Monterey Bay Aquarium
Seafood Watch

Draft Assessment for Review
February 2025

Blue mussel

Species:	*Mytilus edulis*
Location:	Northwest Atlantic: Maine, Massachusetts, New York, Rhode Island
Gear:	Hand dredges, Hand implements
Type:	Wild Caught
Author:	Seafood Watch
Published:	
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Assessed using Seafood Watch Fisheries Standard v3

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About Monterey Bay Aquarium Seafood Watch

The mission of the Monterey Bay Aquarium is to inspire conservation of the ocean and enable a future where the ocean flourishes and people thrive in a just and equitable world. To do this, the Aquarium is focused on creating extraordinary experiences that inspire awe and wonder, championing science-based solutions, and connecting people across the planet to protect and restore the ocean. We know that healthy ocean ecosystems are critical to enabling life on Earth to exist, and that our very survival depends on them. As such, our conservation objectives are to mobilize climate action, improve the sustainability of global fisheries and aquaculture, reduce sources of plastic pollution, and restore and protect ocean wildlife and ecosystems.

The aquarium is focused on improving the sustainability of fisheries and aquaculture given the role seafood plays in providing essential nutrition for 3 billion people globally, and in supporting hundreds of millions of livelihoods. Approximately 180 million metric tons of wild and farmed seafood is harvested each year (excluding seaweeds). Unfortunately, not all current harvest practices are sustainable and poorly managed fisheries and aquaculture pose the greatest immediate threat to the health of the ocean and the economic survival and food security of billions of people.

The Seafood Watch program was started 25 years ago as a small exhibit in the Monterey Bay Aquarium highlighting better fishing practices and grew into one of the leading sources of information on seafood sustainability, harnessing the power of consumer choice to mobilize change. The program's comprehensive open-source information and public outreach raises awareness about global sustainability issues, identifies areas for improvement, recognizes and rewards best practices and empowers individuals and businesses to make informed decisions when purchasing seafood.

We define sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain. As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide.

Built on a solid foundation of science and collaboration, our standards reflect our guiding principles for defining environmental sustainability in seafood.

Recommended Citation: Seafood Watch (2025) Blue mussel Monterey Bay Aquarium

Seafood Watch Ratings

The Seafood Watch Standard for Fisheries is used to produce assessments for wild-capture fisheries resulting in a Seafood Watch rating of green, yellow, or red. Seafood Watch uses the assessment criteria to determine a final numerical score as well as numerical subscores and colors for each criterion. These scores are translated to a final Seafood Watch color rating according to the methodology described in the table below. The table also describes how Seafood Watch defines each of these categories. The narrative descriptions of each Seafood Watch rating, and the guiding principles listed below, compose the framework on which the criteria are based.

Green	Final Score >3.2, and either criterion 1 or criterion 3 (or both) is green, and no red criteria, and no critical scores	Wild-caught and farm-raised seafood rated green are environmentally sustainable, well managed and caught or farmed in ways that cause little or no harm to habitats or other wildlife. These operations align with all of our guiding principles.
Yellow	Final score >2.2, and no more than one red criterion, and no critical scores, and does not meet the criteria for green (above)	Wild-caught and farm-raised seafood rated yellow cannot be considered fully environmentally sustainable at this time. They align with most of our guiding principles, but there is either one conservation concern needing substantial improvement, or there is significant uncertainty associated with the impacts of the fishery or aquaculture operations.
Red	Final Score ≤2.2, or two or more Red Criteria, or one or more Critical scores.	Wild-caught and farm-raised seafood rated Red are caught or farmed in ways that have a high risk of causing significant harm to the environment. They do not align with our guiding principles and are considered environmentally unsustainable due to either a critical conservation concern, or multiple areas where improvement is needed.

Guiding Principles

Seafood Watch defines sustainable seafood as seafood from sources, whether fished or farmed, that can maintain or increase production without jeopardizing the structure and function of affected ecosystems, minimize harmful environmental impacts, assure good and fair working conditions, and support livelihoods and economic benefits throughout the entire supply chain.

As one aspect of this vision, Seafood Watch has developed trusted, rigorous standards for assessing the environmental impacts of fishing and aquaculture practices worldwide. Environmentally sustainable wild capture fisheries:

1. **Follow the principles of ecosystem-based fisheries management**

   The fishery is managed to ensure the integrity of the entire ecosystem, rather than solely focusing on maintenance of single species stock productivity. To the extent allowed by the current state of the science, ecological interactions affected by the fishery are understood and protected, and the structure and function of the ecosystem is maintained.

2. **Ensure all affected stocks[1] are healthy and abundant**

   Abundance, size, sex, age and genetic structure of the main species affected by the fishery (not limited to target species) is maintained at levels that do not impair recruitment or long-term productivity of the stocks or fulfillment of their role in the ecosystem and food web.

   Abundance of the main species affected by the fishery should be at, above, or fluctuating around levels that allow for the long-term production of maximum sustainable yield. Higher abundances are necessary in the case of forage species, in order to allow the species to fulfill its ecological role.

[1]"Affected" stocks include all stocks affected by the fishery, no matter whether target or bycatch, or whether they are ultimately retained or discarded.

3. **Fish all affected stocks at sustainable levels**

   Fishing mortality for the main species affected by the fishery should be appropriate given current abundance and inherent resilience to fishing while accounting for scientific uncertainty, management uncertainty, and non-fishery impacts such as habitat degradation.

   The cumulative fishing mortality experienced by affected species must be at or below the level that produces maximum sustainable yield for single-species fisheries on typical species that are at target levels.

   Fishing mortality may need to be lower than the level that produces maximum sustainable yield in certain cases such as forage species, multispecies fisheries, highly vulnerable species, or fisheries with high uncertainty.

   For species that are depleted below target levels, fishing mortality must be at or below a level that allows the species to recover to its target abundance.

4. **Minimize bycatch**

   Seafood Watch defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, pre-catch mortality and ghost fishing. All discards, including those released alive, are considered bycatch unless there is valid scientific evidence of high post-release survival and there is no documented evidence of negative impacts at the population level.

   The fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss and by efficiently using marine and freshwater resources as bait.

5. **Have no more than a negligible impact on any threatened, endangered or protected species**

   The fishery avoids catch of any threatened, endangered or protected (ETP) species. If any ETP species are inadvertently caught, the fishery ensures and can demonstrate that it has no more than a negligible impact on these populations.

6. **Are managed to sustain the long-term productivity of all affected species**

   Management should be appropriate for the inherent resilience of affected marine and freshwater life and should incorporate data sufficient to assess the affected

species and manage fishing mortality to ensure little risk of depletion. Measures should be implemented and enforced to ensure that fishery mortality does not threaten the long term productivity or ecological role of any species in the future.

The management strategy has a high chance of preventing declines in stock productivity by taking into account the level of uncertainty, other impacts on the stock, and the potential for increased pressure in the future.

The management strategy effectively prevents negative population impacts on bycatch species, particularly species of concern.

7. **Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs**

   The fishery does not adversely affect the physical structure of the seafloor or associated biological communities.

   If high-impact gears (e.g. trawls, dredges) are used, vulnerable seafloor habitats (e.g. corals, seamounts) are not fished, and potential damage to the seafloor is mitigated through substantial spatial protection, gear modifications and/or other highly effective methods.

8. **Maintain the trophic role of all aquatic life**

   All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web, as informed by the best available science.

9. **Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts**

   Fishing activities must not result in harmful changes such as depletion of dependent predators, trophic cascades, or phase shifts.

   This may require fishing certain species (e.g., forage species) well below maximum sustainable yield and maintaining populations of these species well above the biomass that produces maximum sustainable yield.

10. **Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks**

    Any enhancement activities are conducted at levels that do not negatively affect wild stocks by reducing diversity, abundance or genetic integrity.

Management of fisheries targeting enhanced stocks ensures that there are no negative impacts on the wild stocks, in line with the guiding principles described above, as a result of the fisheries.

Enhancement activities do not negatively affect the ecosystem through density dependent competition or any other means, as informed by the best available science.

Introduction

Scope of the analysis and ensuing rating

This report assesses the U.S. North Atlantic fisheries for blue mussel *(Mytilus edulis)*. The states covered in the report are Maine, Massachusetts, New York, and Rhode Island. These states account for nearly all the wild blue mussel catch. Fishers use hand rakes and drags (dredges) to capture mussels. Seafood Watch also has an assessment for farmed mussels, covering both off-bottom and on-bottom culture; farmed mussels are not considered in this report.

Species Overview

Blue mussel is found in the Arctic, North Pacific, and North Atlantic. Along the North American coast, it is are found from Labrador, Canada to Cape Hatteras, North Carolina, with the population centered in Maine (Seed 1976)(Tam and Scrosati 2011).

Blue mussel is a semi-sessile bivalve that anchors to the bottom substrate in intertidal shallow areas and forms dense beds (Newell and Moran 1989). It typically reaches sexual maturity between 1 and 2 years, and on average lives up to 12 years (Newell and Moran 1989)(Massie 1998)(MDMR 2016a). It can grow to a maximum size of 6–10 cm (2–4 in) {Roadhouse 1986}. Blue mussel spawns in the spring and summer and is typically caught in the winter before spawning, when its meat is considered to have the best market value (MDMR 2016a). Blue mussel is a suspension feeder and filters plankton from the seawater for food (Bayne 1983). It is vulnerable to predation when it is a planktonic juvenile, and predators range from jellyfish to larval and adult fish (Newell and Moran 1989). As mussels grow, they are susceptible to larger predators such as sea stars, sea urchins, crabs, lobsters, whelks, fish, and birds (Seed and Suchanek 1992).

The U.S. commercial catch of blue mussels has fluctuated over time, but is at relatively low levels compared to the catch of other shellfish species. The majority of blue mussel fishing occurs in the state of Maine, but small fisheries also take place in Massachusetts, New York, and Rhode Island. Blue mussels are captured by hand with the use of a bull rake, or by boat with the use of a mussel drag (also called a dredge) (MDMR 2016a). Blue mussel is managed at the state level by the Maine Department of Marine Resources, Massachusetts Department of Marine Fisheries, New York Department of Environmental Conservation, and Rhode Island Department of Environmental Management. There is a growing aquaculture industry for blue mussel,

but this report only covers the wild fishery.

Production Statistics

In the state of Maine, where the majority of blue mussel fishing occurs, commercial landings were relatively low from 1950–1974 and rarely exceeded 2 million whole lbs annually. In the late 1970s and 1980s, landings gradually increased. The highest landings occurred in 1995 at approximately 37 million whole lbs. Since the mid-1990s, landings have fluctuated but decreased overall. From 2000–2015, the annual landings ranged from 13 to 28 million whole lbs and averaged 17 million lbs ($2.5 million in value) (MDMR 2016c). In 2015, 5% of the catch (662,306 lbs) was taken with hand rakes, while the remaining 95% (12,448,031 lbs) was caught with mussel dredges. Preliminary 2022 commercial landings for Maine blue mussel were 3% of total commercial marine landings, or around 5.56 million lbs (430.58 MT, $4,003,404 value; see figure) (MDMR 2022)(MDMR 2023). The steady two-decade-long decline is concerning.

In the state of New York, blue mussels have been commercially fished since the 1950s, but landings have been significantly lower than in Maine. Blue mussel landings in New York have fluctuated greatly, and the highest annual catch was 3,752,815 whole lbs (68,233 bushels) in 1973. Since the 1970s, landings have decreased and have remained low since 2000. From 2000– 2014, the annual landings ranged from approximately 5,115 whole lbs (93 bushels) to 69,960 whole lbs (1,272 bushels) (pers comm O'Dwyer, J. 2016). In 2019, annual landings were approximately 1,430 whole lbs (26 bushels), 4,730 whole lbs (86 bushels) in 2020, 110 whole lbs (2 bushels) in 2021, and 6,600 whole lbs (120 bushels) in 2022 {pers comm Wade, C. 2023}. *[Note: New York landings for blue mussels are reported in bushels. For this report, landings were converted to estimated pounds using a conservation factor of 55 pounds per bushel (pers comm O'Dwyer, J. 2016).]*

The blue mussel supports a very small commercial fishery in Rhode Island, and landings are variable. The only available and reliable information for blue mussel commercial landings in Rhode Island is in value rather than pounds. In years when catches were considered high, such as 2009 and 2010, blue mussel landings value was $145,000, and the average landings value from 2007–2013 was approximately $48,100 (CRC 2014). There were no reported mussel landings in 2013 (RIDEM 2018). Additionally, there is no accessible current landings data since 2013.

Available information on blue mussel landings in the state of Massachusetts from 2019-2023 indicate a steady increase in landings, with the exception of 2023. Over the last five years, the highest landings occurred in 2022, at approximately 5.2 million whole lbs {pers. comm Petitpas, C. 2024}.

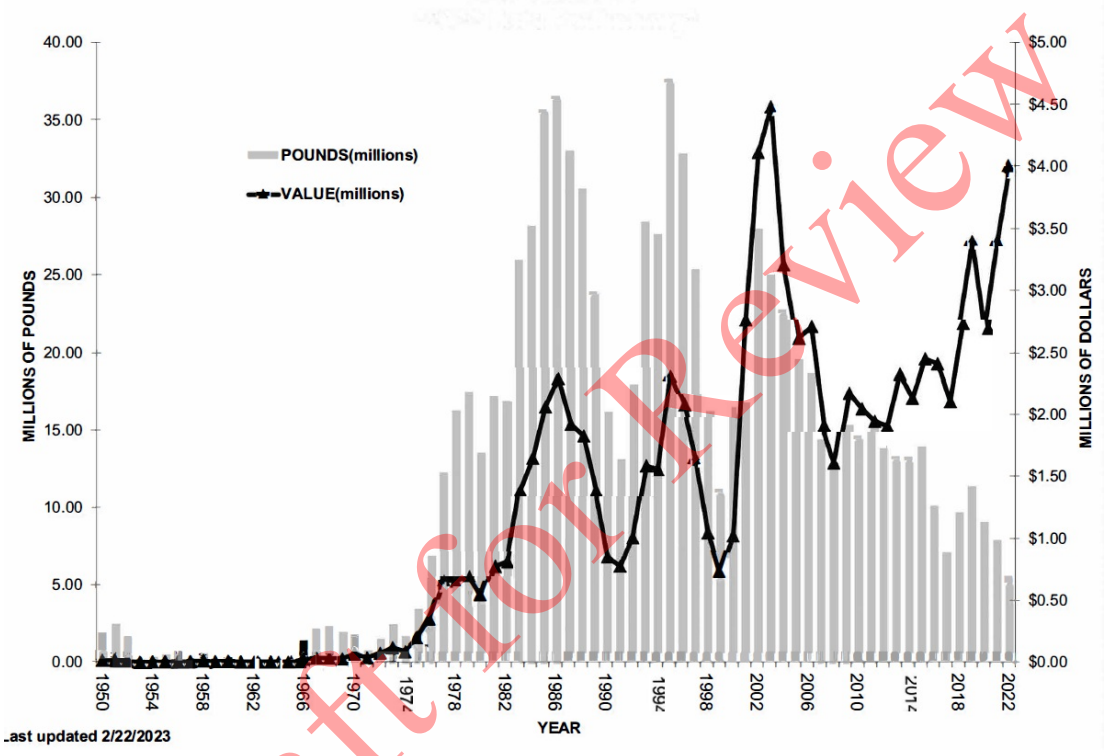

Figure 1: Commercial landings (in whole pounds) of blue mussel (*Mytilus edulis*) in Maine from 1950–2022 (2022 data is preliminary data) (pers comm Steneck, R. 2023).

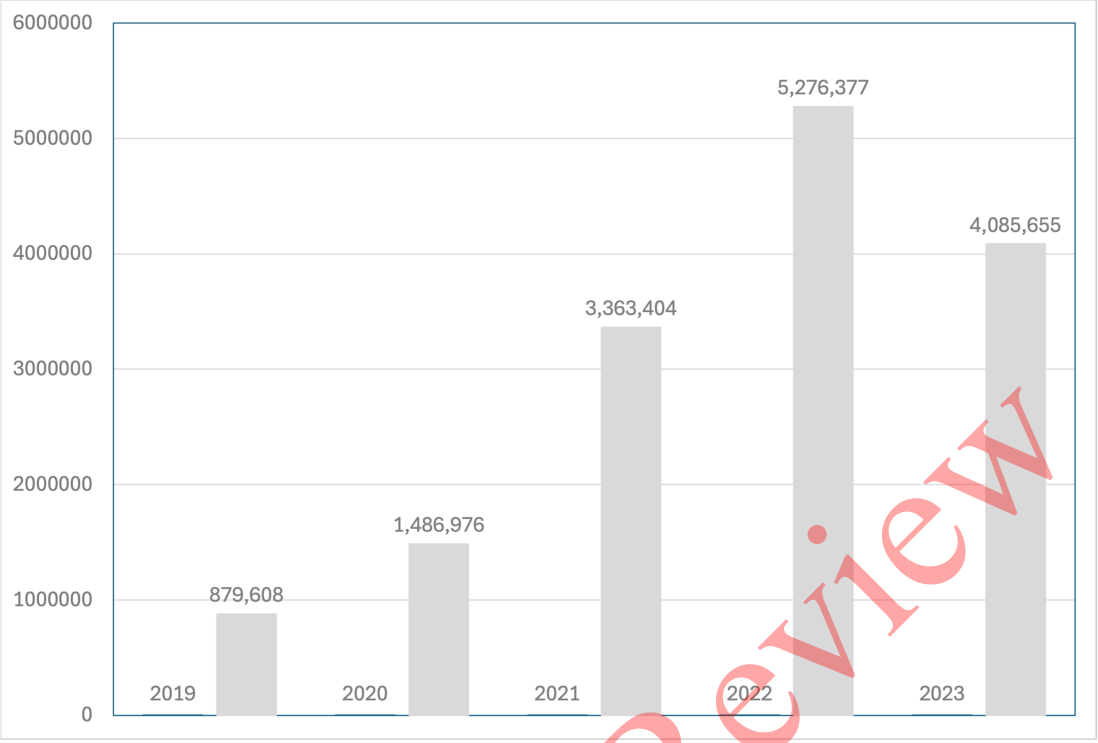

Figure 2: Commercial landings (in whole pounds) of blue mussel (*Mytilus edulis*) in Massachusetts from 2019–2023 {pers comm Petitpas, C. 2024}.

Importance to the US/North American market.

Blue mussel is an economically important species in the northwest Atlantic, especially in Maine. Mussels are both imported and exported in the U.S. domestic fish market. The following import and export values do not solely reflect the wild blue mussel, but all mussel species from both wild and farmed harvest. In 2013 and 2014, the U.S. exported 920,000 lbs ($1.66 million) and 1,098,000 lbs ($2.2 million) of mussels, respectively. U.S. imports of mussels in 2013 and 2014 were 56,308,000 lbs ($93 million) and 58,102,000 lbs ($112 million), respectively (NOAA Fisheries 2015b). The majority of exports are to China, Japan, and Canada, and the majority of imports are from New Zealand, Chile, Canada, and China.

Common and market names.

The blue mussel is occasionally referred to as sea mussel, edible mussel, bay mussel, common mussel, or mussel (CRC 2014){Newell and Morgan 1989}.

Primary product forms

Blue mussels are sold fresh (live), frozen, or cooked. They are typically broiled, sautéed, smoked, or steamed and eaten in the shell.

Final Ratings

Ratings Details	Criterion 1 Target Species	Criterion 2 Other Species	Criterion 3 Management	Criterion 4 Habitat	Rating
Species: Blue mussel **Country:** United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Volume:** 430 mt	2.644	2.644	3.000	2.739	Yellow (2.753)
Species: Blue mussel **Country:** United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges	2.644	2.644	3.000	2.739	Yellow (2.753)

Ratings Details	Criterion 1 Target Species	Criterion 2 Other Species	Criterion 3 Management	Criterion 4 Habitat	Rating
Species: Blue mussel **Country:** United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Volume:** 3 mt	2.644	2.644	3.000	2.739	Yellow (2.753)
Species: Blue mussel **Country:** United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges	2.644	2.644	3.000	2.739	Yellow (2.753)
Species: Blue mussel **Country:** United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Volume:** 430 mt	2.644	5.000	3.000	3.000	Yellow (3.303)

Ratings Details	Criterion 1 Target Species	Criterion 2 Other Species	Criterion 3 Management	Criterion 4 Habitat	Rating
Species: Blue mussel **Country:** United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements	2.644	5.000	3.000	3.000	Yellow (3.303)
Species: Blue mussel **Country:** United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Volume:** 3 mt	2.644	5.000	3.000	3.000	Yellow (3.303)
Species: Blue mussel **Country:** United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements	2.644	5.000	3.000	3.000	Yellow (3.303)

Assessments

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

Criterion 1: Impacts on the Species Under Assessment

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

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

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

Guiding principles

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

Criterion 1 Summary

Blue mussel			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Volume:** 430 mt	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Volume:** 3 mt	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**

Blue mussel			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Volume:** 430 mt	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**

Blue mussel			
Region / Method	**Abundance**	**Fishing Mortality**	**Score**
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Volume:** 3 mt	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements	2.330 Moderate Concern	3.000 Moderate Concern	**Yellow (2.644)**

Criterion 1 Assessment

Scoring Guidelines

Factor 1.1 - Abundance

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

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

species is not highly vulnerable.

- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

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

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

Blue mussel *(Mytilus edulis)*

1.1 Abundance

Northwest Atlantic | United States | Maine | Hand dredges
Northwest Atlantic | United States | Massachusetts | Hand dredges
Northwest Atlantic | United States | New York | Hand dredges
Northwest Atlantic | United States | Rhode Island | Hand dredges
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | Rhode Island | Hand implements

Moderate Concern

There are currently no efforts in place by state management bodies to monitor the U.S. blue mussel populations, so abundance of blue mussels is largely unknown. In several states (MA, NY, and RI) fishing effort is low and abundance is assumed to be high (NYSDEC 2005) (pers comm Carden, W. 2023) (pers comm Shields, T. 2016)(pers comm Steneck, R. 2023).

Currently, there is no estimate of the standing crop of mussels in Maine that reflects their condition (MDMR 2022), but in the Gulf of Maine, which is the center of the blue mussel's range, and of fishing activity (Tam and Scrosati 2011), there have been a few independent studies that have examined the abundance of intertidal blue mussels. A study compared abundance levels of blue mussels (2013–2014) to historical estimates of mussel abundance from 1972–2007 at seven sites in the Gulf of Maine, from Cape Cod to the northernmost point in Maine (Sorte et al. 2016). Results of the study indicate that intertidal blue mussels have declined over the past 40 years at all seven sites, with declines of > 60% on average (*ibid*), suggesting some concern over the abundance of mussels in this area. Petraitis and Dudgeon have noted declines of mussels due to a reduction in mussel recruitment (Petraitis and Dudgeon 2020), as have Maine fishery managers who report declines of blue mussels statewide over the last 5 years. The level of decline and reasons for decline are unknown, but are potentially due to warming water temperature, green

crab predation, overfishing, and/or increasing acidification affecting larvae and shell formation (pers comm Thayer, P. 2016).

Because there is no stock assessment and the lack of defined target abundance reference points for the blue mussel populations (both intertidal, and subtidal, where mussels are harvested) evaluated in this assessment, the Productivity-Susceptibility Analysis (PSA) scoring tool was used to evaluate the vulnerability of blue mussels and to score abundance. Blue mussel has a PSA score of 2.68, showing medium vulnerability (see detailed scoring below). Abundance is therefore scored as “moderate concern".

Supplementary Information

A Fishery Improvement Project (FIP), which is a multi-stakeholder effort to improve the sustainability of a fishery, was initiated in January 2018, and completed in September 2022. The FIP succeeded in achieving its objectives, which were as follows: Conduct research on mussel beds, determine fishery-specific objectives, and determine key components of mussel management. The FIP updated one of its objectives from "Management improves to ensure long-term sustainability of the mussel fishery and access for local harvesters " to "Working group members determine there is a need for better long-term management and a request for a fishery management plan process is submitted to the state agency.", which was achieved in March 2022. However, it was not recommended to the fishery to move to full assessment with many of the PIs with likely scores less than 60 (Fishery Progress 2024).

MAINE: Wild mussels have suffered from green crab (*Carcinus maenas*) predation (Petraitis and Dudgeon 2020), taking mussels up to about 75 mm in length, but really eliminating smaller size classes. Larger intertidal mussels are often taken for clam bakes--that combination has taken a toll on intertidal mussels (pers comm Steneck, R. 2023). It has also been suggested that blue mussel loss is due to recruitment failure associated with processes in the water column (Petraitis and Dudgeon 2020). Nevertheless, periodically Maine gets a big settlement events of mussels; 2021 was a good year (pers comm Steneck, R. 2023)

NY: There is an annual marine biotoxin monitoring program that relies on harvest from wild blue mussel populations each April to stock bags that are deployed at monitoring stations to serve as sentinels for toxin-producing

HABs of species like *Alexandrium fundyense* (red tide). The program knows of several areas that are reliably productive to harvest blue mussels for this purpose. It is believed that the last report's description of fishing effort (low) and abundance (assumed high) remains valid (pers comm Carden, W. 2023)

RI: RI fishing effort is still generally low. Blue mussel data is confidential and does not meet the rule of three (pers comm Barrett, P. 2024).

It is important to note that most data cited applies to intertidal blue mussel; however, vast populations exist subtidally and all harvesting of wild and rope-aquaculture mussels is subtidal; this may be an important disconnect (pers comm Steneck, R. 2023).

Productivity-Susceptibility Analysis

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled

*as follows: S = [(s1 * s2 * s3 * s4) – 1/ 40] + 1 .*

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: V = v(P2 + S2)

Vulnerability Score Range

1. *< 2.64 = Low vulnerability*
2. *= 2.64 and = 3.18 = Medium vulnerability*
3. *> 3.18 = High vulnerability*

For details on the PSA method and scoring, please see the Seafood Watch Criteria

PSA score for US mussel is calculated as follows:

Vulnerability (V) = $v(P^2 + S^2)$

V = $v(1.34^2 + 2.325^2)$

V = $v(1.79 + 5.4)$ = **2.68** (Medium inherent vulnerability)

Detailed scoring of each attribute is shown below.

Table 1

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	1–2 years (Massie 1998)	1
Average maximum age	12 years (MDMR 2016a)	2
Fecundity	High productivity: females release approximately 500,000 to 10,000,000 eggs (Thompson 1979)(Bayne 1983)	1
Average maximum size (fish only)	N/A	N/A
Average size at maturity (fish only)	N/A	N/A
Reproductive strategy	Broadcast spawner (Massie 1998)	1
Trophic level	Second trophic level < 2.75 (Newell and Moran 1989)	1
Density dependence (invertebrates only)	Depensatory dynamics at low population sizes (Allee effects) demonstrated or likely (Commito et al. 2014)	3
Habitat quality	Default scoring	2
Total Productivity (average)		**1.34**

Table 2

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	Unknown level of overlap, but the majority of fishing occurs in Maine, the center of the species' range (Tam and Scrosati 2011)	3
Vertical overlap (Considers all fisheries)	Unknown	3
Selectivity of fishery (Specific to fishery under assessment)	Species is targeted and is not likely to escape the gear	2
Post-capture mortality (Specific to fishery under assessment)	Retained species	3
Total Susceptibility (multiplicative)		**2.325**

1.2 Fishing Mortality

Northwest Atlantic | United States | Maine | Hand dredges
Northwest Atlantic | United States | Massachusetts | Hand dredges
Northwest Atlantic | United States | New York | Hand dredges
Northwest Atlantic | United States | Rhode Island | Hand dredges
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | Rhode Island | Hand implements

Moderate Concern

There have been no assessments of blue mussel to estimate fishing mortality. Maine has accounted for the majority of blue mussel commercial

catches in the U.S. Landings in Maine have fluctuated over time, with the highest catches occurring in the mid-1980s, mid-1990s, and early 2000s (MDMR 2016c). From 2000–2021, annual landings have ranged from 5.5 to 27 million whole lbs, and averaged 17 million lbs (MDMR 2016c)(pers comm Steneck, R. 2023). The majority of the catch is taken with mussel dredges. Much smaller catches of blue mussel occur in Massachusetts, New York, and Rhode Island. Reliable catch data are not available for Massachusetts or Rhode Island.

Catches in New York peaked at just fewer than 4 million whole lbs in 1973, but have since declined. From 2000–2014, annual landings have ranged from 5,115 whole lbs (93 bushels) to 69,960 whole lbs (1,272 bushels). In 2019, annual landings were approximately 1,430 whole lbs (26 bushels), 4,730 whole lbs (86 bushels) in 2020, 110 whole lbs (2 bushels) in 2021, and 6,600 whole lbs (120 bushels) in 2022 (pers comm Carden, W. 2023). New York issued only five dredge permits in 2021, and 10 in 2022, which indicates quite low fishing pressure (pers comm Carden, W. 2023). Because fishing levels relative to a sustainable level are unknown in all states, fishing mortality is rated “moderate concern".

Criterion 2: Impacts on Other Species

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

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

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

Guiding principles

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

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

Blue mussel			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Volume:** 430 mt	2.644	1.000: < 100%	Yellow (2.644)
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges	2.644	1.000: < 100%	Yellow (2.644)
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Volume:** 3 mt	2.644	1.000: < 100%	Yellow (2.644)

Blue mussel			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges	2.644	1.000: < 100%	Yellow (2.644)
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Volume:** 430 mt	5.000	1.000: < 100%	Green (5.000)
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements	5.000	1.000: < 100%	Green (5.000)

Blue mussel			
Region / Method	**Sub Score**	**Discard Rate/Landings**	**Score**
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Volume:** 3 mt	5.000	1.000: < 100%	Green (5.000)
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements	5.000	1.000: < 100%	Green (5.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

Northwest Atlantic | United States | Maine | Hand dredges			
Sub Score: 2.644	**Discard Rate: 1.000**		**Score: 2.644**
Species	**Abundance**	**Fishing Mortality**	**Score**
Benthic inverts	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Northwest Atlantic | United States | Maine | Hand implements			
Sub Score: 5.000	Discard Rate: 1.000		Score: 5.000
Species	Abundance	Fishing Mortality	Score
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Northwest Atlantic | United States | Massachusetts | Hand dredges			
Sub Score: 2.644	Discard Rate: 1.000		Score: 2.644
Species	Abundance	Fishing Mortality	Score
Benthic inverts	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Northwest Atlantic | United States | Massachusetts | Hand implements			
Sub Score: 5.000	Discard Rate: 1.000		Score: 5.000
Species	Abundance	Fishing Mortality	Score
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Northwest Atlantic | United States | New York | Hand dredges			
Sub Score: 2.644	Discard Rate: 1.000		Score: 2.644
Species	Abundance	Fishing Mortality	Score
Benthic inverts	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Northwest Atlantic | United States | New York | Hand implements			
Sub Score: 5.000	Discard Rate: 1.000		Score: 5.000
Species	Abundance	Fishing Mortality	Score
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Northwest Atlantic | United States | Rhode Island | Hand dredges			
Sub Score: 2.644	Discard Rate: 1.000		Score: 2.644
Species	Abundance	Fishing Mortality	Score
Benthic inverts	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Northwest Atlantic | United States | Rhode Island | Hand implements			
Sub Score: 5.000	Discard Rate: 1.000		Score: 5.000
Species	Abundance	Fishing Mortality	Score
Blue mussel	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Information on non-target or bycatch species caught in the blue mussel fisheries is limited. However, bycatch is generally considered to be low and does not regularly include threatened, endangered, or protected species (MDMR 2007a)(FR 2015). Because mussels form dense, aggregate beds, fishers are able to selectively target mussels by dragging or raking directly over the beds. When blue mussels are captured with hand rakes, most non-target catch is likely able to be released alive. Impacts on non-target species in the hand rake fisheries are therefore considered negligible and no other main species are evaluated.

Impacts to non-target species by the dredge fisheries are more uncertain. Species reported to be captured in low levels with mussel dredges include bottom dwelling fish and other benthic invertebrates such as worms, sea urchins, crabs, and starfish that live within the mussel beds (Mesher and Doidge 1995). Non-target species are typically returned to the habitat but they may be harmed due to tumbling and crushing during the fishing process. To account for potential impacts to non-target species, we have evaluated “unknown invertebrates” using the Seafood Watch unknown bycatch matrix, which is based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type (see Appendix 2 in the Seafood Watch Wild Fisheries Assessment Criteria).

Criterion 2 Assessment

Scoring Guidelines

Factor 2.1 - Abundance

(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality

(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Benthic inverts *(Unknown benthic invertebrate spp.)*

2.1 Abundance

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand dredges

Moderate Concern

The species of benthic invertebrates affected by the blue mussel fishery are unknown, but species that have been reported to be caught in mussel dredges include worms, sea urchins, crabs, and starfish (Mesher and Doidge 1995). Following the Seafood Watch Unknown Bycatch Matrix, benthic invertebrates were scored a “moderate concern".

2.2 Fishing Mortality

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand dredges

Moderate Concern

Non-target species captured in the dredge fisheries are typically returned to the habitat (Mesher and Doidge 1995). But some species may be harmed due to tumbling and crushing during the fishing process, or may die due to handling disturbance (pers. comm., Pete Thayer 2016). Based on the Seafood Watch Unknown Bycatch Matrix, fishing mortality for unknown benthic invertebrates caught with dredge gear is typically considered a “high” concern (see Appendix 2 in the Seafood Watch Wild Fisheries Assessment Criteria). But the dredges used in the blue mussel fishery are restricted in size and bycatch is considered low, due to the selective targeting of mussels. Given the characteristics of the gear and fishery, impacts to unknown invertebrates are considered of “moderate" concern".

2.3 Discard Rate/Landings

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand dredges

< 100%

The discard level for the blue mussel drag fisheries is unknown. The average discard rate for other dredge fisheries (based on whelk, scallop, and clam fisheries) is 24.8% (Kelleher 2005). There is no bait used in the fishery. The ratio of discards plus bait to landings is likely < 100%.

Northwest Atlantic | United States | Maine | Hand implements

Northwest Atlantic | United States | Massachusetts | Hand implements

Northwest Atlantic | United States | New York | Hand implements

Northwest Atlantic | United States | Rhode Island | Hand implements

< 100%

When fishing with hand rakes, most non-target species are returned to the habitat unharmed, so effects on non-target species are negligible; therefore discards are < 100%.

Criterion 3: Management Effectiveness

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

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

The Criterion 3 rating is determined as follows:

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

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

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

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

Criterion 3 Summary

Fishery	Management Strategy And Implementation	Bycatch Strategy	Scientific Research And Monitoring	Enforcement Of Management Regulations	Stakeholder Inclusion	Score
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**

Fishery	Management Strategy And Implementation	Bycatch Strategy	Scientific Research And Monitoring	Enforcement Of Management Regulations	Stakeholder Inclusion	Score
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**

Fishery	Management Strategy And Implementation	Bycatch Strategy	Scientific Research And Monitoring	Enforcement Of Management Regulations	Stakeholder Inclusion	Score
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**

Criterion 3 Assessment

Scoring Guidelines

Factor 3.1 - Management Strategy and Implementation

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

Factor 3.2 - Bycatch Strategy

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

Factor 3.3 - Scientific Research and Monitoring

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

Factor 3.4 - Enforcement of Management Regulations

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

Factor 3.5 - Stakeholder Inclusion

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

3.1 Management Strategy And Implementation

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Maine | Hand implements

Moderately Effective

In Maine, the Department of Marine Resources (MDMR) is responsible for the management of the blue mussel fishery. Regulations for blue mussels were first put in place in 1988 by MDMR and were implemented as an effort to protect the wild populations from the growing aquaculture industry (MDMR 2022). There is current management in place to regulate the commercial and recreational fishing of blue mussels. A license is required to commercially fish for blue mussels, and fishers must tag mussels with the following information: fisher's name, license number, date and time of catch, location of catch, and quantity of mussels. Landings of blue mussels cannot be combined with other shellfish (MDMR 2009a)(MDMR 2022).

Regulations restrict mussel drags to have a maximum width of 198 cm, and fishing is prohibited with any gear type between sunset and sunrise (MDMR 2009b)(MDMR 2022). Wild mussels can be fished all year by mussel dredge or hand rake, but the majority of fishing occurs in the winter when the meat quality is at its best (MDMR 2022). There is currently no daily or annual catch limit for participants who fish by hand or with a drag (pers comm Thayer, P. 2016)

Although some management is in place, there have been reported declines of blue mussels in Maine and further monitoring is needed. There are no stock assessments or data-limited assessments, and abundance and fishing morality are unknown, as are their reference points. Due to this, and because it is unlikely that the fishery is having serious negative impacts on the Maine blue mussel population, management strategy and implementation is scored as “moderately effective".

Supplementary Information

In Maine, to reduce conflict between the wild mussel fishery and the growing aquaculture industry, the Maine Department of Marine Resources

designated four “seed conservation areas” from which only seed-size mussels can be taken for grout (MDMR 2016a). To remove any mussels from the conservation areas, a permit issued by MDMR is required (*ibid*).

The Shellfish Management Program of DMR oversees mussels and DMR has made it a priority to better evaluate the resource. Below there are several programs that monitor aspects of the mussel and other shellfish fisheries in the state of Maine (Mateo 2017)(MDMR 2022b):

- **Growing Area Program: Biotoxin** - Monitors levels of PSP (“Red Tide”) and other marine biotoxins in Maine shellfish
- **Growing Area Program: Water Quality** - Monitors the water quality at Maine shellfish flats and conducts shoreline surveys to identify sources of pollution
- **Volunteer Programs** - water quality and phytoplankton monitoring
- **Shellfish Dealer Certification and Inspection** - Evaluates and certifies Maine wholesale shellfish dealers
- **Nearshore Marine Resources Program** - Municipal shellfish co-management, state-level management of mussels, marine worms, periwinkles, whelks, subtidal resources, and seaweed
- **Environmental Permit Review** - Conducts/coordinates environmental impact reviews for permits and projects in the coastal zone.

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand implements

Moderately Effective

In Massachusetts, a commercial shellfish permit is required to commercially fish for blue mussels, and permits cannot be transferred (MADMF 2024). In Massachusetts, each town that borders coastal waters has the authority to control and regulate the taking of any kind of shellfish, including mussels (MSOA 2024). Town regulations may include but are not limited to daily limits, size limits, gear restrictions, and temporary and seasonal closures. The Massachusetts Division of Marine Fisheries (MADMF) does have the authority to regulate shellfish taken from contaminated areas (MADMF 2024).

In Massachusetts, there are no stock assessments or data-limited assessments, and abundance and fishing morality are unknown, as are their reference points. Management effectiveness is uncertain due to the lack of monitoring of the blue mussel population, but there is no evidence of declines or overfishing, and some management strategies are in place. Hence, Management Strategy and Implementation is deemed “moderately effective".

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | New York | Hand implements

Moderately Effective

In New York, blue mussel fishing is managed by the New York Department of Environmental Conservation (NYSDEC). A state permit is required to catch blue mussels by hand (typically with a bull rake) and occasionally a town permit is needed as well, depending on the town (NY State Law 2016). A specific permit is required to catch blue mussels with a dredge/drag (pers comm O'Dwyer, J. 2016). For the commercial fishery, there is a daily limit of 15 bushels per person per day and 30 bushels per boat per day for blue mussels caught with a dredge, but no limit in place for mussels caught by hand (NY State Law 2016)(NYSDEC 2023). For the recreational fishery, there is limit of one half bushel per day (NYSDEC 2023). Shellfish are allowed to be fished year-round, but fishing is restricted to daylight hours and can only occur in designated shellfish areas (NYSDEC 2023).

In New York, there are no stock assessments or data-limited assessments, and abundance and fishing morality are unknown, as are their reference points. Management effectiveness is uncertain due to the lack of monitoring of the blue mussel population, but there is no evidence of declines or overfishing. Hence, Management Strategy and Implementation is deemed “moderately effective.”

Northwest Atlantic | United States | Rhode Island | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand implements

Moderately Effective

In Rhode Island, blue mussel fishing is managed by the Rhode Island

Department of Environmental Management (RIDEM) with advice from the Rhode Island Marine Fisheries Council (CRC 2014)(RIDEM 2024b). Mussels are commercially fished with either hand gear (bull rake) or with a mussel drag (dredge). A specific permit is required to use a mussel drag, and only a small number of fishers currently use this gear type in Rhode Island. A comprehensive Shellfish Management Plan was developed in 2014 by state agencies, the fishing industry, and stakeholders (CRC 2014). This plan established a number of Shellfish Management Areas to help conserve and rebuild shellfish resources. These include the following: Greenwich Bay, Conimicut Point, Potowomut, High Banks, Bissel Cove/Fox Island, Mill Gut, Bristol Harbor, Kickemuit River, Jenny's Creek, Sakonnet River, Pt. Judith Pond, Potter Pond, Ninigret (Charlestown) Pond, Quonochontaug Pond, and Winnapaug Pond (see map below) (RIDEM 2024b). For commercial blue mussel fishing, there is a limit of 3 bushels within Shellfish Management Areas (with the exception of a 12-bushel limit within Conimicut Point Management Area) and no limit outside of the management areas. For the recreational fishery, within shellfish management areas there is a 1 peck limit (4 pecks = 1 bushel) for RI residents and a half peck limit for nonresidents . Outside of shellfish management areas, there is a half bushel limit for RI residents and a 1 peck limit for non-residents (CRC 2014). Fishing is open year round in most Shellfish Management Areas, with the exception of Bissel Cove/Fox Island and Mill Gut, which are closed for blue mussel fishing from May–November (RIDEM 2024b).

In Rhode Island, there are no stock assessments or data-limited assessments, and abundance and fishing morality are unknown, as are their reference points. Management effectiveness is uncertain due to the lack of monitoring of the blue mussel population, but there is no evidence of declines or overfishing. Hence, Management Strategy and Implementation is deemed "moderately effective".

Supplementary Information

Figure 3: The red shaded areas represent the Shellfish Management Areas in Rhode Island, the yellow shaded areas represent quahog spawner sanctuaries, and the red-striped areas represent shellfish prohibited areas due to pollution issues (as of 2014). Image from (CRC 2014).

3.2 Bycatch Strategy

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand dredges

Moderately Effective

In all regions, mussels form dense beds that allow fishers to selectively target mussels. Mussel drags (dredges) are typically deployed directly on a mussel bed and then dragged to remove the mussels from the water in large quantities. Bycatch in mussel dredge fisheries is believed to be low, but some non-target invertebrates that live within the mussel beds are scooped up (benthic invertebrates such as worms, sea urchins, crabs, and starfish), and could be crushed by the gear or die due to handling disturbance (Mesher and Doidge 1995). In Rhode Island, when fishing for mussels, any scallops, oysters, and quahogs that are caught must be released (CRC 2014).

The Gulf of Maine blue mussel dredge fishery is classified as a Category III Fishery (remote likelihood of/no known interactions) in terms of possible interactions with marine mammals by the National Marine Fisheries Service (NOAA 2019). Because bycatch is likely low in the mussel dredge fisheries, no ETP species are likely caught, but impacts to non-target species may not be negligible, management of bycatch is considered “moderately effective".

Northwest Atlantic | United States | Maine | Hand implements

Northwest Atlantic | United States | Massachusetts | Hand implements

Northwest Atlantic | United States | New York | Hand implements

Northwest Atlantic | United States | Rhode Island | Hand implements

Highly effective

In all regions, blue mussels form dense beds that allow fishers to selectively target them. Therefore, bycatch in blue mussel fisheries is generally low. When fishing with hand rakes, impacts to non-target species are considered negligible because any bycatch species can typically be returned to the habitat unharmed. Following the Seafood Watch Fisheries standard, the gear type is considered as highly selective since bycatch is

low. Because of negligible bycatch impacts in the hand rake fisheries, management of bycatch is deemed “highly effective".

3.3 Scientific Research And Monitoring

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Maine | Hand implements

Moderately Effective

In Maine, commercial catches of blue mussel are monitored, but there has been little effort to date by the management agency to assess the abundance of the blue mussel population. In Maine, the only full population assessment was completed in the late 1970s from the Damariscotta River Estuary to Jonesport (MARITEC 1978)(pers comm Thayer, P. 2016). In the 1980s and 1990s, there were some aerial photo surveys and field sampling conducted by the Maine Department of Marine Resources to assess the seed mussel conservation areas prior to permitting seed harvest each year.

More recently, there was an independent scientific study that compared recent blue mussel abundance estimates in the Gulf of Maine to historical estimates (Sorte et al. 2016). This study found declines at all studied sites, indicating that further monitoring is needed to ensure the health of the blue mussel population.

Because only limited data on blue mussels are currently collected and there are no indicators that can be fully evaluated every year and updated annually., but some efforts are underway to improve monitoring, this factor is deemed “moderately effective".

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand implements

Moderately Effective

In the state of Massachusetts, there are efforts currently underway to

summarize the population status of blue mussels and the commercial fishery (pers comm Shields, T. 2016). For example, the Center for Coastal Studies recently completed shellfish surveys in Pleasant Bay, Massachusetts to establish a baseline of shellfish abundance and to develop replicable survey methods (Nichols and Grieco 2018). This research was conducted following the per the advice of the Massachusetts Division of Marine Fisheries--which suggested that comprehensive studies of shellfish fisheries in Pleasant Bay be repeated at least every ten years (Macfarlane 2002). Because some data related to stock abundance are collected and analyzed, a "moderately effective" score is awarded.

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | New York | Hand implements

Moderately Effective

In New York, there have been little to no efforts to track the population trends of blue mussel because of their assumed healthy distribution and low fishing effort (NYSDEC 2005)(pers comm Carden, W. 2023). However, commercial catches of blue mussel are monitored. Given the quite limited scientific monitoring, but low fishing effort and management in place, research and monitoring is deemed “moderately effective".

Supplementary Information

NYSDEC does not have any formal program to track blue mussel population trends; however, they do have an annual marine biotoxin monitoring program that relies on harvest from wild blue mussel populations each April to stock bags that are deployed at monitoring stations to serve as sentinels for toxin-producing Harmful Algal Blooms (HABs) of species like *Alexandrium fundyense* (red tide) (pers comm Carden, W. 2023)(NYSDEC 2024). The program knows of several areas that are reliably productive to harvest blue mussels for this purpose. The description of fishing effort (low) and abundance (assumed high) remains valid (pers comm Carden, W. 2023).

Northwest Atlantic | United States | Rhode Island | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand implements

Moderately Effective

There have not been any efforts in Rhode Island to evaluate the blue mussel population, and at this time, the only reliable catch information available is in value rather than quantity. Because the fishery is considered to have quite low fishing effort, there has not been a demand or need for management to evaluate the population of blue mussels. Recent shellfish research efforts have been in regard to the growing aquaculture industry in Narragansett Bay, to evaluate shellfish disease and growing methods (CRC 2014)(RIDEM 2024c). But, there is some spatial management in place in Rhode Island to conserve wild blue mussels.

Given the quite limited scientific monitoring and spatial management, but low fishing effort and management in place, research and monitoring is deemed “moderately effective".

3.4 Enforcement Of Management Regulations

Northwest Atlantic | United States | Maine | Hand dredges
Northwest Atlantic | United States | Massachusetts | Hand dredges
Northwest Atlantic | United States | New York | Hand dredges
Northwest Atlantic | United States | Rhode Island | Hand dredges
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | Rhode Island | Hand implements

Moderately Effective

In all states, there is enforcement at the state and town level to ensure that fishers comply with regulations.

In Maine, enforcement of the commercial and recreational shellfish fishery is conducted by state officers, including Marine patrol and other law enforcement officers (pers comm Thayer, P. 2016). The Marine Patrol is the division of Maine Department of Marine Resources (MDMR) that is responsible for law enforcement on the state’s coastal waters (MDMR 2016d). Management of Maine’s shellfish resources including wild mussels

is a joint responsibility between the state and its municipalities. A municipality that enacts a shellfish ordinance is responsible for enforcing it. For that, a municipal shellfish conservation warden is appointed by a municipality to enforce the provisions of shellfish management A certified municipal shellfish conservation warden enforces the shellfish ordinances of the municipality and may arrest all violators. A town warden also has, within that warden's jurisdiction, the powers of a marine patrol officer and may arrest all violators. A license is required to commercially fish for blue mussels, and fishers must tag mussels with the following information: fisher's name, license number, date and time of catch, location of catch, and quantity of mussels (MDMR 2009a)(MDMR 2016a).

In the state of Massachusetts, enforcement of commercial and recreational shellfish fishing is conducted by state officers from the Division of Marine Fisheries as well as town officers. In Massachusetts, each city or town that borders coastal waters has the authority to control and regulate the taking of any kind of shellfish, including mussels (MSOA 2024). A commercial shellfish permit is required to commercially fish for blue mussels, and permits cannot be transferred (MADMF 2016a).

In Rhode Island, the Division of Law Enforcement Marine Unit is responsible for providing patrol and enforcement of recreational and commercial fishing, shellfishing, and lobster laws and regulations (RIDEM 2024). The Marine Unit is divided into two units: Marine East and Marine West. Officers assigned to the Marine East unit cover territory from Greenwich Bay north and over to the East Bay. Officers assigned to Marine West cover territory south of Greenwich Bay, including Jamestown. Each unit is lead by a Lieutenant and a Sergeant. They are responsible for patrolling the fishing ports along Rhode Island's coast, including Pt. Judith, which is one of the largest ports in the Northeast. Marine officers provide security for Marine Safety Zones, as well as for emergency closures for fishing and shellfishing (RIDEM 2024). A specific permit is required to use a mussel drag, and only a small number of fishers currently use this gear type in Rhode Island.

In New York, the Department of Environmental Conservation is responsible for the enforcement of regulations (NYSDEC 2016e). NYSDEC's Division of Law Enforcement (DLE) has partrol requirements for all shellfish harvest areas, as mandated by the National Shellfish Sanitation Program's Model Ordinance administered by the US Food & Drug Administration. A specific

permit is required to catch blue mussels with a dredge/drag (pers comm O'Dwyer, J. 2016). When DLE encounters shellfish harvesters on patrol, they routinely check for valid permits and compliance with size and catch limits. In NY, wild harvest of hard clams (*Mercenaria mercenaria*) is the main shellfishery and harvest by mechanical means (*i.e.*, dredges) on public bottom is prohibited. Therefore, the relatively small number of blue mussel harvesters may be subject to greater scrutiny by DLE since they are using gear that is prohibited in another shellfishery (pers comm Carden, W. 2023) . In addition, local towns may require a town permit for shellfish fishing, and have town officers to enforce local and regional regulations (NYSDEC 2015a)(NYSDEC 2024b).

Because there is regular enforcement of regulations, but effectiveness and compliance are uncertain, enforcement is deemed “moderately effective".

3.5 Stakeholder Inclusion

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Maine | Hand implements

Highly effective

In Maine, the Shellfish Advisory Council includes 13 members who have various stakeholder interests in the shellfish fishery. The council consists of four commercial shellfish license holders, two aquaculture lease holders, one member from the wastewater treatment systems, two licensed seafood dealers, one public member, two shellfish wardens, one member with a shellfish depuration certificate, andone member who has a demonstrated knowledge of biological science and holds, at a minimum, a bachelor's degree. The council meets at least once a year (typically three times) to discuss shellfish issues and make recommendations to managers as necessary (Maine Legislature 2016). The meetings are open to the public and allow for public input on the topics discussed. Stakeholder inclusion is considered “highly effective".

Supplementary Information

The state of Maine’s legal system allows individuals access to redress

The state of Maine's legal system allows individuals access to courses through the courts for unresolved disputes over fishery regulations or policy decisions. In the case of license suspensions or revocations, a hearing before the Commissioner can be received. He may reinstate the license or certificate or reduce the suspension period if he is satisfied that to do so would be in the best interests of justice, except that he may not reduce suspensions set by statute. The national regulation incorporates a suitable system, both in the administrative field as well as the judicial for the appropriate resolution of any conflicts (Maine Legislature 2016).

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand implements

Moderately Effective

The Shellfish Advisory Panel (SAP) was formally established by the Massachusetts legislature in 2021 (Commonwealth of Massachusetts 2024). The panel provides communication between the Commonwealth of Massachusetts and members of the shellfish community on matters related to shellfish resources and fisheries. It includes a diverse mix of stakeholders from throughout the state, including state government officials, recreational and commercial harvesters, seafood dealers and processors, aquaculturists, researchers, conservationists, and municipal shellfish officials (*ibid*).

Specifically, the Panel meets at least two times annually to address ongoing matters of importance and emerging issues related to shellfish resources, fisheries, and management. SAP membership includes eight legislatively appointed officials from state government or their designees (*ibid*).

Because there is no information on stakeholder conflict resolution or transparency, a score of “moderately effective” is given.

Supplementary Information

Appointed officials included the DMF Director, who serves as the Chair; the Commissioners from the Department of Agricultural Resources and Dept of Environmental Protection; the Directors of the Office of Coastal Zone Management and the Dept of Public Health'y Food Protection

Program; the Executive Director of the Commission on Indian Affairs; and the House and Seante Chairs of the Joint Committee on Environment, Natural Resources, and Agriculture (Commonwealth of Massachusetts 2024).

Additionally, there are 14 members from Massachusetts' shellfish community. These members are appointed by the DMF Director for three-year terms and may be reappointed. The statute requires they include: a member of the National Sea Grant College Program; two retail or wholesale shellfish dealers; three commercial fishermen, one involved in a state-managed wild harvest shellfish fishery and two involved in a municipally managed wild harvest shellfish fishery; three aquaculturists; one recreational shellfish fisherman; two municipal shellfish constables nominated by the Massachusetts Shellfish Officers Association; a representative from the Marine Fisheries Advisory Commission; and a member of the shellfish conservation community (*ibid*).

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | New York | Hand implements

Moderately Effective

In New York, there is the Marine Resource Advisory Council (MRAC) that was established in 1987 to advise the Department of Environmental Conservation (NYSDEC) on marine resource issues, including commercial and recreational fishing regulations and protection (NYSDEC 2024a). The MRAC holds meetings to present information and answer questions regarding current marine resource issues, including shellfish (NYSDEC 2024a). The council is made up of 15 people including 7 commercial fishing representatives, 7 recreational fishing representatives, and the Director of the Marine Science Research Center from SUNY Stony Brook (NYSDEC 2024a). During a calendar year, the Marine Resources Advisory Council holds seven regularly-scheduled meetings: January, March, April, May, July, September, and November. These meetings are supplemented with extraordinary meetings as occasion and circumstances warrant (MRAC 2024), and are open to the public.

There is also a Shellfish Advisory Committee that meets twice a year to discuss shellfish issues specifically and includes state and town representatives, baymen's associations representatives, and members of

nonprofit organizations (pers comm O'Dwyer, J. 2016). The Department of Environmental Conservation lists meetings open to the public and information about any proposed regulations on their website (NYSDEC 2024c). In addition, because shellfish are also managed at the town level, town meetings are occasionally held to present current regulations and issues. For example, the town of Southold, NY has an individual Shellfish Advisory Committee that represents members of the town before the state (Southold Town Hall 2024).

Because it is unclear whether there is a mechanism in place to resolve stakeholder conflicts, however, this factor is scored as “moderately effective”.

Northwest Atlantic | United States | Rhode Island | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand implements

Moderately Effective

In Rhode Island, the Shellfish Advisory Panel is a division of the Rhode Island Marine Fisheries Council (RIMFC) and includes members with various stakeholder interests in the shellfish industry. All meetings by the RIMFC are open to the public and include a period for public comment. Prior to meetings, the RIDEM gives notice of intent to hold the hearing to provide the opportunity for public comment (RIDEM 2016a).

Because it is unclear whether there is a mechanism in place to resolve stakeholder conflict, and it is unknown if decisions are transparent, stakeholder inclusion is considered “moderately effective".

Criterion 4: Impacts on the Habitat and Ecosystem

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

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

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Fishery	Impact of Fishing Gear on the Habitat/Substrate	Modifying Factor: Mitigation of Gear Impacts	Ecosystem-based Fisheries Management	Score
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 2	+.5	Moderate Concern	**Yellow (2.739)**
Country: United States **Subdivision:** Maine **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 2	+.5	Moderate Concern	**Yellow (2.739)**
Country: United States **Subdivision:** Massachusetts **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**

Fishery	Impact of Fishing Gear on the Habitat/Substrate	Modifying Factor: Mitigation of Gear Impacts	Ecosystem-based Fisheries Management	Score
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 2	+.5	Moderate Concern	Yellow (2.739)
Country: United States **Subdivision:** New York **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 3	Score: 0	Moderate Concern	Yellow (3.000)
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand dredges **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 2	+.5	Moderate Concern	Yellow (2.739)
Country: United States **Subdivision:** Rhode Island **Body of Water:** Northwest Atlantic Ocean **Gear:** Hand implements **Flag Country:** United States **FAO Major Area:** Atlantic, Northwest	Score: 3	Score: 0	Moderate Concern	Yellow (3.000)

Criterion 4 Assessment

Scoring Guidelines

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

Goal: The fishery does not adversely impact the physical structure of the

ocean habitat, seafloor or associated biological communities.

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

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

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

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*

- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management

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

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

4.1 Impact of Fishing Gear on the Habitat/Substrate

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand dredges

Score: 2

A mussel drag or dredge is a framed mouth with an attached bag to collect mussels. It is dragged by a boat along the ocean bottom (MDMR 2016a). Along the bottom of the framed mouth is a cutting bar or chain sweep to loosen mussels while the dredge is pulled across the bottom, and mussels are dislodged and accumulate in the bag (MDMR 2016a). Mussel dredges are small, restricted in size, and not hydraulic, so they have less of an impact on the bottom habitat and substrate compared to other dredging gear (Smolowitz 1998)(Sowles 2011). The majority of fishing for blue mussels with dredges occurs over intertidal and subtidal mudflats in nearshore bays, where the bottom sediment is mostly mud; however, some sediment also has sand and shells mixed within the mud. These portions of muddy nearshore bays may be adjacent to and interspersed with eelgrass (Moore and Atherton 2005)(Neckles et al. 2005).

Dredging can cause disturbances to bottom plants and animals, decreases in water quality, overfishing of adult mussels and seed mussels, and alterations to bay drainage, and can lead to a loss of food for birds and other organisms that depend on mussels {Arter 2007}. Mussel dredges can be especially harmful to sensitive habitats, such as horseshoe crab wintering areas, kelp beds, eelgrass beds, aquaculture leases, and where there are intake or outflow pipes (Sowles 2011). In the past, because of the habitat overlap of blue mussels and eelgrass, dredging has caused damage to eelgrass beds in regions such as Maquoit Bay, Maine {Neckles et al. 2005}. There was a growing concern about the impacts of dredging on eelgrass beds in Maquoit Bay, so a study was commenced in 2000 to identify these effects using aerial surveys, underwater video, and

measurements of eelgrass. The study showed that dredging for blue mussels in Maquoit Bay, Maine in the 1990s left scars on eelgrass beds and did affect the eelgrass populations. It was found that mussel dredges can uproot eelgrass plants and that it would take 11–20 years for dragged areas to completely recover (USGS 2005)(Neckles et al. 2005). As a result, in 2007, the Maine Department of Marine Resources (MDMR) initiated research with the fishing industry to identify and protect habitat areas that are sensitive to the effects of mussel dredges (MDMR 2009a) (Sowles 2011).

Mussel dredge gear receives a score of “2” for this factor because most fishing today occurs over soft-bottom mud habitats.

Northwest Atlantic | United States | Maine | Hand implements

Northwest Atlantic | United States | Massachusetts | Hand implements

Northwest Atlantic | United States | New York | Hand implements

Northwest Atlantic | United States | Rhode Island | Hand implements

Score: 3

Blue mussels can be fished by hand with the use of a rake, and most commonly with a bull rake. A bull rake is a relatively heavy and robust rake weighing 8–11 kg with a metal basket at the end. The basket has a rectangular opening with teeth extending outward along the lower portion of the basket. Hand raking for blue mussels occurs in intertidal shallow zones. As the rake is pulled along the sediment, the mussels are forced into the basket, and when heavy, the rake is removed from the water (Peterson et al. 1983). There are no known studies on the effects of hand rakes on mussel beds, but there have been studies conducted on the effects of fishing with clam rakes and oyster tongs on oyster reefs (Lenihan and Micheli 2000), which produce similar habitats and substrate as mussel beds. One study reported that fishing with clam rakes and oyster tongs reduced the densities of living oysters by 50%–80% compared to densities of unfished oyster reefs (Lenihan and Micheli 2000). A subsequent study showed that the use of hand tongs (a fishing method similar to hand rakes) decreased the height of oyster reef habitats by 23% (Lenihan and Peterson 2004). Hand rake gear receives a score of “3” for this factor.

4.2 Modifying Factor: Mitigation of Gear Impacts

Northwest Atlantic | United States | Maine | Hand dredges

+.5

In Maine, there have been studies conducted on the effects of mussel dredges on the habitat; as a result, closures have been put in place to protect sensitive habitats such as eelgrass beds (MDMR 2009a). The 2007 study by the Maine Department of Marine Resources (MDMR) concluded that dragging is acceptable if the fishery is controlled to protect sensitive habitat areas and non-target resources and to allow for sustainable fishing of blue mussel (Sowles 2011).

In Taunton Bay, Maine, there are multiple general shellfish closures in place, including areas closed to dredging for blue mussels. Additionally, in the Taunton Bay Management Area (TBMA), a dredge plan must be submitted and approved by the Commissioner prior to fishing for mussels (MDMR 2012). In TBMA, mussel dredging is prohibited in areas that are considered "sensitive areas," which include but are not limited to horseshoe crab wintering areas, kelp beds, eelgrass beds, aquaculture leases, and intake or outflow pipes (*ibid*).See Figure 4 in the following "Justification" section for a map of no fishing areas in the TBMA. There are also other areas closed to any fishing of mussels (*ibid*).

Additionally, because hand mussel dredges are small and restricted in size (MDMR 2024), they have less of an impact on the bottom habitat and substrate compared to other dredging gear, such as a scallop dredge (Sowles 2011). Because logic tells us that the impact of hand dredges is less than mechanized dredges, but there is no specific study that says that the impact of these hand dredges are better for the ecosystem (and hence we do not know the impact of hand dredges on the biogneic habitat), mitigation is considered moderate and "+0.5" points is awarded.

Supplementary Information

The state of Maine has seed mussel conservation areas designed to

protect unique mussel areas (MDMR 2009a). The selection of these areas is based on geography, density, population size distribution, subjection to winter mortality and condition (MDMR 2012). These areas include Jordan River, Trenton/Lamoine; West Bay, Gouldsboro; Narraguagus Bay, Milbridge/Harrington; and Harrington River, Milbridge/Harrington (*ibid*).

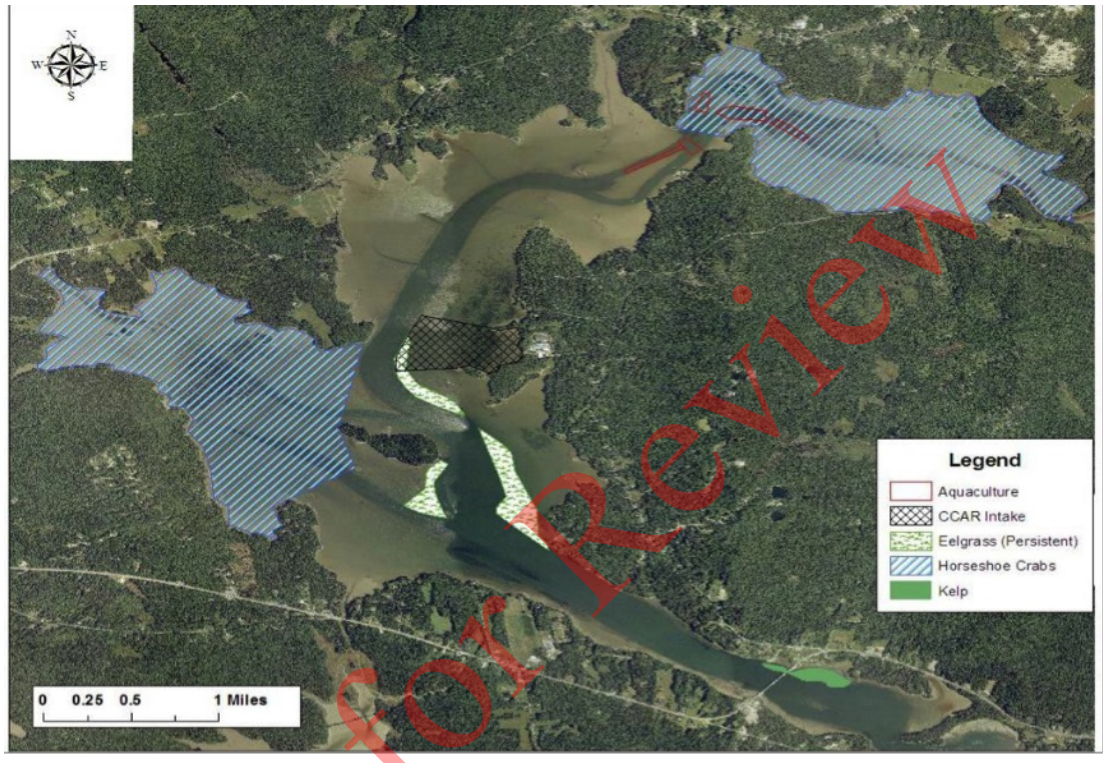

Figure 4: The no-fishing areas for mussel dragging in Taunton Bay Management Area. The eelgrass areas plotted are where persistent eelgrass beds are found. Map from (MDMR 2012).

It is important to note that dragging or raking mussels may selectively remove large and predator resistant mussels (pers comm Steneck, R. 2023).

Northwest Atlantic | United States | Maine | Hand implements

Northwest Atlantic | United States | Massachusetts | Hand implements

Northwest Atlantic | United States | New York | Hand implements

Northwest Atlantic | United States | Rhode Island | Hand implements

Score: 0

There are a few areas closed to any fishing of mussels, including with the

use of hand gear. For instance, there are several permanent and temporary closures in place for sanitation reasons. In Rhode Island, some of the designated Shellfish Management Areas are closed to commercial fishing between May and November each year (CRC 2014). Because the areas closed to blue mussel hand rake fishing are unlikely to cover 20% of all representative blue mussel habitats, no mitigation points are awarded.

Northwest Atlantic | United States | Massachusetts | Hand dredges

+.5

There is no available information on the intensity of hand mussel dredge fishing in Massachusetts.

Because logic tells us that the impact of hand dredges is less than mechanized dredges, but there is no specific study that says that the impact of these hand dredges are better for the ecosystem (and hence we do not know the impact of hand dredges on the biogneic habitat), mitigation is considered moderate and “+0.5” points is awarded.

Northwest Atlantic | United States | New York | Hand dredges

+.5

In New York, blue mussels can be taken with dredge gear in the following areas: in Long Island Sound east of a line from Herod Point on Long Island including the waters surrounding Fishers Island; the Atlantic Ocean easterly of a line south from the rock jetty on the east side of Shinecock Inlet; and in the bays east from the town of Riverbed to and including Block Island Sound {New York State Law 2016}.

In New York, fishing intensity with the use of hand mussel dredges is relatively low. During 2014–2016, only nine dredge permits were issued each year (pers comm O'Dwyer, J. 2016). In New York, mussel dredges are restricted in size and cannot exceed 91 cm in width (NY State Law 2016).

Because logic tells us that the impact of hand dredges is less than mechanized dredges, but there is no specific study that says that the impact of these hand dredges are better for the ecosystem (and hence we do not know the impact of hand dredges on the biogneic habitat),

mitigation is considered moderate and “+0.5” points is awarded.

Northwest Atlantic | United States | Rhode Island | Hand dredges

+.5

In Rhode Island, a specific dredging permit is required to fish with a mussel drag. In certain areas, there are additional regulations in place to restrict the times when mussel dredges can be used. Some Shellfish Management Areas are designated to be open year-round, while some areas closed to commercial harvest between May and November each year and opened from December–April (CRC 2014).

Specifically, in Bissel Cove/Fox Island, Mill Gut, and Bristol Harbor, blue mussel fishing with a dredge is only allowed from the second Wednesday of December to April 30th annually. Areas other than Shellfish Management Areas are open daily for blue mussel fishing unless specifically closed for pollution or other management purposes (RIDEM 2024). Additionally, because mussel hand dredges are small (not exceeding 71 cm in width), they have less of an impact on the bottom habitat and substrate compared to other dredging gear, such as a scallop dredge (Sowles 2011).

Because logic tells us that the impact of hand dredges is less than mechanized dredges, but there is no specific study that says that the impact of these hand dredges are better for the ecosystem (and hence we do not know the impact of hand dredges on the biogenic habitat), mitigation is considered moderate and “+0.5” points is awarded.

4.3 Ecosystem-based Fisheries Management

Northwest Atlantic | United States | Maine | Hand dredges

Northwest Atlantic | United States | Massachusetts | Hand dredges

Northwest Atlantic | United States | New York | Hand dredges

Northwest Atlantic | United States | Rhode Island | Hand dredges

Northwest Atlantic | United States | Maine | Hand implements

Northwest Atlantic | United States | Massachusetts | Hand implements

Northwest Atlantic | United States | New York | Hand implements

Northwest Atlantic | United States | Rhode Island | Hand implements

Moderate Concern

Blue mussels are considered ecosystem engineers, because they form dense beds that act as shelter and substrate for a diversity of invertebrate species in the intertidal regions where they are found (Arribas et al. 2014). These beds provide settlement substrate for other marine species including hydroids, bryozoans, and sponges. They also provide a refuge from predation and physical stressors for many species (Altieri and Witman 2006){Pertness 2007}(Borthagaray and Carranza 2007). In fact, blue mussel abundance has been found to be positively correlated to overall species richness (Borthagaray and Carranza 2007)(Sorte et al. 2016).

Blue mussels are also an important food source for many bottom feeders (NEFMC 2011). A recent study showed that as blue mussels have declined at certain sites in the Gulf of Maine over the past 40 years, there have been other associated community level changes (Sorte et al. 2016). Specifically, the study found an increase in competitors of blue mussel (barnacle, *S. balanoides*) and decrease in predator species (whelk, *N. lapillus*) as the blue mussel has become less dominant in these areas (Sorte et al. 2016).

Further, the blue mussel's function as a filter feeder is an ecologically important role in the ecosystem. As blue mussels filter out plankton from the seawater for food, this helps to clean bacteria and other organic matter from the water column (Bayne 1983). Mussel beds also provide shoreline protection by reducing wave strength and slowing shoreline erosion (CRC 2014).

Limited policies are in place to protect the ecological role of blue mussels, but in recent years states have been making some strides to evaluate and move toward ecosystem-based approaches. A 2011 study was recently completed by the Maine Department of Marine Resources (MDMR) in Taunton Bay to test an ecosystem-based management model and to potentially help inform future ecosystem approaches; as a result of this study, mussel dragging was prohibited in identified sensitive areas of

Taunton Bay (Sowles 2011). Rhode Island has developed a comprehensive Shellfish Management Plan, which describes the ecological importance of shellfish species, including mussels, and designates Shellfish Management Areas to promote the conservation and restoration of shellfish populations. Shellfish Management Areas have reduced daily limits, and some areas have limited access (CRC 2014). New York and Massachusetts have developed Ocean Management Plans that seek to utilize an ecosystem- based approach to sustainably manage resources in their state waters {NYSEDEC 2015b}(MAEEA 2016).

Because the removal of blue mussels due to fishing is likely to affect food webs and the ecosystem as a whole, but some ecosystem/spatial management initiatives have been developed and fishing levels on blue mussels are low in most states, the overall impact is scored as “moderate” concern.

Acknowledgements

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

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Appendix A: Updates to Blue Mussel Report

Updates to the November 20, 2019 Blue Mussel report were made on June 13, 2024:

There were no stock status or management updates made to the existing report due to lack of information.

Updates to the January 9, 2017 Blue Mussel report were made on November 20, 2019:

Overall Recommendations for blue mussel caught in Massachusetts DID NOT change, but the management score (C3) did improve from Ineffective to Moderately Effective. There were no other significant stock status or management updates to the other fisheries in this report. Details for Massachusetts outlined below:

Updates included:

- C3.3 (Scientific Research and Monitoring): Upgraded from Ineffective to Moderately Effective. Scoring and Summary changed. This changed the overall management score.