Monterey Bay Aquarium
Seafood Watch

Environmental sustainability assessment of wild-caught northern quahog and softshell clam from the United States caught using hand implements

Species:	Northern quahog (*Mercenaria mercenaria*), Softshell clam (*Mya arenaria*)
Location:	United States: Northwest Atlantic
Gear:	Hand implements
Type:	Wild Caught
Author:	Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v3

Table of Contents

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- 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.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

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

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

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

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

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

Summary

This report provides recommendations for northern quahog (*Mercenaria mercenaria*) captured along the coasts of Maine, Massachusetts, New Jersey, New York, North Carolina, and Rhode Island in the Northwest Atlantic. In addition, recommendations are provided for softshell clam (*Mya arenaria*) caught along the coasts of Maine and Massachusetts. Fishers use rakes and other hand implements to target these species. The Atlantic surfclam and ocean quahog are not included in this updated report because those fisheries were certified as sustainable by the Marine Stewardship Council in 2016.

Northern quahog is found along the coasts in the Western Atlantic from the Gulf of St. Lawrence, Canada in the north to the Yucatan Peninsula, Mexico in the south, and have been introduced in other parts of the world. This clam primarily inhabits estuaries and shallow coastal areas to depths of about 15 meters (m). Most northern quahogs begin their lives as males and approximately half change to females. Though they can live up to 40 years, predation and harvest restrict the typical quahog lifespan to 4 to 8 years. Females release between 2 million and 25 million eggs, depending on their age (older quahogs produce more eggs), during spawning events in late spring and early summer when water temperatures increase and there is more food availability.

Although market conditions may lead to variations, commercial fisheries generally target clams at the following size classes (shell length): 38–55 mm (littlenecks), 56–76 mm (cherrystones), and >76 mm (chowders). Information on abundance and mortality is generally lacking, though populations in some states are better studied than others. Wild clam fisheries have diminished in recent years in favor of clam aquaculture. There are minimal issues with bycatch, and the ecosystem impacts from fishing are of low concern.

Softshell clam is managed by local municipalities in partnership with the state in both Maine and Massachusetts. In Maine, some of the clam beds under local jurisdiction are surveyed for softshell abundance, and biomass estimates are determined on a flat-by-flat basis upon the request of local governments. This information for specific clam flats cannot be scaled to provide a representation of the softshell clam stocks along the entire Atlantic Coast. Massachusetts does not conduct stock assessments for softshell clam.

None of the fisheries reviewed in this report have significant interactions with other species. The hand-harvest gears used to land northern quahog and softshell clam include rakes, hoes, and shovels; some clammers will use their hand to extract clams, in a method called "pulling." Hand-harvest methods are believed to result in negligible bycatch because hand-harvesting allows fishers to be highly selective of the species they harvest.

Stock assessments are generally not conducted for hard clams except for parts of Rhode Island and New Jersey, but local assessments to inform management are conducted by municipalities in New York because they control the harvest of shellfish in town waters. Catch per unit effort (CPUE) is monitored in other states, and landings have stabilized. Management of softshell clam stocks is delegated to local municipalities, while state-level government provides technical assistance and recommendations to local decision-makers. No statewide stock assessments on softshell clam are performed. This decentralized regulation system and the lack of a statewide stock assessment make it infeasible to determine whether local jurisdictions follow scientific advice, or their track record in maintaining stock abundance. Rakes, hoes, and shovels may affect intertidal and subtidal habitats, depending upon how much disturbance the habitat is subject to from wave, tidal, or current action.

Overall, northern quahog caught in New York, North Carolina, Massachusetts, New Jersey, and Maine is rated Yellow. Softshell clam caught in Massachusetts and Maine is also rated Yellow. Northern quahog caught in Rhode Island is rated Green.

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Northern quahog | Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery	3.413	5.000	5.000	3.000	**Best Choice (4.000)**	180 (MT) 2022
Northern quahog | Northwest Atlantic | United States | North Carolina | Hand implements	2.644	5.000	3.000	3.240	**Good Alternative (3.367)**	38 (MT) 2022
Northern quahog | Northwest Atlantic | United States | New York | Hand implements	2.644	5.000	3.000	3.000	**Good Alternative (3.303)**	553 (MT) 2022
Northern quahog | Northwest Atlantic | United States | New Jersey | Hand implements	2.644	5.000	3.000	3.000	**Good Alternative (3.303)**	Unknown
Northern quahog | Northwest Atlantic | United States | Maine | Hand implements	2.644	5.000	3.000	3.000	**Good Alternative (3.303)**	106 (MT) 2022
Northern quahog | Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery	2.644	5.000	3.000	3.000	**Good Alternative (3.303)**	246 (MT) 2022
Softshell clam | Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery	2.644	5.000	3.000	3.000	**Good Alternative (3.303)**	318 (MT) 2022
Softshell clam | Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery	2.644	5.000	3.000	3.000	**Good Alternative (3.303)**	569 (MT) 2022

From 2018 to 2022, an average of 655.4 mt and 315.2 mt of softshell clam were landed per year in Maine and Massachusetts, respectively (NMFS 2023c). For the same period, average northern quahog landings from NMFS for the states in this report were: 104 mt (Maine), 242 mt (Massachusetts), 686 mt (New York), and 192 mt (Rhode Island) (NMFS 2023c). New Jersey does not require the reporting of landings for harvested clams, so no information is available. North Carolina landings of northern quahog in 2022 were 4.4 million clams, or roughly 38 mt (NCDMF 2023).

Summary

Northern quahog caught in Maine, Massachusetts, New Jersey, New York, and North Carolina and softshell clam caught in Massachusetts and Maine earn a Yellow rating, because of a general lack of information on stock health and reference points, minimal bycatch concerns, moderately effective management, and moderate impacts to ecosystems. Northern quahog caught in Rhode Island earns a Green rating, because of more frequent data collection and better understanding of stock health, minimal bycatch concerns, highly effective management, and moderate impacts to ecosystems.

Scoring Guide

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

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

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

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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

Introduction

Scope of the analysis and ensuing recommendation

This report contains recommendations on two wild-caught clam species: northern quahog (hard clam) (*Mercenaria mercenaria*) and softshell clam (*Mya arenaria*). Gears evaluated in this report include hand rakes, tongs, shovels, and hoes for northern quahog and softshell clam. Farmed clams are not evaluated here. Although the distribution of some of these species includes regions outside the United States, only U.S. fisheries are covered in this report.

This is an updated report on the Atlantic Coast northern quahog fishery in the states of Maine, Massachusetts, New York, Rhode Island, New Jersey, and North Carolina, and the softshell clam fishery in Maine and Massachusetts. This update does not include the Atlantic surfclam and ocean quahog fisheries because the Marine Stewardship Council certified these fisheries as sustainable in 2016.

Species Overview

Northern quahog (*Mercenaria mercenaria*)

Northern quahog, which is commonly called hard clam, is found along the coast of the Western Atlantic from the Gulf of St. Lawrence, Canada to Florida, as well as in the Gulf of Mexico south to the Yucatan Peninsula, Mexico (Eversole 1987). Two species occur in the southern portion of its range (Rice 1992). The species has been introduced to California and Europe. Hard clam primarily occurs in estuaries and shallow coastal areas to depths to 15 m (Eversole 1987), tolerates a range of temperatures and salinities (Hill 2004), and requires adequate water circulation (NCDMF 2008).

Northern quahog are protandric hermaphrodites; most begin life as males and approximately half change to females (Hill 2004). These clams reach maturity at around 1.3 inches or at 1 to 3 years of age, depending on environmental factors, and the typical lifespan is between 4 and 8 years (Eversole 1987). Northern quahog may live up to 40 years without predation or harvest (Hill 2004). Fecundity increases with age and is positively correlated with size, and ranges from 0.8 million to 40 million eggs annually (Eversole 2001). Fertilization is external, with both sperm and eggs expelled through the excurrent siphon ring during late spring and early summer (Rice 1992).

Commercial fishers target clams at varying sizes, and size classes have distinct market and regulatory names. Littlenecks are often 38–55 mm in shell length, cherrystones are 56–76 mm, and chowders are larger than 76 mm, although these criteria may vary across states and dealers (Dacanay 2015). The growth rate is dependent on environmental factors, especially temperature and food availability with salinity, with the number of years to reach commercial size (minimum of 1 inch) ranging from 4 years in Maine to 3 years in Massachusetts, Rhode Island, North Carolina, and New York (Eversole 1987). In Maine, the state provides regulatory guidance (e.g., minimum size limits and gear restrictions), but several municipalities also have specific regulations and management plans. Massachusetts and New York also manage shellfish in partnership with municipalities, while hard clam management occurs at the state level in Rhode Island, North Carolina, Virginia, and New Jersey.

Softshell Clam (*Mya arenaria*)

Softshell clam occurs in intertidal zones, coastal ponds, and estuaries. Softshell clam is native to the United States East Coast, Japan, and Korea, but has spread extensively through human activity and is now found in Europe and the West Coast of the United States (Global Invasive Species Database 2012). Softshell clam

burrows 8–14 inches into mud, sand, and gravel intertidal areas, and is harvested from Labrador, Canada to North Carolina (Maine Sea Grant 2012). Softshell clam shells are fragile and easily broken, leading to various hand-harvest methods (Maine Sea Grant 2012). Because softshell clam occurs in intertidal zones and estuaries, it is managed by each state or local jurisdiction. U.S. landings of softshell clam peaked in 1969 at 6,115 metric tons (mt). From 1969 to 1996, landings declined, reaching a low of 967 mt in 1996. After 1996, landings steadily increased, except for another low in 2009 of 830 mt. Landings increased again in 2010 to 1,940 mt but have declined since to 1,265 mt in 2016 {NMFS 2018}. The value of softshell clam has increased over time, making it a valuable fishery. The majority of softshell clams, roughly 50% each year, are landed in Maine. Softshell clam is the second most valuable fishery in Maine, at $1,720,848 in 2010 {NMFS 2012}. Maine has one of the oldest municipal shellfish management programs in the country. Municipal shellfish management started in Maine in the 1820s and has been jointly managed with the state since the 1880s {pers. comm., Denis-Marc Nault 2012}. Massachusetts manages softshell clam fisheries at the community level with assistance and oversight from the state.

Production Statistics

Globally, capture of wild northern quahog has declined since the mid-20th century, while aquaculture production has increased since the 1980s (FAO 2018). Global trends are unavailable for softshell clam. In the U.S., wild landings of clam species are combined with aquaculture production in National Marine Fisheries Service data, and landings are reported in pounds (or metric tons) of meats. U.S. fisheries landed and produced (i.e., wild and farmed) an average of 3,254 mt of northern quahog and 1,029 mt of softshell clam between 2018 and 2022 (NMFS 2023d). The U.S. landed 3,577 mt of northern quahog worth $56.5 million and 902 mt of softshell clam worth $24.8 million in 2022 (NMFS 2023d).

Virginia accounts for the bulk of northern quahog in the U.S., but clams from this state primarily come from aquaculture, so they are not assessed here (Hudson 2016). Other states continue to land wild clams *and* to produce farm-raised clams, but data are often not segregated. The average northern quahog landings available from NMFS from 2018 to 2022 for the states in this report are: 104 mt (Maine), 242 mt (Massachusetts), 686 mt (New York), and 192 mt (Rhode Island) (Figure 1) (NMFS 2023b). New Jersey does not require the reporting of landings for harvested clams, so no information is available. North Carolina landings of northern quahog averaged 18.4 million clams between 2008 and 2014; landings of northern quahog were the lowest on record (since 1975) in 2020 (3.7 million clams) (Figure 2) (NCDMF 2023).

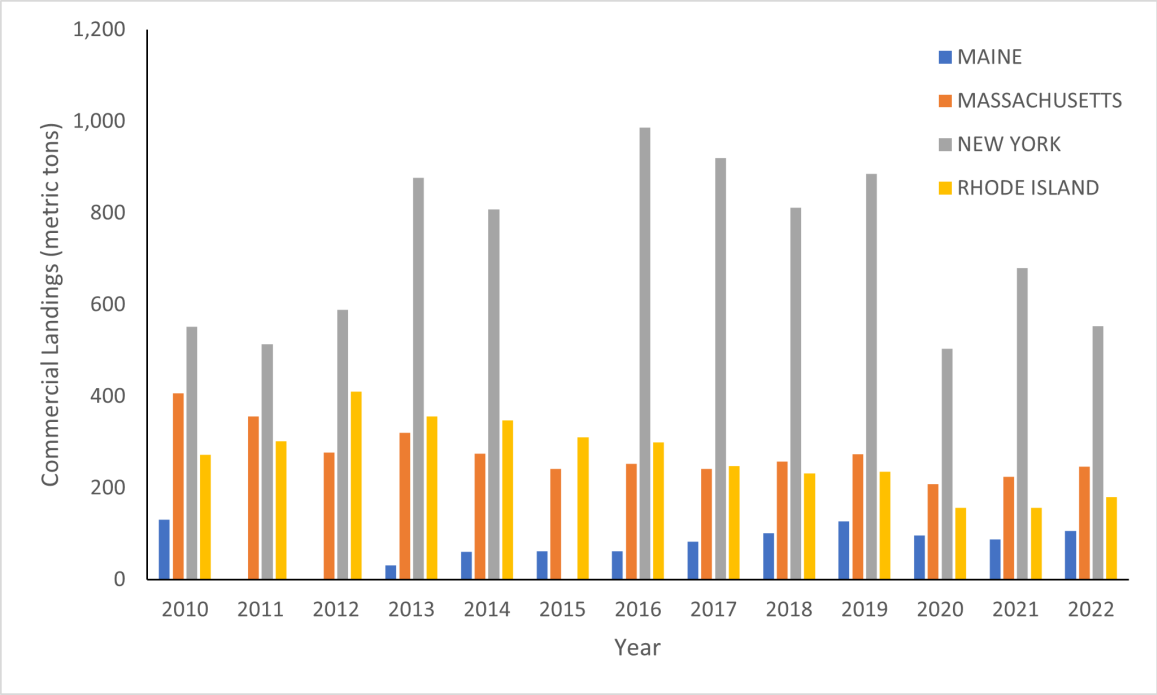

Figure 1: Commercial landings of hard clam in Maine, Massachusetts, New York, and Rhode Island from 2010 to 2022. Data were not available for New York in 2015 or Maine in 2011 and 2012 (NMFS 2023b).

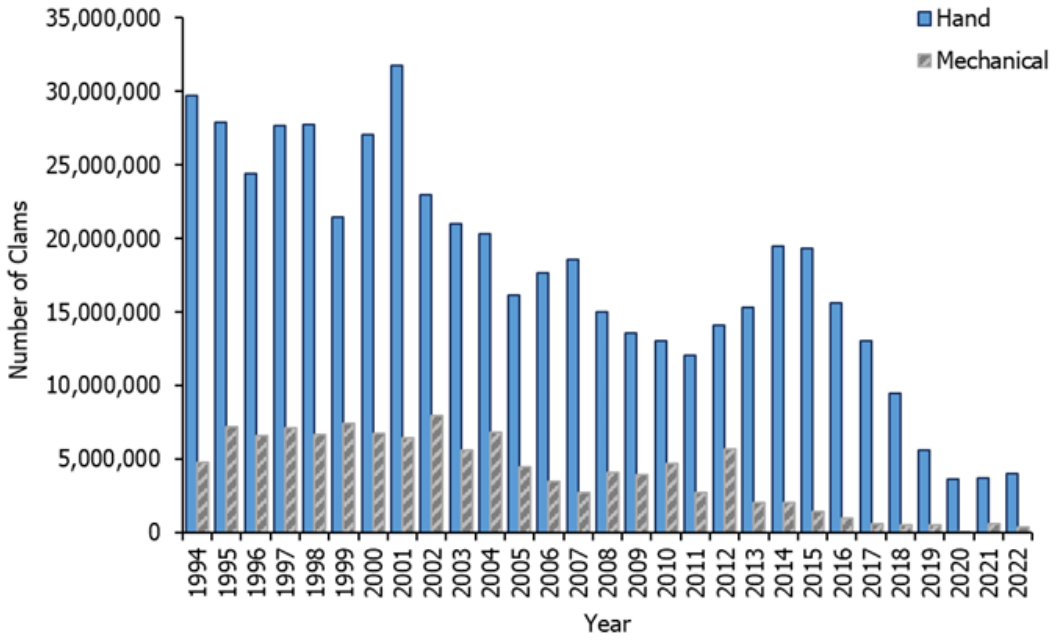

Figure 2: Annual hard clam landings (number of clams) from hand and mechanical harvest in North Carolina, 1994–2022 (NCDMF 2023).

Maine lands most of the softshell clam in the United States. Maine shellfisheries landed an average 655.4 mt of clams per year from 2018–22; Massachusetts averaged 315.2 mt per year during the same period (Figure 3) (NMFS 2023c). Softshell clam represents the second or third most important commercial marine fisheries in Maine behind lobster and glass eel. In 2022, 569 mt of softshell clam were landed, with a dockside value of $16.62 million (NMFS 2023c). Landings of softshell clam in Maine declined by nearly 30% in 2017 and 2018; this decline is linked to increasing seawater temperatures that have resulted in the Gulf of Maine warming at a rate faster than 99% of the world's oceans and a population explosion of the invasive green crab (*Carcinus maenas*) (pers. comm., Brian Beal 2019).

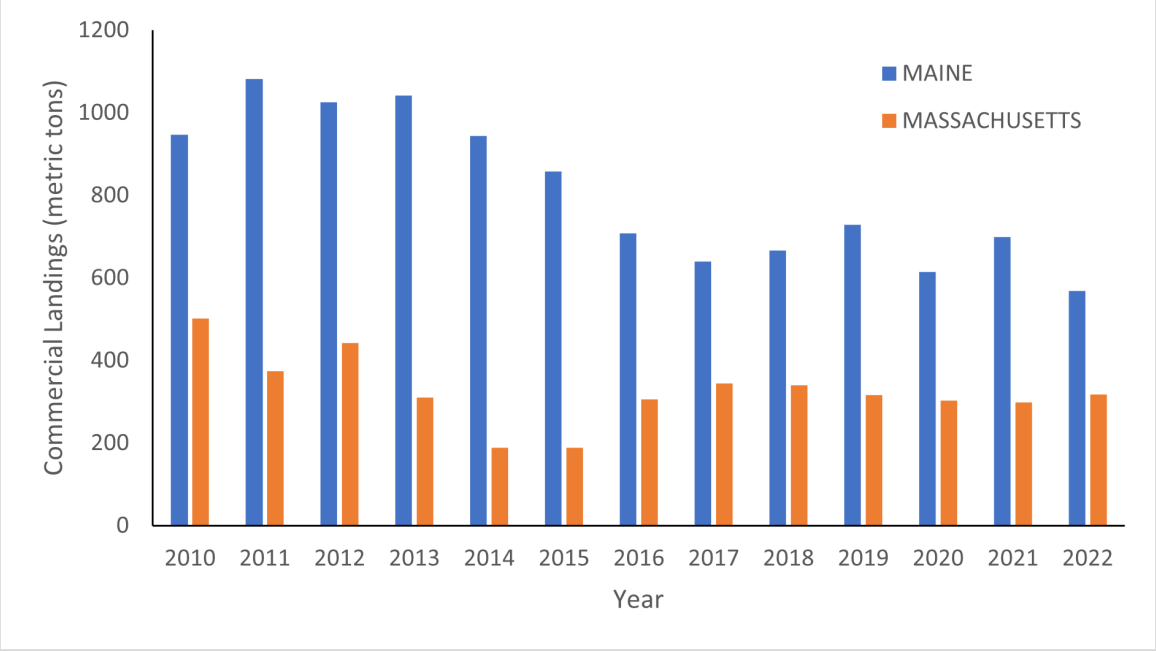

Figure 3: Commercial landings of softshell clam in Maine and Massachusetts from 2010 to 2022 (NMFS 2023c).

The species covered in this report are primarily fished in the United States, with a lesser amount caught in Canada. European fisheries for hard clam exist, but catches are low.

Importance to the US/North American market.

National Marine Fisheries Service import and export data are not broken down to the species level (except for geoduck and razor clam). Therefore, the following data are for all other clam species collected by U.S. Customs and are not specific to the fisheries assessed in this report. The U.S. imported 22,073 mt of clams valued at $76.12 million in 2022, while exports totaled 4,183 mt (NMFS 2023). China exported 10,971 mt of clam products (boiled, canned, dried, frozen, preserved, and prepared) to the United States in 2022, while exports from Canada (3,753 mt) and Vietnam (3,452 mt) to the United States ranked second and third, respectively (NMFS 2023).

Common and market names.

The common name for *Mercenaria mercenaria* is northern quahog. Market names include hard clam and quahog, and vernacular names include hardshell and littleneck. This species is referred to differently, based on size. The smallest are called littleneck clams, slightly larger clams are called topnecks, medium large clams are called cherrystones or topcherries, and the largest clams are called chowders.

The common name for *Mya arenaria* is softshell clam. Market names include clam and softshell, and vernacular names include steamer or maninose clam.

Primary product forms

Hard clam/northern quahog is often served raw on the half shell (littlenecks), baked, or used in dishes such as clam chowder or clam sauces (cherrystone and chowder clams). Hard clam is also often steamed and fried in North Carolina. Soft-shell clam is commonly served steamed or fried.

Assessment

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

Criterion 1: Impacts on the species under assessment

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

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

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

Guiding principles

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

Criterion 1 Summary

NORTHERN QUAHOG			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Northwest Atlantic | United States | North Carolina | Hand implements	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | United States | New York | Hand implements	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | United States | New Jersey | Hand implements	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | United States | Maine | Hand implements	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

SOFTSHELL CLAM			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Criterion 1 Assessments

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.*

Northern quahog

Factor 1.1 - Abundance

Northwest Atlantic | United States | New Jersey | Hand implements

Moderate Concern

Comprehensive hard clam surveys were conducted by the NJDEP in the mid-1980s throughout the Barnegat Bay-Little Egg Harbor (BB-LEH) estuary—historically one of New Jersey's most productive areas for hard clams—and again in BB-LEH in 2011–12 (Celestino 2013)(Dacanay 2015)(Bricelj et al. 2017). Abundance and standing stock trends from these assessments are described in the following Justification section; maps of these areas are also included. Results can be interpreted only for the years of the assessments and not for the years before or between the assessments (Celestino 2013). Researchers have called for more frequent surveys to better track changes in clam populations, as well as to improve the assessment of natural mortality and the development of a management plan for the resource (Bricelj et al. 2017). Since 2011, the Bureau has made an effort to conduct a stock assessment of a different estuarine system annually, to estimate the standing stock of adult hard clams and describe their relative distribution. Some estuaries show an increase in the stock while others show a decrease, likely the result of differences across estuary conditions (NJDEP 2023).

None of the stocks had densities below the suggested minimum for a self-sustaining population of 0.7–0.8 clams m^2, which is a density determined by Kraeuter et al. {Kreauter et al. 2005} based on spawner/recruit analysis of northern quahog in New York (Bricelj et al. 2017). None of the assessed stocks had declined in abundance since 2000, and every stock was above the suggested minimum density to maintain a self-sustaining population (proxy for limit reference point). Although target reference points are not defined, it has been suggested that optimal clam density is 5 clams m^2 (Bricelj et al. 2017). Two of the five stocks for which the condition is reported here are below 75% of this optimal density, so the fishery receives a score of moderate concern.

Justification:

Barnegat Bay (Figure 4): Northern quahog populations have decreased notably since the 1960s within the entire 280 km^2 Barnegat Bay-Little Egg Harbor Estuary Complex, with substantial areas that are no longer inhabited by clams (Bricelj et al. 2017). Increased mortality could be responsible for the decline in abundance, but the factors causing mortality are not known (Bricelj et al. 2017). This Barnegat Bay stock showed a 33% decline in abundance between the 1985–86 and 2012 surveys, and the standing stock was 23% lower in 2012 (Dacanay 2015). The average density is above the suggested minimum level, but at 22% of the presumed optimal level.

Little Egg Harbor (Figure 4) (Celestino 2013): Surveys found a 66% decline in total clam abundance between 1986 and 2001, but no change in abundance between surveys in 2001 and 2011. The standing stock in 2011 was 57% lower than the 1986 survey, but 32% higher than in 2001. The average density in 2011 was above the minimum level, but 22% of the optimal level. Surveys in LEH showed a pronounced increase in the percent of the bay area with no clams, from 3% for total clams (all clam sizes) in the mid-1980s to 40% in 2011. This absence of clams is most noteworthy

in the western part of the bay and for sublegal clams (Bricelj et al. 2017).

Raritan and Sandy Hook Bays (Figure 5): Of the areas with recent stock assessments, this stock is considered the healthiest (Bricelj et al. 2017) and supportive of a sustainable catch (Kraeuter et al. 2009). This stock saw a significant increase in abundance between surveys in 2000 and 2014, and the standing stock was higher in 2014 at approximately 1.2 billion clams (Dacanay 2016). Density estimates are above the optimal and minimum levels. Landings data are confidential for this fishery because of state law.

Navesink River (Figure 6) (Dacanay 2017): No significant difference in abundance between 1983 and 2015; the standing stock was 19% higher in 2015. Density estimates are above the presumed optimal and minimum levels.

Shrewsbury River (Figure 6) (Dacanay 2017): No significant difference in abundance between 1983 and 2015, and no significant change between the 2000 and 2014 surveys. The standing stock was 12% lower in 2015 compared to 1983. The average density is above the minimum level, but 76% of the optimal level.

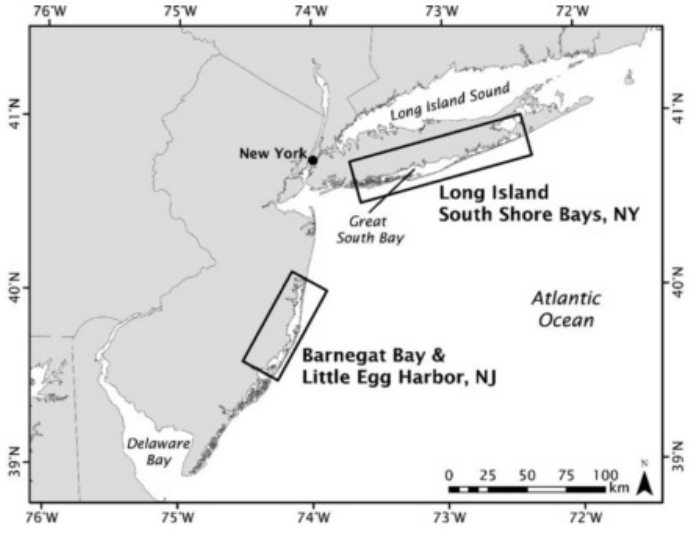

Figure 4: Barnegat Bay and Little Egg Harbor, New Jersey (Bricelj et al. 2017).

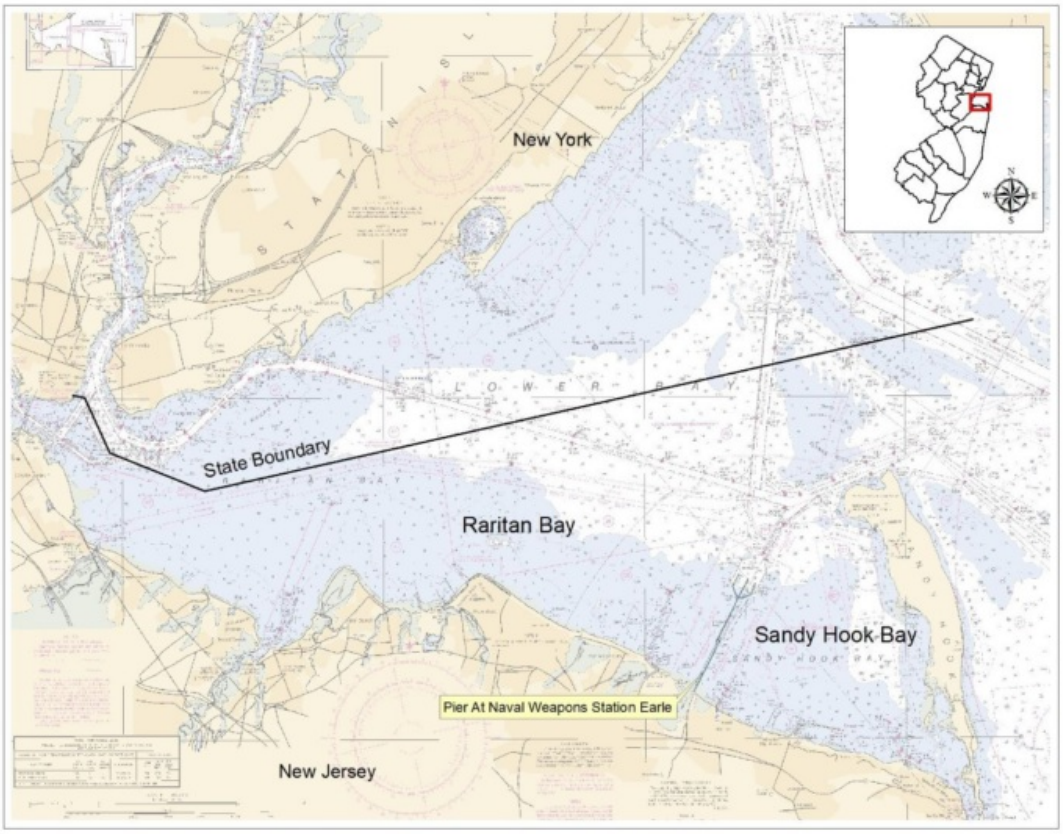

Figure 5: Raritan Bay and Sandy Hook Bay, New Jersey (Dacanay 2016).

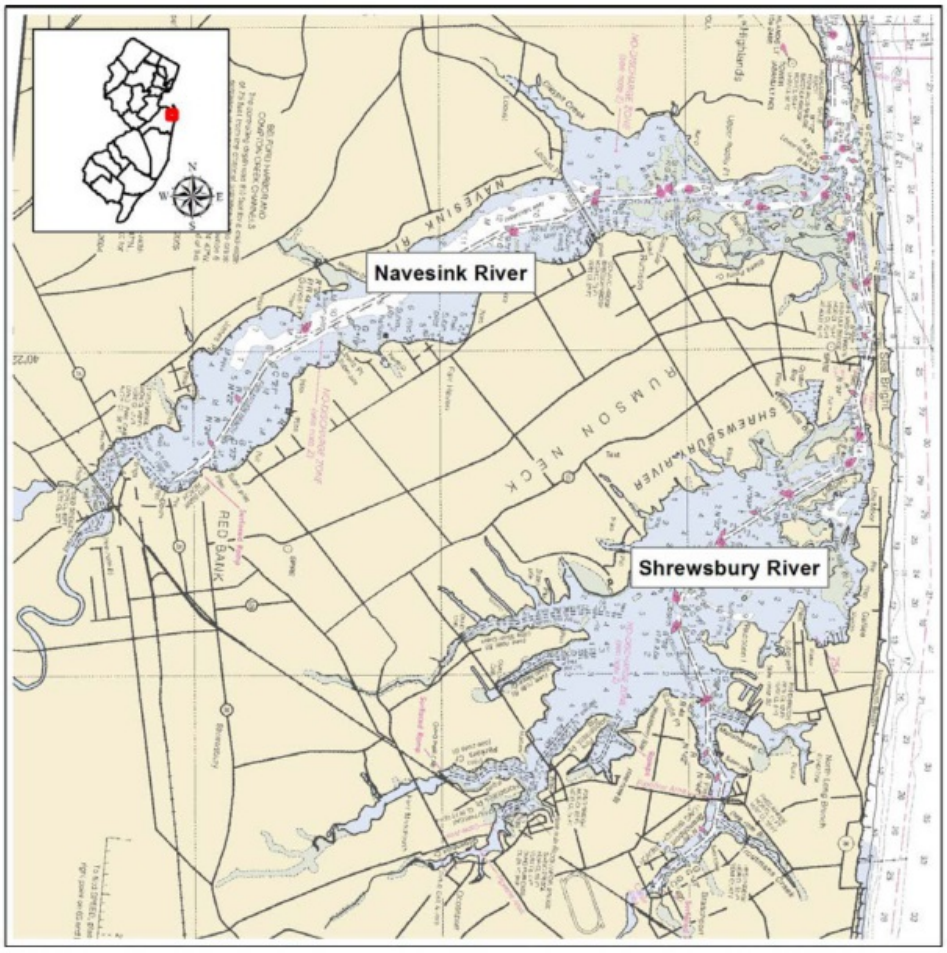

Figure 6: Navesink River and Shrewsbury River, New Jersey (Dacanay 2017).

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | North Carolina | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery

Moderate Concern

The International Union for the Conservation of Nature (IUCN) has not evaluated northern quahog, and this species is not threatened or endangered in the U.S. (Burdette 2018). Because states generally lack stock assessments or reference points for northern quahog (except New Jersey and Rhode Island), we used a productivity-susceptibility analysis (PSA) to assess the vulnerability of this species to fishing across its range. We have included the PSA and state-specific information for northern quahog in the following Justification section. Given that northern quahog is not highly vulnerable (vulnerability score = 2.73) and the general lack of information on the health of stocks, we award a score of moderate concern.

Justification:

Productivity attribute	Relevant Information	Risk (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	1–3 years (Hill 2004)(Eversole 2001)	1
Average maximum age	28–46 years {Grizzle et al. 2001}	1
Fecundity	Annual fecundity size-related, 0.8–40 million (Eversole 2001)	1
Reproductive strategy	Broadcast spawner (Rice 1992)	1
Trophic level	2.1 for mollusks (Jacobsen and Bennett 2013); northern quahog is a primary consumer	1
Density dependence score	Depensatory dynamics (Allee effect) demonstrated or likely at low population sizes (Mann et al. 2005)	3
Habitat quality	Moderately compromised (PREP 2018)(Rhode Island 2014)	2
Productivity score = 1.42		
Susceptibility Attribute	**Relevant Information**	**Risk (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (considers all fisheries)	Most of the species concentration is fished, considering all fisheries	3
Vertical overlap (considers all fisheries)	Default score for target species	3
Selectivity of fishery	Default; conditions under "high risk" do not apply	2
Post-capture mortality (specific to fishery under assessment)	Default for retained species	3
Susceptibility score = 2.33		
Total vulnerability score = 2.73		

Maine

Some surveys may be conducted at the municipal level (MDMR 2016), but little information is available on the abundance of northern quahog in Maine. There are no stock assessments or reference points for northern quahog in Maine, so abundance is not known.

Massachusetts

Massachusetts contracts an NMFS survey vessel to perform a spring trawl survey of marine resources out to 3 nautical miles. Few hard clams are reported caught in this survey (MDMF 2011). No information on quahog trawl data was provided by MDMF in 2017 {MDMF 2018}. But higher densities of northern quahog occur in the intertidal areas, which cannot be covered by trawl surveys (Eversole 1987). These areas are managed by local governments, which may or may not perform stock assessments as part of their management activities (Wellfleet 2012).

New York

The status of the northern quahog stock is currently unknown, although population surveys are conducted at a local municipality level in town waters alongside further management measures. Previous analysis indicated that a stock decline occurred from the 1970s through the 2000s, although this decline was observed only in part of the state and not this fishery's entire region (Kraeuter et al. 2008). In 1999, the Northern Quahog Initiative was launched by Sea Grant New York to address the decline of northern quahog in the South Shore Estuary area; the sharp early

decline in abundance was attributed to overfishing (Buckner 1984)(Kraeuter et al. 2008). Despite reduced fishing efforts in the 1990s, the population continued to decline. Potential contributing factors included the occurrence of brown tide blooms since 1985, reduced reproductive success associated with low clam density and poor food quality, and poor recruitment; however, predation pressure of postlarvae and juveniles could not be ruled out as a contributing factor (Bricelj 2009). Shellfish sanctuaries have also been established that are closed to harvesting as part of a large-scale restoration project that has stocked millions of adult hard clams and resulted in an increase in landings (NYDEC 2023).

North Carolina

The status of the stock in North Carolina is currently listed as unknown because there are limited data to assess the population (NCDENR 2018). Commercial landings data provide some insight to population abundance and fishing effort, but there is not enough information to determine trends in age distribution or recruitment because of caveats such as area closures, market fluctuations, and environmental variables (NCDENR 2018). There is a small sampling program in Core Sound that provides environmental information and some baseline data on abundance, although few hard clams are caught due to the random stratified sampling design and gear type (NCDENR 2018). Catch per unit effort from this sampling program has ranged (annually) from 0.39 to 1.27 clams per station between 2007 and 2022. No trend was found over the relatively short sampling period, and new statewide fishery-independent monitoring programs are being considered (NCDENR 2018).

Rhode Island

Rhode Island conducts dredge surveys in Narragansett Bay (where most of the state's quahogs are landed) annually since 1993 (Rhode Island 2014). Clam density has averaged 1.5–2 clams m^2 over the entire Bay in recent years (Rhode Island 2014). This density is above a potential limit reference point (0.7–0.8 clams m^2) but below 75% of a potential target reference point (5 clams m^2) (Bricelj et al. 2017).

Factor 1.2 - Fishing Mortality

Northwest Atlantic | United States | New Jersey | Hand implements

Moderate Concern

In a 2009 study in Raritan Bay, levels of landings were considered sustainable given the assumed natural mortality and recruitment rates (Kraeuter et al. 2009). Although this study is 9 years old, a recent survey found an increase in clam abundance in the bay (Dacanay 2016), suggesting that fishing mortality has not affected the stock since the previous survey. Mortality rates are elevated in Barnegat Bay-Little Egg Harbor, but the cause(s) of mortality are not known (Bricelj et al. 2017). Overall, fishing mortality relative to reference points is unknown in most areas of the state, and landings data, which alone are of limited value for stock assessment, are unavailable because of unreliable/inadequate records. There is an incomplete understanding of fishing mortality, so we award a moderate concern score.

Northwest Atlantic | United States | North Carolina | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery

Moderate Concern

Overall, the fishing mortality for northern quahog is unknown in Maine, Massachusetts, New York, and North Carolina. We have included available state-specific information in the Justification section. Because fishing mortality is unknown in these states, we award a score of moderate concern.

Justification:

Maine and Massachusetts

These states manage northern quahog in partnership with local municipalities; therefore, each state does not have a statewide fishing mortality estimate {MDMF 2012}(MDMR 2016). Fishing mortality reference points have not been established.

New York

New York does not have a current fishing mortality estimate for northern quahog because of a lack of a statewide survey and biomass data {pers. comm., Jennifer O'Dwyer 2015}. Shellfish in the bays fall under township jurisdictions, and some areas have conducted surveys {pers. comm., Jennifer O'Dwyer 2015}{NYSDEC 2015a}. Data are limited and insufficient to determine mortality statewide. Historical analysis indicated that population declines during the 1970s to 1980s were related to overfishing, but declines during the 1990s and 2000s were not (Kraeuter et al. 2008).

North Carolina

The fishing mortality in North Carolina is unknown. There are currently no management triggers or methods to track stock abundance, fishing mortality, or recruitment. Although the state is unable to quantify the fishing mortality for its commercial hard clam fishery, landings and effort have decreased over time (NCDENR 2018).

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery

Low Concern

The Rhode Island Department of Environmental Management (RI DEM) uses a Bay Wide Stock Assessment Model to monitor the sustainability of fishing effort (Rhode Island 2014). This model incorporates fishery-independent and -dependent data. Since 2004, the fishing mortality rate (F) has been below 0.3, which is below the limit reference point ($F > 0.45$) and the target reference points (F between 0.3 and 0.45) (Rhode Island 2014). Fishing mortality has been below a sustainable level since 2004, so we award a score of low concern.

Justification:

RI DEM defines an F greater than 0.45 as the fishing mortality rate that leads to decreased abundance; F between 0.3 and 0.45 as the fishing mortality rates where recruitment and fishing mortality are roughly in balance; $F < 0.3$ results in moderate increases in abundance (Rhode Island 2014).

Softshell clam

Factor 1.1 - Abundance

Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Moderate Concern

Because of the lack of information or reference points from states with the majority of the softshell clam stock, the stock status is unknown. There is no long-term, fishery-independent dataset for clam densities in Maine, but landings have decreased by nearly 75% over the last several decades (Beal et al. 2016). The apparent decline is thought to be related to increasing seawater temperature and the subsequent population explosion of invasive green crab, which greatly reduces the number of young clams, though other factors may be involved (Beal et al. 2018). There is no evidence to suggest that the stock is either above or below the reference points, the species is not highly vulnerable (see the following PSA), and abundance is unknown, so we award a score of moderate concern.

Justification:

Maine manages its softshell clam resource in partnership with local municipalities. Some of these local municipalities conduct stock surveys for clam beds of interest {pers. comm., Denis-Marc Nault 2012}. In Maine, landings and effort are tracked monthly; this approximation of CPUE has been slowing increasing, which indicates a healthy stock status; however, scientific stock assessments are not performed on a statewide level {pers. comm., Denis-Marc Nault 2012}.

Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery

Moderate Concern

The International Union for the Conservation of Nature (IUCN) has not evaluated softshell clam. Because of the lack of information or reference points, the stock status is unknown. We used a productivity-susceptibility analysis (PSA) to assess the vulnerability of this species to fishing pressure. Given that softshell clam is not highly vulnerable (vulnerability score = 2.89; see the PSA scoring in Justification) and the general lack of information on the health of stocks, we award a score of moderate concern.

Justification:

Productivity attribute	Relevant Information	Risk (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	5 years (Ayers 1956)(Abraham and Dillon 1986)	2
Average maximum age	10–12 years (Abraham and Dillon 1986)	2
Fecundity	100,000 to 5 million (Jensen 2010)	1
Reproductive strategy	Broadcast spawner (Jensen 2010)	1
Trophic level	2.1 for mollusks (Jacobsen and Bennett 2013)	1

Density dependence score	Depensatory dynamics may limit recruitment (Glaspie et al. 2018)	3
Habitat quality	Moderately altered (Buchsbaum et al. 2016)	2
Productivity score = 1.71		
Susceptibility Attribute	**Relevant Information**	**Risk (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (considers all fisheries)	Most of the species concentration is fished, considering all fisheries	3
Vertical overlap (considers all fisheries)	Default score for target species	3
Selectivity of fishery	Default; conditions under "high risk" do not apply	2
Post-capture mortality (specific to fishery under assessment)	Default for retained species	3
Susceptibility score = 2.33		
Total vulnerability score = 2.89		

Factor 1.2 - Fishing Mortality

Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Moderate Concern

Fishing mortality for softshell clam is deemed unknown because of the lack of information needed to determine fishing mortality. In Maine and Massachusetts, some municipalities may conduct stock assessments or track CPUE, but these data sources cannot be scaled up to determine the fishing mortality at the state level {pers. comm., Denis-Marc Nault 2012}. Landings have declined over the last four decades, but this may be caused by the low survival of juvenile clams (Beal et al. 2016). It has been widely suggested that predation on softshell clam is relatively the most important factor regulating populations, but it is unknown whether overfishing has occurred (Beal et al. 2016). Given this uncertainty in the sustainability of fishing mortality, we award a moderate concern score.

Justification:

Recent research on softshell clam recruitment in Maine suggests that recruitment is not limited by fishing, but by other factors that cause mortality after settlement (Beal et al. 2018). Specifically, the high level of mortality is likely due to predation by the invasive green crab (*Carcinus maenas*) and by increasing seawater temperatures in the Gulf of Maine (Beal et al. 2018).

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.

NORTHERN QUAHOG			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | North Carolina | Hand implements	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | New York | Hand implements	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | New Jersey | Hand implements	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | Maine | Hand implements	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery	5.000	1.000: < 100%	Green (5.000)

SOFTSHELL CLAM			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery	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 IMPLEMENTS			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northern quahog	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | UNITED STATES | MAINE | HAND IMPLEMENTS | SOFTSHELL CLAM FISHERY

SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Softshell clam	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | UNITED STATES | MASSACHUSETTS | HAND IMPLEMENTS | NORTHERN QUAHOG FISHERY

SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Northern quahog	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | UNITED STATES | MASSACHUSETTS | HAND IMPLEMENTS | SOFTSHELL CLAM FISHERY

SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Softshell clam	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | UNITED STATES | NEW JERSEY | HAND IMPLEMENTS

SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Northern quahog	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
Northern quahog	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | UNITED STATES | NORTH CAROLINA | HAND IMPLEMENTS

SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Northern quahog	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | UNITED STATES | RHODE ISLAND | HAND IMPLEMENTS | NORTHERN QUAHOG FISHERY

SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Northern quahog	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

Fishers target northern quahog and softshell clam in estuaries and mudflats with rakes and other hand implements, and are able to easily distinguish nontarget species that are brought to the surface (Barnette 2001). There is minimal bycatch and discards because hand tools are highly selective. No other main species are included in this fishery.

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

Northern quahog

Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | North Carolina | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | New Jersey | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery

< 100%

There is minimal bycatch and discards because hand tools (rakes, shovels, and tongs) are used in this fishery. Lenihan and Micheli (2000) demonstrated that clam digging can reduce the densities of oysters when beds of the two shellfish overlap, by smothering oysters or puncturing their shells. Reduced oyster densities of 50–80% were observed on intertidal oyster reefs that experienced clam digging compared to unharvested areas (Lenihan and Micheli 2000). But oyster beds are equally affected by clamming alone, by oyster harvesting alone, and by the concurrent targeting of both shellfish (Lenihan and Micheli 2000).

In New Jersey, undersized clams must immediately be returned to the substrate from which they were taken (NJDEP 2018a). In Maine, undersized clams may account for no more than 5% of any random subsample taken (MDMR 2017). Unfortunately, there is no research on the survivability of discarded undersized northern quahog, but damage to target species in other similar fisheries has been documented (Kaiser et al. 2001)(Kaiser et al. 2001). The discard ratio relative to total landings does not exceed 100%.

Softshell clam

Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

< 100%

There is minimal bycatch and discards because hand tools (rakes, shovels, and tongs) are used in this fishery. Lenihan and Micheli (2000) demonstrated that clam digging can reduce the densities of oysters when beds of the two shellfish overlap, by smothering oysters or puncturing their shells. Reduced oyster densities of 50–80% were observed on intertidal oyster reefs that experienced clam digging compared to unharvested areas (Lenihan and Micheli 2000). But oyster beds are equally affected by clamming alone, by oyster harvesting alone, and by the concurrent targeting of both shellfish (Lenihan and Micheli 2000).

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Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | North Carolina | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | New Jersey | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

< 100%

There is minimal bycatch and discards because hand tools (rakes, shovels, and tongs) are used in this fishery. Lenihan and Micheli (2000) demonstrated that clam digging can reduce the densities of oysters when beds of the two shellfish overlap, by smothering oysters or puncturing their shells. Reduced oyster densities of 50–80% were observed on intertidal oyster reefs that experienced clam digging compared to unharvested areas (Lenihan and Micheli 2000). But oyster beds are equally affected by clamming alone, by oyster harvesting alone, and by the concurrent targeting of both shellfish (Lenihan and Micheli 2000).

In New Jersey, undersized clams must immediately be returned to the substrate from which they were taken (NJDEP 2018a). In Maine, undersized clams may account for no more than 5% of any random subsample taken (MDMR 2017). Unfortunately, there is no research on the survivability of discarded undersized northern quahog, but damage to target species in other similar fisheries has been documented (Kaiser et al. 2001)(Kaiser et al. 2001). The discard ratio relative to total landings does not exceed 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	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Northwest Atlantic | United States | Maine | Hand implements	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | New Jersey | Hand implements	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | New York | Hand implements	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | North Carolina | Hand implements	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery	Highly effective	Highly effective	Highly effective	Highly effective	Highly effective	**Green (5.000)**

Northern quahog and softshell clam fisheries occurs in tidal creeks, estuaries, and shallow nearshore waters. Therefore, local municipalities often manage these fisheries with assistance and/or oversight from state governments, such as in Maine, New York, and Massachusetts (MDMR 2016){pers. comm., Jennifer O'Dwyer 2015}{MDMF 2012}. North Carolina, New Jersey, and Rhode Island fisheries are managed at the state level. Most fisheries lack sufficient data (e.g., stock assessments) to determine the sustainability of the fishery, but have policies to control effort, monitor, and enforce fishing activities (see Factors 3.1–3.5).

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.

Factor 3.1 - Management Strategy And Implementation

Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Moderately Effective

In Maine, the state sets shellfish program criteria and puts management into the hands of municipalities (Figure 7). Under state statute, a town's legislative body can vote to raise and appropriate funds for shellfish conservation programs and make amendments to shellfish ordinances (MDMR 2016). Any town that adopts such a program must develop conservation goals, establish a shellfish conservation committee, actively enforce ordinances, and submit an annual report to the state (Maine Legislature 2018). Some towns with management plans may be required to conduct surveys in approved harvesting areas and/or before approving changes in the Municipal Shellfish Conservation Ordinance (MDMR 2016). These surveys are used to estimate clam average density and size distribution. There are currently 74 coastal towns (out of 77) that comanage shellfish resources, representing 57 shellfish programs (some towns collaborate) (McGreavy et al. 2018). Though the fishery allows for adaptive management (e.g., towns can open and close flats under specific conditions, fix the amount of shellfish take, and regulate the possession of shellfish), no reference points have been defined. Recent research suggests that effort and spatial restrictions may not be effective at maintaining viable clam populations, because closing flats for conservation purposes (without protecting clams from predators) does little to sustain or enhance the fishery (Beal et al. 2018). Managers' efforts may need to shift to transplanting recruits into protected plots to allow for sustainable fisheries in areas heavily affected by green crab (Beal et al. 2018). Overall, the effectiveness of management is unknown and it is unlikely that the fishery is having serious negative impacts on retained populations, so a moderately effective score is given.

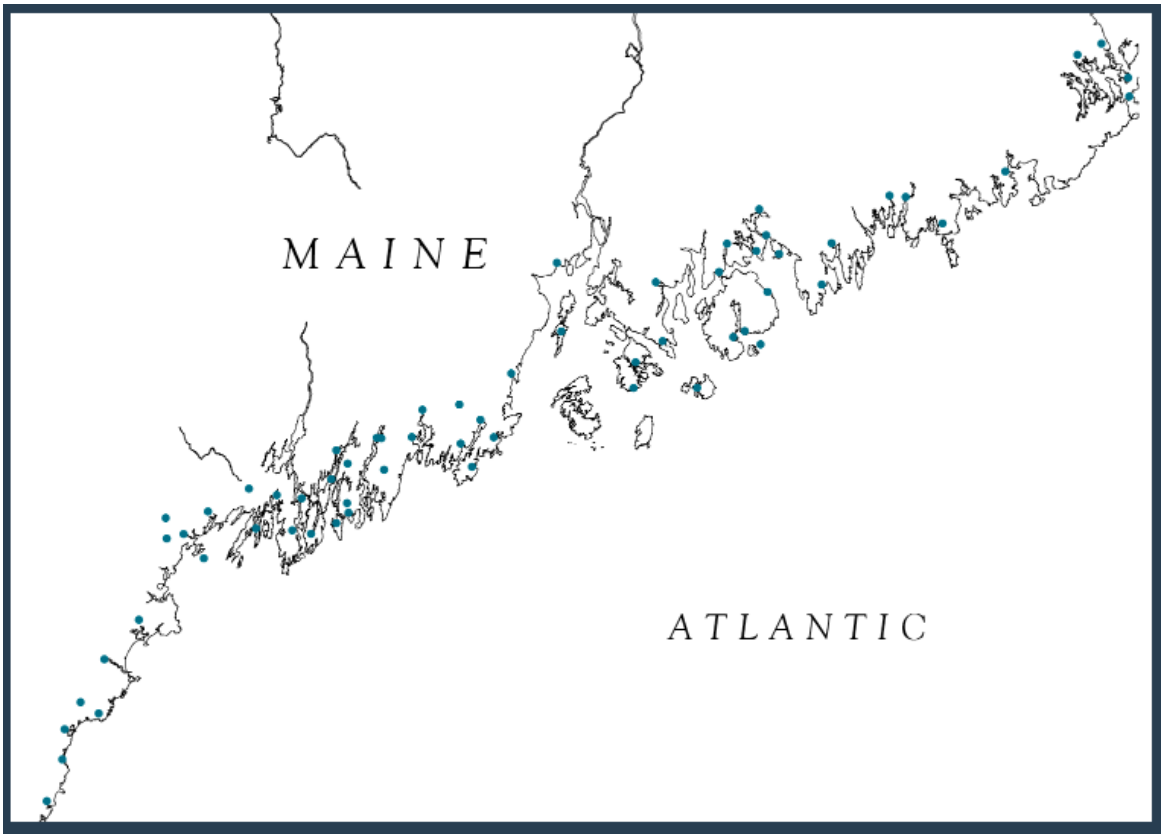

Figure 7: Municipalities with shellfish management plans. From the New England Sustainability Consortium (NEST).

Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery

Moderately Effective

Massachusetts manages its northern quahog and softshell clam resources in partnership with local municipalities (MDMF 2012b). The Massachusetts Division of Marine Fisheries mostly focuses management on shellfish sanitation, with some direct and indirect management of shellfish resources (MDMF 2017). The only statewide regulations regarding northern quahog include licensing requirements, a minimum size limit of 1 inch thickness, and a limit of 40 bushels per day; the minimum size limit for softshell clam is 2 inches, and there is no daily limit (MDMF 2017)(MDMF 2012b).

The local government controls which clam beds may be harvested and when licenses are available for harvesting. Because management occurs on a local level, how well local jurisdictions incorporate scientific information and recommendations is unknown, and the track record of management is also unknown (MDMF 2012a). Softshell clam landings experienced a steep decline from the mid-1980s to the mid-1990s across the Atlantic Coast, and although the management of softshell clams is appropriate for managing fishing pressure, additional threats to the fishery have emerged due to

poor water quality and habitat degradation that could benefit from additional management actions. The decline in water quality has led to extensive red tide shellfish closures for Massachusetts, which has created a control on clam harvest {pers. comm., Dennis Erkan 2012}. Some additional actions have been taken in the form of restoration and mitigation projects (MDMF 2017)(Shields 2009) and relay and depuration of contaminated shellfish to make them safe for the marketplace (MDMF 2017).

Although there is some management in place, its effectiveness is unknown, and it is unlikely that the fishery is having serious negative impacts on clam populations. Thus, management strategy and implementation scores moderately effective for this gear type.

Northwest Atlantic | United States | New Jersey | Hand implements

Moderately Effective

Northern quahog is managed at the state level within the New Jersey Department of Environmental Protection (NJDEP). In New Jersey, the minimum landing size is 1.5 in., clams cannot be harvested by mechanical means or motor power, and commercial fishers require a commercial license (Bricelj et al. 2017). Landings, commercial licenses, and recreational licenses for northern quahog have declined in a major estuary in New Jersey that historically supported substantial fisheries, but the reasons for this decline are not well understood (Bricelj et al. 2017). New Jersey lacks an overall management plan for northern quahog, and stock assessments are not conducted frequently enough, given the biology of the species (Bricelj et al. 2017). Also, the reporting of northern quahog landings is not mandatory, making management more challenging (Dacanay 2015). Bricelj and colleagues (2017) indicate that there is an interest in managing and restoring clams at the local level, but municipalities lack the authority to do so. The effectiveness of the management strategies in place is not known, and it is unlikely that the fishery is having a serious negative impact on northern quahog in New Jersey, so a score of moderately effective is awarded.

Northwest Atlantic | United States | New York | Hand implements

Moderately Effective

New York manages its northern quahog resource in partnership with local municipalities. Statewide regulation includes harvest limits by size and number as well as gear restrictions. The minimum harvest size for northern quahog is 1 in. thickness; the recreational harvest limit is 100 clams per day, and the commercial harvest is unrestricted; no recreational permit is required in state lands; and a New York State Digger Permit is required for commercial harvest (NYSDEC 2018)(NYSDEC 2015). Some towns and groups have conducted surveys in the Great South Bay area, and statewide management has discussed management plans for surveys, although this has not yet been acted on {pers. comm., Jennifer O'Dwyer 2015}. Also, some townships have begun to develop spawner sanctuaries, which are designed to increase densities to help spawning success and are off-limits to harvesting (LISRP 2017). New York does not have a statewide fishery management plan. Thus, it is unknown if harvest restrictions are appropriate. Therefore, New York's management strategy and implementation is considered moderately effective.

Northwest Atlantic | United States | North Carolina | Hand implements

Moderately Effective

A state Fishery Management Plan (FMP) was prepared by the North Carolina Department of Environmental Quality and approved by the North Carolina Marine Fisheries Commission in 2001, with amendments in 2008 and 2017 (details of Amendment 2 are described in the Justification section) (NCDENR 2018). The goal of hard clam fishery management is to "manage hard clams stocks in a manner that achieves sustainable harvest and protects its ecological value" ((NCDMF 2008), p. 21). But the FMP acknowledges that this is not possible until appropriate data are collected (NCDMF 2017). The northern quahog commercial fishery has been managed through limits on harvest (maximum daily limit of 6,250 clams) and size (minimum size limit of 1-in thickness) as well as through season, area restrictions, and a relay program where clams are moved from polluted areas and placed on leases for depuration (NCDMF 2008)(NCDMF 2017). In addition, the management program is reassessed and modified as data become available. The management strategy and goals are appropriate for this fishery, and landings have declined over the past 10 years.

Management strategy and implementation scores moderately effective, because there is some effective management in place and managers take a precautionary approach, but reference points cannot be determined at this time.

Justification:
Amendment 2 was adopted in 2017, which eliminated mechanical harvest in Pamlico Sound, instituted shading requirements from April 1 to September 30, modified shellfish lease provisions, and added to the types of violations that could result in a loss of license (NCDENR 2018).

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery

Highly effective
The Rhode Island Department of Environmental Management (RI DEM) manages the quahog fishery with advice from the Rhode Island Marine Fisheries Council (RI DEM 2008)(RIDEM 2023). Rhode Island's northern quahog management includes statewide stock surveys and fishing effort limits (harvest limits, licenses, and seasons) (Rhode Island 2014)(RIDEM 2023). Northern quahog is the only shellfish species in Rhode Island that has sufficient data to relate the actual population density to the minimum population density needed to sustain the population (Rhode Island 2014). Managers consider a fishing mortality rate (F) that exceeds 0.45 as a limit reference point (i.e., leads to decreased abundance and/or recruitment), while F between 0.3 and 0.45 (the target reference point) results in a balance between fishing mortality and recruitment (Rhode Island 2014). F has been consistently below 0.3 since 2004, which suggests that the management strategy has kept F below a sustainable level (Rhode Island 2014). Management targets have been defined and the fishery has precautionary policies in place, resulting in a score of highly effective.

Factor 3.2 - Bycatch Strategy

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | North Carolina | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | New Jersey | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Highly effective
The fishery has minimal bycatch because of the selectivity of the gear on target species.

Factor 3.3 - Scientific Research And Monitoring

Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Moderately Effective
There are no formal stock assessments for northern quahog or softshell clam in Maine, nor long-term fishery-independent datasets of clam densities (Beal et al. 2018). Most of the research on shellfish focuses on the interactions of invasive green crab with softshell clam (Beal et al. 2018)(Beal et al. 2016). Surveys are periodically conducted by the state and/or towns, but the results of these surveys are not available. The state has a landings program to monitor commercial landings and achieve management targets (MDMR 2018d). Because some data are used to monitor the stock, the fishery receives a moderately effective score.

Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery

Moderately Effective
The decision to employ stock assessments to manage clam fisheries is left to local municipalities, which may or may not collect data related to stock abundance; there is no statewide stock assessment, but landings data are collected by the state {MDMF 2012}(Wellfleet 2012). All shellfishers are required to label containers of shellfish with the name of the harvester, the commercial permit number, the date and time of harvest, and the type and quantity of shellstock (MDMF 2017b). Scientific research and monitoring scores moderately effective for northern quahog and softshell clam in Massachusetts, because some stock abundance and health data are collected but they are insufficient to determine the status of clam stocks or guarantee the long-term maintenance of them.

Northwest Atlantic | United States | New Jersey | Hand implements

Moderately Effective

The New Jersey Bureau of Shellfisheries has made it a priority to research the distribution and abundance of shellfish within state waters to improve fisheries management, with the first inventory occurring in 1983 (NJDEP 2018a). Since the turn of the century, the state has conducted northern quahog stock assessments for the Navesink and Shrewsbury Rivers (2015), Raritan and Sandy Hook Bays (1983, 2000, and 2014), Little Egg Harbor Bay (2001 and 2011), and Barnegat Bay (2012) {NJDEP 2018}. Further data have since been collected and a statewide hard clam management plan is under development; however, these have not been finalized. But commercial fishers are not required to submit landings data from coastal bays, making effective monitoring of stocks difficult (Dacanay 2015). There are few concerns with bycatch in this fishery, and the state actively conducts research to track stock health. But with an incomplete understanding of fishing mortality, the fishery does not meet the criteria for a highly effective score, so we award a score of moderately effective.

Northwest Atlantic | United States | New York | Hand implements

Moderately Effective

New York does not have biomass estimates or a fishery management plan for northern quahog. Some of the local jurisdictions have conducted surveys on hard clams, mostly in the Great South Bay area {O'Dwyer 2015}. In 1999, the Hard Clam (northern quahog) Initiative was launched by New York Sea Grant to improve science-based understanding of factors that control the hard clam population. In 2005, New York completed a comprehensive wildlife conservation study that acts as the guiding document for management of species. The plan was updated in 2015 and is called the State Wildlife Action Plan (SWAP) (DEC 2015). Northern quahog was listed as a high-priority species of greatest conservation need. The goals set forth for management of mollusks, including northern quahog, include continued research into the efficacy and optimal placement of reef sites and spawner sanctuaries, as well as continued work with local governments to manage the resource (NYSDEC 2005). Although New York set forth goals to improve its management of northern quahog, it currently lacks a fishery management plan and has limited data to determine the status of the northern quahog stock statewide. Therefore, we award a score of moderately effective.

Northwest Atlantic | United States | North Carolina | Hand implements

Moderately Effective

North Carolina is continuing with its biomass surveys for northern quahog. A monitoring program is ongoing in Core Sound to provide baseline data on hard clam abundance and to gather environmental parameters (NCDMF 2008). A fishery-dependent monitoring program started in 1999 to collect data at the trip level on gear type, catch composition, and the size distribution of northern quahog by market grade. These fishery-dependent data are currently being used to manage the fishery (NCDMF 2017). Although some data are collected related to stock abundance and health, they are insufficient to meet the highly effective threshold, so a score of moderately effective is awarded.

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery

Highly effective

Annual or biannual surveys allow the Rhode Island Department of Environmental Management (RI DEM) to consider both fishery-dependent and -independent data in its management decisions, including data collected from dredge shellfish surveys (Rhode Island 2014). This information is used to calculate the maximum sustainable yield and set harvest schedules annually. RI DEM previously conducted a stock assessment for northern quahog using production models (RI DEM 2018). The state notes that improvements in landings data and reporting compliance are needed to help ensure the health of the fishery (Rhode Island 2014). Although the last peer-reviewed stock assessment is more than 10 years old (Rhode Island 2014){RI DMF 2019}, the management agency regularly conducts surveys to collect stock information through fishery-dependent and fishery-independent data and updates management measures using them, resulting in a score of highly effective.

Factor 3.4 - Enforcement Of Management Regulations

Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Highly effective

Most clam fisheries are managed at the town level with oversight from the state. The Maine Department of Marine Resources manages fisheries in locations where there is no municipal shellfish program (MDMR 2016). Municipal management extends to the low tide line. As part of a shellfish management plan, towns must describe conservation measures (e.g., limiting licenses and spatial and temporal closures) and enforce ordinances with a certified Shellfish Warden (MDMR 2016). Seafood dealers buying directly from fishers are required to report to MDMR; these data are used to inform fisheries management (MDMR 2018b). This fishery scores highly effective because there is the capacity to enforce management regulations through local shellfish wardens and an elected shellfish conservation committee, along with guidance from the state.

Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery

Highly effective

Regulations are enforced by the local marine police or shellfish constables through regular patrols {MDMF 2012}. Landings can be independently verified by shellfish endorsements (permits) for commercial clam diggers and by shellfish ID cards {MDMF 2012}. The Director of Marine Fisheries may suspend permits without a prior hearing if there is reasonable cause that fishers are in violation of regulations (MDMF 2017b). Enforcement scores highly effective for northern quahog and softshell clam in Massachusetts.

Northwest Atlantic | United States | New Jersey | Hand implements

Highly effective

Licensing requirements and dealer certifications are regularly enforced by the New Jersey Bureau of Shellfisheries (NJDEP 2018c). By law (NJ Rev Stat § 50:2-3.1, 2013), shellfish license fees are used to fund enforcement activities related to shellfish resources. Poaching was a problem in spawner sanctuaries in New Jersey in the 1980s and 1990s, but it is unknown if it still occurs (Bricelj et al. 2017). Compliance overall is not known to be poor, and monitoring and enforcement is appropriate for the scale of the fishery, so we award a score of highly effective.

Northwest Atlantic | United States | New York | Hand implements

Highly effective

The New York State Department of Environmental Conservation's (NYSDEC) environmental conservation police officers are authorized to enforce state fisheries laws and check recreational and commercial fishers for compliance with state laws (NYSDEC 2015). Shellfish diggers are required to record the species harvested, quantity, location, and the date and time of harvest in logbooks, which must be completed daily before landing {NYSDEC 2018b}.

New York must be in compliance with the National Shellfish Sanitation Program (NSSP), which has enforcement requirements. As a deterrent to illegal harvesting, officials patrol harvest areas that are classified as the following: "restricted, conditionally restricted, or prohibited, or conditionally approved or approved when in closed status." These patrols occur 4 to 16 times per 30 harvestable days, depending on the risk category (4 days for low risk, 8 for medium, and 12 for high). Risk categories are determined by shellfish productivity, ease of harvest, and difficulty of patrol (NSSP 2017). New York has 66 patrol areas, of which 11 are considered exceptions because of either a lack of resources or they do not have closures. Of the remaining areas, 50 are low risk, 4 are medium risk, and 1, Jamaica Bay, is high risk {pers. comm., Jennifer O'Dwyer 2015}. New York's robust enforcement strategy is considered highly effective.

Northwest Atlantic | United States | North Carolina | Hand implements

Highly effective

Regulations are enforced by the North Carolina Marine Patrol through regular patrols and are independently verified through the trip ticket program (NCDMF 2012). A mandatory, dealer-based, trip-level reporting system has been in place since 1994 (NCDMF 2017). Patrol officers heavily enforce hard clam regulations, especially related to fishing with mechanical gear (NCDMF 2017). The fishery is actively enforced and receives a score of highly effective.

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery

Highly effective

The Rhode Island Department of Environmental Management administers regulatory programs and enforces compliance through its licensing system (Rhode Island 2014). Enforcement is done by the Bureau of Natural Resources Fish and Wildlife & Law Enforcement. Marine officers are in charge of enforcing fishing regulations, patroling the coast, and providing security for emergency closures for shellfishing (DEM 2018). The fishery is actively monitored and regulations are enforced, resulting in a score of highly effective.

Factor 3.5 - Stakeholder Inclusion

Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Highly effective
Under municipal shellfish management plans, towns can elect or appoint members of a shellfish committee. In its guidance documents, the state suggests that committees host monthly meetings that encourage harvester participation and address user conflicts (MDMR 2016). Municipalities are required to provide notification to the public of any shellfish openings or closures (MDMR 2016), which demonstrates a level of transparency. Further, these types of changes also require approval from state biologists, showing a constructive relationship between managers and scientists. Finally, the Maine Clammers Association actively participates in shellfish management and has advocated for an "ecology-based active shellfish management approach" (Maine Clammers Association 2018). Because over 70 municipalities have shellfish management plans, combined with the nature of these plans as mentioned in Factor 3.1, this fishery scores highly effective for stakeholder inclusion.

Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery

Highly effective
Decisions regarding shellfish management are made at public meetings, which are announced to stakeholders in accordance with Massachusetts General Laws Chapter 39, Section 23B (Wellfleet 2012)(MDMF 2012b). Massachusetts has a Shellfish Advisory Panel that provides communication between industry and managers. The panel includes representatives from the fishing industry, academia, conservation groups, and municipal shellfish officials (see https://www.mass.gov/orgs/shellfish-advisory-panel for a current list of members). Because the management process is transparent and includes stakeholder input, stakeholder inclusion is considered highly effective.

Northwest Atlantic | United States | New Jersey | Hand implements

Highly effective
New Jersey first implemented its "comanagement" strategy in 1985 to increase clam production in the state. The program involved the creation of spawner sanctuaries, and its members included state officials, shellfishers, and scientists, but early success of the restoration efforts was limited by a variety of factors (Bricelj et al. 2017). New Jersey has both a Marine Fisheries Council and a Shellfisheries Council. The Marine Fisheries Council must comprise various fishers (including two shellfishers), two members of the public, and one active fish processor (NJDEP 2018b). This council meets twice monthly, prepares management plans, holds public hearings, and performs other duties related to fisheries within the state (NJDEP 2018b). Because New Jersey's fishery has a long history of comanagement and ample opportunity for stakeholder input, we award a highly effective score.

Northwest Atlantic | United States | New York | Hand implements

Highly effective

The management process is transparent and stakeholders have the opportunity to comment on the state's comprehensive wildlife conservation strategy plan (NYSDEC 2005). The Department of Environmental Conservation (DEC) has a Marine Resources Advisory Council, comprising members from the commercial and recreational fishing industry and one member from the School of Marine and Atmospheric Sciences at SUNY Stony Brook (or a designee) (NYSDEC 2018c). This council advises DEC on marine resource issues. The DEC has a Shellfish Advisory Committee made of local town officials and industry members, specifically baymen's groups. The meetings are open to the public and occur multiple times per year {pers. comm., Jennifer O'Dwyer 2015}. Therefore, stakeholder inclusion is considered highly effective.

Northwest Atlantic | United States | North Carolina | Hand implements

Highly effective

North Carolina allows for stakeholder involvement through its fisheries commission. The North Carolina Marine Fisheries Commission regularly holds public meetings; commission members include commercial and recreational fishing industry representatives, scientists, and at-large selections (NCDEQ 2018). The state also offers mediation services to address user conflicts; mediation is managed by a neutral third party (NCDEQ 2018b). The management process is transparent and includes avenues for stakeholder input. We award a highly effective score.

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery

Highly effective

Shellfish fisheries in Rhode Island are managed under the Rhode Island Shellfish Management Plan (SMP). The SMP was created by a diverse group of stakeholders, including industry representatives, state and federal management agencies, nonprofit organizations, and members of academia (Rhode Island 2014). The creation of the SMP was guided by a transparent and open process, and included dozens of stakeholder meetings and educational events (Rhode Island 2014). One of the objectives of the management of hard clams is to maintain the existing social and cultural characteristics of the fishery wherever possible (Rhode Island 2014). The management process is transparent and includes stakeholder input, scoring highly effective for stakeholder inclusion.

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***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- 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.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Northwest Atlantic | United States | Maine | Hand implements	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Northwest Atlantic | United States | New Jersey | Hand implements	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Northwest Atlantic | United States | New York | Hand implements	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Northwest Atlantic | United States | North Carolina | Hand implements	Score: 3	+.5	Moderate Concern	**Green (3.240)**
Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**

All states participate in the the National Shellfish Sanitation Program (NSSP), a cooperative program that helps to assure the safety of shellfish consumption (NSSP 2019). Through participation in the NSSP, states may close marine waters to shellfishing because of concerns with pollution or the algae that causes paralytic shellfish poisoning. These closures may create refuges for northern quahog and softshell clam, but we cannot quantify the amount of habitat that is indirectly protected from fishing gear through sanitation closures.

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g.,*

cobble or boulder)

- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl) Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.*

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

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

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

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

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

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | North Carolina | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | New Jersey | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Score: 3

A rake is dragged through the sediment and pulled toward the raker on intertidal beaches; raking through water is ineffective because the silty water makes it difficult to locate clams (MacKenzie et al. 2002b). Rakes are known to affect bottom habitats and benthic infauna (Brown and Wilson 1997), and the resulting sediment disturbance can smother oysters and other sessile organisms (Lenihan and Micheli 2000). The effects on community composition vary according to the intensity of effort (Kaiser et al. 2001), but there are unlikely to be significant areas untouched by diggers targeting hard clams, other bivalve mollusks, and marine worms (Brown and Wilson 1997). This fishery scored 3 for this category because of its low to moderate disturbance to mud and sand substrates.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | New Jersey | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Score: 0

Maine and Massachusetts

Spatial areas can be closed to clam raking if the water quality is so poor that it threatens shellfish consumers (MDMR 2012)(MDMF 2017). Other spatial closures, such as closures for successful recruitment and restrictions to fishing effort, happen on the local level in both Maine and Massachusetts (MDMR 2016)(Sea Grant Woods Hole 2000). Because conservation closures primarily occur at the local level, the percentage of habitats protected from all bottom contact cannot be quantified. Therefore, no mitigation credit is awarded.

New Jersey

New Jersey has initiated shellfish restoration projects, created spawner sanctuaries, and designated the state's first marine conservation zone; commercial shellfishing is prohibited in the protected area but recreational shellfishing is permitted (Bricelj et al. 2017). New Jersey does have some mitigation measures, but recreational raking is still allowed in protected areas, so no mitigation credit is awarded.

New York

New York closes spatial areas in response to marine biotoxins, viruses, and bacteria that make shellfish hazardous for consumption (NYSDEC 2015), but there is minimal mitigation for this gear.

Northwest Atlantic | United States | North Carolina | Hand implements

+.5

The North Carolina Division of Marine Fisheries (NCDMF) has mapped roughly 95% of commercial shellfish habitat, of which 3.59% (21,221 acres) are classified as shell bottom, where >30% of the bottom is covered by living or dead shells and it is known to provide protection for adult and juvenile northern quahogs (NCDMF 2017). Also, North Carolina has established shellfish sanctuaries to protect habitats for oysters and northern quahog; currently, 228 acres are designated as shellfish sanctuaries (NCDMF 2017). The state prohibits certain bottom gears from areas that contain submerged aquatic vegetation, shell bottom, or serve as nursery grounds for finfish, but hand rakes are still permitted (NCDMF 2017). In addition, bottom habitats are protected from fishing in Military Restricted Areas; these areas cover 104,452 acres of coastal area, of which 21,718 are estuarine habitat, but it is unknown what portion of this is clam habitat (NCDMF 2017). These measures are reasonably expected to be effective, so we award a mitigation credit of 0.5.

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery

Score: 0

Rhode Island closes areas to northern quahog harvest, protecting the clam stock and the habitat in spawner sanctuaries and management areas (Figures 8–10) (Rhode Island 2014). There are currently six spawner sanctuaries in the state that are permanently closed to fishing (RIDEM 2021). Because of the unsustainability of mechanical dredging for northern quahog, oysters, and softshell clam, the practice has been banned in the state since 1969 (Rhode Island 2014). The hand gears used in the fishery are managed to "help ensure continued sustainability of the resource and fishery and to conserve the natural habitat" (Rhode Island 2014). The primary management strategy of these spawning sanctuaries is to protect larval supply, rather than mitigate habitat damage from the fishing gear. A Rhode Island Shellfish Restoration and Enhancement Plan is currently being developed, although only a small portion of habitat is protected in spawner sanctuaries. Therefore, we do not award mitigation credit.

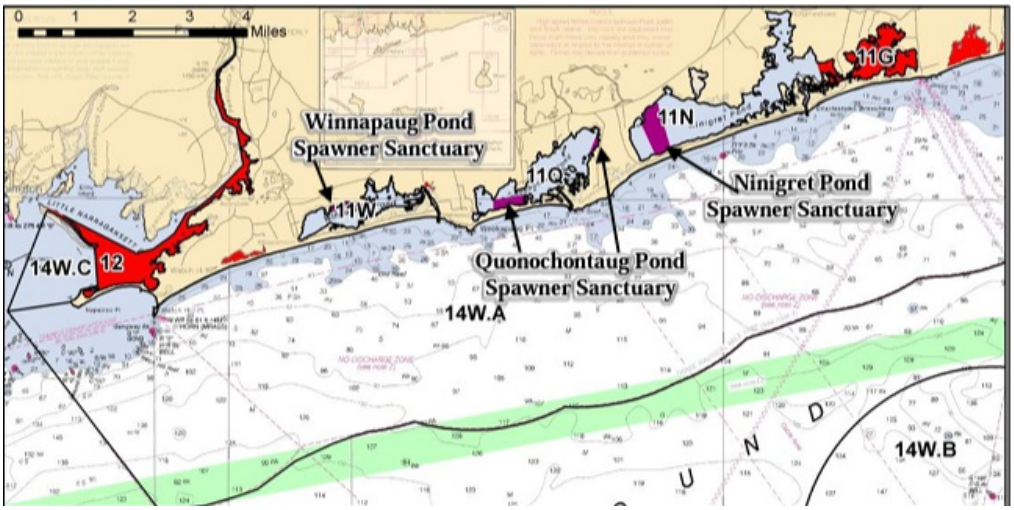

Figure 8: Winnapaug Pond, Quonochontaug Pond, and Ninigret Pond Spawner Sanctuaries in Rhode Island (RIDEM 2021).

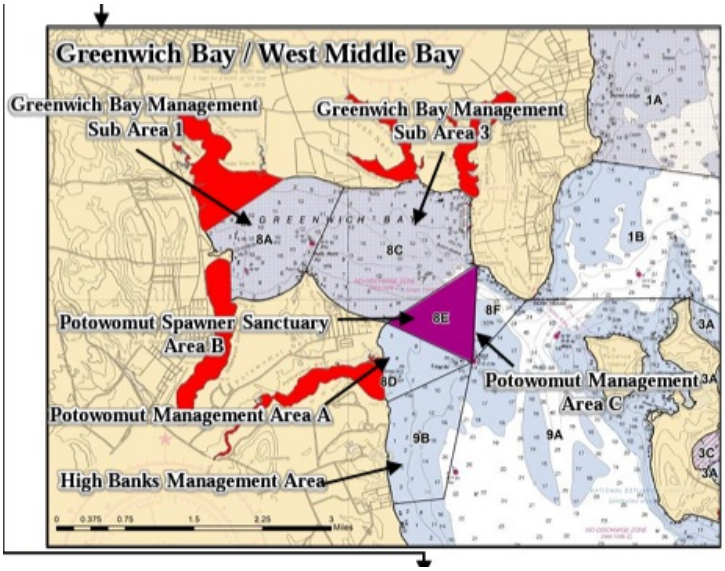

Figure 9: Potowomut Spawner Sanctuary in Rhode Island (RIDEM 2021).

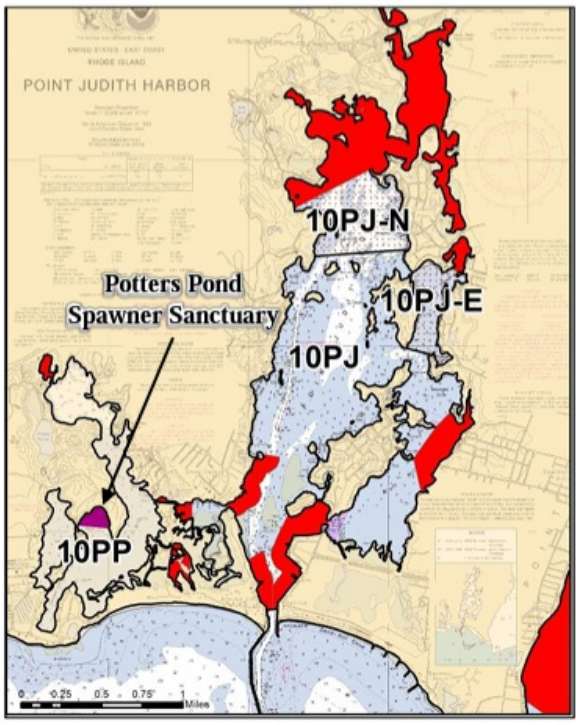

Figure 10: Potters Pond Spawner Sanctuary in Rhode Island (RIDEM 2021).

Factor 4.3 - Ecosystem-based Fisheries Management

Northwest Atlantic | United States | Rhode Island | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | North Carolina | Hand implements
Northwest Atlantic | United States | New York | Hand implements
Northwest Atlantic | United States | New Jersey | Hand implements
Northwest Atlantic | United States | Maine | Hand implements
Northwest Atlantic | United States | Massachusetts | Hand implements | Northern quahog Fishery
Northwest Atlantic | United States | Massachusetts | Hand implements | Softshell clam Fishery
Northwest Atlantic | United States | Maine | Hand implements | Softshell clam Fishery

Moderate Concern

Bivalves in dense aggregations can affect the abundance of phytoplankton, thus improving water quality and eutrophication control (Bricelj et al. 2017)(Dame 2012)(Alpine and Cloern 1992)(Asmus and Asmus 1993). The use of hand harvest to capture clams allows nontarget species to be returned to the substrate alive, resulting in negligible bycatch of species that are important for ecosystem functioning. But there are no efforts to fully assess the ecological impacts in the fishery.

Quahog veligers are fed on by larval fishes; juvenile clams are eaten by gastropods, decapods,

lobsters, various crabs, and birds (e.g., brants and herring gulls); and adults have fewer predators as they grow (MacKenzie et al. 2002a). Several states along the East Coast of the U.S. have established spawner sanctuaries to increase recruitment to unprotected areas and maintain the ecosystem function of clams and other bivalves (e.g., (Bricelj et al. 2017)(NCDMF 2017)(Rhode Island 2014)). This strategy is analogous to the reported spillover benefits of Marine Protected Areas to surrounding fishing areas (Rowley 1994), but the efficacy of the sanctuaries is variable (LoBue 2010)(Rhode Island 2014)(Bricelj et al. 2017). All states have harvest control rules in place, and states such as Maine, New York, and Massachusetts coordinate spatial closures at the municipal level (see section 3.1 for details).

There are few policies in place to protect ecosystem functioning and account for northern quahog's ecological role, but detrimental food web impacts are not likely. Therefore, we award a score of 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® is solely responsible for the conclusions reached in this report.

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Appendix A: Updates to the U.S. Atlantic Clam Report

2023

This report was reviewed for any significant stock status and management updates to the fishery in May 2023. Landings through 2022, trade data, and management and data collection measures were updated for all fisheries in this report. The Factor 3.3 score for northern quahog caught in Rhode Island was increased from "moderately effective" to "highly effective" because of the regular collection of data to inform stock status, despite an out-of-date peer-reviewed stock assessment. Overall, no ratings have changed.

2020

Updates to the December 4, 2015 U.S. Atlantic Clam report were made on April 8, 2020. The following recommendations were updated against the most recent version of the Seafood Watch Standard (F3.2).

- Overall recommendations for northern quahog caught with hand implements in Massachusetts, North Carolina, and New York were downgraded from Best Choice to Good Alternative when scored against version F3.2 of the Seafood Watch Standard.
- Overall recommendations for softshell clam caught with hand implements in Maine and Massachusetts were downgraded from Best Choice to Good Alternative when scored against version F3.2 of the Seafood Watch Standard.
- *New* recommendations for northern quahog caught with hand implements in Maine and New Jersey were added to the report.
- Recommendations for Atlantic surfclam and ocean quahog caught with clam dredges were removed from the report, and Seafood Watch defers to the Marine Stewardship Council's (MSC) certification for this fishery.

Other updates included:

- Criterion 3, northern quahog (Rhode Island): Upgraded from moderately effective to highly effective, because management targets have been defined and the fishery has precautionary policies in place that result in sustainable levels of fishing mortality.
- Criterion 4, northern quahog (North Carolina): Mitigation credits of +0.5 were given for Factor 4.2 because the state has mapped 95% of commercial shellfish habitat, established shellfish sanctuaries, prohibited certain bottom gears in shellfish habitat, and a significant portion of habitat is protected in military restricted areas.

Appendix B: Municipal Conservation Closures in Maine

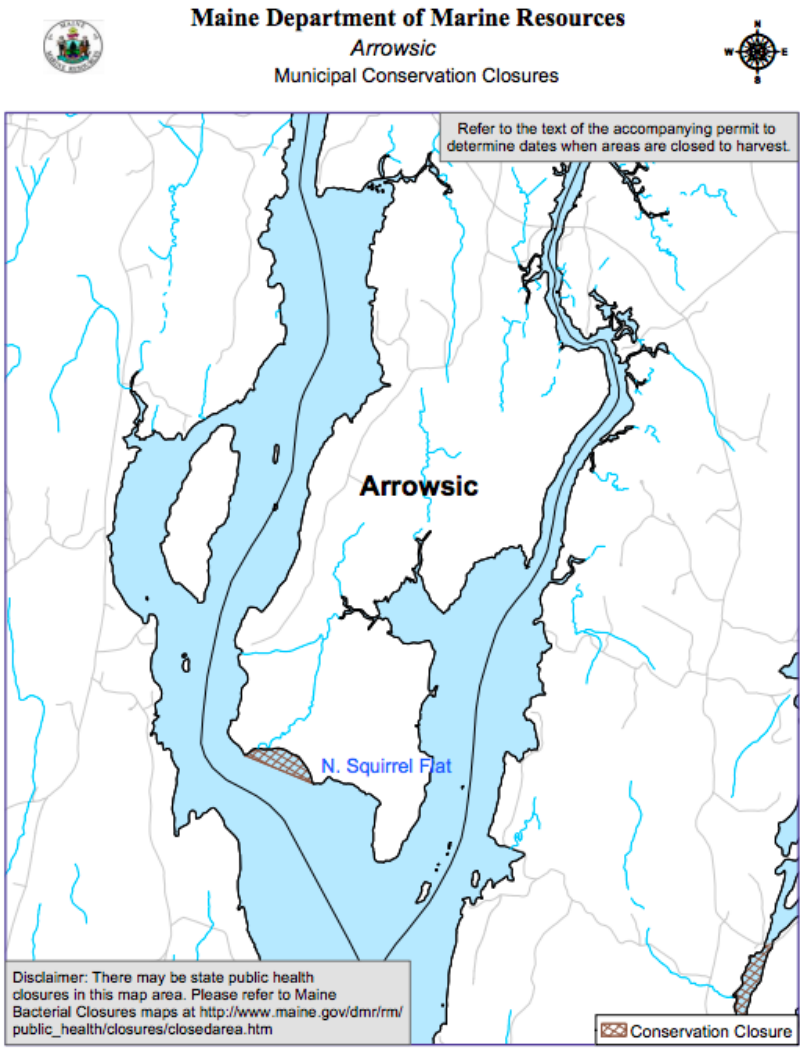

Figure 11: Municipal Conservation Closure Arrowsic. From {MDMR 2018}.

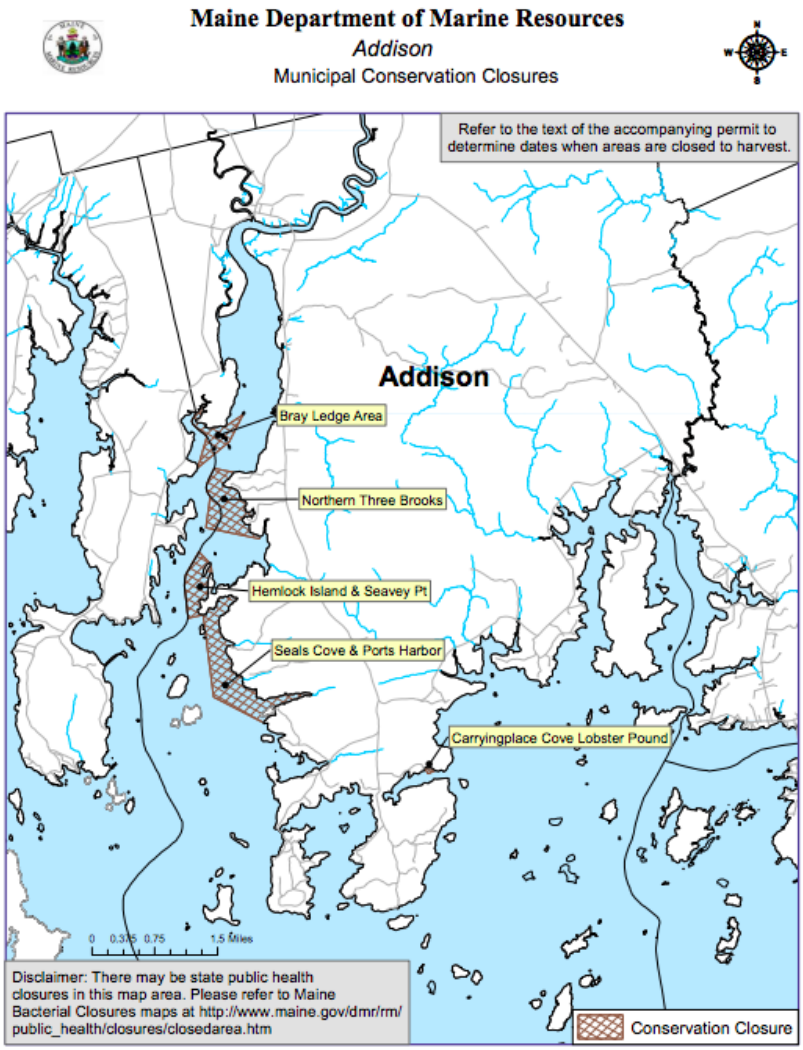

Figure 12: Municipal Conservation Closure Addison. From {MDMR 2018}.

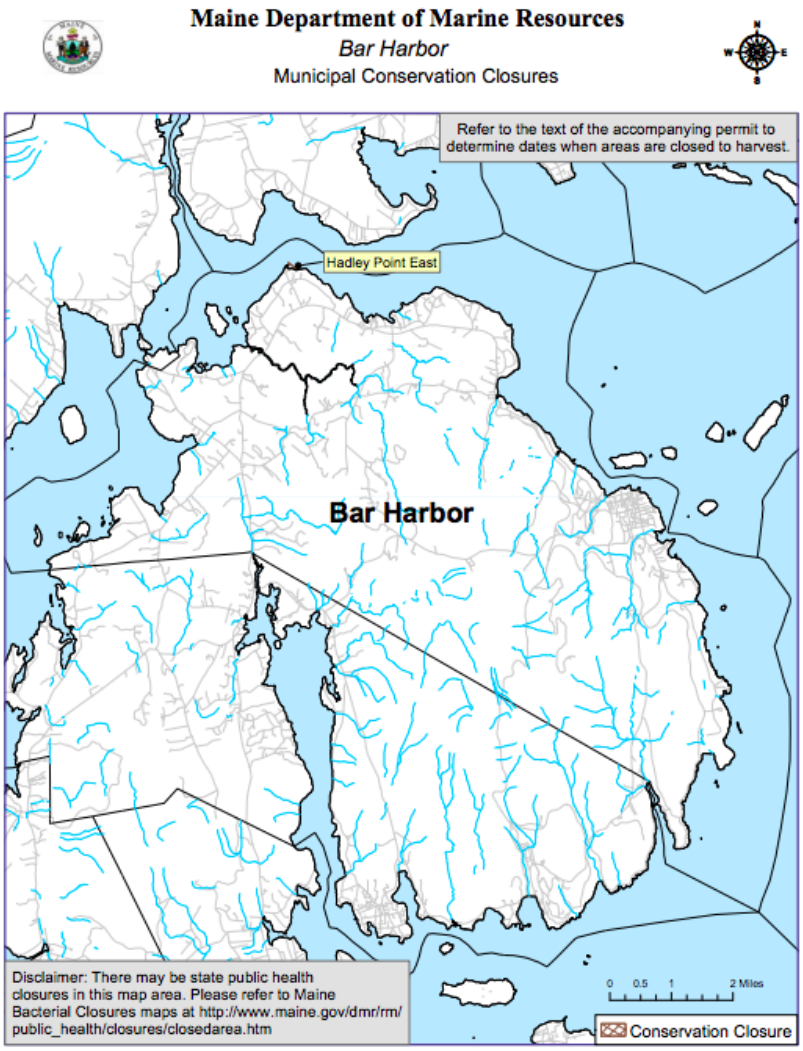

Figure 13: Municipal Conservation Closure Bar Harbor. From {MDMR 2018}.

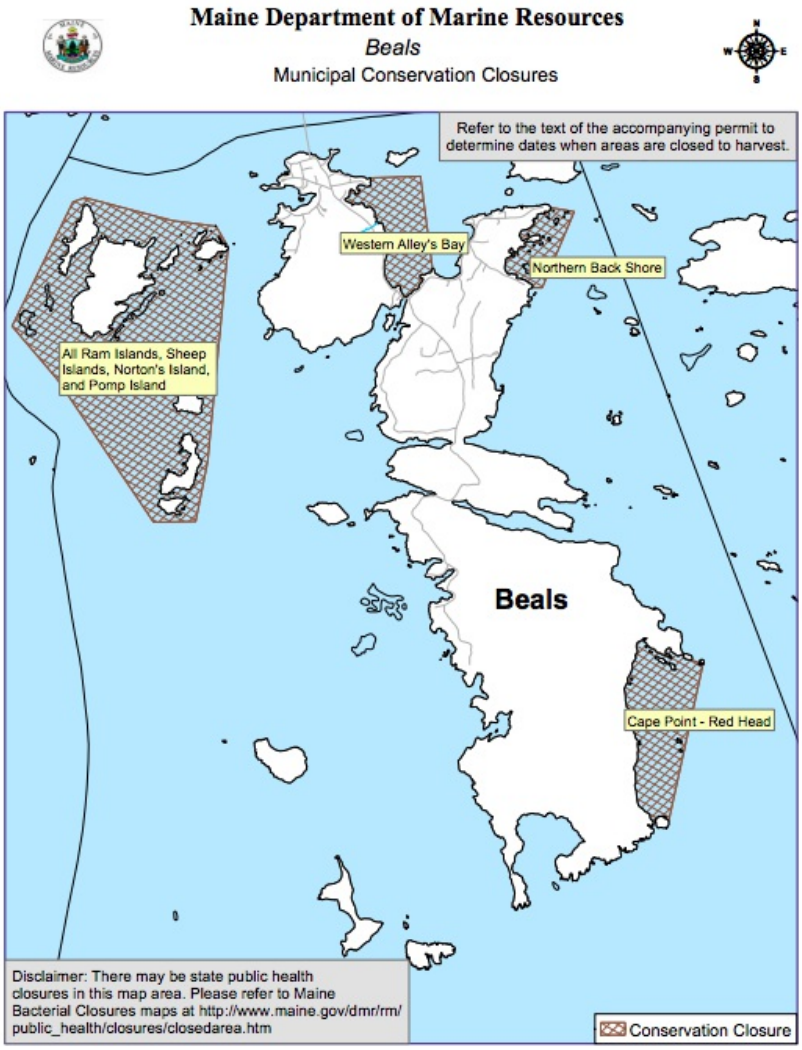

Figure 14: Municipal Conservation Closure Beals. From {MDMR 2018}.

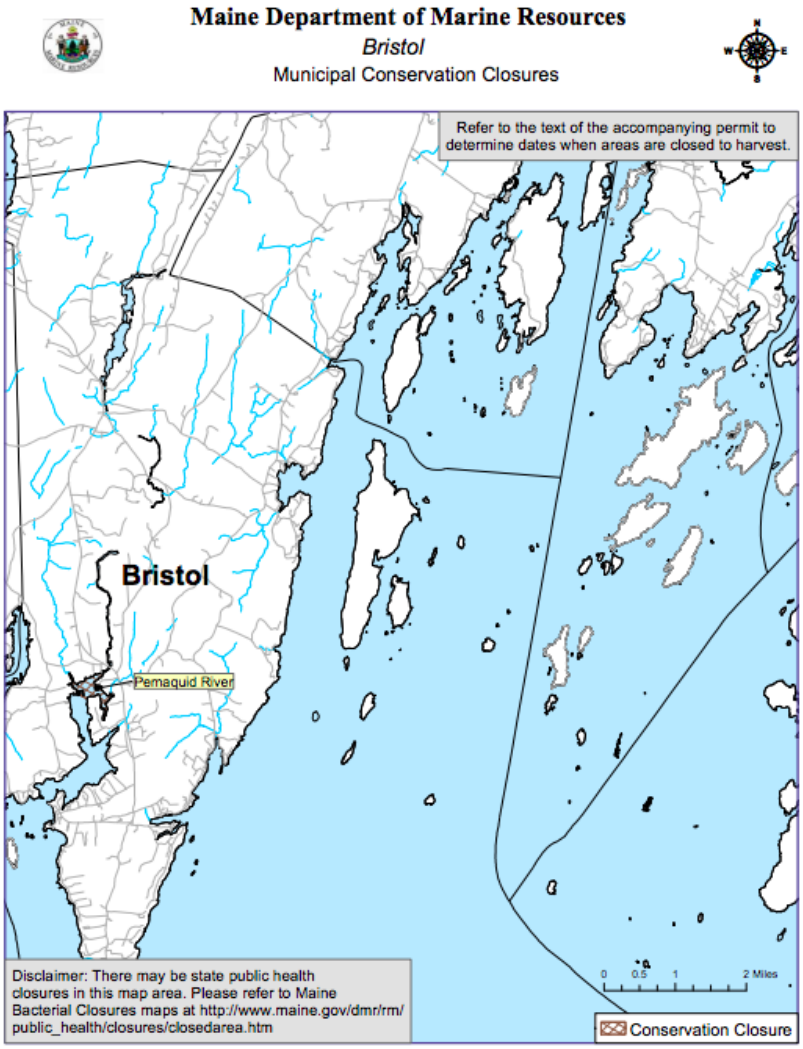

Figure 15: Municipal Conservation Closure Bristol. From {MDMR 2018}.

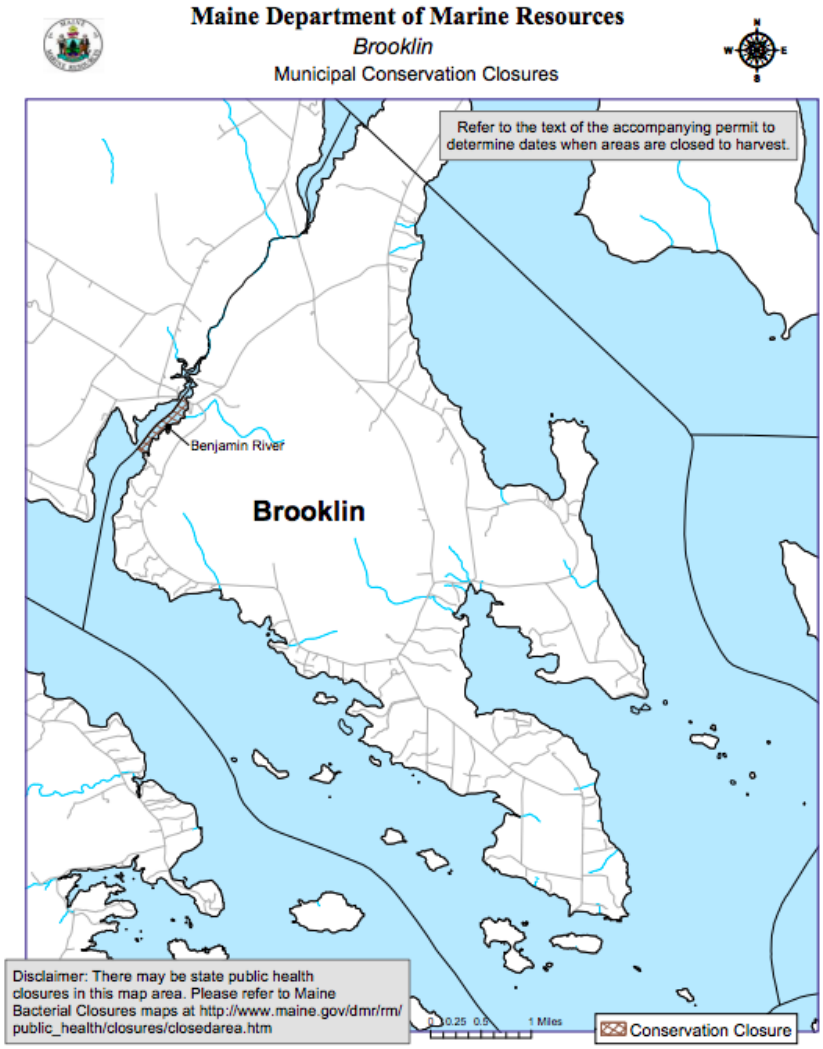

Figure 16: Municipal Conservation Closure Brooklin. From {MDMR 2018}.

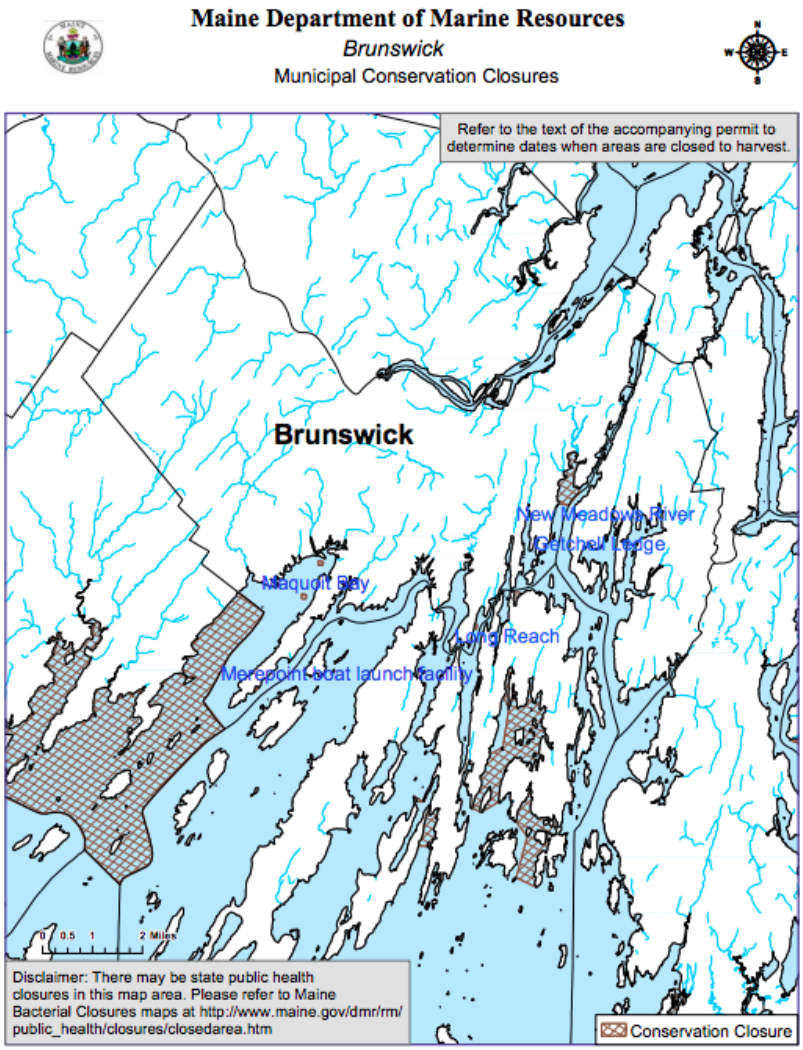

Figure 17: Municipal Conservation Closure Brunswick. From {MDMR 2018}.

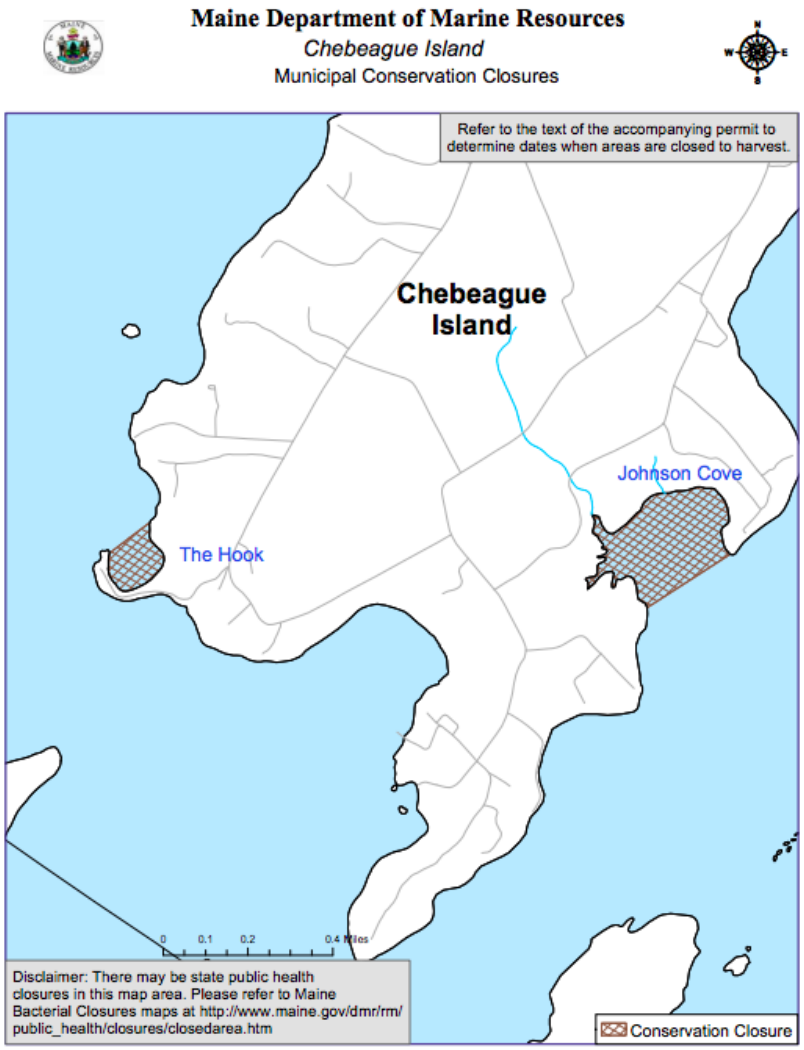

Figure 18: Municipal Conservation Closure Chebeague Island. From {MDMR 2018}.

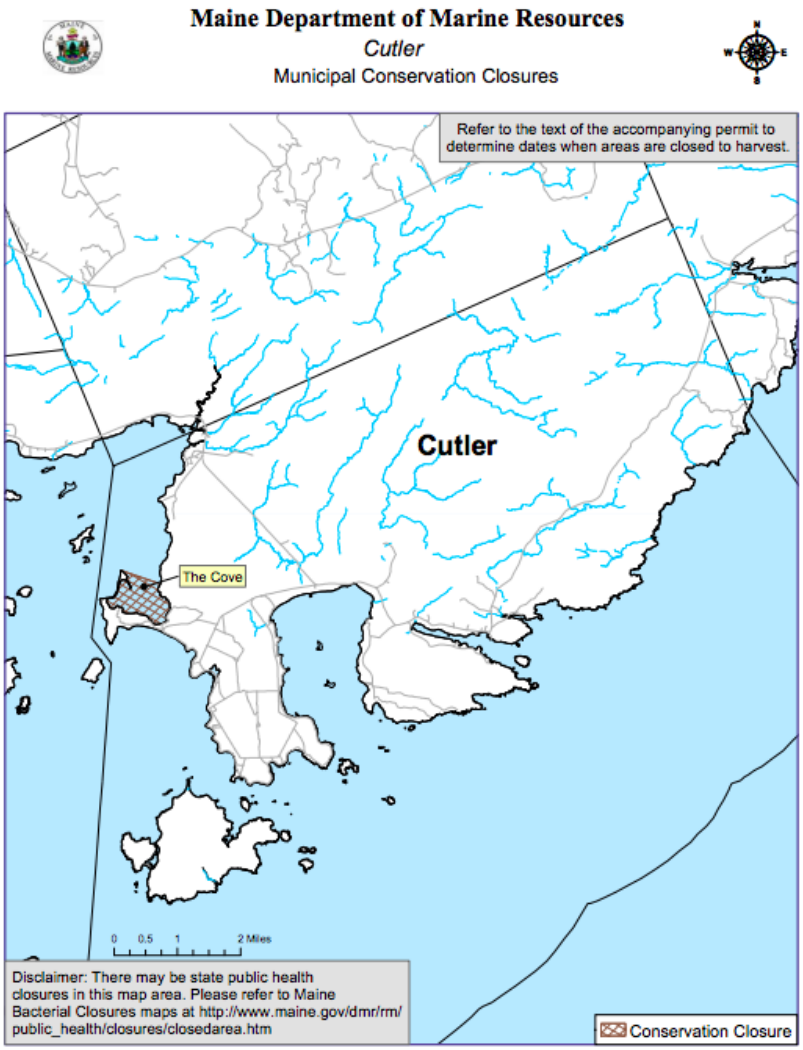

Figure 19: Municipal Conservation Closure Cutler. From {MDMR 2018}.

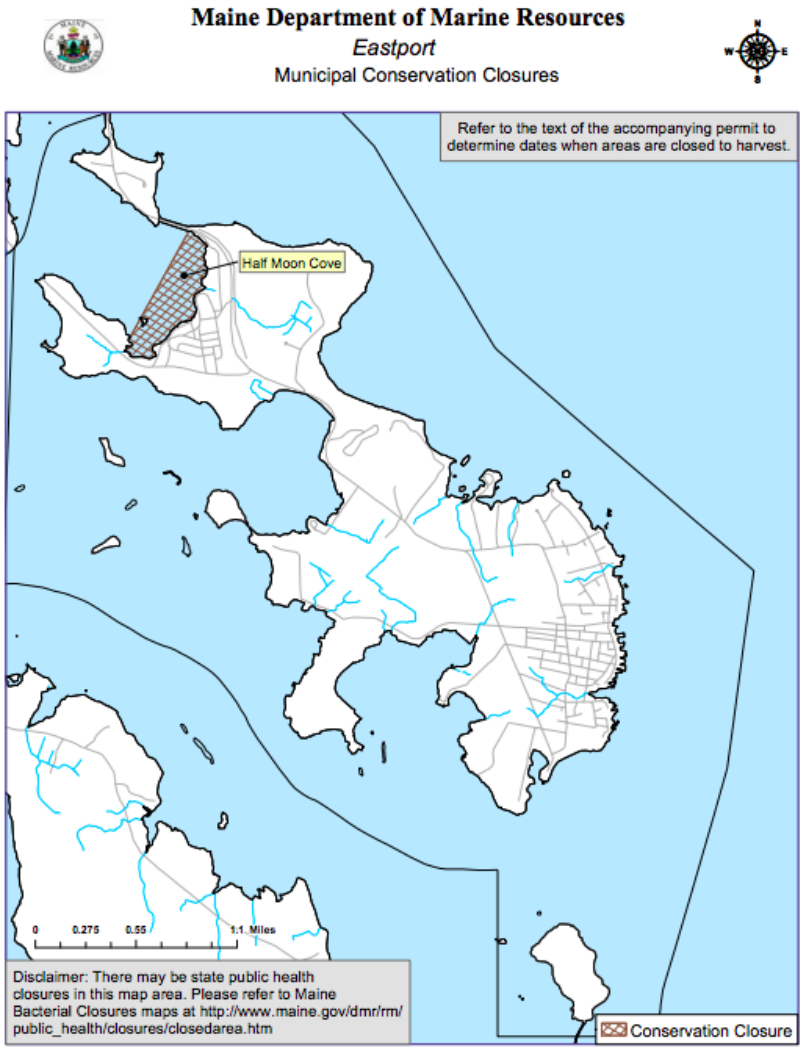

Figure 20: Municipal Conservation Closure Eastport. From {MDMR 2018}.

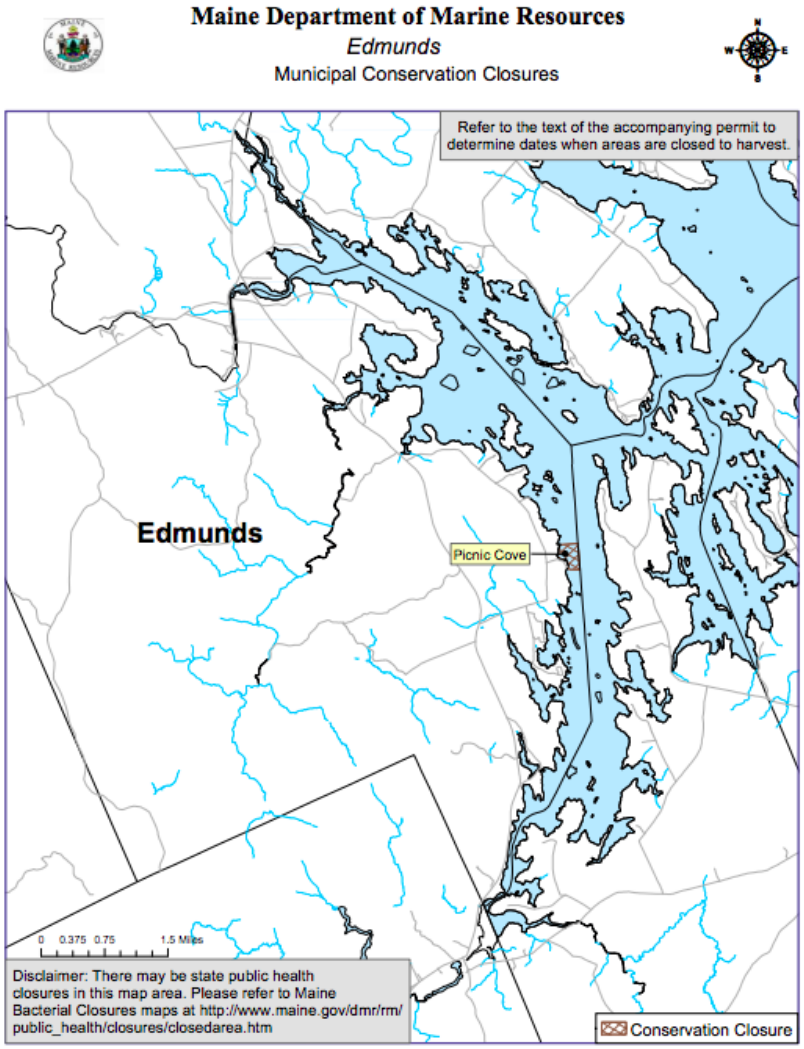

Figure 21: Municipal Conservation Closure Edmunds. From {MDMR 2018}.

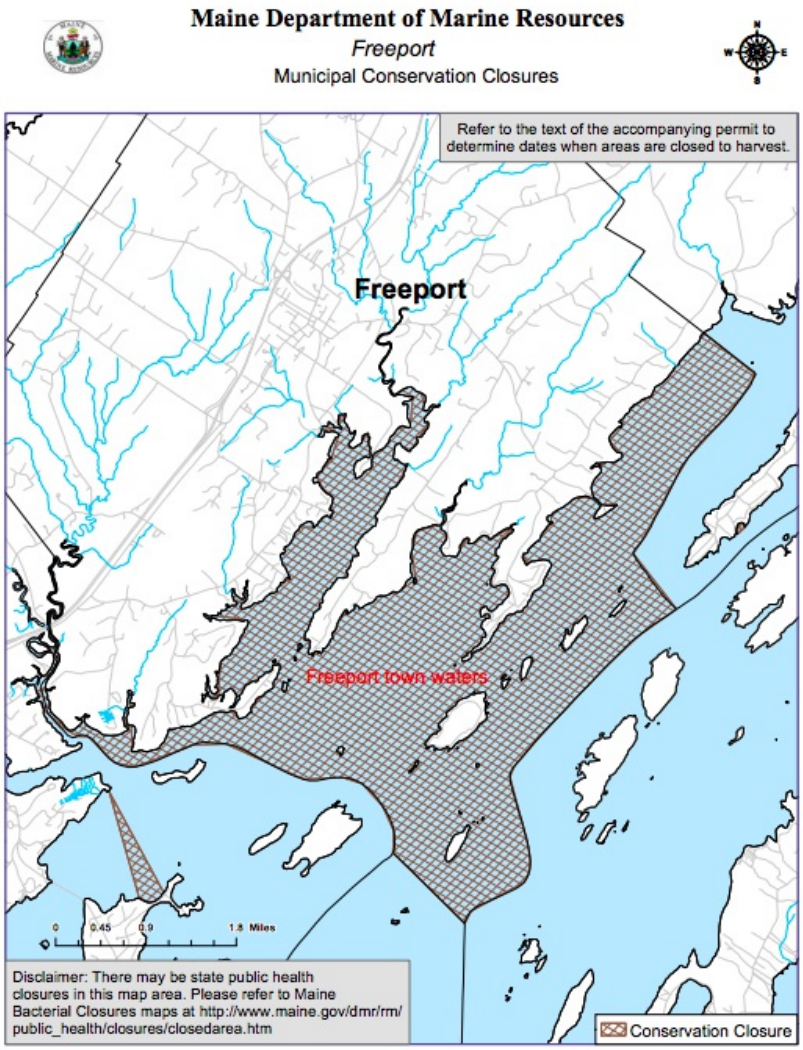

Figure 22: Municipal Conservation Closure Freeport. From {MDMR 2018}.

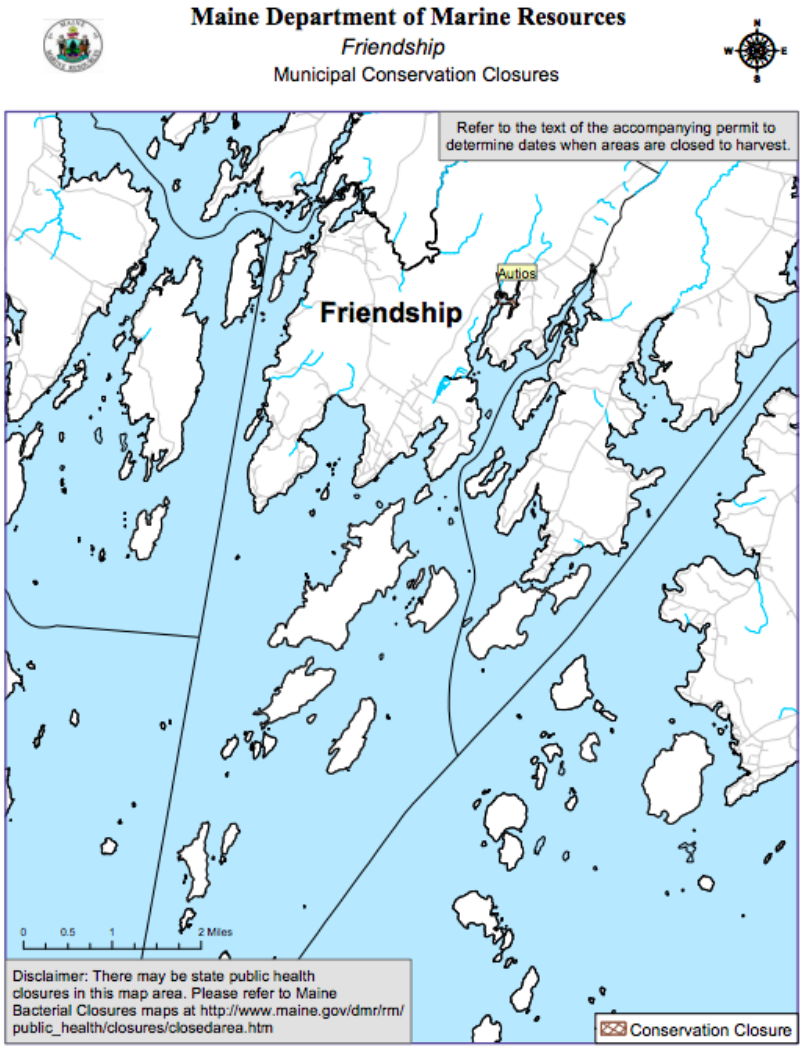

Figure 23: Municipal Conservation Closure Friendship. From {MDMR 2018}.

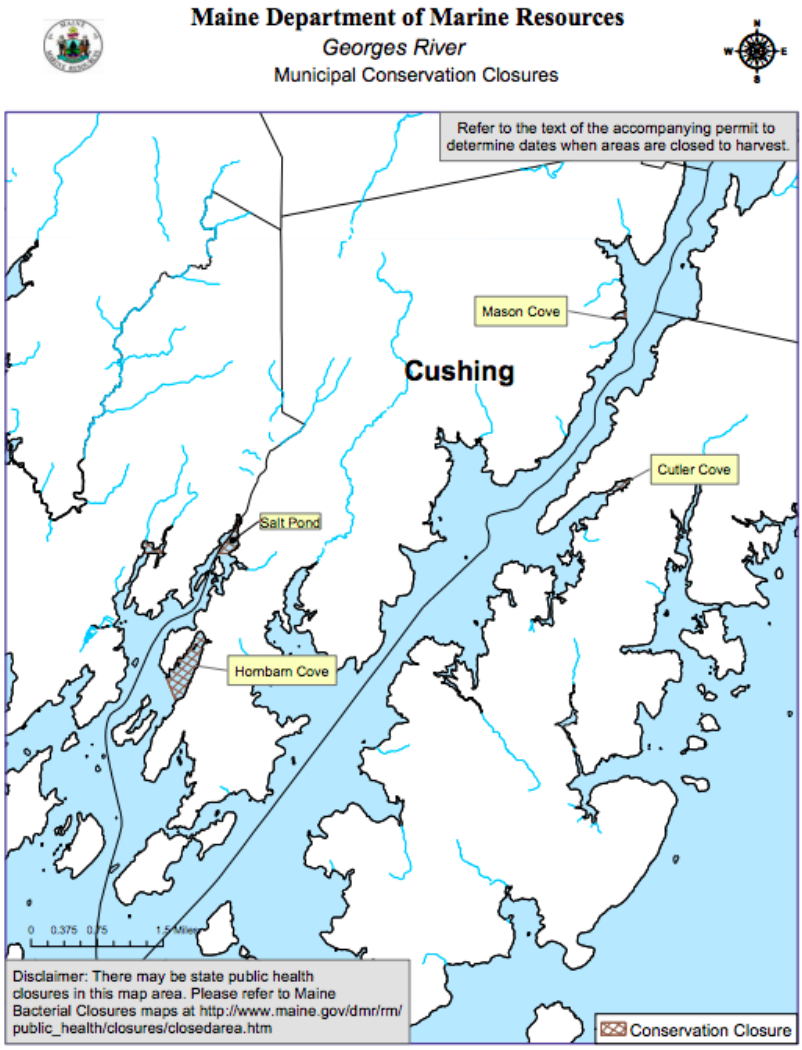

Figure 24: Municipal Conservation Closure Georges River. From {MDMR 2018}.

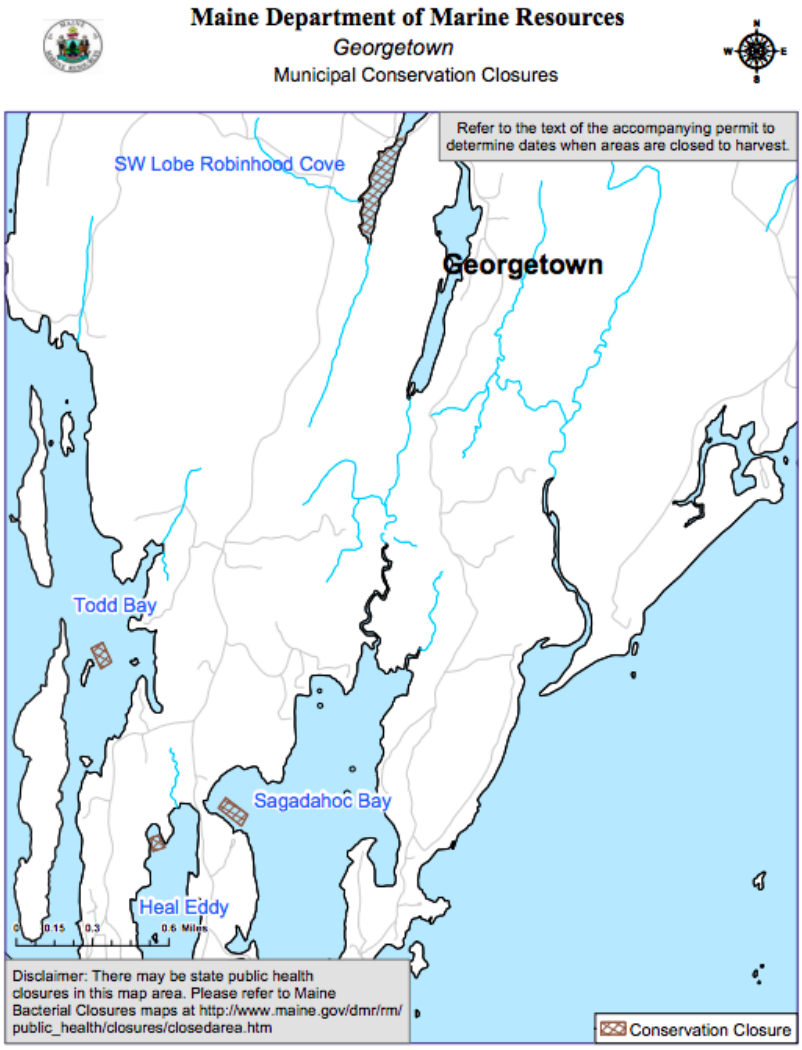

Figure 25: Municipal Conservation Closure Georgetown. From {MDMR 2018}.

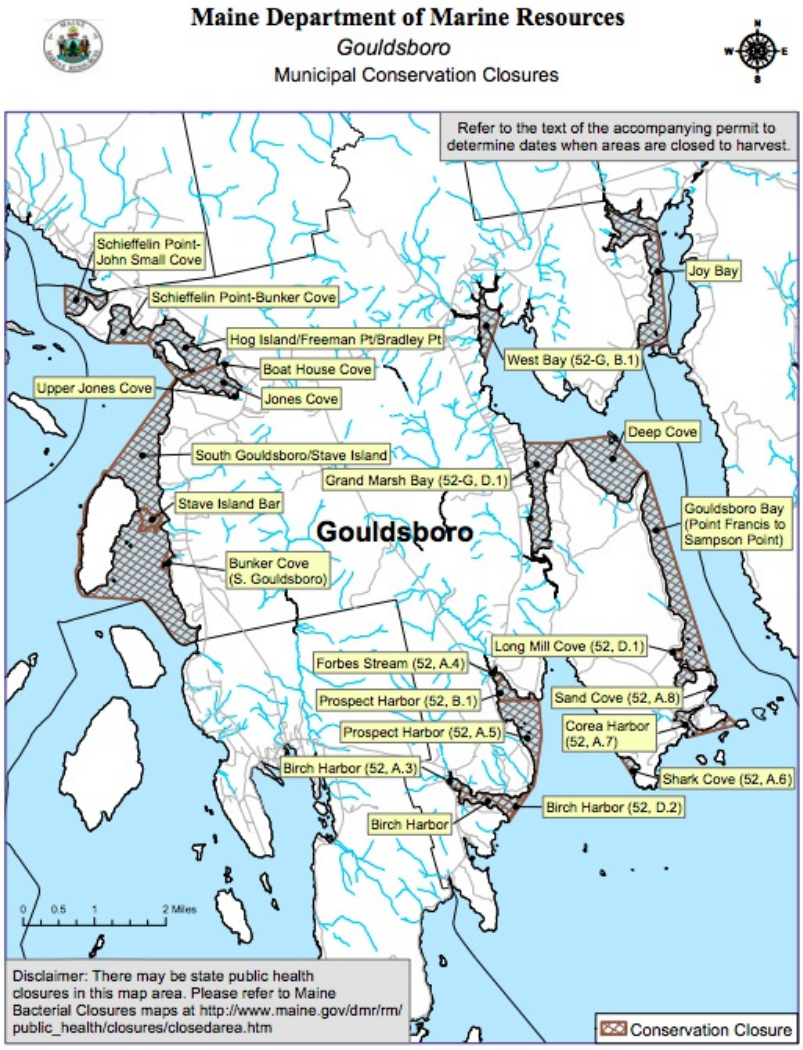

Figure 26: Municipal Conservation Closure Gouldsboro. From {MDMR 2018}.

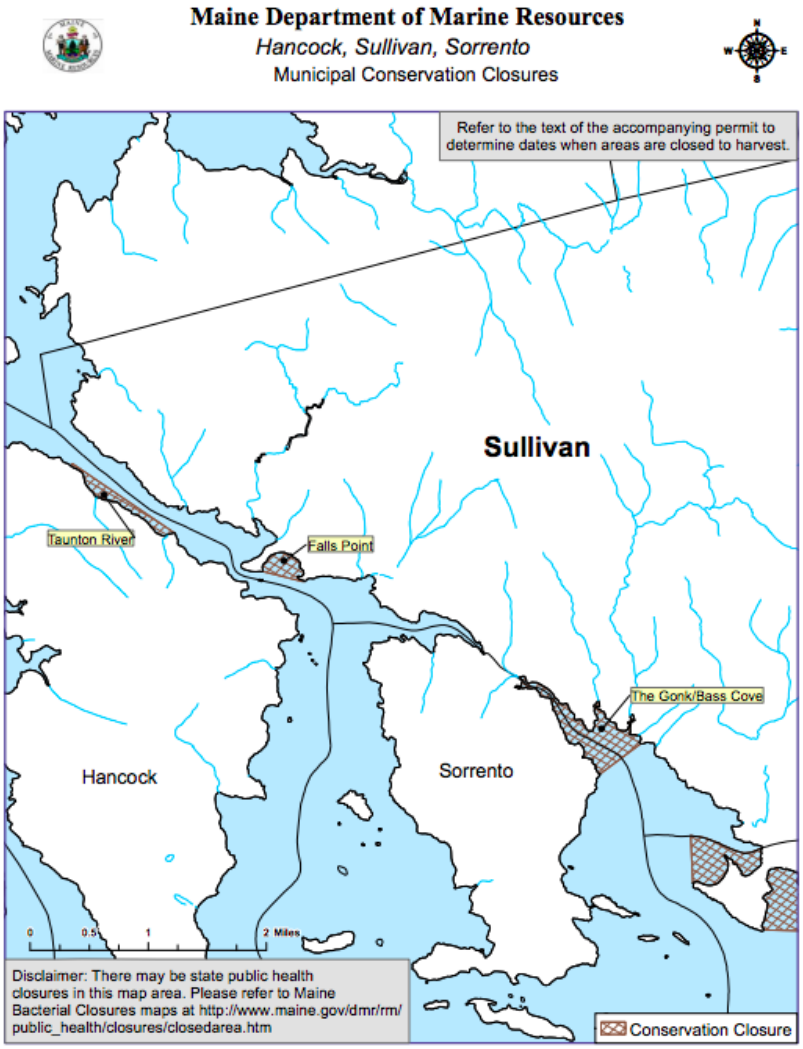

Figure 27: Municipal Conservation Closure Hancock, Sullivan, and Sorrento. From {MDMR 2018}.

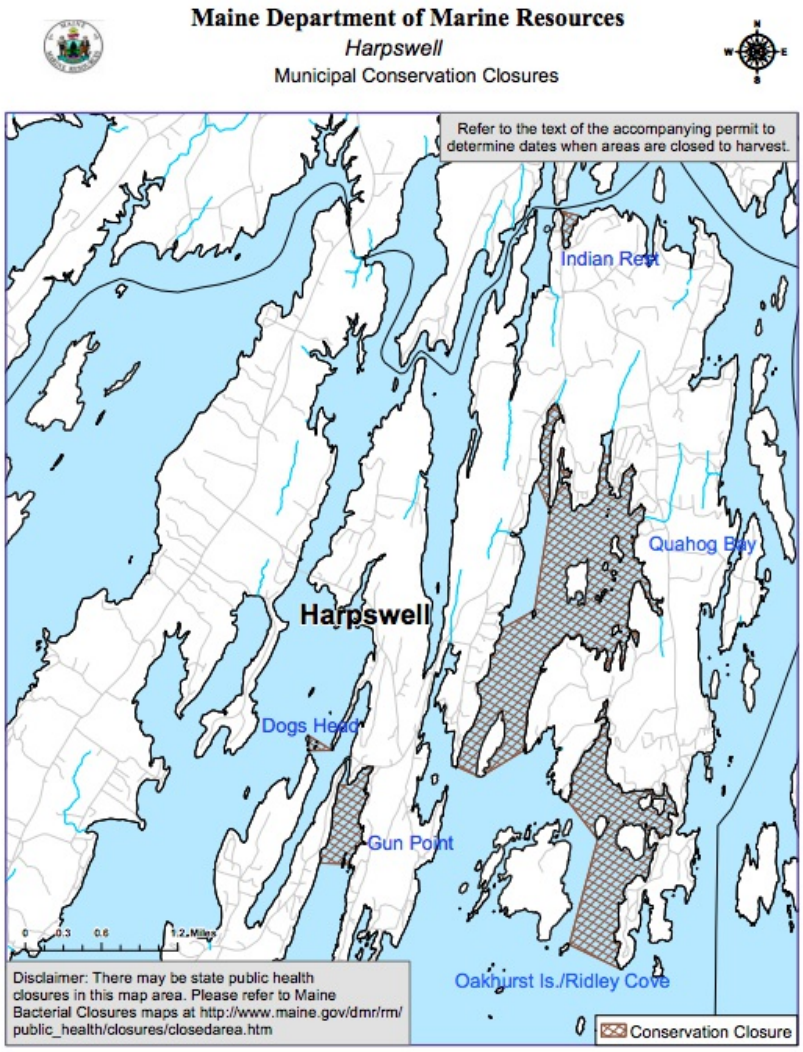

Figure 28: Municipal Conservation Closure Harpswell. From {MDMR 2018}.

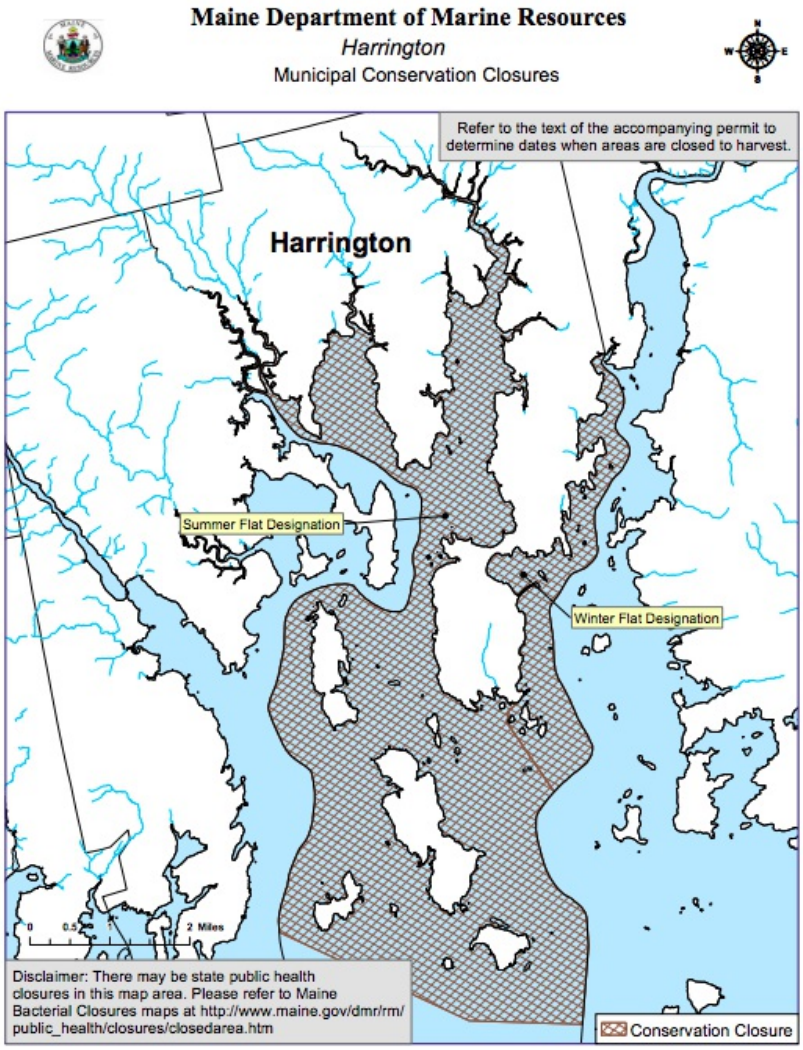

Figure 29: Municipal Conservation Closure Harrington. From {MDMR 2018}.

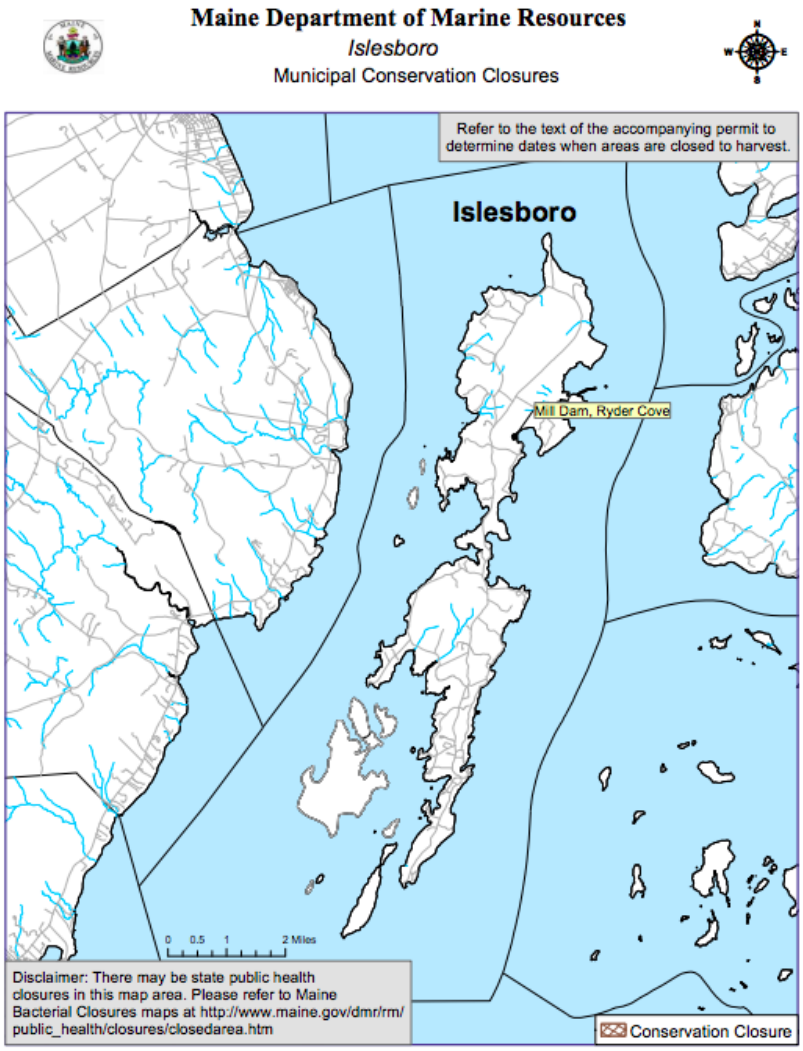

Figure 30: Municipal Conservation Closure Islesboro. From {MDMR 2018}.

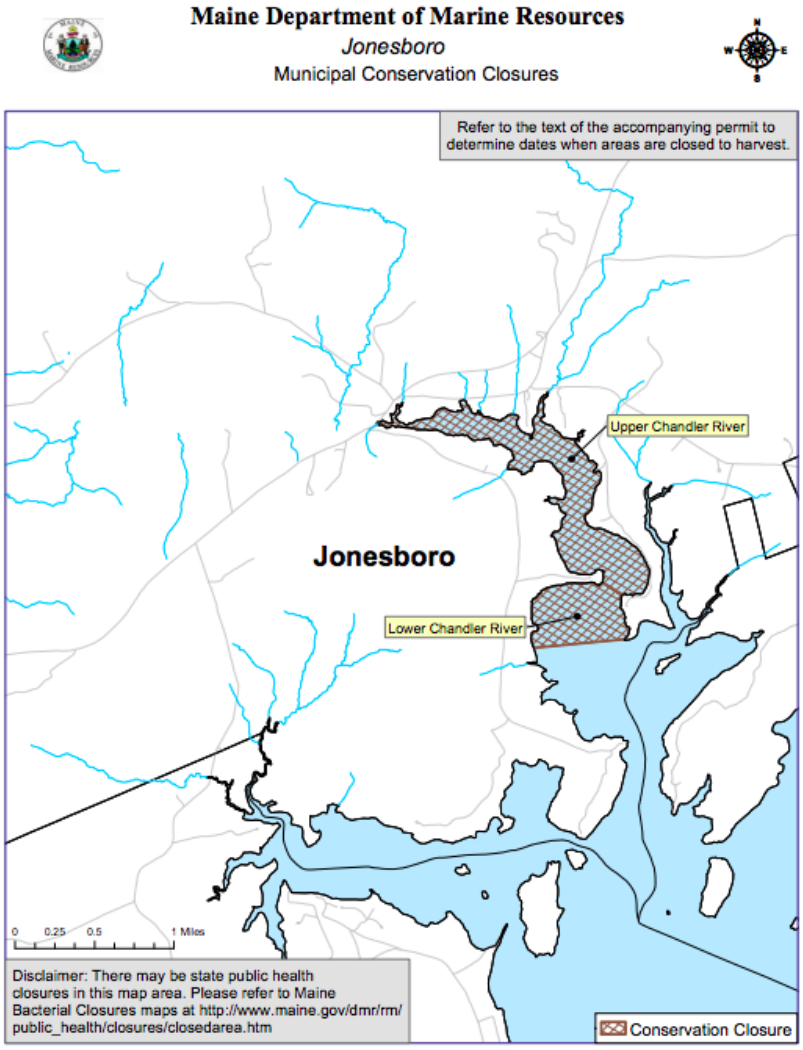

Figure 31: Municipal Conservation Closure Jonesboro. From {MDMR 2018}.

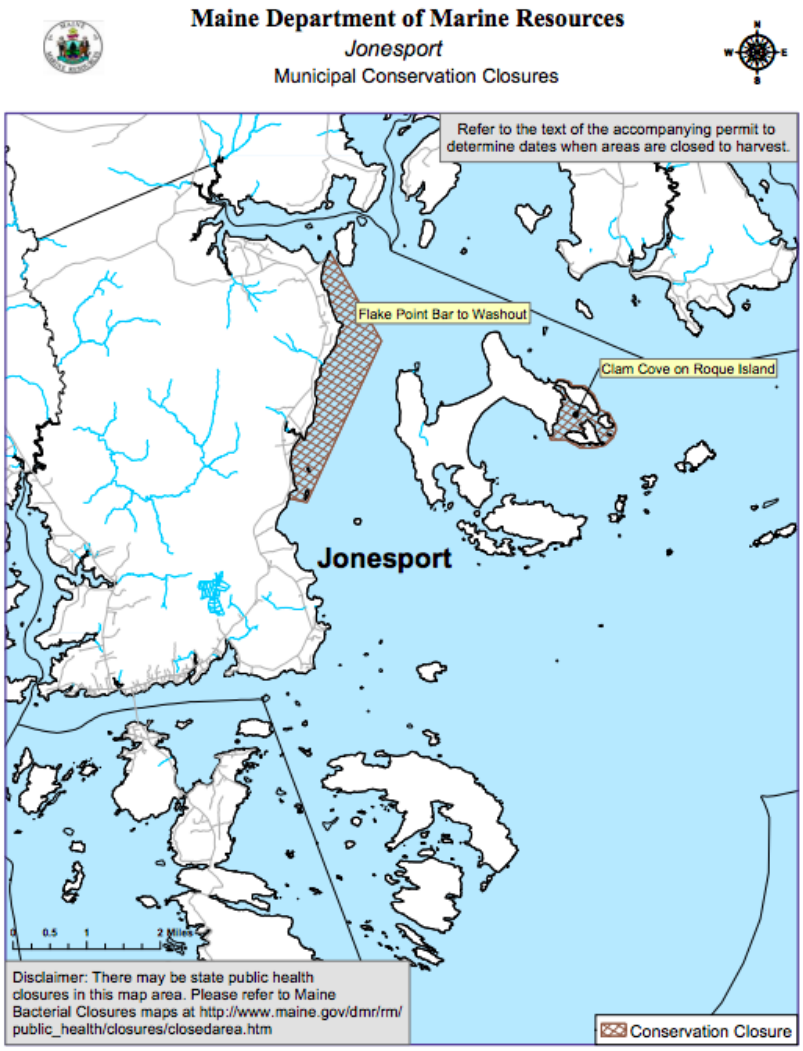

Figure 32: Municipal Conservation Closure Jonesport. From {MDMR 2018}.

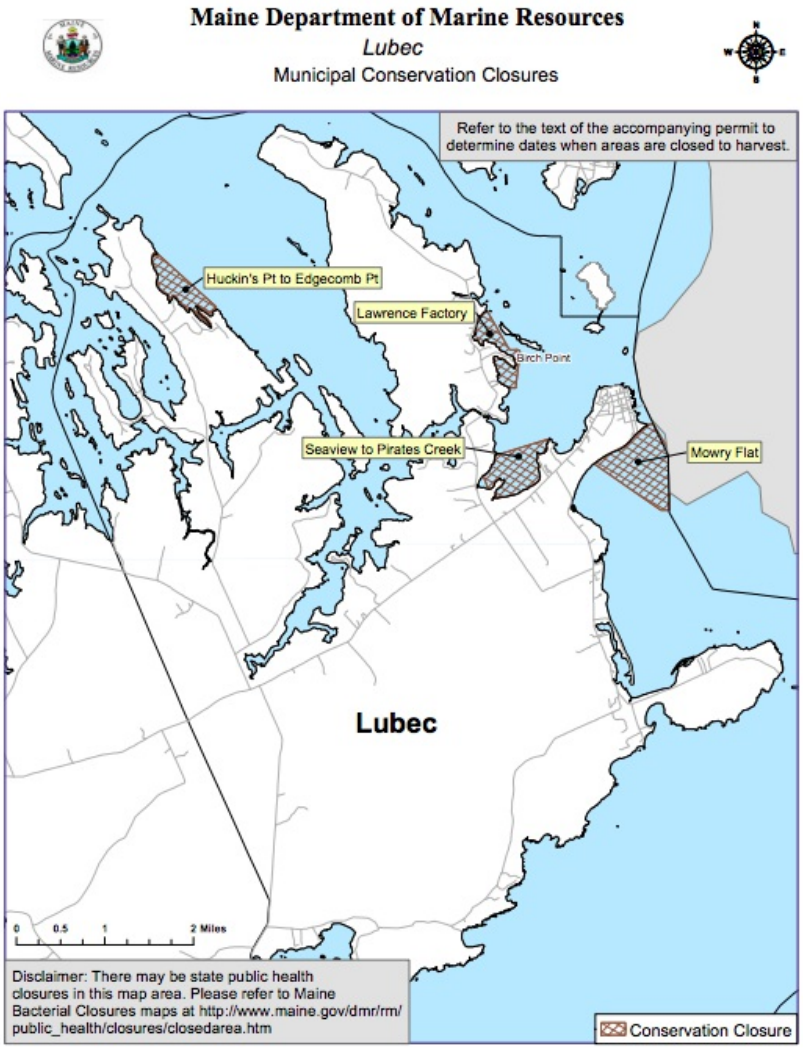

Figure 33: Municipal Conservation Closure Lubec. From {MDMR 2018}.

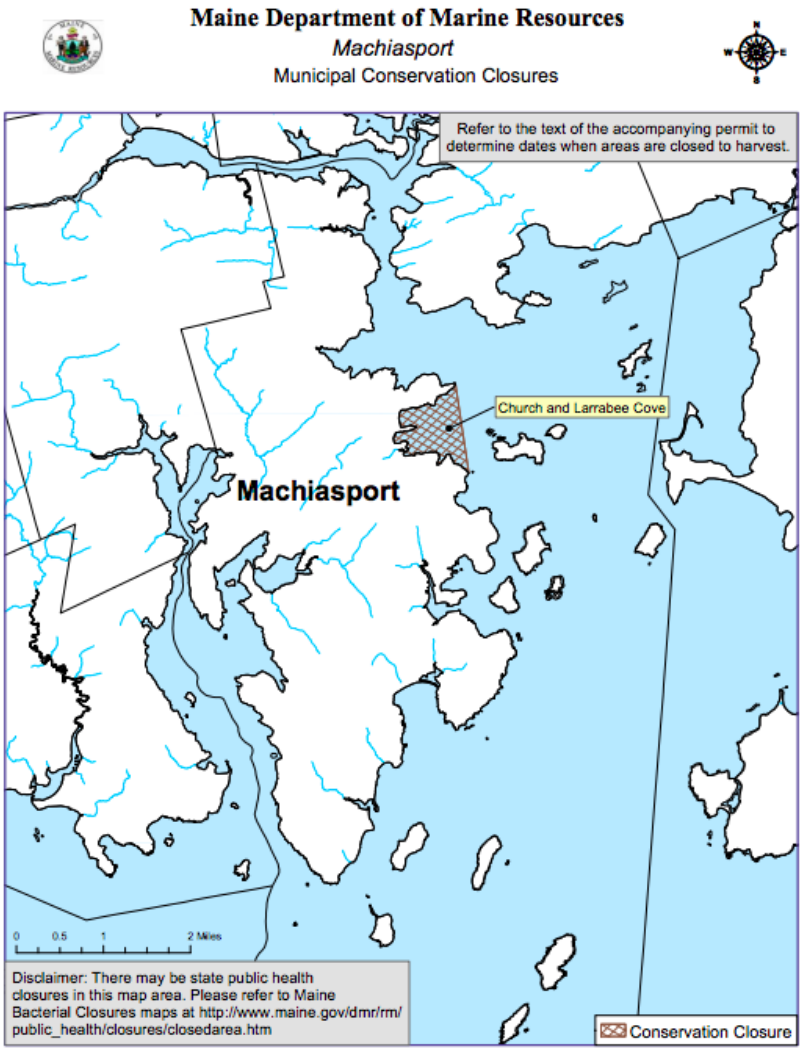

Figure 34: Municipal Conservation Closure Machiasport. From {MDMR 2018}.

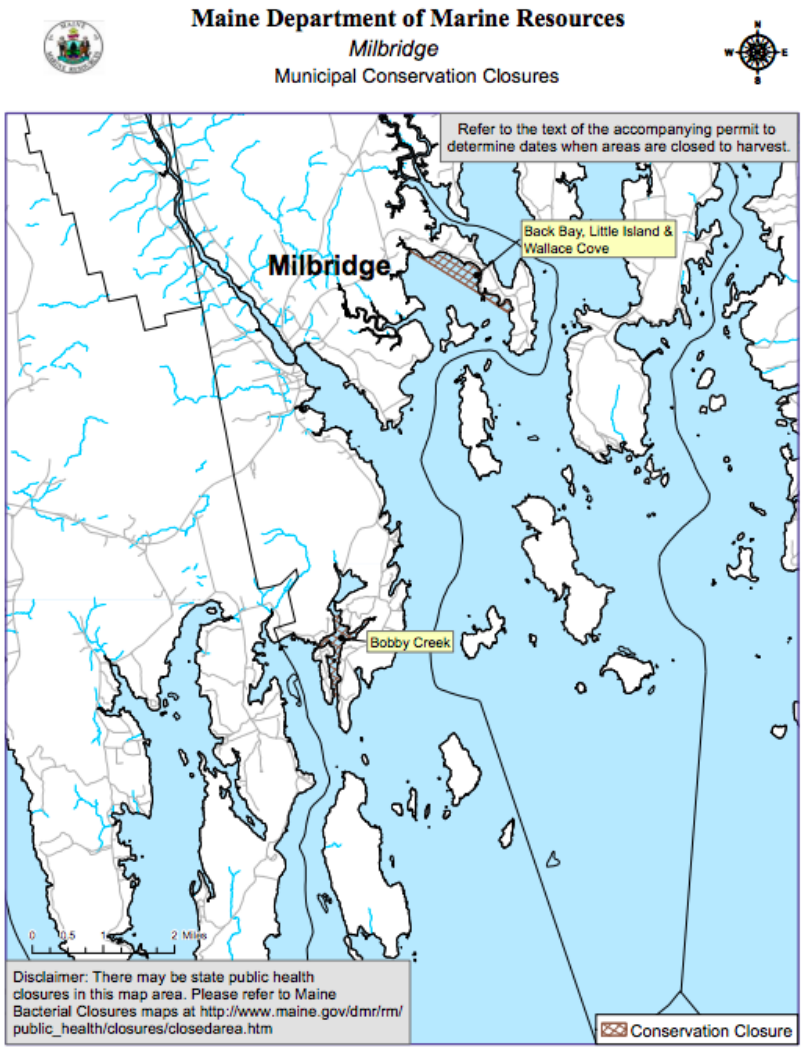

Figure 35: Municipal Conservation Closure Milbridge. From {MDMR 2018}.

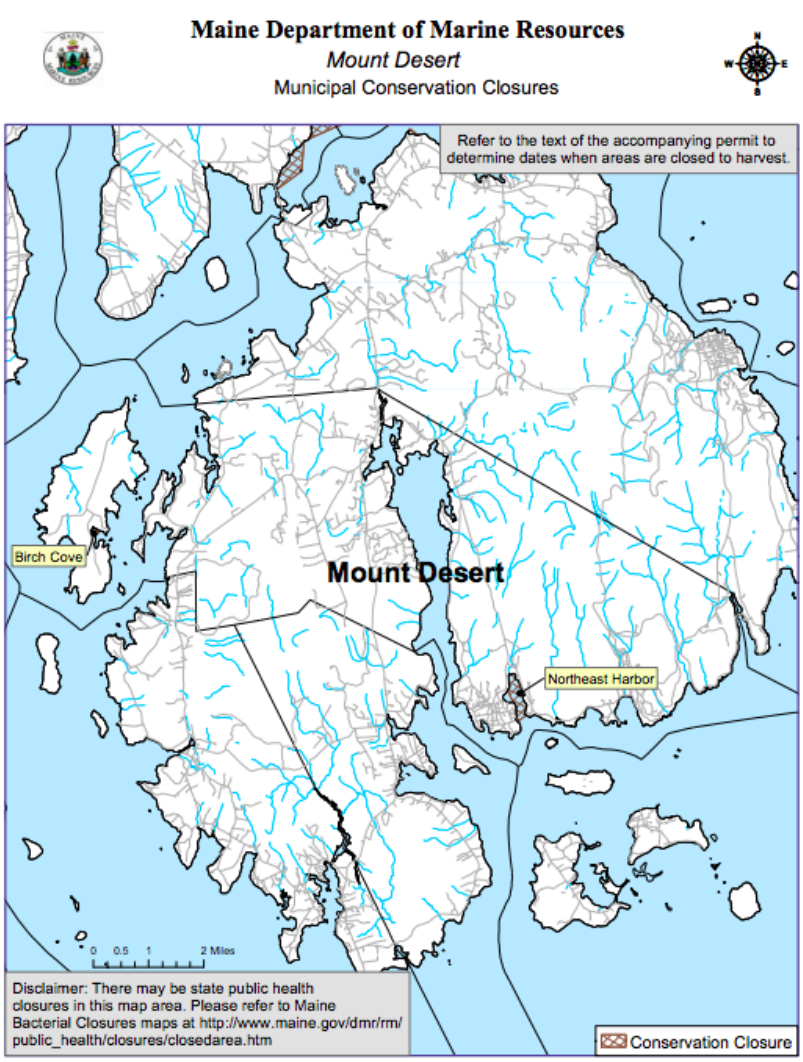

Figure 36: Municipal Conservation Closure Mount Desert. From {MDMR 2018}.

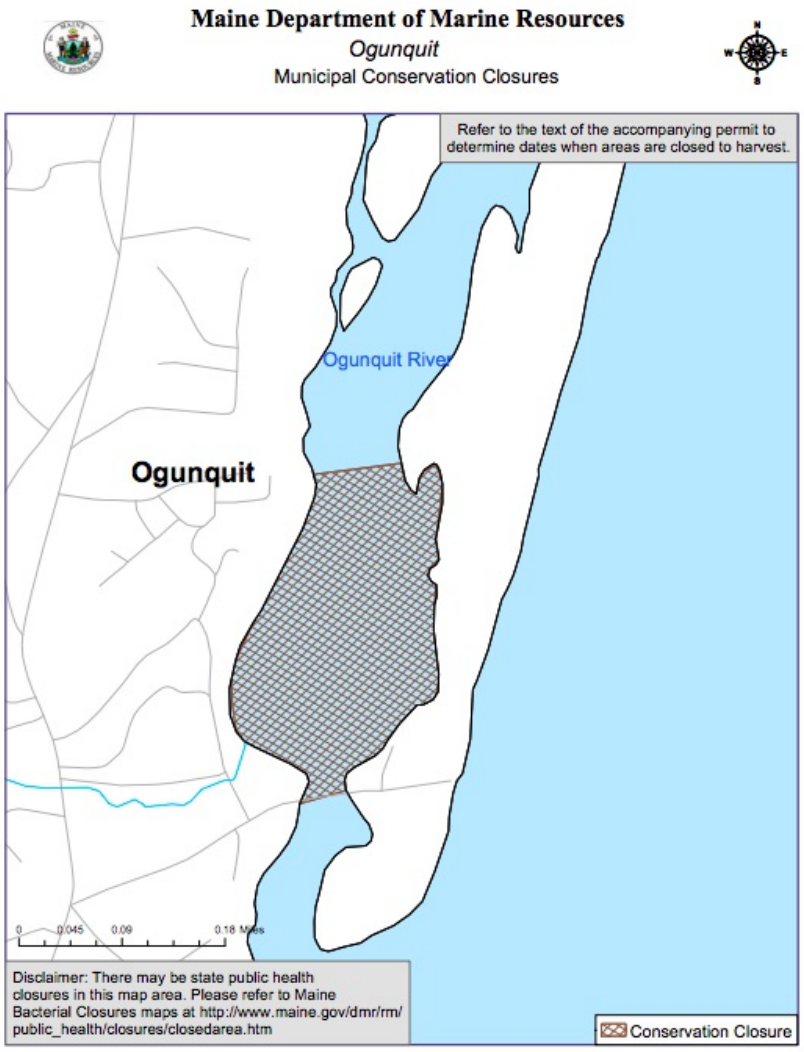

Figure 37: Municipal Conservation Closure Ogunquit. From {MDMR 2018}.

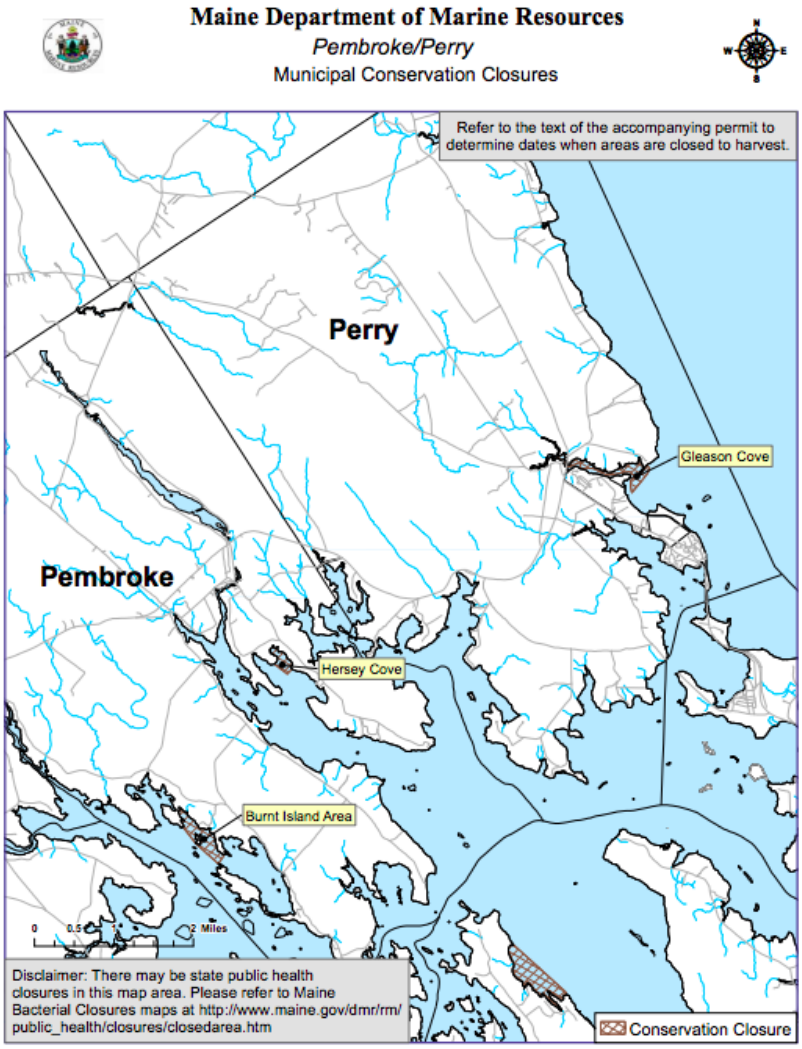

Figure 38: Municipal Conservation Closure Pembroke and Perry. From {MDMR 2018}.

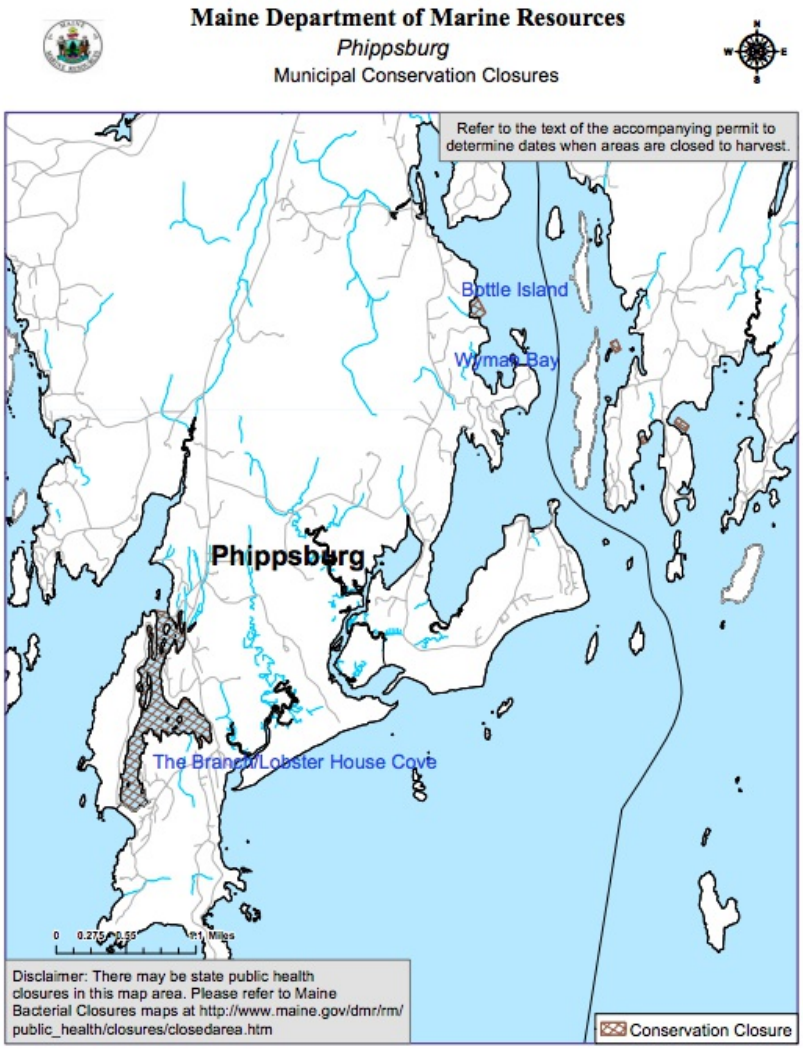

Figure 39: Municipal Conservation Closure Phippsburg. From {MDMR 2018}.

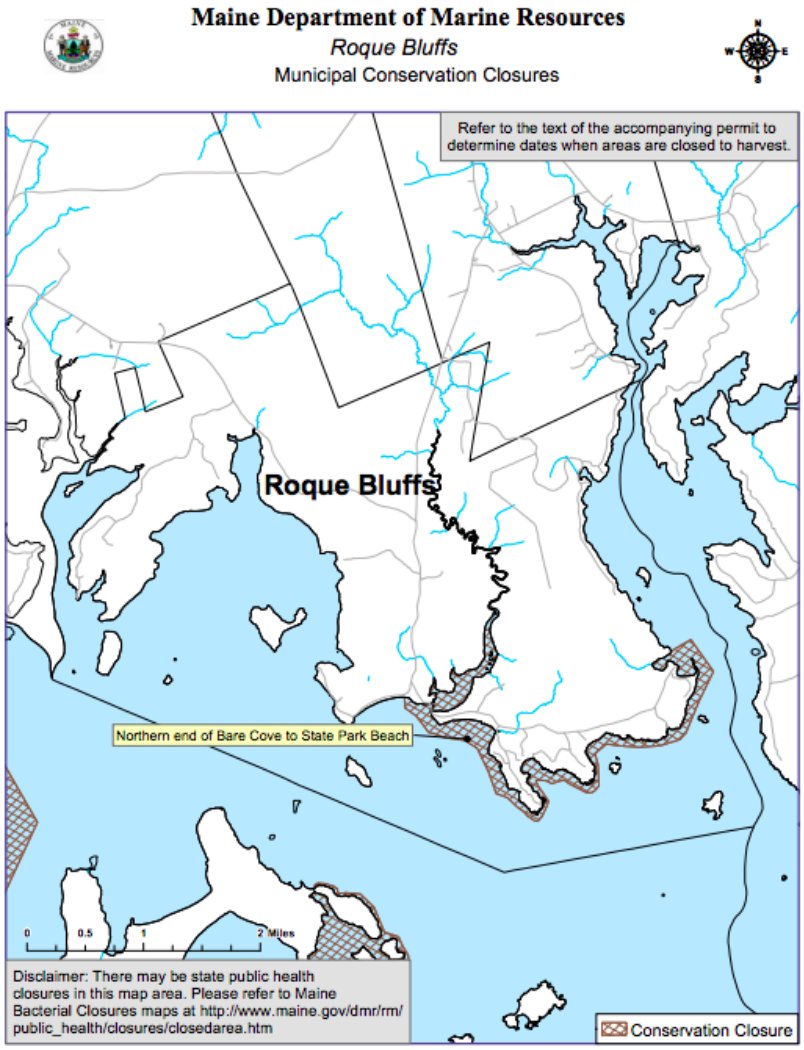

Figure 40: Municipal Conservation Closure Roque Bluffs. From {MDMR 2018}.

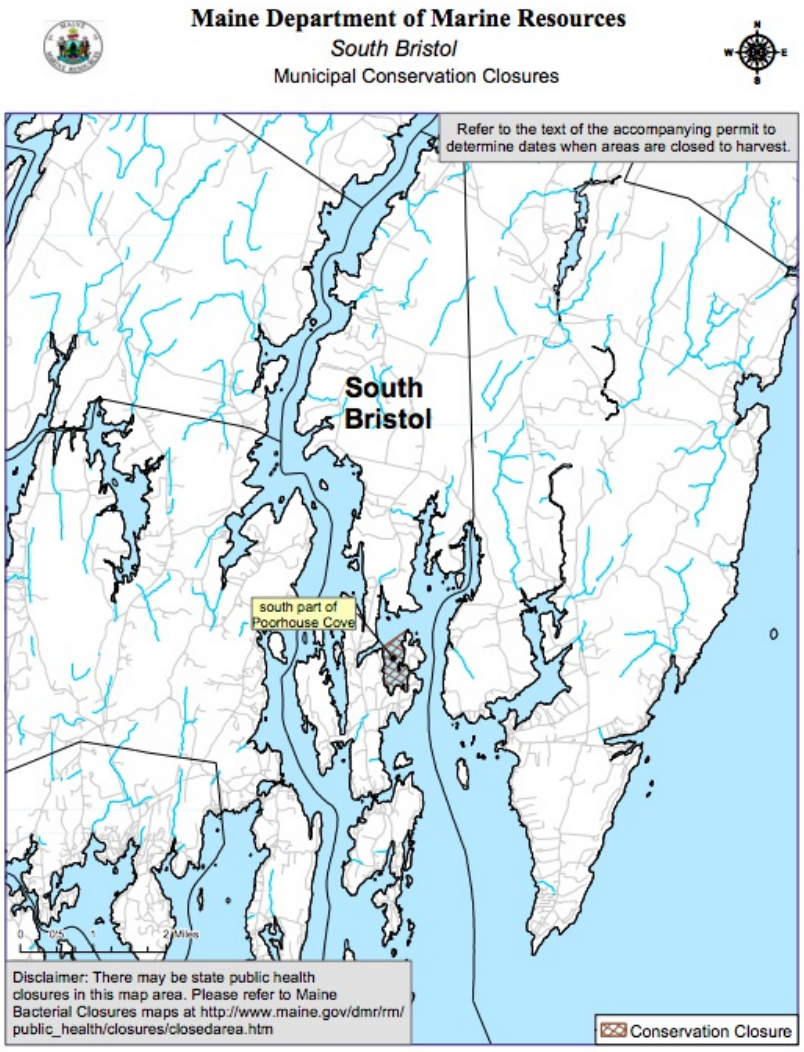

Figure 41: Municipal Conservation Closure South Bristol. From {MDMR 2018}.

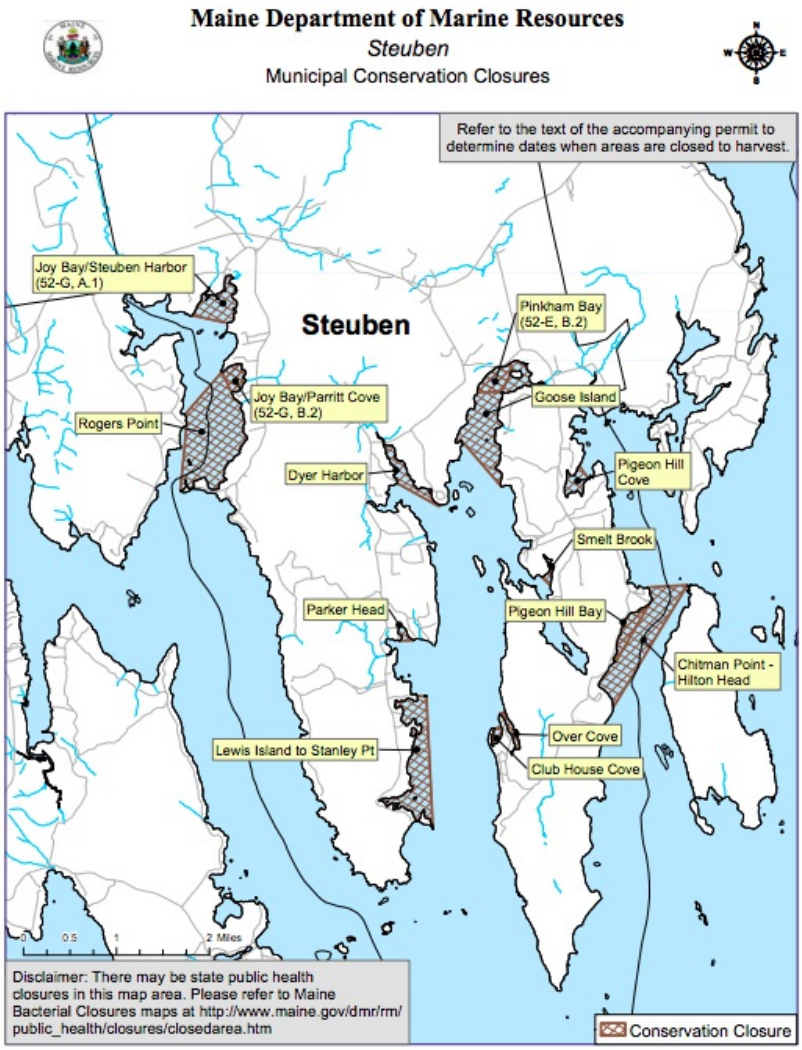

Figure 42: Municipal Conservation Closure Steuben. From {MDMR 2018}.

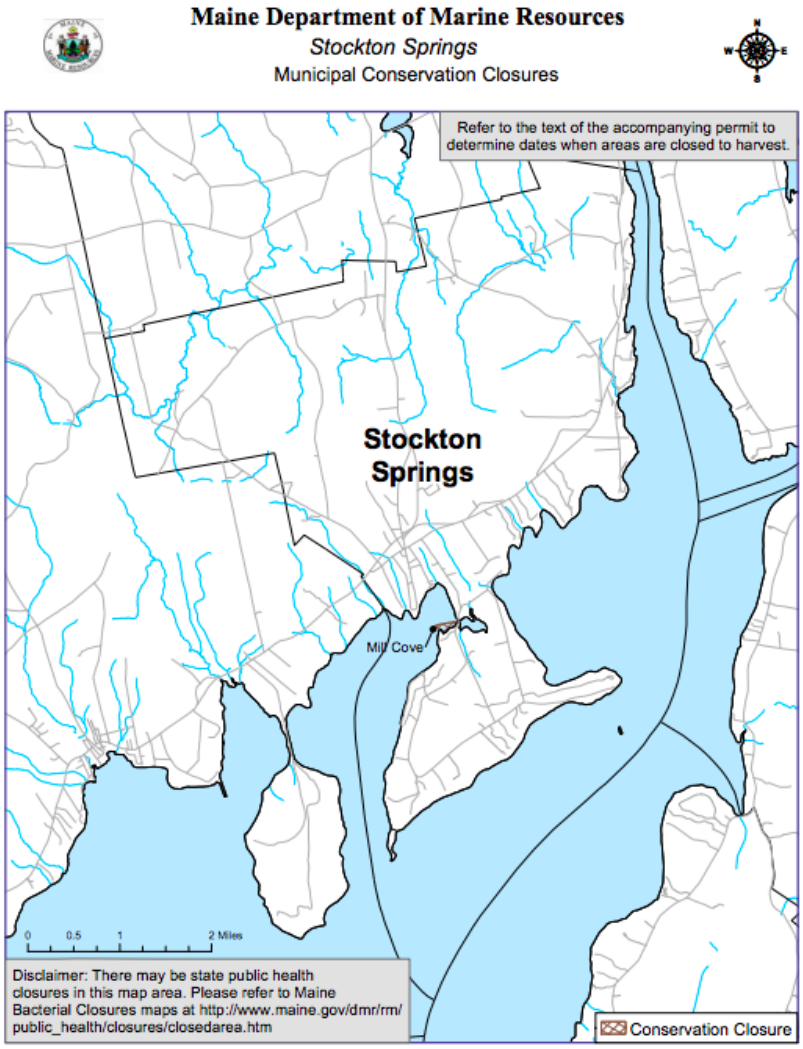

Figure 43: Municipal Conservation Closure Stockton Springs. From {MDMR 2018}.

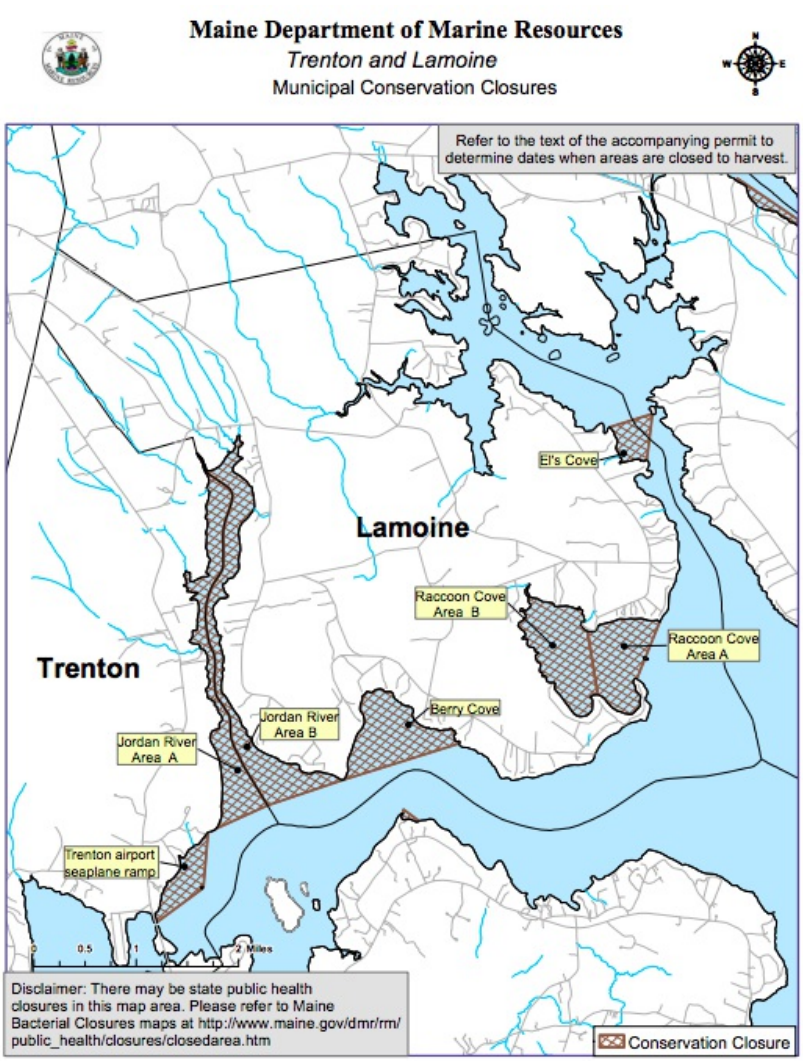

Figure 44: Municipal Conservation Closure Trenton and Lamoine. From {MDMR 2018}.

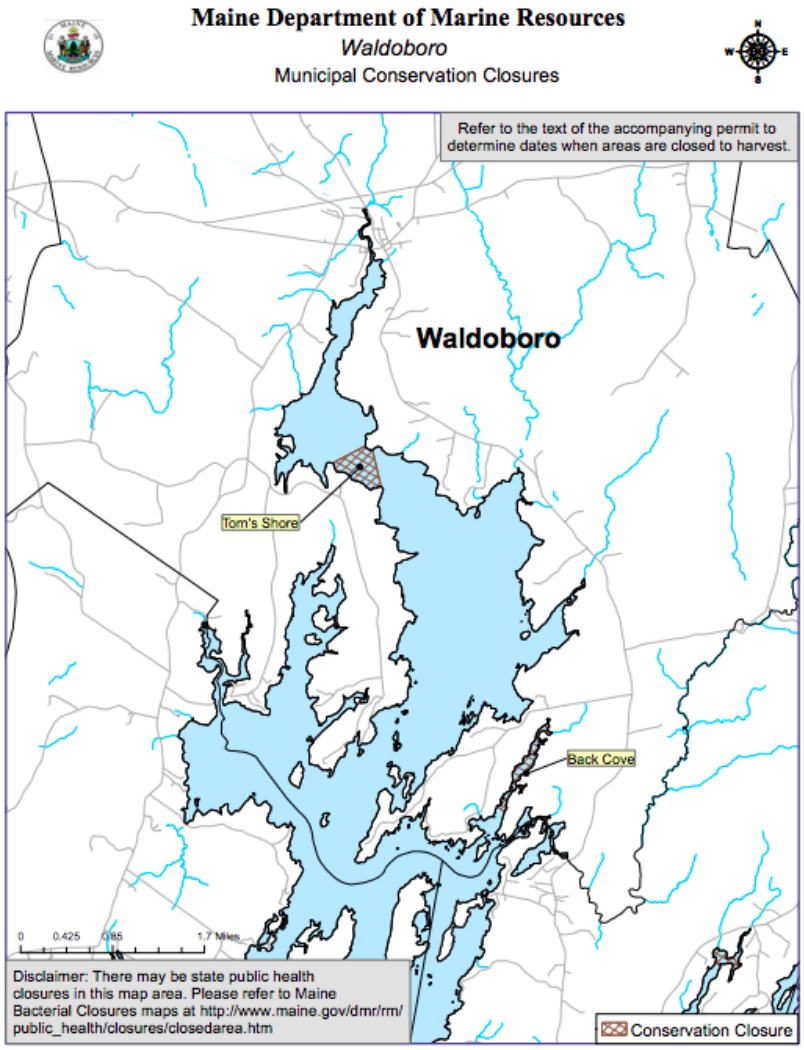

Figure 45: Municipal Conservation Closure Waldoboro. From {MDMR 2018}.

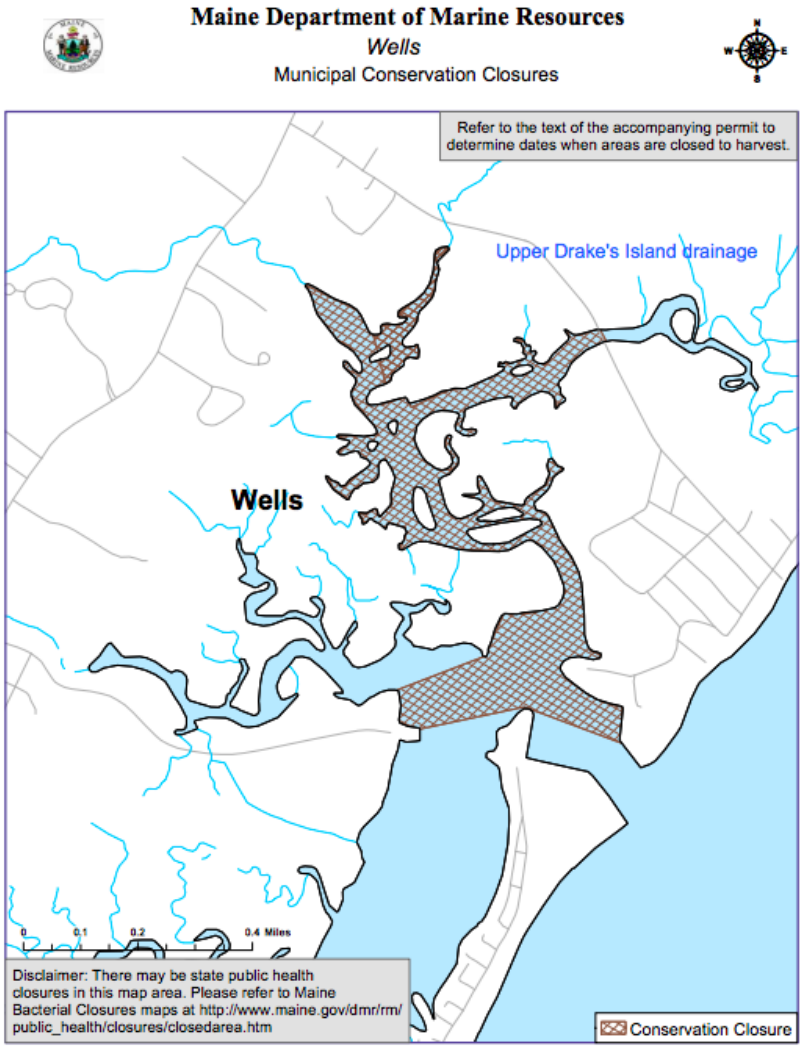

Figure 46: Municipal Conservation Closure Wells. From {MDMR 2018}.

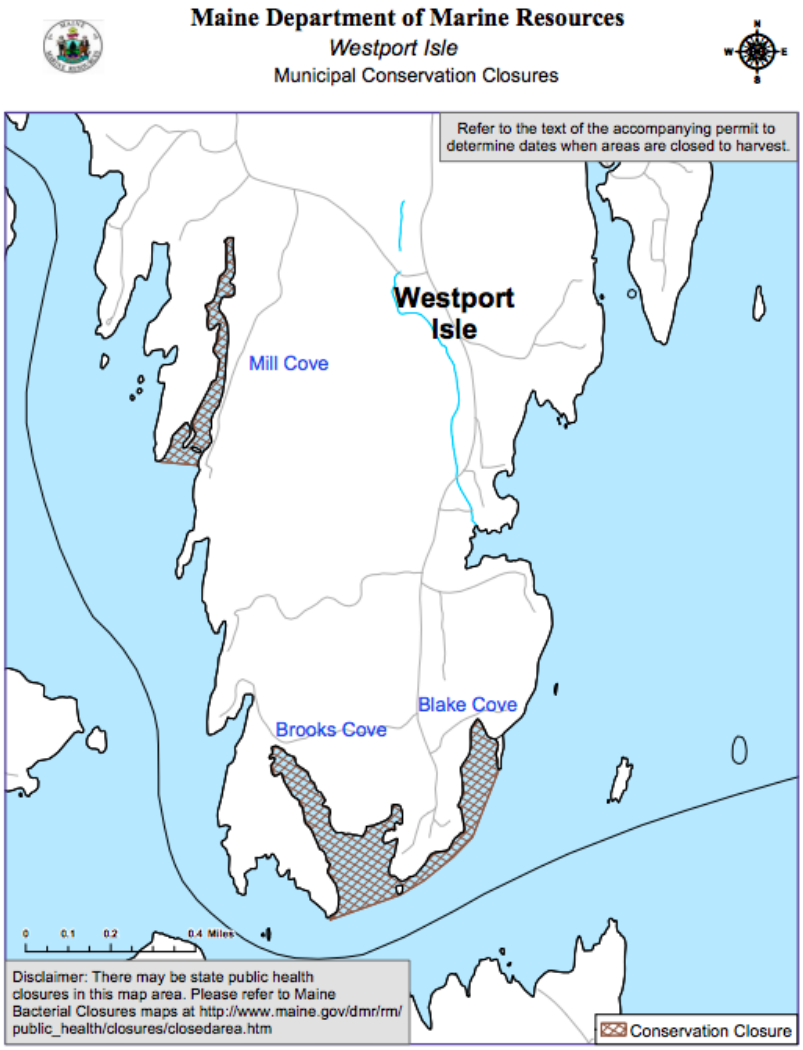

Figure 47: Municipal Conservation Closure Westport Isle. From {MDMR 2018}.

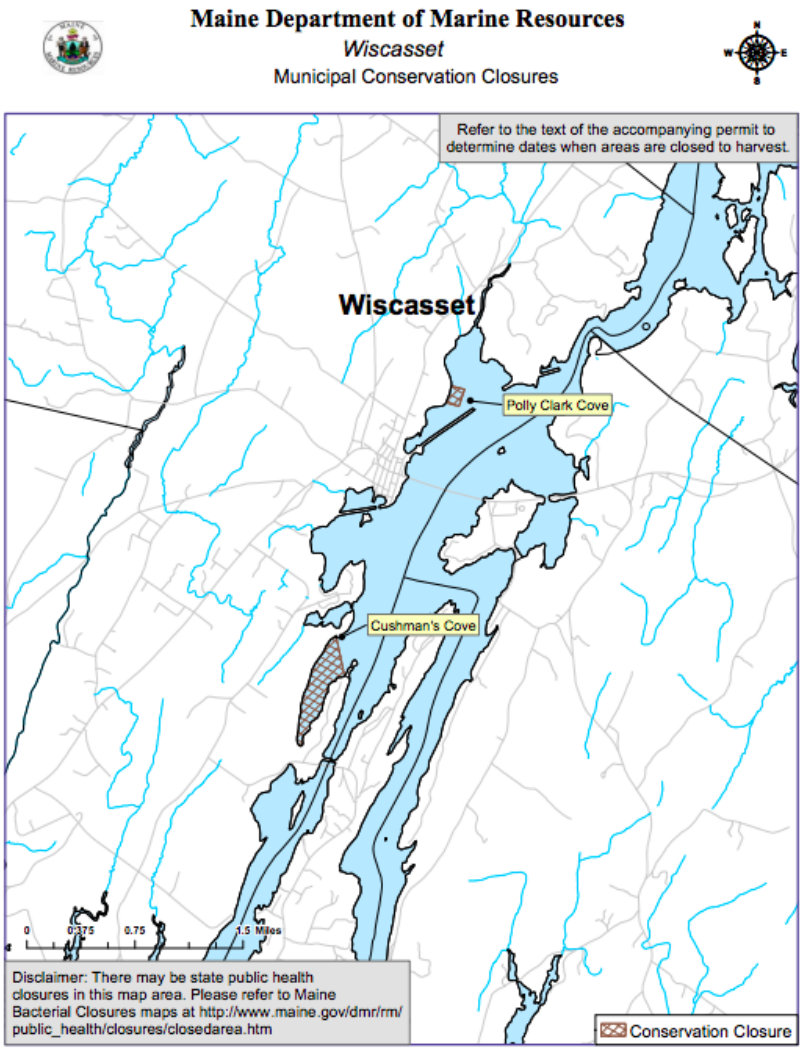

Figure 48: Municipal Conservation Closure Wiscasset. From {MDMR 2018}.

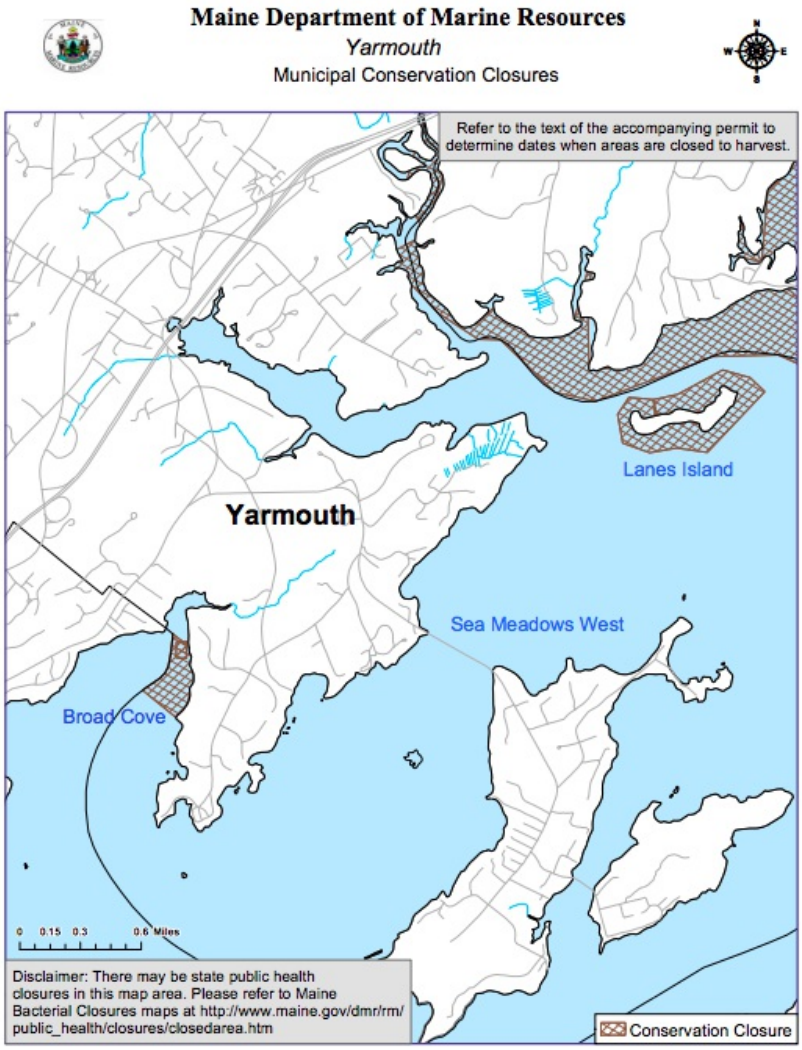

Figure 49: Municipal Conservation Closure Yarmouth. From {MDMR 2018}.