

The Safina Center
at Stony Brook University
AND
Monterey Bay Aquarium
Seafood Watch[®]

Oyster, Eastern (Canada)

Crassostrea virginica



©Scandinavian Fishing Yearbook/www.scandposters.com

Canada/Southern Gulf of St. Lawrence

Hand implements

Published October 03 2016, Reviewed November 20, 2019 – see Appendix A for more information

The Safina Center Seafood Analysts

Disclaimer

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

Seafood Watch Standard used in this assessment: Standard for Fisheries vF2

Table of Contents

About The Safina Center	3
About Seafood Watch	4
Guiding Principles	5
Summary	6
Final Seafood Recommendations	7
Introduction	8
Assessment	10
<i>Criterion 1: Impacts on the species under assessment</i>	10
<i>Criterion 2: Impacts on other species</i>	14
<i>Criterion 3: Management Effectiveness</i>	16
<i>Criterion 4: Impacts on the habitat and ecosystem</i>	22
Acknowledgements	25
References	26
Appendix A: Updates to Eastern Oyster Report	28

About The Safina Center

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

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

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

The Safina Center's Sustainable Seafood Program

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

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

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

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

About Seafood Watch

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

Each sustainability recommendation on the regional pocket guides is supported by a Seafood 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

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

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

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

Each criterion includes:

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

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

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

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

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

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

Summary

The eastern oyster (*Crassostrea virginica*), also commonly known as the American oyster, is an immobile, two-shelled mollusk found in coastal waters of the Western Atlantic Ocean. This report assesses the sustainability of the Canadian Southern Gulf of St. Lawrence wild eastern oyster fishery in New Brunswick, Prince Edward Island, and Nova Scotia waters.

The abundance of the wild eastern oyster population in the Southern Gulf of St. Lawrence is not known because no population studies have been conducted. But several management measures are in place for the Southern Gulf of St. Lawrence oyster fishery, including a minimum size limit and seasonal and area closures.

Oysters are caught with hand-operated tongs and rakes. These gear types have a low impact on bottom habitats and are selective for the capture of oysters. There are no bycatch concerns in this fishery.

Overall, eastern oyster caught in the Southern Gulf of St. Lawrence is rated "Green/Best Choice."

Final Seafood Recommendations

SPECIES FISHERY	CRITERION 1: Impacts on the Species	CRITERION 2: Impacts on Other Species	CRITERION 3: Management Effectiveness	CRITERION 4: Habitat and Ecosystem	OVERALL RECOMMENDATION
Eastern oyster Canada/Southern Gulf of St. Lawrence Hand implements Canada	Yellow (2.644)	Green (5.000)	Yellow (3.000)	Yellow (3.122)	Best Choice (3.335)

Scoring Guide

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

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

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

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

Introduction

Scope of the analysis and ensuing recommendation

This report assesses the sustainability of the eastern oyster (*Crassostrea virginica*) caught with rakes and tongs in the Southern Gulf of St. Lawrence (Gulf Management Region) in eastern Canada.

Species Overview

The eastern oyster (also known as the American oyster) is a filter-feeding, two-shelled mollusk. Its shells can be a variety of brown, green, grey, or white and are generally rough in appearance. The bottom shell is cupped to hold the soft body of the oyster, while the top shell is usually flat. The shell's appearance and thickness can vary based on water conditions, habitat type, or the abundance of surrounding oysters (DFO 2009).

Eastern oyster is native to the North American Atlantic coast from Canada's Gulf of St. Lawrence south to Mexico, the Caribbean Islands, and the coasts of Brazil and Argentina. Additionally, eastern oyster has been transplanted to a range of locations, including western Canada, the western United States, western Mexico, Hawaii, Fiji, and Japan (EOBRT 2007). It can survive in a range of habitats with varying environmental conditions. Along the Atlantic coast of Canada, eastern oyster is primarily concentrated in the Southern Gulf of St. Lawrence and found in warm shallow bays and estuaries. Oysters are not mobile and tend to congregate in large colonies called "beds" (EOBRT 2007) (DFO 2003).

Eastern oysters start out as free-swimming larva, and anywhere from 2 to 12 weeks after hatching (depending on environmental conditions), they develop shells and look for a site to settle permanently (EOBRT 2007). In the Gulf of St. Lawrence, it takes about 4 to 7 years for eastern oyster to reach market size, which is 76 mm (3 in) (DFO 2003). It is highly fecund, with females releasing millions of eggs per year (EOBRT 2007).

The Canadian Southern Gulf of St. Lawrence eastern oyster fishery is managed federally by the Department of Fisheries and Oceans Canada (DFO) and at the provincial level by the New Brunswick, Prince Edward Island, and Nova Scotia governments. This fishery is managed under the Integrated Fishery Management Plan for American Oyster in the Southern Gulf of St. Lawrence (DFO 2014b). There is no commercial catch limit for this fishery, but there is a minimum size limit along with area and seasonal closures (DFO 2015c).

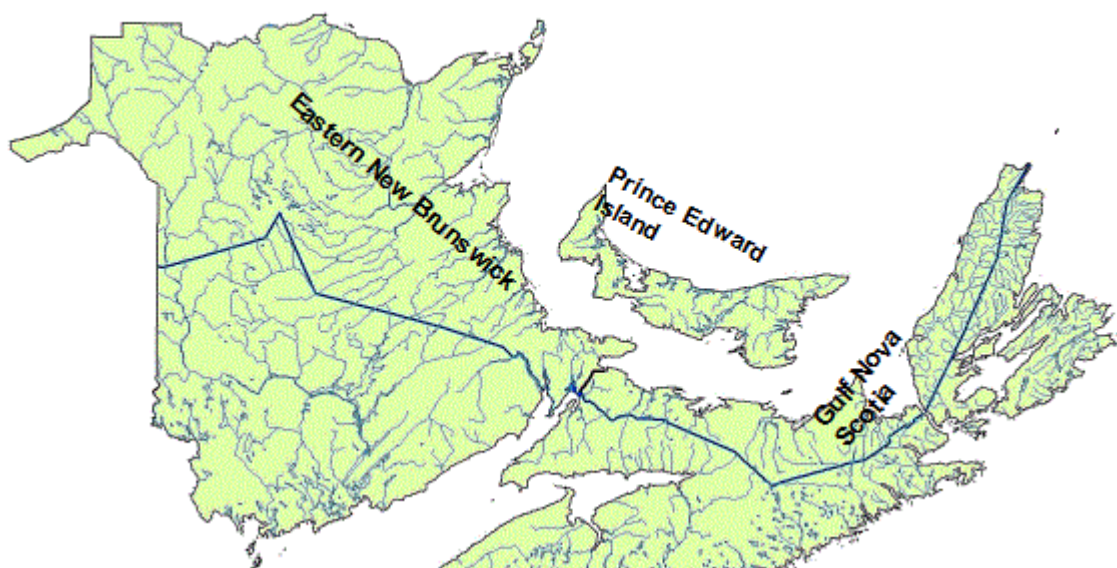


Figure 1 Map of the Canadian Southern Gulf of St. Lawrence Region. Image from the Department of Fisheries

and Oceans Canada (DFO) American Oyster Integrated Fishery Management Plan, 2014.

Production Statistics

Wild eastern oyster is commercially fished in the Southern Gulf of St. Lawrence off the coasts of Nova Scotia, New Brunswick, and Prince Edward Island. Fishers catch oysters using hand-operated tongs and rakes. From 2004 to 2014, total reported oyster landings ranged from 1,258 to 4,299 metric tons (MT) (3,700,000 to 9,500,000 lbs). In the most recent years (2012–2014), reported landings have been less than 2,000 MT. Because of data collection methods, these landings may include some farmed oyster landings in addition to wild oyster landings (DFO 2014b) (DFO 2016a) (pers. comm., DFO Gulf Region, Statistics Division 2016). Although actual wild vs. farmed oyster landings remain uncertain, aquaculture production appears to be roughly 2–3 times greater than wild production in recent years (reported aquaculture production was around 4,000 MT for 2012–2014 (DFO 2016b)). Prince Edward Island accounts for the majority (80%) of the wild and aquaculture oyster production (DFO 2014b) (DFO 2016a) (DFO 2016b).

Importance to the US/North American market.

The eastern oyster is almost exclusively fished in North America. U.S. landings of eastern oysters (wild plus farmed) have totaled around 11,000 MT in recent years (NOAA 2016).

In 2014, the United States imported 10,186 MT of oysters (all species), mostly from China, Canada, South Korea, and Mexico. These imports consisted of a variety of product forms including live/fresh wild, live/fresh farmed, canned, smoked, and frozen/dried/salted/brined. Oyster imports from Canada totaled 2,738 MT, accounting for 27% of the total U.S. imports. Most oysters imported from Canada are reported to be live/fresh farmed oysters. Imports of live/fresh wild oysters from Canada totaled 299 MT (NOAA 2015).

Total Canadian exports of oyster in 2014 were 3,103 MT worth CAD 25 million (DFO 2015b).

Common and market names.

The eastern oyster (*Crassostrea virginica*) can be referred to as the American oyster, American cupped oyster, common oyster, or Atlantic oyster.

Primary product forms

Eastern oyster is primarily sold fresh in the shell and is graded, based on the shell shape, as fancy, choice, standard, or commercial (DFO 2003). Some are sold shucked and can be canned and smoked, frozen, dried, or brined (NOAA 2015).

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: Impacts on the species under assessment

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

EASTERN OYSTER				
Region Method	Inherent Vulnerability	Abundance	Fishing Mortality	Score
Canada / Southern Gulf of St. Lawrence Hand implements Canada	3.00: Low	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.64)

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Inherent Vulnerability

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator). Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.*

Factor 1.2 - Abundance

- 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.

Factor 1.3 - Fishing Mortality

- 5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible ($\leq 5\%$ of a sustainable level of fishing mortality).
- 3.67 (Low Concern)—Probable ($>50\%$) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).
- 2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.
- 1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.
- 0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

EASTERN OYSTER

Factor 1.1 - Inherent Vulnerability

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Low

The eastern oyster (*Crassostrea virginica*) is a sessile, two-shelled (bivalve) mollusk that feeds on small plants and animals (plankton) from the water (DFO 2003). The majority of oysters begin life as male, with some switching sex to female later in life. A 1:1 ratio of males to females in the population seems to be reached when oysters are at around 50 mm in length or 2 to 3 years old. If necessary, some female oysters can revert to males if males are absent from the oyster colony (DFO 2014b). Growth and maturity varies with latitude (EOBRT 2007). It takes about 4 to 7 years for oysters to reach market size (76 mm or 3 in) in the Gulf of St. Lawrence (DFO 2003), whereas in warmer waters of the Gulf of Mexico it takes them only 2 or 3 years to reach that size (DFO 2009). Eastern oyster is considered highly fecund, and a female can release anywhere from 2 to 115 million eggs per year, depending on its size and location (EOBRT 2007). Spawning of eggs by the female is triggered by the release of sperm into the water by the male (Sellers et al. 1984) and the eggs are fertilized externally in the surrounding water (DFO 2003). The eastern oyster can live to about 20 years (Buroker 1983); some can live 25–30 years, but this is uncommon and generally occurs in areas with little fishing disturbance (EOBRT 2007). The life history traits of the eastern oyster indicate that it has a low inherent vulnerability to fishing (see Detailed Rationale below).

Justification:

Life History Attribute Table for the Eastern Oyster

Vulnerability Attribute	Category	Score (can range from 1–3; higher scores signify more resilient life history attributes)
Average age at maturity	< 5 years	3
Average maximum age	10–25 years	2
Fecundity	>100 eggs	N/A
Reproductive strategy	Broadcast spawner	3
Density dependence	No depensatory or compensatory dynamics demonstrated or likely	2
<i>Average score</i>	<i>Low vulnerability</i>	<i>2.5</i>

Species with average attribute scores between 2.46 and 3.00 are deemed to have a "low" vulnerability.

Factor 1.2 - Abundance

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderate Concern

The last status report for eastern oyster in the Southern Gulf of St. Lawrence was in 1996. This report stated that little is known about the status of the wild population because landing/catch statistics are combined for wild and aquaculture beds (DFO 1996b). Little effort has been made since then to evaluate the wild oyster population.

From the perspective of fishery management, there is no issue with the population status of oysters, so managers have not asked scientists to conduct a population survey (pers. comm., DFO Gulf Region Fishery Management 2016). Public oyster bed enhancement projects are underway, which include seeding areas, spreading old shells from oysters and other shellfish species on the bottom habitat to increase settlement surface area, and cleaning sediment from oyster shells to increase clean available space for juvenile oysters to settle (PEI Department of Agriculture and Fisheries 2005) (DFO 2014b).

Because the current abundance of wild oysters in this region is unknown, and the species has a low vulnerability to fishing, we have awarded a "moderate" concern score.

Justification:

The Malpeque Oyster disease is thought to have eliminated 90% of the naturally occurring oysters in this region in the early to mid-1900s. This disease affected Prince Edward Island from 1915 to 1939 and New Brunswick from 1950 to 1960 (DFO 1996b). Today, nearly all oysters in the Southern Gulf of St. Lawrence originate from a small Prince Edward Island population that survived the disease and passed on resistance to their offspring (DFO 2014b).

Factor 1.3 - Fishing Mortality

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderate Concern

Fishing mortality on the wild eastern oyster population in the Southern Gulf of St. Lawrence is unknown. Reported commercial landings of oysters have remained relatively stable over the years (DFO 1996b) (DFO 2016a). In 2014, commercial landings totaled 1, 258 metric tons (MT), with 69 MT landed in Nova Scotia, 153 MT in New Brunswick, and 1,034 MT in Prince Edward Island (DFO 2016a). But because of the way catch information is collected, the commercial landings include some farmed oyster landings in addition to wild oyster landings, so actual wild oysters landings are uncertain (DFO 1996b) (DFO 2014b) (DFO 2016a) (pers. comm., DFO Gulf Region, Statistics Division 2016). A "moderate" concern is awarded.

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

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

EASTERN OYSTER					
Canada/Southern Gulf Of St. Lawrence Hand Implements Canada					
Subscore:	5.000	Discard Rate:	1.00	C2 Rate:	5.000
Species Stock	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore	
No other main species caught					

Overall, there is a lack of data on this fishery. But there is likely little to no bycatch in the Canadian Southern Gulf of St. Lawrence eastern oyster fishery because of the areas fished and the gears used. Fishing occurs over oyster beds, which primarily contain oysters; and the tong and rake gears are selective for the capture of oysters. There are no bycatch issues discussed in the recent management plan (DFO 2014b). Although bycatch of nontarget species is likely negligible, it is not known if there are discards of undersized oysters in the fishery. Overall discards relative to the retained catch are assumed to be low.

2.4 - Discards + Bait / Landings

CANADA / SOUTHERN GULF OF ST. LAWRENCE
Hand Implements Canada
< 20%
Overall, there is a lack of data on this fishery. But there is likely little to no bycatch in the Canadian Southern Gulf of St. Lawrence eastern oyster fishery, because fishing occurs over oyster beds (which primarily consist of oysters) and the rake and tongs gears used are selective for the capture of shellfish {DFO 2014b}. Any discards are likely to consist of undersized oysters. The amount of undersized oysters that is discarded is not known, but overall discards relative to the retained catch are assumed to be low.

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	Harvest Strategy	Bycatch Strategy	Score
Canada/Southern Gulf of St. Lawrence Hand implements Canada	3.000	0.000	Yellow (3.000)

There are several management measures in place for the Southern Gulf of St. Lawrence oyster fishery, but research and monitoring need to be improved. There are no bycatch issues in this fishery, so bycatch strategy has not been scored.

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Harvest Strategy

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
Canada / Southern Gulf of St. Lawrence Hand implements Canada	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderately Effective

The Canadian Southern Gulf of St. Lawrence eastern oyster fishery is managed federally by the Department of Fisheries and Oceans Canada (DFO) Gulf Region and at the provincial level by the New Brunswick, Prince Edward Island, and Nova Scotia governments. The current Integrated Fishery Management Plan (IFMP) for Eastern Oyster in the Southern Gulf of St. Lawrence identifies the main management objectives for both wild and farmed production in the region (DFO 2014b). Specific DFO Area management plans (eastern New Brunswick, Prince Edward Island, Gulf Nova Scotia) for the commercial oyster fishery are developed through consultation among provincial and departmental officials, Aboriginal organizations, fish harvester representatives, aquaculturists, and processor organizations. There are advisory committees representing each DFO Area that meet as needed (DFO 2014b). Although management measures are in place for the commercial oyster fishery (see Detailed Rationale below), there is little information available on the status of the wild oyster population, so the effectiveness of the current management strategy is uncertain. For this reason, management strategy and implementation is considered "moderately effective."

Justification:

The oyster fishery is made of a variety of license holders. Approximately 2,900 commercial permits are renewed each year for the harvest of oysters from public beds in the Gulf Region, but only a small proportion of license holders are actually active in the oyster fishery (pers. comm., DFO Gulf Region, Statistics Division 2016). An additional 220 licenses are issued for the relay fishery (a process by which oysters harvested in a restricted area as a result of bacteriological contamination are transferred to an approved area for the purposes of decontamination prior to marketing) and 131 communal commercial licenses are issued to Aboriginal organizations. There are 150 licenses issued for recreational fishing in the Gulf Region. Each recreational license has a daily bag limit of 150 oysters. There are about 1,530 privately held aquaculture leases issued and 183 licenses issues for spat collection (DFO 2014b).

General management regulations for the wild commercial oyster fishery include limits on the number of available licenses, a minimum size limit, gear restrictions, fishing seasons, and restrictions on where fishing can occur. Harvested oysters must be at least 76 mm (3 in) in length (DFO 2009) (DFO 2014b) (DFO 2015c). This size limit is in place to allow for oysters to have at least two full spawning seasons before they are captured and to ensure that a proper sex ratio (1:1) is maintained in the population (DFO 2014b). Rakes and tongs are the only permitted gear for commercial harvest of wild oysters, and these gears must be operated

by hand (DFO 2014b) (DFO 2015c). The small dredge fishery was discontinued in 2014 (pers. comm., DFO Gulf Region Fishery Management 2016).

Shellfish harvesting is a carefully regulated industry in Canada, with respect to shellfish sanitation and public health. The Canadian Shellfish Sanitation Program (CSSP), co-managed by the Department of Fisheries and Oceans Canada, Environment Canada, and the Canadian Food Inspection Agency, regulates shellfish harvesting areas, shellfish processing, and distribution to ensure that oysters are safe for human consumption (DFO 2014b).

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.

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

N/A

There has been no assessment of the wild eastern oyster population in the Southern Gulf of St. Lawrence; however, the population is not believed to be at risk or threatened (DFO 2014b). This factor is ranked not applicable.

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.

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderately Effective

Purchase slips from commercial seafood buyers are given to the Department of Fisheries and Oceans Canada (DFO). Using these slips, the amount of commercially harvested oysters along with their value are calculated. The provinces document what is being produced in the aquaculture sector. These numbers provide a way for managers to compare landings on a year-to-year basis (DFO 2014b). But wild and aquaculture oyster landings are not fully separated (DFO 1996b) (DFO 2016a). The last status report (1996) for the eastern oyster in the Southern Gulf Region noted that little is known about the status of the wild oyster populations because landings data are not specific to the public fishing areas, and that collection of bed-specific catch effort information is needed to estimate the available wild oyster resource (DFO 1996b).

The Department of Fisheries and Oceans Canada, provincial governments, and several universities have conducted various research projects on the Gulf of St. Lawrence oysters, but projects have been heavily focused on studies and improvements upon aquaculture practices (DFO 2003). Some current research efforts are focused on disease management, predator interactions, aquaculture management, and genetic studies (DFO 2014b). There are also monitoring programs in place to monitor oyster larvae and spat settlement rates for the management of farming operations (NB Department of Agriculture, Aquaculture and

Fisheries 2016) (PEI Department of Agriculture and Fisheries 2016); this information could potentially be used to provide an index of natural recruitment to wild oyster beds (DFO 2014b).

Because some data are collected but are insufficient to ensure the maintenance of wild oyster populations, a "moderately effective" score is awarded.

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.

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderately Effective

There is a lack of scientific population assessments for the eastern oyster, and there seems to be little scientific advice provided on the management of this fishery, particularly in recent years. The last status report produced by the Department of Fisheries and Oceans Canada (DFO) for the Southern Gulf of St. Lawrence oyster resource was in 1996. This report indicated that collection is needed of oyster landings data that are specific to public beds, to quantify catch effort information for the public oyster fishery and to estimate the wild oyster resource (DFO 1996b). This recommendation has not been followed. DFO notes that some of the challenges with separating wild oyster landings on public beds from aquaculture landings include the lack of distinction in the landings by reporting jurisdictions, overlap of the wild and aquaculture fishery seasons, some fishers who have both wild fishery and aquaculture licenses, and fishers who are not limited to selling oysters in their own province. Although wild and aquaculture landings are not fully separated, the amount of aquaculture landings mixed in with wild oyster landings reported through purchase slips to DFO is believed to be limited (pers. comm., DFO Gulf Region Fishery Management 2016). Additionally, from the perspective of fishery management, there is no issue with the population status of oysters (pers. comm., DFO Gulf Region Fishery Management 2016). We are not aware of any other scientific advice given for this fishery, but there are stakeholder advisory committees for each region that meet as needed to discuss and develop management plans (DFO 2014b). Because of the limited information, we have awarded a score of "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.

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderately Effective

Sustainability and compliance in the eastern oyster fishery is implemented as part of the DFO's Conservation and Protection (C&P) program. Fishery officers conduct both land and sea patrols to check the catch, gear, and licensing. Air patrols are also conducted to try to ensure that there is no fishing during closed seasons or in closed areas. This can also be useful in investigating reports of illegal harvest (DFO 2014b).

For the years 2000 to 2013, enforcement of the oyster fishery in the Gulf Region accounted for an average of approximately 3% of fishery officers' time, which is the equivalent of an average of approximately 2,350

hours/year. In some instances, the total time spent by fishery officers in the Gulf Region has risen closer to 3,100 hours in one year (DFO 2014b). Between April 2013 and March 2014, over 5,000 patrol hours were conducted as part of the surveillance for the Canadian Shellfish Sanitation Program, which covered coastal shellfish areas including oyster grounds. Over that same period, over 1,000 patrol hours were dedicated to the oyster fishery and resulted in 37 infractions related to illegal oyster size, fishing without a license, or fishing out of season or area (DFO Fishery Enforcement Activities Tracking System (FEATS) and Departmental Violations System [DVS] databases, as of July 25th, 2016). Additionally, it is noted in the management plan that compliance with the submission of harvest logbooks and oyster reporting documents is low, which contributes to the lack of data for the fishery. In the current management plan, top priorities for compliance and enforcement include a focus on sea and dockside inspections and investigating illegal harvesting activities (DFO 2014b).

Enforcement measures are in place, but because there are some compliance issues in this fishery, we have awarded a score of "moderately 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.

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderately Effective

There are management measures in place for the Southern Gulf of St. Lawrence eastern oyster fishery. But without a formal and current population assessment, it is difficult to determine if these measures have been successful in maintaining the wild oyster population. Because the track record is uncertain, this factor is awarded a score of "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.

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | CanadaY

Highly Effective

Stakeholders in the Southern Gulf of St. Lawrence commercial eastern oyster fishery include Aboriginal organizations, fish harvester representatives, aquaculturists, processors, and officials from the federal and provincial governments. These stakeholders contribute to the development of the management plans for eastern oysters in Prince Edward Island, Nova Scotia, and eastern New Brunswick. Representatives from the Department of Fisheries and Oceans Canada (DFO) meet with Aboriginal organizations to work together on management plans, and advisory committees from each DFO Area meet as necessary (DFO 2014b). Because the management process is transparent and regularly includes stakeholder input, a "highly effective" score is awarded.

Factor 3.2 - Bycatch Strategy

SCORING GUIDELINES

Four subfactors are evaluated: Management Strategy and Implementation, Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.' Unless reason exists to rate Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations differently, these ratings are the same as in 3.1.

- 5 (Very Low Concern)—Rated as 'highly effective' for all four subfactors considered
- 4 (Low Concern)—Management Strategy 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 but some other factors rated 'ineffective.'
- 1 (Very High Concern)—Management exists, but Management Strategy rated 'ineffective.'
- 0 (Critical)—No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substantially impacted by the fishery

FACTOR 3.2 - BYCATCH STRATEGY					
Region Method	All Kept	Critical	Strategy	Research Advice	Enforce
Canada / Southern Gulf of St. Lawrence Hand implements Canada	Yes	All Species Retained			

Subfactor 3.2.3 – 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

Subfactor 3.2.4 – 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.

Subfactor 3.2.5 – 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.

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	Score
Canada/Southern Gulf of St. Lawrence Hand implements Canada	3.00: Low Concern	0.25: Minimal Mitigation	3.00: Moderate Concern	Yellow (3.122)

Criterion 4 Assessment

SCORING GUIDELINES

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

- *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.

Factor 4.2 - Mitigation of Gear Impacts

- *+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*

Factor 4.3 - Ecosystem-Based Fisheries Management

- *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.*

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

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Low Concern

An oyster rake comprises a long handle and a metal "head" at the end used to collect the oysters. The head can be curved and has a row of metal "teeth" (DFO 2003). Oyster tongs are another commonly used gear. They comprise two long rakes that are hinged together and are used in a scissors-like fashion. Either one or both heads can have a row of "teeth" (DFO 2003). Both oyster tongs and rakes are operated by hand off a small boat called a dory. Rakes usually are made to reach to depths of 14 ft but can be used in depths as great as 25 ft. Oyster tongs are usually used in depths to 18 ft (DFO 2003).

Oysters settle and grow on hard surfaces, and large populations form oyster reefs, which are important habitats for many fish and invertebrate species (EOBRT 2007). Rakes and tongs can remove a large amount of oysters from oyster reefs, and may reduce or alter the structure of the reefs. But these gears are not as damaging as dredges (Barnette 2001). The removal of oysters from reefs is considered beneficial by some, because larval oysters tend to prefer clean shells on which to settle (DFO 2014b). Overall, oyster tongs and rakes are considered to have a low impact on the habitat. This is scored as "low" concern.

Factor 4.2 - Mitigation of Gear Impacts

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Minimal Mitigation

The Department of Fisheries and Oceans Canada (DFO) has several designated Marine Protected Areas (MPAs) throughout Canadian waters (DFO 2014a). The only MPA in the Southern Gulf Region is the Basin Head MPA off Prince Edward Island. Fishing is permitted in some areas within the MPA and prohibited in others (DFO 2014b) (DFO 2015a). But this area does not support a significant amount of oysters. Fishing effort and intensity in the oyster fishery is regulated through licensing and fishing seasons (DFO 2014b). We have awarded a "minimal" mitigation score.

Factor 4.3 - Ecosystem-Based Fisheries Management

CANADA / SOUTHERN GULF OF ST. LAWRENCE

Hand Implements | Canada

Moderate Concern

Eastern oyster is considered a species of exceptional importance because of its ability to create reefs (DFO 2014b) (which are important habitats for many species) while also providing various ecosystem services (Coen et al. 2007). Because of these characteristics, oysters are frequently referred to as "ecosystem engineers, colonizers, or keystone species" (EOBRT 2007). Oyster reefs provide shelter and habitat for many aquatic organisms (DFO 2014b). Oyster reefs have a high biodiversity, which means that a greater variety of species of invertebrates and fish are found on them compared to other estuary habitats, such as sand or mud. Some fish use this habitat for their whole life, while others may only use it during a specific phase (Coen et al. 2007). Further, oyster reefs can help keep soft-bottomed banks from eroding (EOBRT 2007). Additionally, as oysters feed, they filter the water for small pieces of plankton. This action can lead to increased water quality (Coen et al. 2007) and may have the ability to prevent eutrophication, or the excess accumulation of nutrients (e.g., nitrogen) that causes algae blooms (DFO 2014b). Predators of oysters can include crabs, snails, starfish, and boring sponges and worms. Green crabs and oyster drills can prey heavily on oyster reefs. (DFO 2014b) (DFO 2003).

Several projects to help restore oyster reefs and to encourage young oysters to settle are underway in the Southern Gulf of St. Lawrence. These projects include seeding areas, spreading old shells from oysters and other shellfish species on the bottom habitat to increase settlement surface area, and cleaning sediment from oyster shells to increase clean available space for juvenile oysters to settle (PEI Department of Agriculture and Fisheries 2005)(DFO 2014b).

This factor is ranked as "moderate" concern because specific objectives/policies to protect the ecosystem value of oysters have not been defined in the Eastern Oyster Management Plan, but some projects are underway to encourage the regrowth and rebuilding of oyster reefs in this region to improve the health of coastal marine ecosystems.

Acknowledgements

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

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

The Safina Center and Seafood Watch would like to thank several anonymous reviewers and Dr. Michael Chadwick (retired), former Regional Director of the Oceans and Science Branch, DFO, Gulf Region for graciously reviewing this report for scientific accuracy.

References

Barnette, M.C. 2001. A review of the fishing gear utilized within the Southeast Region and their potential impacts on essential fish habitat. U.S. Department of Commerce, NOAA National Marine Fisheries Service. NOAA Technical Memorandum NMFS-SEFSC-449.

Buroker, N.E. 1983. Population genetics of the American oyster *Crassostrea virginica* along the Atlantic coast and the Gulf of Mexico. *Marine Biology*. 75:99-112.

Coen, L.D., R.D. Brumbaugh, D. Bushek, R. Grizzle, M.W. Luckenbach, M.H. Posey, S.P. Powers, and S. G. Tolley. 2007. Ecosystem Services Related to Oyster Restoration. *Marine Ecology Progress Series*. 341: 303-307.

Department of Fisheries and Oceans Canada (DFO). 1996b. Southern Gulf American Oyster, Maritimes Region. Stock Status Report 96/105E.

Department of Fisheries and Oceans Canada (DFO). 1996a. Cape Breton American Oyster, Maritimes Region. Stock Status Report 96/124E.

Department of Fisheries and Oceans Canada (DFO). 2013. ARCHIVED - 2000 - 2004 Integrated Fisheries Management Plan - Oyster Prince Edward Island (Inclusive). Available online at: <http://www.glf.dfo-mpo.gc.ca/Gulf/FAM/IMFP/2000-2004-Oyster-PEI>

Department of Fisheries and Oceans Canada (DFO). 2003. Profile of the American Oyster (*Crassostrea virginica*): Gulf Region. Policy and Economic Branch, Gulf Region, DFO.

Department of Fisheries and Oceans Canada (DFO). 2009. American oyster (*Crassostrea virginica*) Integrated Fishery Management Plan: Eastern New Brunswick area, Gulf Region; 2009-2012.

Department of Fisheries and Oceans Canada (DFO). 2012. Compliance and Enforcement. Available online at: <http://www.dfo-mpo.gc.ca/fm-gp/enf-loi/index-eng.htm>

Department of Fisheries and Oceans Canada (DFO). 2014a. Marine Protected Areas. Available online at: <http://www.dfo-mpo.gc.ca/>

Department of Fisheries and Oceans Canada (DFO). 2014b. Integrated Fisheries Management Plan: American Oyster in the Southern Gulf of Saint Lawrence. In press.

Department of Fisheries and Oceans Canada (DFO). 2015c. Maritime Provinces Fishery Regulations (SOR/93-55). Available on the Justice Laws Website at: <http://laws-lois.justice.gc.ca/eng/regulations/SOR-93-55/FullText.html>

Department of Fisheries and Oceans Canada (DFO). 2015b. Canadian Trade by Species Group and Species: Oysters, 2014. Available online at: <http://www.inter.dfo-mpo.gc.ca>.

Department of Fisheries and Oceans Canada (DFO). 2015d. The American Oyster: Important to the Balance of the Marine Ecosystem. Available online at: <http://www.dfo-mpo.gc.ca/science/publications/article/2009/12-14-09-eng.html>

Department of Fisheries and Oceans Canada (DFO). 2016a. Commercial Fisheries, Landings, Seafisheries: Atlantic Region- Quantities and Values. Available online at: <http://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm>.

Department of Fisheries and Oceans Canada (DFO). 2016b. Aquaculture Production Quantities and Values. Available online at: <http://www.dfo-mpo.gc.ca/stats/aqua/aqua-prod-eng.htm>

Department of Fisheries and Oceans Canada (DFO). 2015a. Basin Head Marine Protected Area Regulations. SOR/2005-293, OCEANS ACT. Available online at: <http://laws.justice.gc.ca/>

Eastern Oyster Biological Review Team (EOBRT). 2007. Status review of the eastern oyster (*Crassostrea virginica*). Report to the National Marine Fisheries Service, Northeast Regional Office. February 16, 2007. 105 pp.

Food and Agriculture Organization of the United Nations (FAO). 2015a. Fishing Gear types. Rakes. Technology Fact Sheets. Bibliographic citation [online]. Rome. Updated 13 September 2001. [Cited 20 January 2015]. <http://www.fao.org/fishery/geartype/316/en>

Food and Agriculture Organization of the United Nations (FAO). 2015b. Fishing Gear types. Tongs. Technology Fact Sheets. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 13 September 2001. [Cited 20 January 2015]. <http://www.fao.org/fishery/geartype/317/en>

New Brunswick Department of Agriculture, Aquaculture and Fisheries. 2016. Oyster Spat Collection Updates. Available online at http://www2.gnb.ca/content/gnb/en/departments/10/aquaculture/content/oyster_spat_collection_updates.html

National Oceanic and Atmospheric Association (NOAA). 2015. 2014 Import Query: Oysters. National Marine Fisheries Service, Fisheries Statistics and Economic Division. Available online at: <http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade>.

National Oceanic and Atmospheric Association (NOAA). 2016. Landings Query: Eastern Oyster. National Marine Fisheries Service, Fisheries Statistics and Economic Division. Available online at: <http://www.st.nmfs.noaa.gov/commercial-fisheries/foreign-trade>.

Osborne, P. 1999. "*Crassostrea virginica*" (On-line), Animal Diversity Web. Available online at http://animaldiversity.org/accounts/Crassostrea_virginica/

PEI Department of Agriculture and Fisheries. 2005. Oyster Production in Prince Edward Island. Aqua Info Aquaculture Notes. AIN 18.2005.

Prince Edward Island, Department of Agriculture and Fisheries. 2016. Oyster Monitoring Program. Available online at <http://www.gov.pe.ca/fard/index.php3?number=1002298>.

Sellers, M.A., and J.G. Stanley. 1984. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic)—American oyster. U.S. Fish Wildl. Serv. FWS/OBS-82/11.23. U.S. Army Corps of Engineers, TR EL-82-4. 15 pp.

Appendix A: Updates to Eastern Oyster Report

This report was reviewed for any significant stock status and management updates to the fishery on November 20, 2019. None were found that would indicate the final rating is no longer accurate.