000	3.000	Yellow(3.000)
Maritimes Gulf of Maine Trap	1.000	3.000	Red(1.732)
Quebec Gulf of St. Lawrence Trap	3.000	3.000	Yellow(3.000)

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**
Gulf Mgmt. region Gulf of St. Lawrence Trap	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
Maritimes Bay of Fundy Trap	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
Maritimes Gulf of Maine Trap	Ineffective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Ineffective	Highly Effective
Quebec Gulf of St. Lawrence Trap	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective

The Department of Fisheries and Oceans (DFO) Canada manages the Canadian Jonah (*Cancer borealis*) and Atlantic rock crab (*Cancer irroratus*) fisheries. Management of the species is intended to protect the reproductive capacity of the populations. Thus, like some management measures for lobster, regulations have been in place that protect immature animals through minimum size limits and the prohibition of landing females and ovigerous females. Since both *Cancer* species are caught using lobster and crab traps, gear restrictions mandate the use of traps with biodegradable panels and escape vents to minimize bycatch. Effort control levels have also been implemented through trap number limits and limited entry into the fisheries, as well as area and season closures. Because these fisheries are mainly bycatch and bait fisheries within the directed Canadian lobster fisheries, many management measures in place are established through Integrated Fisheries Management Plans for lobster in the specific management regions. This is especially true for the Jonah crab fisheries, and in particular the offshore Jonah crab fisheries. Additionally, both *Cancer* crab fisheries in Atlantic Canada began as experimental fisheries in the region in 1995 and they have only been permanent fisheries since 2000. The *C. borealis* fisheries in the Maritimes region have not fared well; since their inception, catches have continually decreased due to a decrease in abundance and low market demand and price. In the offshore fishery, Jonah crabs are under a TAC (720 t) that was set not on scientific basis, but on what was set for the lobster fishery. This TAC has since been determined to be unsustainable and was lowered to 540 t in

2010. Since then, the directed fishery for Jonah crab offshore is inactive, and landings in the region are now mainly from the bycatch and bait fisheries in the lobster fishery.

C. irroratus stocks in the Gulf and Quebec regions appear to be more cautiously managed, and these fisheries appear to be more stable than the Jonah crab fisheries. This could be attributed to management but also to differences in the biology and resiliency of the two species. The concern with both *Cancer* crab fisheries is the lack of information and data regarding total removals and bait use in the lobster fisheries, because these are often significantly higher than through the directed fisheries. The lack of reporting and limits on removals for such purposes hinders the ability to properly assess the status and the effects of the lobster fishery on these stocks.

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Moderately Effective

The Atlantic rock crab fishery in the Gulf region (southern Gulf of St. Lawrence) comprises three distinct components, prioritized by DFO in the following order: the bycatch fishery, the bait fishery, and the directed fishery. The bycatch and bait fisheries are conducted through the lobster fishery by lobster license holders (DFO 2013a). The directed fishery is conducted at a different time by specific rock crab license holders, so it does not overlap with the lobster fishing season. Although the directed fishery is managed conservatively and primarily through effort control measures, the bycatch and bait fisheries operated by the lobster fishery currently are not. Lobster license holders are allowed to keep any size male crabs without limit as a condition of the Atlantic Fisheries Act (1985). This factor is scored as "moderately effective."

Rationale:
The fishery is managed through effort control measures including the number of licenses, individual trap allocations (except in LFA 24), gear restrictions, limited fishing seasons, and minimum legal size limits (DFO 2013a). The individual allocations are not based on stock status. Like in the lobster fisheries, no females are allowed to be landed. As a condition of license, logbooks are mandatory and daily catch, effort, and fishing location must be recorded (DFO 2013a).

The bycatch and bait fisheries are currently conducted in the lobster fishery. There is no mandatory logbook requirement and, because of the Atlantic Fisheries Regulations (1985), lobster license holders are allowed to keep any size male crabs without limit (DFO 2013a). Between 1999 and 2003, the bycatch

fishery did operate with daily limits and a minimum legal size; however, these restrictions were dropped because they conflicted with the Atlantic Fisheries Regulations (1985). Because there are no mandatory dockside monitoring or logbook requirements in the bait and bycatch fisheries, the potential number of harvesters for Atlantic rock crab is equal to the number of lobster license holders (DFO 2013a), which could have significant effects on the stocks due to the potential fishing pressure.

Maritimes Bay of Fundy, Trap

Moderately Effective

The directed Jonah crab fishery in the Scotia-Fundy region (inshore) (LFAs 34 and 38) occurs after the lobster fishing season and a crab license is required. The directed fishery is managed primarily to protect the reproductive potential of the resource and it is only for male crabs, with minimum size limits as well as trap limits and numbers. As the fisheries were being developed, the effect of the fishery on the Jonah crab resource was not understood, and Jonah crab populations declined steadily from the inception of the fishery in 1995. Additionally, the minimum size limits were based in relation to market demands and did not appear to protect the reproductive potential of male crabs in the LFA 34 fishery, because functional maturity for this species is around 128 mm (5 in) carapace width (CW) and the minimum size limit in LFA 34 is 121 mm (4.8 in) CW (Robichaud and Frail 2006). Though there are continual declines in the *C. borealis* stocks, there are management strategies in place, so this factor is deemed “moderately effective.”

Rationale:
The fishery is managed primarily through trap allocations, gear restrictions, and minimum legal size limits. Additionally, there are few licenses issued: five for both LFA 34 and LFA 38 in 2004 (Robichaud and Frail 2006). There are no individual allocations. As a condition of license, all crab fishers in the directed Jonah crab fishery are required to complete logbooks recording the number of traps hauled, soak days, liveweight landed, depth, date, location, and the type of trap fished (Robichaud and Frail 2006). Little current information on the fishery is available, probably because there is currently little to no activity in the fishery.

Maritimes Gulf of Maine, Trap

Ineffective

The *C. borealis* fishery in LFA 41 (offshore) presently operates under the 2006–2010 Integrated Harvesting Plan for American Lobster (DFO 2009a) with eight licenses and a TAC, and fishing is allowed only in the 4X and 5Zc portions of LFA 41. A TAC of 720 t (not based on science) was set at the beginning of the fishery in 1995 (DFO 2009b); however, due to the continual declines in the Jonah crab populations and a determination that the original TAC was unsustainable, the TAC was lowered in 2010

to 540 t (DFO 2010b) (DFO 2010c). The original TAC in 1995 was not set according to any rigorous science, but because that was the TAC for lobsters in the lobster fishery. The assumption that all crustaceans can tolerate the same fishing pressure is erroneous. The fact that the TAC was not reduced as soon as the Jonah crab resource began to decline indicates a lack of monitoring and assessment of the stock. As of the last stock assessment in 2009 (DFO 2009b), there was no evidence of recovery, which suggests that the current management strategy and implementation is "ineffective."

Rationale:
The offshore *C. borealis* fishery is managed by input and output controls including a minimum legal size, no taking of females, limited entry, and a TAC (DFO 2009b). Additionally, area closures for Jonah crab and lobster fishing are imposed, especially around Browns Bank (LFA 40), and this area has been closed since 1979 (DFO 2009b). The fishing season is year-round. Jonah crabs are caught as bycatch in the offshore lobster fishery as well as boats targeting Jonah crab.

Quebec Gulf of St. Lawrence, Trap

Moderately Effective

In Quebec, the *C. irroratus* fishery is a directed fishery that requires a license. As in the Gulf region, Atlantic rock crabs are caught as bycatch and used for bait in the directed lobster fisheries in the area. Because of the Atlantic Fisheries Regulation (1985), lobster fishers are allowed keep male rock crab as bycatch (DFO 2013e). The directed fishery in Quebec is managed primarily through effort control measures to keep harvest levels low, and a fishing season. Additionally, it is exclusively a male crab fishery with a minimum legal size of 102 mm (4 in) CW (DFO 2013e).

Rationale:
The *C. irroratus* fishery in Quebec is managed by effort control measures and by fishing area in order to keep fishing effort more evenly distributed. Management measures in place are similar to those seen for other crustacean fisheries, including no taking of females, minimum legal size limits (>102 mm [4 in] CW), trap limits, trap size requirements, a fishing season, and area closures (DFO 2013e). In the different fishing areas (Gaspè Peninsula, Magdalen Islands, and North Shore), allocations are either individual or shared (DFO 2013e). A mandatory logbook, as a condition of license, is in place in the Magdalen Islands and the Gaspè Peninsula (DFO 2013e).

The fishery is also managed by restricting the fishing seasons, and the directed rock crab fishery occurs after the lobster season. Additionally, management measures were implemented to protect vulnerable rock crab populations in the Northern Gaspè Peninsula, and these areas are closed to the directed fishery. There are also exclusion areas around the Southern Gaspè Peninsula because lobster fishers were concerned that the directed rock crab fishery would harm the lobster stock in this area. In 2000, an exclusion area was implemented in area 12C1 around the Magdalen Islands (DFO 2013e). Other measures intended to keep harvest levels low include trap limits and trap sizes, which vary by area, and

allocations, which vary by location and can either be individual or shared.

Atlantic rock crabs are taken as bycatch and used as bait in the directed lobster fisheries in Quebec. Currently, there are no mandatory dockside monitoring or logbook requirements for recording bycatch or bait use in the lobster fishery (although bait use data collection is beginning to be implemented (pers. comm., Gendron 2014)) and, because of the Atlantic Fisheries Regulations (1985), lobster license holders are allowed to keep any size male crabs (DFO 2013e). Between 1999 and 2003, the bycatch fishery did operate with daily limits and a minimum legal size; however, these restrictions were dropped as they were in direct conflict to the Atlantic Fisheries Regulations (1985).

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

N/A

There are no stocks of concern in this fishery. However, no other species are allowed to be landed.

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Moderately Effective

The *C. irroratus* stocks in the Gulf region appear to be assessed every 6 years, with the last assessments occurring in 2002, 2008, and the most recent in 2013. The stock assessments for *C. irroratus* are based on a limited number of fishery-dependent indicators, such as CPUE and landings data, and some fishery-independent data collected from bottom trawl surveys between 2010 and 2011 (DFO 2013a). The indicators from the trawl survey included distribution, size frequecies, sex ratios, catch rates, and biomass estimates; however, the survey only sampled areas in LFA 25 and 26A. There is uncertainty surrounding the sources of data, especially the fishery dependent data, because data were collected from a number of independent sources, leading to delays in data aquisition and an increase in errors in the data. Additionally, for the latest assessment, only preliminary data for 2011 were available. Therefore, due to a lack of robust data and indicators, scientific research and monitoring is "moderately effective."

Rationale:
The latest assessment for Atlantic rock crab in the southern Gulf of St. Lawrence brings to light the difficulty in assessing this stock. Because of the limited number of indicators on which to assess the stock as well as the uncertainty surrounding the sources, such as logbooks and official catch statistics, the assessment is incomplete at best. Information such as total removal of crabs used as bait in the lobster fishery is not known because the data are not available (DFO 2013a). Catch rates and fishing effort indicators are derived from logbook data; however, those data are also uncertain because that data, though mandatory, may not always be recorded or complete(DFO 2013a). Interpretations of the catch rates are also unreliable since most LFAs have a maximum allocation. It is speculated that fishers may be employing strategies to maintain high catch rates, leading to an appearance of stability in CPUE that could actually be masking fluctuations in abundance (DFO 2013a). Other factors such as temperature, socio-economic considerations, and changes in fishing technologies could also affect catch rates (DFO 2013a).

Other important biological data that contribute to a complete and accurate stock assessment, such as stock structure and dynamics, rock crab movements, larval biology, and recruitment dynamics, are all unknown or not well understood. A lack of this basic information makes biomass and exploitation estimates difficult to calculate (DFO 2013a), although efforts are being made to collect these data and to increase the reliability and completeness of the logbooks.

Maritimes Bay of Fundy, Trap

Moderately Effective

The last assessment by DFO for the inshore Jonah crab fishery was conducted in 2000 (DFO 2000). Since then, the only comprehensive review of the resource was completed by Robichaud and Frail in 2006 (Robichaud and Frail 2006). The only research and monitoring of this fishery was a set of Joint Partnership Agreements between DFO and individual crab fishers that agreed to conduct and pay for at-sea sampling between 2003 and 2004 (Robichaud and Frail 2006). Because there are no further stock

assessments, Scientific Research and Monitoring is deemed “moderately effective.”

Maritimes Gulf of Maine, Trap

Moderately Effective

The *C. borealis* stocks in LFA 41 were last assessed in 2009. Prior to that assessment, Jonah crab stocks in LFA 41 were assessed in 2000 (DFO 2000). The most current stock assessment (DFO 2009b) used abundance, fishing pressure, and production indicators developed from lobster logbooks, at-sea sampling, and a DFO RV summer bottom-trawl survey (DFO 2009b). Abundance indicators included landings, catch rates, and an RV survey of mean number/tow. Fishing pressure indicators were number of trap hauls, changes in size frequencies from the RV survey, and at-sea samples of the commercial catch. Spawning indicators were developed from the RV survey and the at-sea sampling (DFO 2009b). There are no direct estimates for population abundance. Due to the infrequency of the stock assessments as well as the limited number of indicators from lobster fishery sources, this factor is deemed “moderately effective.”

Quebec Gulf of St. Lawrence, Trap

Moderately Effective

The *C. irroratus* stocks in Quebec are assessed every 3 years. This is a more regular schedule than that for the *Cancer* crab fisheries in the Maritimes region or Gulf region, and it supports the cautious management strategy of the resource in this region (DFO 2013e). However, like other Cancer crab assessments in Canada, the assessment is based on a limited number of fishery-dependent indicators such as landings and CPUE. The source of the data is from logbooks, and validation comes from purchase slips and dockside monitoring (DFO 2013e). Fishery-independent abundance and recruitment indicators were assessed from data collected from trawl surveys for lobster (DFO 2013e). Due to the limited number of indicators and the sources of data, there is much uncertainty surrounding the resource assessments, so Scientific Research and Monitoring is deemed “moderately effective.”

Rationale:
Assessing the status of the *C. irroratus* stocks in Quebec has similar challenges and sources of uncertainty as the stocks in the Gulf region: primarily a lack of robust indicator data to adequately assess the resource (DFO 2013e). In Quebec, the main source of uncertainty and concern lies in the unknown quantities of rock crabs taken as bycatch or used as bait in the lobster fishery. Without knowledge of these removals, which could represent significant quanties, the impact on the crab stocks as a whole cannot be determined (DFO 2013e). The number of crabs removed in the lobster fishery could increase if access to other forms of bait become too expensive and/or limited (DFO 2013e).

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Moderately Effective

To our knowledge, there is no evidence that scientific advice is not being followed in this region. However, because individual allocations are not being set based on science or stock status, this factor is rated “moderately effective.”

Maritimes Bay of Fundy, Trap

Moderately Effective

To our knowledge, there is no evidence to suggest that scientific advice is not being followed in this region. However, due to the lack of commercial activity and subsequently the lack of any scientific assessments, this is difficult to gauge. This factor is rated “moderately effective.”

Maritimes Gulf of Maine, Trap

Moderately Effective

To our knowledge, there is no evidence to suggest that scientific advice is not being followed in this region. However, due to the lack of commercial activity and subsequently the lack of any scientific assessments, this is difficult to guage. Additionally, although the TAC of 720 t was lowered to 540 t in 2010, there is no evidence that this has had any effect on the status of the population, and currently the industry is not directing for Jonah crab. This factor is rated “moderately effective.”

Quebec Gulf of St. Lawrence, Trap

Moderately Effective

To our knowledge, there is no evidence that scientific advice is not being followed in this region. However, because individual allocations are not being set based on science or stock status, this factor is rated “moderately effective.”

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Highly Effective

There is little information regarding the enforcement of regulations for the Atlantic rock crab fishery. As a condition of holding a rock crab license, logbooks are mandatory and daily catch, effort, and locations must be recorded. Additionally, since the inception of the fishery, all rock crab landings from the directed fishery are verified through a dockside monitoring program (DMP). There is no evidence that enforcement is not being carried out, so enforcement is deemed “highly effective.”

Maritimes Bay of Fundy, Trap

Highly Effective

There is little information regarding the enforcement of regulations for the Jonah crab fishery in the Scotia-Fundy region. As a condition of holding a crab license, logbooks are mandatory and daily catch, effort, and locations must be recorded. Additionally, since the inception of the fishery, all Jonah crab landings from the directed fishery in LFA 34 and LFA 38 are verified through a dockside monitoring program (DMP). There is no evidence that enforcement is not being carried out, so enforcement is deemed “highly effective.”

Maritimes Gulf of Maine, Trap

Highly Effective

There is little information regarding the enforcement of regulations for the offshore Jonah crab fishery. As a condition of holding a lobster/Jonah crab license, logbooks are mandatory and daily catch, effort, and locations must be recorded. Additionally, since the inception of the fishery, Jonah crab landings are verified through a dockside monitoring program (DMP). There is no evidence that enforcement is not being carried out, so enforcement is deemed “highly effective.”

Quebec Gulf of St. Lawrence, Trap

Highly Effective

There is little information regarding the enforcement of regulations for the Atlantic rock crab fishery. As a condition of holding a rock crab license, logbooks are mandatory and daily catch, effort, and locations must be recorded. Additionally, since the inception of the fishery, all rock crab landings from the directed fishery are verified through a dockside monitoring program (DMP). There is no evidence that enforcement is not being carried out, so enforcement is deemed “highly effective.”

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Moderately Effective

The management track record for this fishery is uncertain, and determining the effectiveness of the measures is limited because of the lack of stock indicators to reliably assess them with. Therefore, this factor is scored as “moderately effective.”

Maritimes Gulf of Maine, Trap

Ineffective

The management track record for this fishery is uncertain and determining the effectiveness of the measures is limited because of the lack of stock indicators and assessments to reliably assess them with. However, due to the belated determination that a TAC of 720 t for Jonah crab in LFA 41 was too high and the subsequent fishing down of the population, this factor is rated as “ineffective.”

Quebec Gulf of St. Lawrence, Trap

Moderately Effective

The management track record for this fishery is uncertain and determining the effectiveness of the measures is limited because of the lack of stock indicators to reliably assess them with. Therefore, this factor is scored as “moderately effective.”

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Highly Effective

Generally, in Canada, stakeholder inclusion in the advisory process is through committees that comprise representatives from industry, Aboriginal communities, Provincial governments, DFO, and other community stakeholders. There are a number of levels to fishery management that allow stakeholder participation in the fishery management process. This is undertaken by the regular consultation with the large number of representative organizations and through public meetings. In the Gulf region, a peer review meeting was held in February 2013 to discuss the assessments of the staus of lobster and Atlantic rock crab in the southern Gulf of St. Lawrence (DFO 2013a). Stakeholder inclusion is deemed "highly effective."

Maritimes Bay of Fundy, Trap

Highly Effective

Generally, in Canada, stakeholder inclusion in the advisory process is through committees that comprise representatives from industry, Aboriginal communities, Provincial governments, DFO, and other community stakeholders. There are a number of levels to fishery management that allow stakeholder participation in the fishery management process. This is undertaken by regular consultation with the large number of representative organizations and through public meetings. However, due to the lack of commercial activity and stock assessments in LFA 34 and LFA 38, the need for stakeholder inclusion appears to be unnecessary in the current state of the fishery. Stakeholder inclusion is deemed "highly effective."

Maritimes Gulf of Maine, Trap

Highly Effective

Generally, in Canada, stakeholder inclusion in the advisory process is through committees that comprise representatives from industry, Aboriginal communities, Provincial governments, DFO, and other community stakeholders. There are a number of levels to fishery management that allow stakeholder

participation in the fishery management process. This is undertaken by regular consultation with the large number of representative organizations and through public meetings. As a bycatch fishery in the lobster fishery, Jonah crab is under the perview of the Maritimes region Lobster Conservation Strategy (2004-2008), which requires that within each LFA, indicators be developed that are supported by a broad representation of stakeholders (DFO 2009b). Stakeholder inclusion is deemed “highly effective.”

Quebec Gulf of St. Lawrence, Trap

Highly Effective

Generally, in Canada, stakeholder inclusion in the advisory process is through committees that comprise representatives from industry, Aboriginal communities, Provincial governments, DFO, and other community stakeholders. There are a number of levels to fishery management that allow stakeholder participation in the fishery management process. This is undertaken by regular consultation with the large number of representative organizations and through public meetings. In Quebec, a peer review meeting was held in February 2013 to discuss the assessment of rock crab in Quebec Inshore Waters (DFO 2013a). Stakeholder inclusion is deemed “highly effective.”

Bycatch Strategy

Factor 3.2: Management of fishing impacts on bycatch species						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Gulf Mgmt. region Gulf of St. Lawrence Trap	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Maritimes Bay of Fundy Trap	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Maritimes Gulf of Maine Trap	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Quebec Gulf of St. Lawrence Trap	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective

There is little information on the management impacts of bycatch species directly associated with the Jonah and Atlantic rock crab fisheries in Atlantic Canada. Crabs actually constitute a large portion of the bycatch in the lobster fisheries and, in some cases, bycatch landings of *Cancer* crabs in the lobster fisheries are significantly higher than in the directed crab fisheries. There are little to no data on the effects of the directed *C. borealis* and *C. irroratus* fisheries on bycatch species and, in general, other than legal-sized male crabs, all other bycatch is not landed. Because of the lack of information and because Jonah and rock crabs are significant bycatch fisheries in the lobster fishery, we will use the impacts of

the lobster fishery on bycatch species as a proxy. Many of the issues within the lobster fishery are by extension applicable to the directed and bycatch *Cancer* crab fisheries.

Subfactor 3.2.1 – Management Strategy and Implementation

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Moderately Effective

In the lobster fisheries (and by extension the *Cancer* crab fishery), management of bycatch is in place, although the effectiveness of these protocols is hard to assess. The main bycatch species that interact with the lobster fishery in Atlantic Canada are cusk, wolffish, and large marine fauna such as North Atlantic Right whales and leatherback turtles. Except for male Atlantic rock crabs, Jonah crabs, green crabs, and sculpins (DFO 2012b) caught as bycatch in the lobster fishery, no other species are allowed to be kept, and interactions with larger marine fauna appear to be minimized due to the timing and location of the fishing areas. During the crab fishing seasons, even lobster bycatch is unlikely because the crab season is after the lobster season. The survival rate of invertebrate species after being returned to the water is likely high (DFO 2009c); however, finfish (such as cusk) have swim bladders and their survival after being returned to the water is likely low (e.g., in LFA 41, cusk mortality was estimated at >86%) (DFO 2009c). Because of the limited amount of information regarding the effect of the fishery on bycatch species, management is ranked “moderately effective.”

Rationale:
Management policies regarding bycatch in the lobster fisheries (and by extension, the *Cancer* crab fisheries) are in place and are fairly straightforward. Few species are allowed to be kept in the lobster fishery and most (except for male Jonah and Atlantic rock crabs) are returned to the water, where survival rates are not well known, although invertebrates are likely to survive much better than finfish (DFO 2009c) (Gavaris et al. 2010).

Interaction with larger marine fauna such as right whales and leatherback sea turtles is a major concern in this fishery because these species are endangered and any fishery-induced mortalities or injuries would have serious impacts on the populations. But because of the timing and location of the lobster

fisheries (and some of the directed *Cancer* crab fisheries), the chances of frequent interactions with these species are considered to be quite low. With regard to interactions (especially entanglements) with the North Atlantic right whale, bottlenose whale, and leatherback turtle, there are ongoing efforts to reduce the frequency of entanglements in lobster gear. The risk of interactions with right whales is highest in the Bay of Fundy, which is a known area for right whales to congregate. The lobster fishery in this region and offshore operates to reduce entanglement risks by using long strings of traps (approximately 100) with two endlines per string (Bannister et al. 2010). The groundlines are made of neutrally bouyant rope to reduce floating loops from the groundlines (Bannister et al. 2010). In the Bay of Fundy (LFAs 36–38), a right whale mitigation plan is in place (Anon. 2012). This plan includes recommended fishing practices when whales are in the area, aerial surveys for whales, and a telephone number for fishermen to call to receive information on the location of right whales or to report right whale sightings (Anon. 2012).

With regard to bycatch mitigation of other at-risk species, including cusk, cod, and wolffish, these species are not allowed to be landed and must be returned to the water (DFO 2009a) (DFO 2011) (DFO 2012d). Lobster traps (and crab traps) are fitted with vents to allow species smaller than legal-sized lobsters to escape. Lobster traps are also fitted with ghost fishing panels that, if gear is lost, will open after a period of time to reduce the impact of continued ghost fishing (DFO 2009a) (DFO 2011).

Subfactor 3.2.2 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery's impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Moderately Effective

There is little information regarding scientific research and monitoring of bycatch in the lobster fishery or in the directed *Cancer* crab fisheries. Although logbooks are mandatory in the directed fisheries, they are not always reliable, and observer coverage in any of these fisheries is quite low (Gavaris et al. 2010). To date there is only one known bycatch study in the Atlantic rock crab fishery in Canada (Gendron and Duluc 2012). Mandatory electronic logbooks in the lobster fishery in Gaspè and the

Magdalen Islands to collect bycatch and bait usage data have been recently introduced but not yet fully implemented. Scientific research and monitoring of bycatch is ranked “moderately effective.”

Subfactor 3.2.3 – 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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Moderately Effective

Lobster/crab trap gear is inherently a highly specific gear that catches the targeted species 90% of the time (den Heyer et al. 2010). But beyond a few studies in the Maritimes and Quebec regions, little is known about the effect of the lobster (and *Cancer* crab) fisheries on bycatch species. Aside from the limited and basic management measures already implemented, there is no evidence that the fisheries are not heeding scientific advice. Scientific advice is ranked “moderately effective.”

Subfactor 3.2.4 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen’s compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Highly Effective

There is no evidence that enforcement is not being carried out.

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.
Gulf Mgmt. region Gulf of St. Lawrence Trap	3.00:Low Concern	0.25:Minimal Mitigation	3.00:Moderate Concern	**Yellow (3.123)**
Maritimes Bay of Fundy Trap	3.00:Low Concern	0.25:Minimal Mitigation	3.00:Moderate Concern	**Yellow (3.123)**
Maritimes Gulf of Maine Trap	3.00:Low Concern	0.25:Minimal Mitigation	3.00:Moderate Concern	**Yellow (3.123)**
Quebec Gulf of St. Lawrence Trap	3.00:Low Concern	0.25:Minimal Mitigation	3.00:Moderate Concern	**Yellow (3.123)**

Because *C. borealis* and *C. irroratus* are caught mainly using lobster traps and conical crab traps, the impacts of these types of gear on the ocean floor are generally considered moderate to low. The directed crab fisheries in Atlantic Canada are small, with an average of five to eight vessels directing for *Cancer* crabs. However, because Jonah and rock crabs are often bycatch in the lobster fishery, which is a more intensive and larger fishery using greater numbers of traps, the impacts may be underestimated. The cumulative effect of thousands of lobster traps being set and recovered daily could be more damaging to benthic habitats than previously thought, but little information is available.

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.

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Low Concern

The directed *C. borealis* and *C. irroratus* fisheries in Atlantic Canada occur on a variety of different benthic habitats including complex hard rocky bottoms, mud, sand, and gravel bottoms. These fisheries are small and, in some regions (especially the Jonah crab fisheries), fishing effort currently is quite low (BIO 2013) (DFO 2009b) and the impacts of these trap fisheries on bottom substrates are likely to be low. This factor is deemed “low” concern.

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.*

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Minimal Mitigation

DFO has implemented measures to reduce effective and nominal fishing effort in the lobster fishery (FRCC 2007), but there are no specific mitigations of gear impacts on benthic habitats. Because a significant proportion of the crab landings come from the lobster fishery, it is believed that there has been a reduction in the impact of the gear on the seabed, so there is "minimal" effective mitigation.

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.*

Gulf Mgmt. region Gulf of St. Lawrence, Trap

Maritimes Bay of Fundy, Trap

Maritimes Gulf of Maine, Trap

Quebec Gulf of St. Lawrence, Trap

Moderate Concern

It is difficult to assess what effects the Atlantic rock crab and Jonah crab fisheries have on the ecosystem. Little data (if any) exist regarding bycatch in the *Cancer* crab fisheries. Additonally, it is well known that trophic linkages exist between Jonah and Atlantic rock crabs and lobsters, as well as other groundfish species (DFO 2013e) (DFO 2013a). And at the beginning of the fisheries, there was concern that the *Cancer* crab fisheries would have deleterious effects on the lobster populations; however, this does not appear to be the case because few lobsters are caught as bycatch in the crab fisheries (Robichaud and Frail 2006). Except for a few recent bycatch studies (Gendron and Duluc 2012) (den Heyer et al. 2010), there is currently no evidence of ongoing research to assess ecosystem impacts of the *Cancer* crab fisheries. This factor is of “moderate” concern.

Rationale:
No studies have examined the impact of the *Cancer* crab fisheries on food webs and the ecosystem, although the effects are likely negligible given the size of the directed fisheries. However, the removal of Jonah and Atlantic rock crabs by the lobster industry could be having significant impacts on the ecosystem, but that has yet to be determined. Additionally, there has likely been an ecosystem shift in Eastern Canada due to the overfishing of groundfish stocks in recent years, which could add to the uncertainty surrounding the role of crustaceans within this ecosystem.

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References

ADFG 1994. ADFG Wildlife Notebook Series: Dungeness Crab.

Atlantic Leatherback Turtle Recovery Team 2006. Recovery Strategy for Leatherback Turtle (Dermochelys coriacea) in Atlantic Canada. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, vi + 45 pp.

Anonymous. 2012. Mitigation Strategy 2012-2013: Right Whale/ Lobster Fishing Gear Interactions Lobster Fishing Areas 36, 37, 38.

Atlantic Fisheries Regulations. 1985. http://laws.justice.gc.ca/en/F-14/SOR-86-21/index.html

Bannister C, Powles H, Angel J, Knapman P (2010) Final Report for the Eastern Canada offshore lobster fishery. For Client Clearwater Seafoods Partnership Limited by Moody Marine Limited, Halifax, Nova Scotia. 189 pp.

Bigford, T.E. 1979. Synopsis of biological data on the rock crab, Cancer irroratus Say. NOAA technical report 426. v + 26 p.

Bedford Institute of Oceanography. 2013. http://www.bio.gc.ca/science/research-recherche/fisheries-pecheries/managed-gere/jonah-nordique-eng.php. Accessed 12/02/2013

Brillant SW, Trippel EA. 2010 Elevations of lobster fishery groundlines in relation to their potential to entangle endangered North Atlantic right whales in the Bay of Fundy, Canada. ICES Journal of Marine Science 67, 355-364.

Brown M.W., Fenton D., Smedbol K., Merriman C., Robichaud-Leblanc K., Conway J.D.2009. Recovery Strategy for the North Atlantic right whale (Eubalaena glacialis) in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. vi + 66p.

Cheung W.W.L., Pitcher T.J., Pauly D. 2005. A fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing. Biol. Conserv. 124:97-111.

Chuenpagdee, R., Morgan, L.E., Maxwell, S.M., Norse, E.A., Pauly, D. 2003. Shifting gears: assessing collateral impacts of fishing methods in US waters. Frontiers in Ecology and the Environment, 1(10): 517-524. http://www.mcbi.org/publications/pub_pdfs/Chuenpagdee_et_al_2003.pdf

Cobb J.S., Booth J.D., Clancy M. 1997. Recruitment strategies in lobsters and crabs: a comparison. Marine and Freshwater Research 48: 797-806.

COSEWIC. 2012a Wildlife Species Assessments (detailed version), November 2012. http://www.cosewic.gc.ca/rpts/Detailed_Species_Assessments_e.html

COSEWIC. 2012b. COSEWIC assessment and status report on the Leatherback Sea Turtle Dermochelys coriacea in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xv + 58 pp. www.registrelep-sararegistry.gc.ca/default_e.cfm.

COSEWIC 2011. COSEWIC assessment and status report on the Northern Bottlenose Whale Hyperoodon ampullatus in Canada. Committee on the Endangered Wildlife in Canada. Ottawa. Xii +31pp (www.sararegistry.gc.ca/status/staus_e.cfm)

COSEWIC 2010. COSEWIC assessment and status report on the Atlantic Cod Gadus morhua in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiii + 105 pp. www.sararegistry.gc.ca/status/status_e.cfm

COSEWIC 2003a. COSEWIC assessment and status report on the cusk Brosme Brosme in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 30 pp. 36

COSEWIC 2003b COSEWIC assessment and update status report on the North Atlantic right whale Eubalaena glacialis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 28 pp.111

COSEWIC 2000. COSEWIC assessment and status report on the Atlantic wolffish Anarhichas lupus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 21 pp.

den Heyer, C.E., Bundy, A., and MacDonald, C. 2010. At-Sea Catch Analysis of Inshore Scotian Shelf Lobster Fishery and 4VsW Commercial Index Groundfish Sentinel Fishery. Can. Tech. Rep. Fish. Aquat. Sci. 2890: viii + 39 p.

DFO. 2014. Stock Assessment of NAFO Subdivision 3Ps Cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/001.

DFO 2013c. Assessment of Lobster (Homarus americanus) in Lobster Fishing Area (LFA) 34. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/024.

DFO. 2013a. Assessment of the Rock Crab (Cancer irroratus) fishery in the southern Gulf of St. Lawrence for 2006 to 2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/030.

DFO. 2013b. American lobster, Homarus americanus, stock status in the southern Gulf of?St. Lawrence: LFA 23, 24, 25, 26a and 26b. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/029.

DFO. 2013d. Assessment of Lobster (Homarus americanus) in Lobster Fishing Areas (LFA) 35-38. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/023.

DFO. 2013e. Assessment of Rock Crab Stock Status in Quebec in 2012. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/007.

DFO. 2013f. Stock Assessment of NAFO Subdivision 3Ps Cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/078.

DFO. 2012. 2012-2014 MANAGEMENT PLAN LOBSTER AREAS 19, 20, 21 GASPE—LOWER ST. LAWRENCE

DFO 2012a. Assessment of Leatherback Turtle (Dermochelys coriacea) Fishery and Non-fishery Interactions in Atlantic Canadian Waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/041.

DFO 2012b. Proceedings of the Maritimes Region Science Advisory Process to Review Assessment of Lobster Stock Status in LFAs 27-33; July 21-22, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2012/019.

DFO 2012c. Stock Assessment of Subdivision 3Ps cod, October 2011. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/079.

DFO. 2011. Integrated Fishery Management Plan (Summary). Lobster Fishing Areas 27-38; Scotia-Fundy Sector, Maritimes Region. 2011 http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/maritimes/insholob-2011-eng.htm

DFO 2010. “Cusk”. http://www.dfo-mpo.gc.ca/species-especes/species-especes/cusk-brosme-eng.htm

DFO 2010. ARCHIVE. http://www.dfo-mpo.gc.ca/decisions/fm-2010-gp/atl-005-eng.htm

DFO. 2010. Minutes of the Offshore Lobster and Jonah Crab Advisory Committee.

DFO 2009a. DFO Maritimes Region Offshore Lobster and Jonah Crab Integrated Fisheries Management Plan 2006-2011.

DFO 2009b. Assessment of Jonah crab in Lobster Fishing Area 41 (4X + 5Zc). Can. Sci. Adv. Sect. Sci. Adv. Rep. 2009/034: 11 pp.

DFO 2009c. Assessment of Lobster in Lobster Fishing Area 41 (4X+5Zc). DFO Can.Sci. Advis.Sec.Sci.Advis.Rep. 2009/033

DFO 2008a. Offshore Lobster and Jonah Crab Management Board Minutes. June 26, 2008

DFO 2008b. Recovery potential assessment for cusk (Brosme brosme). Can. Sci. Adv. Sect. Sci. Adv. Rep. 2008/024: 11 pp.

DFO 2000. Inshore Gulf of Maine Jonah crab (Cancer borealis). DFO Science Stock Status report C3-66 (2000).

Drew, D.J. 2011. A Comparative Morphometric Analysis of Cancer borealis Stimpson, 1859 and C. irroratus Say, 1817 (Decapoda: Brachyura: Cancridae) in the Northwest Atlantic Ocean.Bulletin of the Peabody Museum of Natural History, 52(2):241-254.

Fisheries Act. 1985. http://lois.justice.gc.ca/eng/acts/F%2D14/

Fishonline.org.2011. Brown Crab. Available at: http://www.fishonline.org/search/advanced/?step=2fish_id=12

FRCC 2007. Sustainability framework for Atlantic lobster 2007: Report to the Minister of Fisheries and Oceans. FRCC.07.R1

Froese, R. Pauly, D., 2015. Editors. Fishbase. World Wide Web Electronic Publication www.fishbase.org, version (02/2015)

Froese, R. and D. Pauly. Editors. 2013.FishBase. World Wide Web electronic publication. www.fishbase.org, version (12/2013).

Fujiwara, M. and H. Caswell 2001.Demography of the endangered North Atlantic right whale. Nature 414: 537-541.

Fuller, S, D., Picco, C., Ford, J.F., Tsao, C,F., Morgan, L,E., Hangaard, D., Chuenpagdee, R. 2008. How We Fish Matters: Addressing the Ecological Impacts of Canadian Fishing Gear. Ecology Action Centre, Living Oceans Society, and Marine?Conservation Biology Institute. 28pp

Gavaris S., Clark K.J., Hanke A.R., Purchase C.F., Gale J. 2010. Overview of discards from Canadian commercial fisheries in NAFO Divisions 4V, 4W, 4X, 5Y and 5Z for 2002-2006. Can. Tech. Rep. Fish. Aquat. Sci. 2873: vi + 112 p.

Gendron, L. and C. Duluc. 2012. Bycatch in the lobster fishery in the Gaspe (LFAs 19 and 20) and the Magdalen Islands (LFA 22), Quebec in 2011. DFO Can. Sci. Adv. Sec. Res. Doc. 2012/100, vii + 36 p.

Haefner, P.A. 1977. Aspects of the biology of the Jonah crab, Cancer borealis Stimpson, 1859 in the mid-Atlantic Bight. Journal of Natural History 11: 303-320.

Hare, J.A., Manderson, J. P., Nye, J.A., Alexander, M.A.,Auster, P.J.,Borggaard, D.L.,capotondi, A.M.,Damon-Randall. K.B.,Heupel, E.,Mateo, I.,O'Brien, L.,Richardson, D.E., Stock, C.A. and Biegel, S.T. 2012. Cusk (Brosme brosme) and climate change: assessing the threat to a candidate marine fish species under the US Endangered Species Act. ICES Journal of Marine Science 69(10):1753-1768.

Harris L.E., Hanke A.R. 2010. Assessment of the status, threats and recovery potential of cusk (Brosme brosme). DFO Can. Sci. Adv. Sec. Res. Doc. 2010/004, vi + 23 p.

Harris, L.E., C.L. Waters, R. K. Smedbol, and D.C. Millar. 2007. Assessment of the recovery potential of the Scotian Shelp population of the northern bottlenose whale, Hyperoodon ampullatus. DFO Can. Sci. Advis. Sec. Res. Doc 2007/078

Johnson, A., Salvador G., Kenney, J., Robbins, J., Kraus, S., Landry, S., and Clapham, P. 2005. Fishing Gear Involved in Entanglements of Right And Humpback Whales. Marine Mammal Science. 21: 635-645.

Johnston T.L., Smedbol R.K., Serdynska A., Vanderlaan A., Helcl N., Harris L., Taggart C.T. 2007. Patterns of fishing gear in areas of the Bay of Fundy and southwest Scotian Shelf frequented by North Atlantic right whales. Canadian Technical Report of Fisheries and Aquatic Sciences 2745, v + 52.

Khatain, L. 2000. "Cancer magister" (On-line), Animal Diversity Web. Accessed June 06, 2013 at http://animaldiversity.ummz.umich.edu/accounts/Cancer_magister/

Knowlton, A. and S. Kraus.2001. Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. Journal of Cetacean Research Management Special Issue 2: 193-208.

Knowlton, A.R., Marx, M.K., Pettis, H.M., Hamilton, P.K., and Kraus, S.D. 2005. Analysis of scarring on North Atlantic Right Whales (Eubalaena glacialis): Monitoring Rates of Entanglement Interaction. 1980 – 2002. Final Report to the National Marine Fisheries Service, Contract #43EANF030107. 20 pp.

Kraus, S.D. 1990. Rates and potential causes of mortality in North Atlantic right whales (Eubalaena glacialis). Mar. Mamm. Sci. 6(4):278-291.

Kraus, S.D., M.W. Brown, H. Caswell, C.W. Clark, M. Fujiwara, P.K. Hamilton, R.D. Kenney, A.R. Knowlton, S. Landry, C.A. Mayo, W.A. McLellan, M.J. Moore, D.P. Nowacek, D.A.Pabst, A.J. Read and R.M. Rolland 2005. North Atlantic right whales in crisis. Science 309(5734): 561-562.

Krouse, J.S. 1980. Distribution and catch composition of Jonah crab, Cancer borealis, and Rock crab, Cancer irroratus, near Boothbay Harbor, Maine. Fishery Bulletin. 77(3): 685- 693.

Kulka, D., C. Hood and J. Huntington. 2007. Recovery Strategy for Northern Wolffish (Anarhichas denticulatus) and Spotted Wolffish (Anarhichas minor), and Management Plan for Atlantic Wolffish (Anarhichas lupus) in Canada. Fisheries and Oceans Canada: Newfoundland and Labrador Region. St. John’s, NL. x + 103 pp.

Moriyasu M, Benhalima K, Duggan, D, Lawton P, Robichaud D.2002 .Reproductive biology of male Jonah crab, Cancer borealis Stimpson, 1859 (Decapoda: Cancridae) on the Scotian Shelf, Northwestern Atlantic. Crustaceana 75: 891-913.

NMFS. 2011. Draft Environmental Assessment, Draft Regulatory Impact Review and Draft Regulatory Flexibility Analysis of a Limited Access Program for the Lobster Trap Fishery in Federal Lobster Management Area 1. Available at: http://www.nero.noaa.gov/nero/regs/frdoc/11/11LobArea1EA.pdf

NMFS. 2005. Recovery plan for the North Atlantic right whale (Eubalaena glacialis). Silver Spring, MD, National Marine Fisheries Service: 138.

O’Boyle, R. 2012. Assessment of Leatherback Turtle (Dermochelys coriacea) Fisheries and Non-Fisheries Related Interactions in Atlantic Canadian Waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/063. iii + 99 p

Page, K. 2002. "Cancer irroratus" (On-line), Animal Diversity Web. Accessed March 01, 2013 at http://animaldiversity.ummz.umich.edu/accounts/Cancer_irroratus/

Pettis, H.2012. North Atlantic Right Whale Consortium 2012 Annual Report Card. Report to the North Atlantic Right Whale Consortium, November 2012.7pp.
http://www.narwc.org/pdf/2012_Report_Card.pdf

Pezzack, D.S., C.M. Frail, A. Reeves, and M.J. Tremblay. 2011. Assessment of the LFA 41 Offshore Jonah Crab (Cancer borealis) (NAFO 4X and 5Zc). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/113: viii + 52 p.

Pezzack D.S., Frail C.M., Reeves A., Tremblay M.J. 2009. Offshore Lobster LFA 41 (4X and 5Zc). DFO Can. Sci. Advis. Sec. Res. Doc. 2009/023. vi + 118 p.

Reardon, K. 2006. Development, assessment, and management of a potential directed fishery for Jonah crab (Cancer borealis), in the near shore Gulf of Maine. Masters thesis, University of Maine, 136 pp. Available at http://www.library.umaine.edu/theses/pdf/ReardonKM2006.pdf

Reilly, P.N., and S.B. Saila. 1978. Biology and ecology of the rock crab, Cancer irroratus Say, 1817, in southern New England waters (Decapoda, Brachyura). Crustaceana 34: 121-140.

Rice, J., 2006. Impacts of mobile bottom gears on seafloor habitats, species, and communities: a review and synthesis of selected international reviews. DFO Can. Sci. Advis. Sec. Res. Doc 2006/057.

Robichaud, D.A., Frail, C.A. 2006. Development Of The Jonah Crab, Cancer borealis and Rock Crab, Cancer irroratus, Fisheries in the Bay of Fundy (LFAs 35-38) and off Southwest Nova Scotia (LFA 34): Exploratory to Commercial Status (1995-2004). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2775; available athttp://www.dfo-mpo.gc.ca/Library/326113.pdf

Robichaud, D.A., Frail, C., Lawton, P., Pezzack, D.S., Strong, M.B., and D. Duggan. 2000. Exploratory Fisheries for Rock Crab, Cancer irroratus, and Jonah Crab, Cancer borealis, in Canadian Lobster Fishing Areas 34, 35, 36, 38. DFO Can. Sci. Advis. Sec. Res. Doc 2000/051.

Species at Risk Act (SARA). 2012. Species profile: Leatherback Sea Turtle. http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=274

Simon J., Rowe S.L, Cook A. 2012. Pre-COSEWIC Review of Atlantic Wolffish (Anarhichas lupus), Northern wolffish (A. denticulatus), and Spotted Wolffish (A. minor) in the Maritimes Region. DFO. Can. Sci. Advis. Sec. Res. Doc. 2011/088: vi + 73 p.

Smolowitz, R. 1998. Bottom tending gear used in New England. Effects of Fishing Gear on the Sea Floor of New England. Boston, MA, Conservation Law Foundation: 46-53.

Stehlik, L.L., MacKenzie, C.C., Morse, W.W .1991. Distribution and Abundance of Four Brachyuran Crabs on the Northwest Atlantic Shelf. Fishery Bulletin 89: 473-492.

Steneck R.S. 2006. Possible demographic consequences of intraspecific shelter competition among American lobsters. Journal of Crustacean Biology 26: 628-638

Vanderlaan A.S.M., Smedbol R.K., Taggart C.T. 2011. Fishing-gear threat to right whales (Eubalaena glacialis) in Canadian waters and the risk of lethal entanglement. Can. J. Fish. Aquat. Sci. 68: 2174–2193

Wahle R.A., Steneck R.S. 1991. Recruitment habitats and nursery grounds of the American lobster Homarus americanus: a demographic bottleneck? MEPS 69: 231-243

Waring, G. T., R. M. Pace, et al. 2004. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2003.Woods Hole, MA, Northeast Fisheries Science Center.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel, eds. 2012. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2012. NOAA Technical Memorandum NMFS-NE-223. National Marine Fisheries Service, Woods Hole, MA.

Williams, A.B. 1984. Shrimps, Lobsters, and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida. Washington, DC: Smithsonian Institute Press. 550 pp.

Wilson, C.J. 2005. A cooperative investigation towards an exempted trap to exclusively target Cancer borealis in Lobster Management Area 1.Completion Report

Wimmer, T., and H. Whitehead. 2004. Movements and distribution of northern bottlenose whales, Hyperoodon ampullatus, on the Scotian Slope and in adjacent waters. Canadian Journal of Zoology 82:1782-1794.