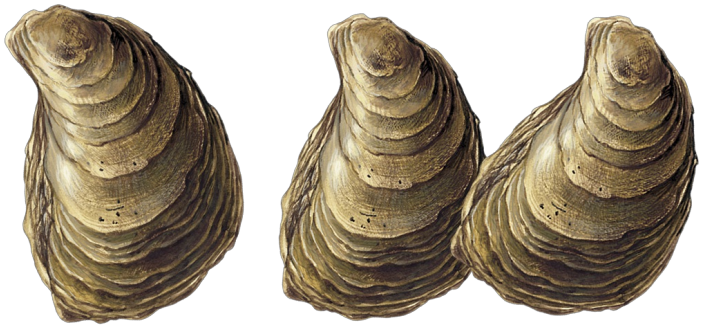
Monterey Bay Aquarium Seafood Watch

Draft Assessment for Review
April 2023

Eastern oyster
Crassostrea virginica



United States, Northwest Atlantic

Towed dredges, Hand Implements

Report ID 28278

Seafood Watch Standard used in this assessment: Fisheries Standard v4

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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

The commercial harvest of the eastern oyster occurs along the entire length of the US Atlantic and Gulf coasts, but this report focuses on the US North and Mid-Atlantic coast wild-caught fishery, using dredge, rakes, tongs, and hand harvest. As the majority of the Gulf Coast oysters produced are farmed, the Gulf Coast Oyster fishery will be addressed in a separate aquaculture report.

Eastern oysters have low inherent vulnerability to fishing pressure, and in New England waters they can reproduce within 1 to 2 years of hatching, and grow to a harvestable size within 3 to 5 years. Oyster populations are not at risk of overfishing now or in the foreseeable future in the US. However, fishing is not the biggest source of mortality for wild oysters in the US North and Mid-Atlantic. Rather, their biggest threats are from disease, especially in the Mid-Atlantic and South but rarely in New England, and habitat loss/degradation. Currently, abundance in the North Atlantic states is very low compared to virgin stocks due to centuries of overharvest and environmental degradation. There are no reference points for determining harvests in any state or region, so abundance relative to reference points is unknown.

Regardless of the type of gear used for harvesting, the oyster fishery in the US is highly selective and bycatch is negligible. Each state regulates harvesting practices, and states share research and harvest information with each other. Although each state has slightly different management programs, they all employ size limit regulations, seasonal and area closures, and gear restrictions to promote oyster abundance and meet human health standards for seafood consumption. None of the states has a total allowable catch. Although most states conduct some kind of assessment, there are no regional or statewide biomass estimates.

Regulations are enforced through active patrolling on the water and at the dock by local and state enforcement agencies. All management bodies hold public meetings. During these meetings, management decisions are made in collaboration with state agencies and local producers.

Dredges can change oyster reef structure, which reduces larval recruitment and survival. Moreover, large amounts of sediment suspended in the water column by dredging operations may limit the ability of oysters to feed (although oysters have been shown to tolerate high levels of suspended sediment up to 1g/L for 40 days). Hand tonging also can degrade oyster reefs by reducing reef height. Regulations to reduce the impact of these gears are generally implemented by banning these gears in specific areas or by rotating harvest reefs.

Various state regulations recognize the oyster as a keystone species for a healthy estuarine environment. Because larval substrates are critical to supporting the fishery, habitat is a primary concern for oyster managers. All of the North Atlantic states implement oyster reef restoration projects; some of these projects are led by state agencies, and others by non-governmental organizations and academic institutions. Although it is still early to measure the level of success of the projects, some signs of improving conditions have been reported. Overall, wild eastern oysters from Delaware are a Seafood Watch "Best Choice." Oysters from Rhode Island and South Carolina represent a "Good Alternative," but wild oysters harvested from New York, Maryland, Virginia, and North Carolina are rated as an "Avoid."

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Eastern oyster | Northwest Atlantic | Hand implements | United States | South Carolina	2.644	5.000	3.000	3.742	**Good Alternative (3.490)**	Unknown
Eastern oyster | Northwest Atlantic | Hand implements | United States | Rhode Island	1.732	5.000	3.000	3.742	**Good Alternative (3.140)**	Unknown
Eastern oyster | Northwest Atlantic | Hand implements | United States | New York	1.732	5.000	2.000	3.742	**Avoid (2.837)**	Unknown
Eastern oyster | Northwest Atlantic | Hand implements | United States | Virginia	1.732	5.000	1.000	3.742	**Avoid (2.386)**	Unknown
Eastern oyster | Northwest Atlantic | Hand implements | United States | Maryland	1.000	5.000	1.000	3.742	**Avoid (2.080)**	Unknown
Eastern oyster | Northwest Atlantic | Hand implements | United States | North Carolina	1.000	5.000	1.000	3.742	**Avoid (2.080)**	Unknown
Eastern oyster | Northwest Atlantic | Towed dredges | United States | Delaware	4.284	5.000	5.000	3.162	**Best Choice (4.290)**	Unknown
Eastern oyster | Northwest Atlantic | Towed dredges | United States | South Carolina	2.644	5.000	3.000	3.162	**Good Alternative (3.346)**	Unknown
Eastern oyster | Northwest Atlantic | Towed dredges | United States | Virginia	1.732	5.000	1.000	3.162	**Avoid (2.288)**	Unknown
Eastern oyster | Northwest Atlantic | Towed dredges | United States | Maryland	1.000	5.000	1.000	3.162	**Avoid (1.994)**	Unknown
Eastern oyster | Northwest Atlantic | Towed dredges | United States | North Carolina	1.000	5.000	1.000	3.162	**Avoid (1.994)**	Unknown

Summary

The eastern oyster (Crassosstrea virginica) is a filter-feeding bivalve mollusk that occurs naturally along the eastern seaboard of the Americas from Canada's Gulf of Saint Lawrence to the Gulf of Mexico, the Caribbean Islands, and the coasts of Brazil and Argentina. The eastern oyster has also survived out-of-range transplantations to western North America, Fiji, Tonga, Japan, Mauritius-Indian Ocean, and likely England. The eastern oyster supports both an aquaculture and wild-caught fishery. This report focuses on the United States (US) wild-caught fishery in the North and Mid-Atlantic using dredges, tongs, and rakes.

Eastern oysters from Delaware caught via dredge are considered a "Best Choice" while oysters harvested with dredges, rakes, and tongs from Rhode Island and South Carolina are ranked as "Good Alternative." Eastern oysters from New York, Maryland, North Carolina, and Virginia harvested with rakes and dredges are ranked as "Avoid."

The Best Choice ranking for Delaware oysters is primarily driven by top scores for Criteria 1 to 3 and a moderate score for Criterion 4.

The "Good Alternative" rank for Rhode Island (rakes) oysters is driven by low scores for Criterion 1 but top scores in C2 (all gears) and C4 (for rakes and tongs).

The "Good Alternative" rank for South Carolina oysters (dredge and tong) is driven by moderate scores for Criteria 1, 3, and 4.

The "Avoid" rank for New York (rakes) rank for Maryland (dredge and tong), North Carolina (both dredge and tong), Virginia (dredge and rakes) oysters is driven by low scores for both Criterion 1 and Criterion 3.

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

The eastern oyster (*Crassostrea virginica*) is a bivalve mollusk widely distributed along the eastern coasts of North and South America, ranging from Canada's Gulf of Saint Lawrence to the coasts of Brazil and Argentina (FAO 2004-2016). In the US, this species supports both an aquaculture and wild-caught fishery, with aquaculture predominating the oyster production in the country in recent years. This report focuses on the North and Mid-Atlantic States (Rhode Island, New York, Delaware, Maryland, Virginia, North Carolina, and South Carolina) that accounted for 84-88% of the the wild-harvest production on the east coast from 2019 to 2021 (NMFS 2022). Fishermen in this area generally employ four harvesting techniques: dredge, tong, hand collection, and rakes. In most cases harvest data do not specify between rakes, tongs, or hand picking.

Species Overview

Crassostrea virginica can be found in almost all estuaries along the US Atlantic and Gulf coasts (EOBRT 2007). Eastern oysters are most abundant in shallow, nearshore habitats in state waters (EOBRT 2007). Consequently, the species is managed under state regulations. Some federal regulations, however, do exist, like the Interjurisdictional Fisheries Unit that requires states to gather and share information to support management actions (IJF 1986). Management regulations can vary by state, but they commonly establish minimum size limits, seasonal and area closures, and gear exclusion zones (EOBRT 2007).

The harvest of different mollusks including Eastern oysters started with the first European settlers in North America in the 1600s {Coen et al. 2007}. Due to high exploitation levels, the abundance of most species started to decrease, and with the incorporation of more effective fishing techniques, abundant stocks almost vanished from several regions along the east coast (MacKenzie 1997). Multiple efforts to restore natural populations have been implemented in several regions, but in general, stocks still remain low compared to the size of virgin stocks (EOBRT 2007).

Production Statistics

Globally, total oyster landings (all species) have increased 72% since 1990, but this is due to increased aquaculture production (increased 76% between 1990 and 2004) (FAO 2016) (Figure 1). As a result, total landings of wild-caught oysters have decreased by 26% during this period (FAO 2016). Of the total global, wild-capture landings, an average of 78% (since 1990) were of *C. virginica,* all of which were from the following three locations: US (66%), Mexico (32%) and Canada (2%) (FAO 2016). Between 2010 and 2014, Mexico's landings have decreased 13% (average) while the US landings have increased by 43% (average) with an average of 54,270 MT in 2014 (latest data year in FAO database). Canadian landings have declined by 4% (average) (FAO 2016).

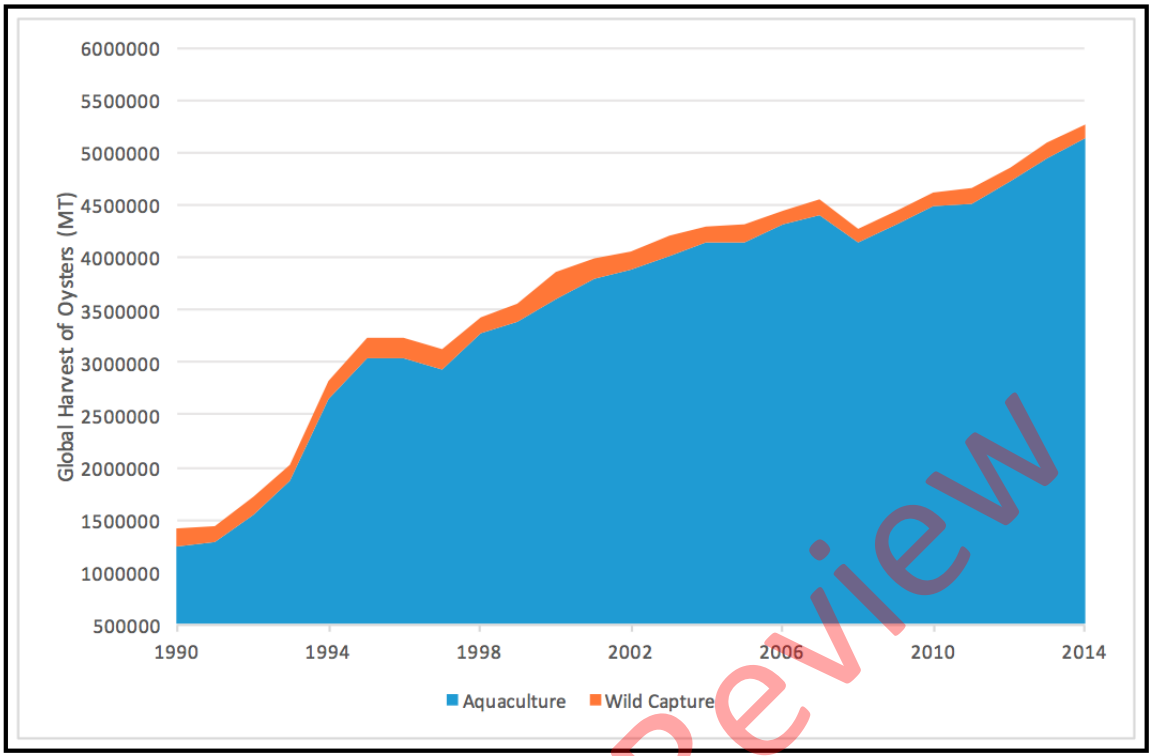

Figure 1. Global harvest of oysters between 1990-2014. Data compiled from FAO 2016

Importance to the US/North American market.

Imports of oysters to the US have remained fairly stable since 2011, averaging approximately 10,573 MT annually between 2011 and 2016 (NMFS 2016) (Figure 2). Actual imports of wild-captured *C. virginica* are small due to the geographic sources of landings. Most oyster imports enter as canned from South Korea, China, Thailand, and Japan, which do not produce wild *C. virginica* (FAO 2012a). Wild-caught imports (which averaged 722 MT annually between 2011 and 2016) were primarily from South Korea, Hong Kong, Japan and Canada, with Canada's portion averaging 25% from 2011 to 2016 (NMFS 2016).

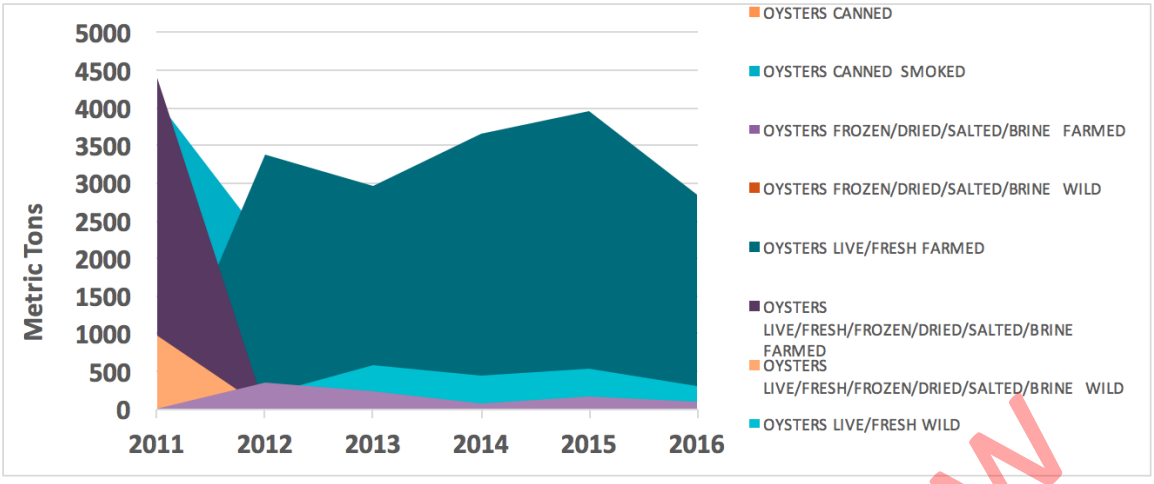

Figure 2.Oyster imports to US 2011-2016. Data from NMFS 2016

Exports of US oysters have been steady in recent years (2011 to 2016), averaging 315 MT annually (NMFS 2016) (Figure 3). There is no differentiation between wild and farmed or whether they are *C. virginica* or *C. gigas* (NMFS 2012b) (NMFS 2016). The largest buyers have consistently been Canada, Hong Kong, and Taipei.

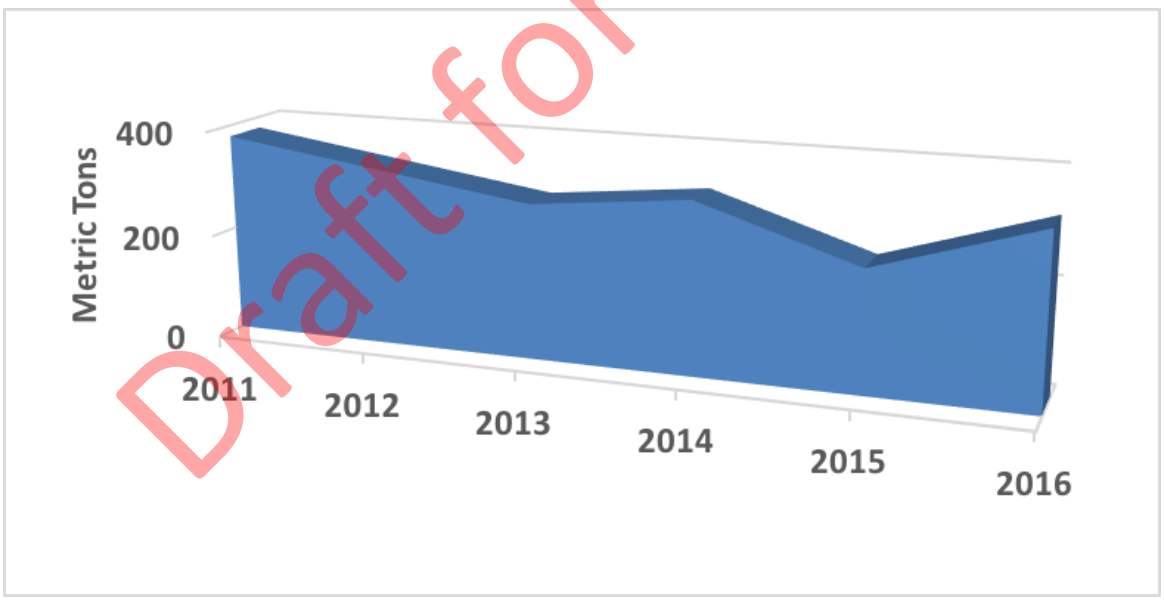

Figure 3. Exports of US oysters 2011-2016. Data from NMFS 2016

Since 2004, total *C. virginica* landings comprised an average of 67% of all oyster capture (wild and farmed) in the US. Because many North American reporting jurisdictions do not distinguish between cultured and

wild-caught oysters (Lively 2016), it is difficult to estimate a precise percentage of wild versus cultured oysters. Adding to the difficulty in distinguishing between wild harvested oysters and farmed oysters, several states rely on seed that comes from wild larvae settling on shell cultch, which is then moved to growing grounds that are leased or owned and which some states refer to as cultured, but others refer to as wild (Rheault 2017). The United Nations Food and Agriculture Organization estimates that approximately 55% of *C. virginica* landings in the US are wild-caught (FAO 2016). As noted earlier, the majority of these landings currently come from the southeastern Gulf Coast region. Since the early 1980s the Gulf of Mexico fishery has been the dominant source of oysters for the US (Figure 8), although more and more of these oysters are farmed and not harvested from the wild.

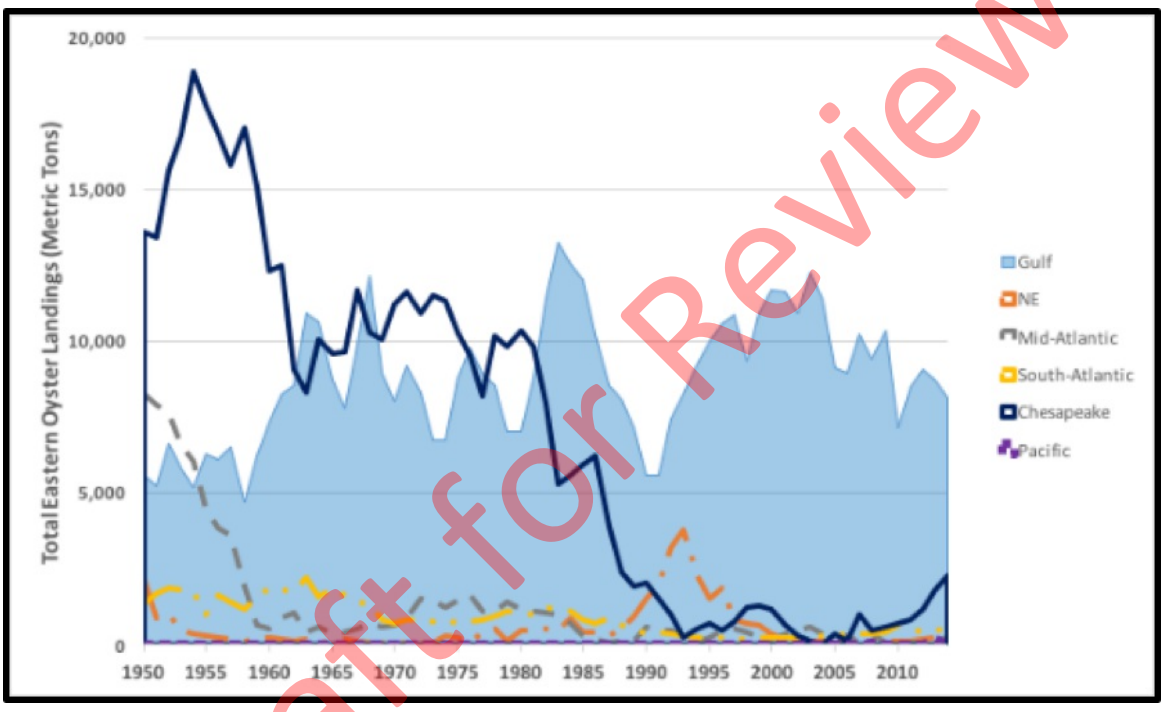

Figure 8. Total eastern oyster landings (wild and cultured) in the US in metric tons by region between 1950-2014 compiled from NMFS landings data (NMFS 2016)

Common and market names.

The eastern oyster is also known as American oyster, common oyster, and American cupped oyster. Oysters are also named for their place of origin (e.g., Gulf oyster, Virginia oyster, or Atlantic oyster).

Primary product forms

The eastern oyster is available fresh, frozen, dried, salted, smoked, or canned in brine. It is available year-round (although on the East Coast you can only harvest wild oysters from October until May).

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

EASTERN OYSTER			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Atlantic | Hand implements | United States | South Carolina	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | Hand implements | United States | Rhode Island	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northwest Atlantic | Hand implements | United States | New York	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northwest Atlantic | Hand implements | United States | Virginia	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northwest Atlantic | Hand implements | United States | Maryland	1.000: High Concern	1.000: High Concern	Red (1.000)
Northwest Atlantic | Hand implements | United States | North Carolina	1.000: High Concern	1.000: High Concern	Red (1.000)
Northwest Atlantic | Towed dredges | United States | Delaware	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Northwest Atlantic | Towed dredges | United States | South Carolina	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Northwest Atlantic | Towed dredges | United States | Virginia	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northwest Atlantic | Towed dredges | United States | Maryland	1.000: High Concern	1.000: High Concern	Red (1.000)
Northwest Atlantic | Towed dredges | United States | North Carolina	1.000: High Concern	1.000: High Concern	Red (1.000)

In 2007, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) organized a biological review team (BRT) to assess the status of eastern oyster populations as either threatened or endangered under the US Endangered Species Act (EOBRT 2007). The BRT concluded that despite the low abundance levels compared with the virgin stocks, eastern oyster stocks were not at risk of extinction then or in the foreseeable future (EOBRT 2007), and with the exception of Long Island Sound, Peconic Bay, and the Hudson-Raritan Estuary, recruitment was sufficient to maintain oyster viability (EOBRT 2007).

However, In a recent global review of oyster sustainability, Beck et al. {2011} advised that native oyster fisheries continue to be unsustainable worldwide, with the exception of the Gulf of Mexico. As a result of sustained seeding effort, the Gulf of Mexico is one of the last areas for both conservation and sustainable harvest {Beck et al. 2011}.

C. virginica has a low inherent vulnerability to fishing pressure. It is able to reproduce within a few years (1 to 2 years) and has high fecundity (2 to 115 million eggs). However, due to the decline of reef areas by both environmental factors and diseases, a precautionary approach should be used. Since recent stock assessments relative to reference points are not available for any of the states, this factor is scored on the basis of the species' inherent vulnerability and data-limited assessments (abundance, CPUE, spat collection, etc.).

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.*

Eastern oyster

Factor 1.1 - Abundance

Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Towed dredges | United States | Maryland

High Concern

The most recent stock assessment was completed in 2020 and used data from 1999-2019. Total abundance for all life stages was highest in 1999 with an estimated abundance of 2.79 billion oysters. Abundance has steadily decreased since then. The total abundance for 2019 was 1.2 billion oysters, which is below the long-term average from the time series of 1.3 billion oysters (MDNR 2020). The stock assessment evaluates 36 sites individually and compares the estimated abundance of market-sized oysters against reference points U_{limit}, which is set for each site. The reference points are calculated based on abundance estimates from 1999-2017, rather than unfished biomass (MDNR 2018). Despite the generous reference points, 3 of the sites assessed had abundance estimates below U_{limit} (MDNR 2020). There is no target reference point for abundance.

Considering that the fishery for this species has experienced a notable decline in abundance (MDNR 2019), the reference points are based on this period of historically low abundance, and several sites are still overfished, the abundance of this stock scores "High concern."

Justification:

The stock assessment evaluates the abundance of 36 sites, based on geographic delineation in NOAA codes, and treats each of these sites as separate stocks (MDNR 2018). There is no evidence that these sites constitute individual stocks.

The reference points used in the stock assessment are not appropriate for the stock. The reference points for the sites are set based on estimates of abundance from 1999-2017, rather than unfished biomass or another biological limit. The abundance of Eastern oyster throughout the 20th century is well-documented (MDNR 2019). There are issues with setting reference points based on an abundance time-series from a period when the abundance is historically low. Nevertheless, U_{limit} is defined as the lowest estimated abundance from 1999-2017. There is no target reference point for abundance. The stock assessment notes that a target could not be calculated due to the current state of the historically low abundance (MDNR 2018)

Northwest Atlantic | Hand implements | United States | New York

High Concern

Wild oysters are found in scattered populations in New York, with very low reported abundance levels and they are rarely found in the form of oyster reefs (Medley 2010). For these reasons, the abundance of wild eastern oysters in New York is deemed a "high" concern.

Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | North Carolina

High Concern

The state of North Carolina does not perform oyster stock assessments. Stock assessments were attempted in 1999, 2006, and 2014, but the input data was not good enough to produce results which could be used for management purposes (NCMFC 2021). Instead, landings data and harvest effort (number of bushels per trip) are used to estimate relative oyster abundance (NCDMF 2015). Although eastern oysters have low risk for overfishing (see Table 1), the North Carolina Division of Marine Fisheries (NCDMF) reported that North Carolina oyster stocks are a "concern" (NCDMF 2016) due to habitat destruction and historic overharvest. Thus, Seafood Watch considers the abundance of the North Carolina oyster stock as "high" concern.

Northwest Atlantic | Hand implements | United States | Rhode Island

High Concern

There used to be several wild oyster beds in Rhode Island waters including Narragansett Bay, Greenwich Bay, Sakonnet River, Block Island, and Salt ponds. However, wild oyster populations practically disappeared from these natural beds due to the combination of overharvest and environmental factors (Oviatt et al. 2003). The Rhode Island stock of Eastern oysters is currently unassessed (RIDEM 2022). Seafood Watch rates the abundance of wild eastern oysters in Rhode Island as "high" concern.

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | South Carolina

Moderate Concern

In South Carolina, *C. virginica* hasn't been as heavily harvested as in other states on the east coast, but coastal development has increased the threats to tidal creek habitats, including oyster reefs (Lerberg, Holland, and Sanger 2000), {Holland et al. 2004}. Data on abundance or size structure of the reefs have been lacking for many years (SCSWAP 2015). Current efforts focus on monitoring changes in the acreage and condition of intertidal reefs (SCDNR 2016). However, the current status of the stocks is unknown. Although eastern oysters in South Carolina have not been as intensively harvested as in other states in the mid-Atlantic (SCDNR 2016), there is no evidence to suggest that stock is either above or below reference points. Based on their low inherent vulnerability (Table 1) and their unknown stock status, the South Carolina stocks are rated as "moderate" concern.

Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Virginia

High Concern

The Virginia Institute of Marine Science (VIMS) uses spat fall collectors to assess annual recruitment and stock status (Southworth and Mann 2021). Recruitment is increasing with mean spat per shell 2008-2020 at 77.3 compared to the mean for 1994-2007 which was 5.7. Spatfall started improving in 2007 and has maintained a good level since 2010 (Southworth and Mann 2021). The abundance of market oysters had been increasing over the course of 2007-2015 to an average of 60.9 oysters per bushel. Abundance declined in 2015-2019 to 33.6 oysters per bushel. 2020 saw an increase to an average 52.6 oysters per bushel, which is still below the 2007-2015 average (Southworth and Mann 2021). Despite the recent increase, the abundance of market oysters in the Virginia tributaries

remains low and landings are at 0.1% compared to historic levels (Schulte 2017). Stocks within the Chesapeake Bay still have strong signs of being overfished. Although abundances in the Virginia section of the Bay have increased since the mid-1990s (CBP 2012), current abundance levels in the Chesapeake Bay overall are still low {Ermgassen et al. 2012}. As a result, Seafood Watch deems eastern oyster abundance in the Virginia as a "high" concern.

Justification:

Northwest Atlantic | Towed dredges | United States | Delaware

Low Concern

Delaware conducts annual dredge surveys to generate an index of the relative abundance of oysters on each bed, termed market oysters per bushel. The average number of market oysters per bushel corresponds to the relative abundance at which the oyster population is still capable of recovering (Cole, Coakley, and Greco 2010). Currently, Delaware maintains market oyster densities throughout the stock unit above target and limit reference points, where 18.27 market oysters per bushel is the lower control limit (LCL), 22.98 is the average (AVG), and 27.69 is the upper control limit (UCL). The LCL of 18.27 market oysters per bushel is the closure threshold {Cole et al. 2010}. Using the pooled average survey index from the stock unit as a reference, stocks in Delaware have been steadily increasing since 2009 and are currently above UCL (27.69 market oysters per bushel) (DDFW 2021). Since the species is not highly vulnerable and Delaware managers rely on these two data limited assessments to control the population, Seafood Watch rates eastern oyster abundance in Delaware as "low" concern.

Justification:

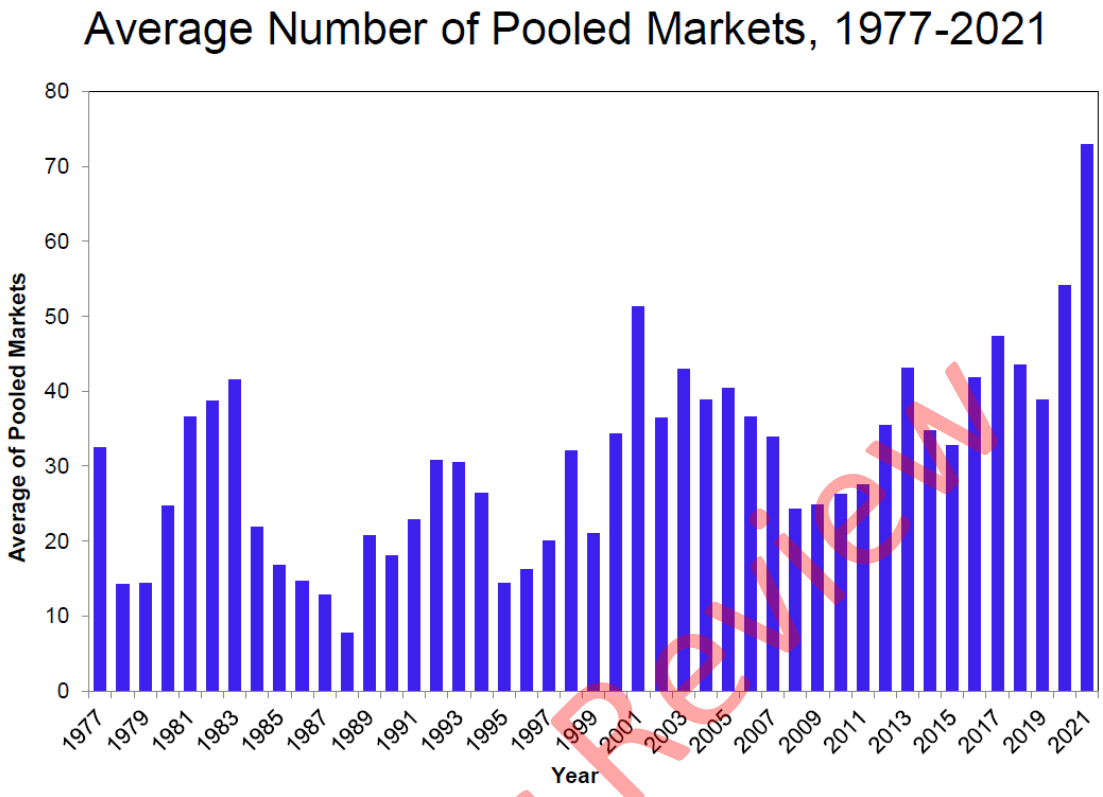

Figure 1: Average number of market oysters per bushel pooled for all sizes 1977-2021 (DDFW 2021).

Table 1. Productivity-Susceptibility Analysis

productivity Attribute	Relevant information	Score(1=low risk, 2=medium risk, 3=high risk)
Average age at maturity	1 to 2 years (**Rheault pers comm, 2017)**	1
Average maximum age	2 to 5 years (Rarely up to 15 years) (Rothschild, et al., 1994) (Powell and Cummins 1985)	1
Fecundity	NA	
Average maximum size (fish only)	NA	
Average size at maturity (fish only)	NA	
Reproductive strategy	Broadcast spawners that can spawn multiple times each season (Kennedy 1996) (Shumway 1996)	1
Trophic level	2	1
Density dependence (invertebrates only)	No depensatory or compensatory dynamics demonstrated. Greatest limiting factor is amount of substrate; density may influence survival and growth (Powell et al., 2009)	2

Susceptibility Attribute	Relevant Information	Score(1=low risk, 2= medium risk, 3=high risk)
Areal Overlap (Considers all fisheries)	Default value used	3
Vertical overlap (Considers all fisheries)	Default value used	3
Selectivity of fishery (specific to fishery under assessment)	Default value used	2
Post-capture mortality (specific to fishery under assessment)	Default value us	3

Factor 1.2 - Fishing Mortality

Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Towed dredges | United States | Maryland

High Concern

The 2020 stock assessment evaluated fishing mortality for 36 sites, which are based on NOAA codes. Reference points for fishing mortality are U_{MSY} and U_{crash}. Where U_{MSY} is defined as the exploitation rate that would result in a stable or increasing population size. U_{crash} is defined as the maximum harvest rate that would allow for a stable population (MDNR 2018). Out of 36 sites, 6 had fishing mortality above U_{MSY} and 5 were above U_{crash} (MDNR 2020). While that leaves 25 sites below U_{MSY}, there is no evidence that these sites represent individual stocks and should be assessed separately. In these cases, SFW takes a precautionary approach and scores the fishery as a whole based on the lowest scoring portion of the fishery.

Given the historically low abundance of this species (MDNR 2019), the questionable methods for delineating the assessment, and the fact that some of these sites are still above a sustainable level, fishing mortality scores "High concern."

Northwest Atlantic | Hand implements | United States | New York

Moderate Concern

Wild oyster harvest in New York has been very low for several years due to a heavy decline in wild stocks {Timmons et al. 2004}. It was estimated that wild harvest could be between 10 to 15% of the total landings, but exact landings from wild harvest are not known (F= unknown) {Timmons et al. 2004} (Figure 7). According to the New York Department of Natural Resources (NYDNR), there are no limits on commercial harvest but recreational harvest is limited to 1/2 bushel per day per fisher (DEC 2016a). Several areas are closed to harvest for human health and safety reasons. Due to lack of more precise information on wild harvest and the lack of harvest limits, this factor is rated as "moderate" concern for New York.

Justification:

In 2014 to 2015, New York accounted for a little more than 3% of the eastern oyster landings from the Northern Atlantic states (NMFS 2016). Farm-raised oysters have accounted for at least 85% of the landings in the state in the past (Timmons et al. 2004). Recently, aquaculture production has increased by more than 300% (LISS 2015).

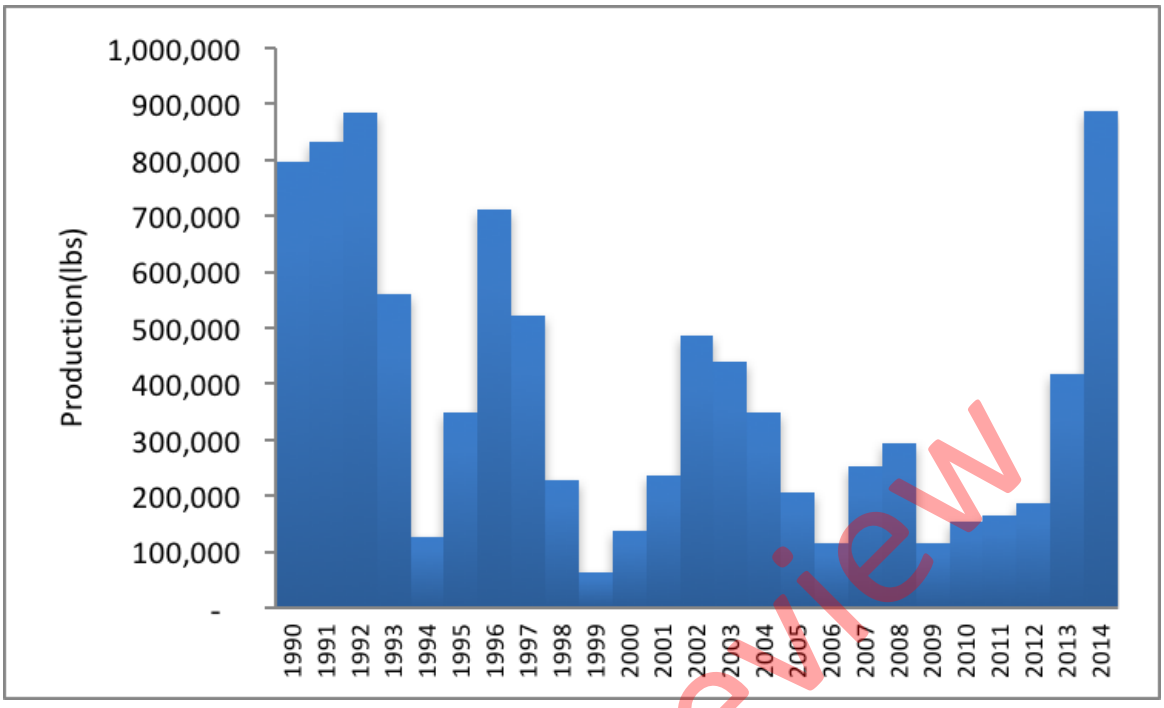

Figure 7. New York oyster landings reported from 1993 to 2014 (NYSDEC Shellfish Division, 2015

Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | North Carolina

High Concern

A stock assessment has not been completed for this stock. However, the landings from this fishery steadily declined throughout the 20th century and landings are currently at historic lows (NCMFC 2021). The decline in landings was initiated by overfishing and compounded by changes in environmental factors which decreased survivability (NCMFC 2021) (MDNR 2019). While F is currently unknown, the continued decline in abundance suggests that fishing is occurring at a rate that may hinder recovery. Therefore, fishing mortality for this stock scores "High concern."

Northwest Atlantic | Hand implements | United States | Rhode Island

Moderate Concern

Because of low oyster abundance and seasonal harvesting restrictions, there is little effort to harvest wild oysters in Rhode Island (RIDEM 2022). The actual level of fishing mortality (F) is unknown. Therefore, fishing mortality in Rhode Island is rated as "moderate" concern.

Justification:

Approximately 1-2% of the 2020 to 2021 oyster landings from the Northern Atlantic states came from Rhode Island (NMFS 2022). Oyster landings in Rhode Island have been decreasing. According to the Shellfish Management Plan, annual harvest of oysters is extremely low, with only 59,082 harvested in 2016. The stock is not routinely assessed due to lack of sufficient data and uncertainty around landings data (RIDEM 2018).

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | South Carolina

Moderate Concern

Oysters in South Carolina are harvested via permitted, non-mechanical gear (such as rakes, scoops, tongs) or dredges (SCDNR 2016) (Walker 2005) (Davis 2017). There are no harvesting limits for the commercial fishery, but recreation extraction limits allow for two bushels per person per day from marked public or state shellfish grounds (SCDNR 2016). Managers will limit extraction if over-harvesting is detected during routine monitoring {Coen et al. 2011}. However, current data on level of exploitation are not available. Thus, we rate fishing mortality as "moderate" concern for South Carolina.

Justification:

South Carolina accounted for a little more than 6% of the 2014 to 2015 landings from the Northern Atlantic states (NMFS 2016). Wild populations of *C. virginica* in the state are harvested by commercial and recreational fishers. Harvest season is typically open from October to March but can be extended or closed by the South Carolina Department of Natural Resources (SCDNR).

Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Virginia

Moderate Concern

In 2020 and 2021, Virginia accounted for 53% of the landings from the Northern Atlantic states (NMFS 2022). In Virginia, harvest controls include limits on size, limits on the number of bushels per day, gear restrictions, and seasonal and area closures (VMRC 2022). Disease has been a major cause of mortality in adult oysters. Consequently, harvest pressure has decreased, with fewer reported landings and less fishing effort (CBP 2012). Although fishing mortality is not considered the primary cause of oyster mortality by managers, actual levels of F are unknown. Therefore, this factor is rated as "moderate" concern.

Northwest Atlantic | Towed dredges | United States | Delaware

Low Concern

The Delaware Division of Fish and Wildlife (DDFW) establishes a harvest quota every year based on a fixed 2% harvest rate from the primary seed beds. The 2022 quota was 19,270 bushels (DDFW 2021). Due to harvest control rules that are based on fisheries dependent and independent data and the increasing abundance since 2009, it is probable that fishing mortality from all sources is at a sustainable level. Therefore, Seafood Watch rates this factor as "low" concern.

Criterion 2: Impacts on Other Species

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

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

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

Guiding principles

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

Criterion 2 Summary

Criterion 2 score(s) overview

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

EASTERN OYSTER			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Atlantic | Hand implements | United States | South Carolina	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Hand implements | United States | Rhode Island	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Hand implements | United States | New York	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Hand implements | United States | Virginia	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Hand implements | United States | Maryland	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Hand implements | United States | North Carolina	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Towed dredges | United States | Delaware	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Towed dredges | United States | South Carolina	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Towed dredges | United States | Virginia	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Towed dredges | United States | Maryland	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | Towed dredges | United States | North Carolina	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 | HAND IMPLEMENTS | UNITED STATES | MARYLAND			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	1.000: High Concern	Red (1.000)

NORTHWEST ATLANTIC | HAND IMPLEMENTS | UNITED STATES | NEW YORK			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

NORTHWEST ATLANTIC | HAND IMPLEMENTS | UNITED STATES | NORTH CAROLINA			
SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	1.000: High Concern	Red (1.000)

NORTHWEST ATLANTIC | HAND IMPLEMENTS | UNITED STATES | RHODE ISLAND			
SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

NORTHWEST ATLANTIC | HAND IMPLEMENTS | UNITED STATES | SOUTH CAROLINA			
SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | HAND IMPLEMENTS | UNITED STATES | VIRGINIA			
SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

NORTHWEST ATLANTIC | TOWED DREDGES | UNITED STATES | DELAWARE			
SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHWEST ATLANTIC | TOWED DREDGES | UNITED STATES | MARYLAND			
SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	1.000: High Concern	Red (1.000)

NORTHWEST ATLANTIC | TOWED DREDGES | UNITED STATES | NORTH CAROLINA			
SUB SCORE: 5.000	DISCARD RATE: 1.000	SCORE: 5.000	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	1.000: High Concern	Red (1.000)

NORTHWEST ATLANTIC | TOWED DREDGES | UNITED STATES | SOUTH CAROLINA			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST ATLANTIC | TOWED DREDGES | UNITED STATES | VIRGINIA			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern oyster	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

Eastern oysters are harvested primarily using dredges, tongs, and rakes. Because these gears are deployed directly on oyster reefs, effects are limited (Rheault 2008). Coen {1995} (in (Rheault 2008)) stated that, although several studies agree that dredging causes some impact on epifaunal organisms (small crustaceans, polychaetes, etc.), most of these regenerate quickly due to high fecundity and colonization capacity (Rheault 2008). They are likely well under 5% of the fishery's catch, although there is very little known about this. Thus, we conclude that there are no main bycatch species associated with 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

Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Hand implements | United States | Rhode Island
Northwest Atlantic | Hand implements | United States | New York
Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | Delaware
Northwest Atlantic | Towed dredges | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Maryland
Northwest Atlantic | Towed dredges | United States | North Carolina

< 100%

Discards in the eastern oyster fisheries are thought to be minimal; therefore, this is scored as <100% (EOBRT 2007).

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	DATA COLLECTION AND ANALYSIS	ENFORCEMENT	INCLUSION	SCORE
Northwest Atlantic | Hand implements | United States | Maryland	Ineffective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Red (1.000)**
Northwest Atlantic | Hand implements | United States | New York	Moderately Effective	Highly effective	Ineffective	Highly effective	Highly effective	**Red (2.000)**
Northwest Atlantic | Hand implements | United States | North Carolina	Ineffective	Highly effective	Ineffective	Highly effective	Highly effective	**Red (1.000)**

Northwest Atlantic | Hand implements | United States | Rhode Island	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | Hand implements | United States | South Carolina	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | Hand implements | United States | Virginia	Ineffective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Red (1.000)**
Northwest Atlantic | Towed dredges | United States | Delaware	Highly effective	Highly effective	Highly effective	Highly effective	Highly effective	**Green (5.000)**
Northwest Atlantic | Towed dredges | United States | Maryland	Ineffective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Red (1.000)**
Northwest Atlantic | Towed dredges | United States | North Carolina	Ineffective	Highly effective	Ineffective	Highly effective	Highly effective	**Red (1.000)**
Northwest Atlantic | Towed dredges | United States | South Carolina	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | Towed dredges | United States | Virginia	Ineffective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Red (1.000)**

Overfishing in the early years of the fishery in all states greatly impacted natural populations. In most of the eastern states, current stock status is a small percent of the virgin stocks (e.g., some regions of the Chesapeake Bay have around 1% of the original levels) (EOBRT 2007). For this reason, managers in all states have implemented regulations to protect the stocks by controlling harvest and implementing other management strategies. They have also created restoration projects that include the recovery of oyster habitat, which is one of the most serious barriers to recovery (Southworth and Mann 2013). Managers have implemented programs to provide oyster substrate and rotate harvest areas to allow for recovery. In addition, they have implemented minimum size limits and gear restrictions in certain areas. In Rhode Island, New York, and South Carolina, the fisheries are unlikely to be causing serious negative impacts to the stocks and these management measures are rated as "moderately effective." Delaware is rated "highly effective" because it has taken a more fine-scale approach to management and has a rebuilding plan. The management strategy for Maryland, Virginia, and North Carolina are deemed "ineffective" as these state continue to fish the stock without having reference points to guide management decisions and the size of the landings in these states means that they are likely having negative impacts on the stocks.

Since no other species are reported as caught within the fisheries, Factor 3.2 is scored as "highly effective" because the fishery has little to no bycatch.

Delaware scored "highly effective" for research and monitoring because they conduct fine-scale, per-bed abundance monitoring. Rhode Island, Maryland, Virginia, and South Carolina monitor abundance through a mix of stock assessments and surveys and therefore score "moderately effective." New York does not collect very much data on wild oyster abundance, with routine monitoring ending in 2005, so it scores "ineffective." North Carolina has repeatedly attempted to conduct stock assessments and failed due to insufficient data, yet data collection methods have not changed. Therefore, North Carolina scores "ineffective."

In every state, local enforcement bodies collaborate with managers to enforce oyster harvest and conservation regulations. In addition, due to the nature of oyster consumption (raw), health agencies also assure that areas where oysters have been harvested are safe for human consumption. Enforcement agencies patrol oyster harvesting areas and docks to guarantee that the proper gear is being used in authorized areas and seasons, and to enforce size and harvest limits. Generally, these enforcement activities are effective. However, poaching activities have been detected and punished: Rhode Island (Schieldrop 2016), Delaware (DelmarvaNow 2016), Maryland (CBS 2011), Virginia (Dietrich 2015), North Carolina, and South Carolina (HighBeam 2016). The amount of time, staff, and resources devoted to law enforcement for all states is evidence of regular compliance monitoring and enforcement of oyster management regulations. We therefore rate enforcement for all states in this report as "highly effective."

Meetings of the respective fisheries commissions in each of the east coast states are public processes. They include noticed, open meetings, and allow for the participation of fishers and seafood dealers. Through the Fisheries Management Council meetings, stakeholders can provide input on the individual state management processes. Some states have implemented joint efforts, like Maryland and Virginia, to increase management success. The management processes in each state are transparent, involve all major user-groups, provide mechanisms to address conflict, and encourage participation. Therefore, Seafood Watch rates Stakeholder Inclusion for all states as "highly effective."

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 | Hand implements | United States | Maryland
Northwest Atlantic | Towed dredges | United States | Maryland

Ineffective

Chesapeake Bay Oyster Management Plan was adopted in 1989 and was updated in 1994, 2004, and 2010 (MDNR 2019). Although there are clear management strategies that are based on scientific monitoring and advice, the stock abundance has continued to decline (MDNR 2020). The reference points used for the stock assessments are not appropriate for the stock. There is no target biomass and the fishing mortality reference points are aimed at maintaining the current abundance (MDNR 2018). This is despite the current abundance being at a historic low point following a considerable decline throughout the 20th century (MDNR 2019). Further, there is no rebuilding plan for the stock (MDNR 2019). For these reasons, the management regulations and implementation for Maryland scores "Ineffective."

Northwest Atlantic | Hand implements | United States | New York

Moderately Effective

The Department of Environmental Conservation (DEC) of New York regulates shellfish in the state. Although some regulations are in place, their effectiveness is unknown. Most landings probably come from aquaculture {Timmons et al. 2004}. State restoration projects have improved water quality and it is likely that conditions will continue to improve (Starke, Levinton, and Doall 2011). Oyster fishery management effectiveness is unknown and it is unlikely that the fishery is having serious negative impacts. Therefore, Seafood Watch rates this factor as "moderately effective."

Justification:

Oyster regulations include the following:

-Harvest limits of ½ bushel per day per person for recreational harvest and no limit for commercial catch
-No closed season
-Minimum size limit of 3 in at longest diameter
-Mechanical gears prohibited. Dredges with sail are allowed only in state-owned areas
- "Shellfish digger permit" required if harvest is for commercial purposes

Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | North Carolina

Ineffective

In North Carolina, an Oyster Management Plan has been in place since 2001, which is reviewed every five years (NCDMF 2016). The plan lists harvest limits, a fishing season, and a minimum size requirement (three in). These regulations aim to protect the status of the stock. However, no traditional stock assessment has been developed due to lack of data (NCDMF 2008) (NCDMF 2016) (NCMFC 2021). Instead, the status of the stock is inferred from commercial landings and effort. The North Carolina Division of Marine Fisheries (NCDMF) reported that North Carolina oyster stocks are a

"concern" (NCDMF 2016) due to habitat destruction and historic overharvest. While the current level of fishing is unknown relative to reference points, the continued decline in abundance indicates that fishing is likely occurring at a rate which would hinder recovery is likely having negative impacts on the stock. The lack of information on the effectiveness of current measures and indications of declining abundance suggest that the fishery is contributing to negative impacts on the stock. Therefore, Management Strategy and Implementation scores "Ineffective."

Justification:
Oyster season in public areas normally begins on October 15 and could last through March 31. However, the plan states that the Fisheries Director has the authority to limit these days, and open or close the fishery if needed (NCDMF 2016). In addition to fishing season, the use of mechanical gear is prohibited in public harvest areas, and there is a maximum daily harvest limit of 50 bushels per fishing operation per day (NCDMF 2016). However, managers recognize the need for a better monitoring system to improve accuracy of oyster abundance, commercial landings, and recreational harvest data. Also, it is important to identify the effects of harvest on habitat and expand restoration efforts.

Northwest Atlantic | Hand implements | United States | Rhode Island

Moderately Effective
The Department of Environmental Management (DEM) and the Rhode Island Marine Fisheries Council (RIMFC) are responsible for regulating *C. virginica*. Rhode Island has implemented appropriate management measures that include harvest regulations to control fishing mortality and respond to the state of the stock. However, the effectiveness is still unknown. Therefore, this factor is rated as "moderately effective."

Justification:
Regulations are part of the Shellfish Management Plan (SMP) created in 2014 and include the following:

-Annual harvest season from September 15 to May 15
-Minimum harvest size of 3 in at longest axis (RIDEM 2016)
-Harvest limits of three bushels per person per day for commercial harvest and ½ bushel for recreational (established in 2014 and renewed in the 2016 revision of the plan)
-Shellfish Management areas (15 in total in RI) that implement any of four management strategies: daily harvest limits, no harvest, limited access, and rotational harvest
-Prohibition on harvest using dredges and other gear operated with mechanical power or hauled by power boats
-Restoration projects to increase recruitment and rebuild natural stocks to self-sustaining levels (RIDEM 2016)

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | South Carolina

Moderately Effective
The South Carolina Department of Natural Resources (SCDNR) regulates commercial and

recreational harvest through lease areas that have been established since 1906. Licenses are needed to harvest recreationally and commercially. Due to the special characteristics of oyster reefs (three dimensional, intertidal reef), the State of South Carolina has classified them as Critical Habitats of Concern (SCSWAP 2015) and has increased their protection and coverage (South Carolina Oyster Restoration and Enhancement program, SCORE). Management measures are in place and it is unlikely that the fishery is negatively impacting oyster populations. Therefore, this factor is rated as "moderately effective."

Justification:

Recreational harvest limits for oysters (and shellfish in general) is two bushels per person per day on public and state shellfish grounds, and recreational harvest is limited to a maximum of two days within a seven-day period (SCDNR-MRD 2015). There are no commercial harvest limits, but commercial harvesting can only occur on state shellfish grounds, and is prohibited from public grounds (SCDNR-MRD 2015). The populations of *C. virginica* in South Carolina have remained stable. Managers believe that this is likely the result of the implementation of oyster restoration projects (Coen et al 2011), and a management strategy (Walker 2005) that includes limited access to the fishery through licenses and a harvest season from October to May (Walker 2005). Regulations focus on controlling fishing mortality. Managers recognize that loss of habitat and disease are the biggest causes of oyster mortality, and have thus implemented restrictions on harvesting.

Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Virginia

Ineffective

Chesapeake Bay Oyster Management Plan was adopted in 1989 and was updated in 1994, 2004, and 2010 (MDNR 2019). Although there are clear management strategies that are based on scientific monitoring and advice, it is not clear they are effective. Oyster populations throughout Chesapeake Bay differ and some areas (mostly sanctuaries) recently have improved (MDNR 2016a) (Southworth and Mann 2021). Despite the recent increase, the abundance of market oysters in the Virginia tributaries remains low and landings are at 0.1% compared to historic levels (Schulte 2017). Stocks within the Chesapeake Bay still have strong signs of being overfished. Although abundances in the Virginia section of the Chesapeake Bay have increased since the mid-1990s (CBP 2012), current abundance levels in these sections are still at historically low levels (Southworth and Mann 2021). Furthermore, the abundance surveys conducted by Virginia lack reference points for abundance and fishing mortality (Southworth and Mann 2021). For these reasons, the management regulations and implementation in the Bay is rated as "Ineffective."

Justification:

The Chesapeake Bay Oyster Management Plan has the following four components:

-Manage oyster harvest
-Establish oyster sanctuaries
-Overcome the effects of disease
-Restore reefs with hatchery-raised seeds

In addition, the Chesapeake Bay Program goals are to:

-Increase oyster populations to levels that restore important ecological functions
-Achieve a sustainable oyster fishery through a combination of harvest from public oyster grounds and private aquaculture
-Reduce the impacts of disease on oyster populations
-Increase hatchery production and develop disease-resistant strains

Northwest Atlantic | Towed dredges | United States | Delaware

Highly effective

The Delaware Division of Fish and Wildlife (DDFW) is responsible for managing natural oyster beds. They conduct annual dredge surveys that provide information on oyster abundance per bed. Based on the status of each natural bed the Division assigns a quota per bed. Exploitation rates range between 2.6% and 3.3% of the total abundance (Cole, Coakley, and Greco 2010). Other regulations are as follows:
-Two commercial seasons: a) April 1 to May 30; and b) September 1 to December 31 (excluding Sundays)
-Minimum size requirement of 2 ¾ inches
-Fishing registration and tag requirements

In addition to the harvest controls, a shell planting program is in place. This project seeks to revitalize natural oyster beds to increase recruitment and oyster abundance. For the last six years, commercial harvest has been stable, which likely results from current management regulations and restoration projects. Since Delaware managers assigned a specific harvest limit based on the abundance per bed in addition to the other regulations, management and strategy implementation has been successful and is therefore deemed as "highly effective."

Factor 3.2 - Bycatch Strategy

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Hand implements | United States | Rhode Island
Northwest Atlantic | Hand implements | United States | New York
Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | Delaware
Northwest Atlantic | Towed dredges | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Maryland
Northwest Atlantic | Towed dredges | United States | North Carolina

Highly effective

Since no other species are reported as caught within the fisheries, this factor is scored as "highly effective" because the fishery has little to no bycatch.

Factor 3.3 - Scientific Data Collection and Analysis

Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Towed dredges | United States | Maryland

Moderately Effective

The first stock assessment with reference points was completed in 2018 and was updated in 2020 (MDNR 2018) (MDNR 2020). The assessments estimate abundance and fishing mortality. The stock delineations used in the assessments are based on NOAA code harvest reporting regions in the Chesapeake Bay (MDNR 2019). This method implies that there are 36 separate stocks or populations being evaluated. Further, the reference points are based on abundance estimates from 1999-2019, a period of historically low abundance (MDNR 2019). The FMP includes data collection from fishery-dependent and fishery-independent sources.

While the pieces are in place for strong scientific research and monitoring, the deficiencies in the stock assessment mean that this fishery does not rise to the level of "Highly effective." Therefore, it scores "Moderately effective."

Northwest Atlantic | Hand implements | United States | New York

Ineffective

Currently, most of the commercial harvest from New York comes from aquaculture. Restoration projects are in place and are well-documented (BOP 2016) (Starke, Levinton, and Doall 2011). There is very little information about monitoring of wild stocks. Abundance of wild oysters was reported by the New York City Department of Parks & Recreation {NYCD P&R 2016} in 2004 and 2005, but no similar data have been reported since then. Consequently, Seafood Watch rates this factor as "ineffective."

Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | North Carolina

Ineffective

North Carolina does not have enough fishery independent data to perform a comprehensive stock assessment {NCDMF 2021}. Stock assessments were attempted in 1999, 2006, and 2014. They all failed because the data was insufficient to estimate sustainable harvest levels. However, data collection practices have not substantially improved since then. The only data available are of commercial landings and harvest effort. Managers focus on trends in catch rates for the commercial harvesters. However, these catch rates are not a clear representation of trends in population size. Although there is no stock assessment, the current use of the data allows managers to monitor the status of the stocks (abundance on reefs). While some data related to stock abundance and health are collected, it has been demonstrated that the data is insufficient for stock assessment purposes and future stock assessments will be unsuccessful unless data collection practices are improved. Based on this poor track record, Scientific Research and Monitoring scores "Ineffective."

Northwest Atlantic | Hand implements | United States | Rhode Island

Moderately Effective

Although restoration efforts are in place (e.g., TNC restoration project (TNC 2016)), Rhode Island does not conduct routine assessments of oysters. The state, however, uses landings data to generate assessments that managers use in combination with controls in harvest access. Managers rely on this monitoring process to manage the wild oyster population. Therefore, Seafood Watch rates this factor as "moderately effective."

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | South Carolina

Moderately Effective

In South Carolina, the Marine Resources Research Institute (MRRI) conducts fisheries-independent research and qualitative assessments to evaluate the status of the natural population after the harvest season (Walker 2005). However, these data are unavailable. In a recent State Wildlife Action Plan (SCSWAP 2015), managers recommended implementing a more rigorous oyster habitat monitoring program. Some data related to stock health are collected and used in monitoring the population. Therefore, Seafood Watch rates this factor as "moderately effective."

Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Virginia

Moderately Effective

In Virginia, the Virginia Institute of Marine Science (VIMS) monitors recruitment by counting spat. These assessments consider many factors that contribute to the health of oyster stocks, including physical and chemical environmental conditions. This information is used to help evaluate the condition of oyster populations in Virginia (Southworth and Mann 2015). Additionally, the VA Conservation and Replenishment Department systematically and scientifically monitors all the restoration activities to determine their success. As a result, this factor is rated as "moderately effective."

Northwest Atlantic | Towed dredges | United States | Delaware

Highly effective

The DDFW conducts annual surveys to monitor oyster abundance, which provide information about the condition of the stock. The DDFW also conducts regression analyses on fishery dependent data to set harvest quotas. Managers consider the factors that influence recovery of oyster stocks (i.e., pollution, densities, and environmental conditions) and estimate the population that must remain on each bed to achieve a viable population (Cole, Coakley, and Greco 2010). Thus, Seafood Watch rates scientific research and monitoring for Delaware as "highly effective."

Factor 3.4 - Enforcement of and Compliance with Management Regulations

Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Towed dredges | United States | Maryland

Highly effective

In Maryland, the Natural Resources Police (NRP), formerly the State Oyster Police, enforce laws and regulations that protect Maryland's oysters, crabs, and other fisheries. They patrol docks, roadways, and waterways to enforce regulations on minimum size limits, harvest amounts, and seasonal harvest restrictions, and have successfully prosecuted poachers of wild and farmed oysters (MDNR 2016b). Because the fishery is heavily regulated and enforced, this factor is considered "highly effective."

Northwest Atlantic | Hand implements | United States | New York

Highly effective

The Department of Environmental Conservation's Division of Law Enforcement is responsible for enforcing laws pertaining to fish and wildlife and water quality. Fish and Wildlife enforcement includes addressing complaints of poaching, illegal sale of species and checking fishermen, trappers, and commercial fishermen, including those targeting shellfish, for compliance of the regulations (DEC 2016b). There are no specifics regarding how often shellfish grounds are monitored or how, although the DEC website says enforcement is through "proactive and reactive patrols in marked police vehicles" (DEC 2016b). Therefore, Seafood watch considers this factor to be "highly effective."

Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | North Carolina

Highly effective

The North Carolina Marine Patrol enforces marine and estuarine fisheries regulations in the coastal waters of North Carolina. They patrol piers and beaches, and inspect commercial and recreational fishing vessels, seafood warehouses, vehicles, and restaurants. Currently, the Marine Patrol has 56 officers that work in three law enforcement districts along the coast. Officers use a variety of different size boats, aircraft, and patrol vehicles to accomplish these tasks. Due to the regular monitoring and enforcement as well as the number of marine patrol officers, this factor is considered "highly effective."

Northwest Atlantic | Hand implements | United States | Rhode Island

Highly effective

In Rhode Island, the state Department of Environmental Management, Law Enforcement Division, patrols oyster harvest and closed areas. The Division staffs a 24-hour hotline to report violations of the state's wide-ranging environmental laws. Because regular enforcement of regulations and the capacity to control compliances is appropriate, Seafood Watch rates this factor "highly effective."

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | South Carolina

Highly effective

The South Carolina Department of Natural Resources, Division of Law Enforcement, enforces state and federal laws for commercial fishing and other natural resources conservation concerns. The division covers the 46 counties and coastal marine shoreline and waters out to 200 mi. Therefore, because regulations are regularly enforced by an independent body, we rate this as "highly effective."

Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Virginia

Highly effective
The Virginia Marine Police enforces oyster management in the state. The agency monitors commercial and recreational fishing activities (MRC 2016). In addition, state and local police agencies support compliance with management regulations by checking fishing licenses and inspecting commercial fishing vessels for compliance with appropriate regulations. Therefore, based on SFW criteria, this factor is considered "highly effective."

Northwest Atlantic | Towed dredges | United States | Delaware

Highly effective
The Delaware Division of Watershed Stewardship is responsible for monitoring aquatic and plant health, and the shellfish program is responsible for monitoring and classifying shellfish growing areas to determine if recreational and commercial shellfish harvesting is safe, as well as inspecting and ensuring certification of all commercial shellfish shippers and processors within Delaware. The Division of Fish and Wildlife enforces oyster regulations through on-water and dock patrols, and regulates catch limits and harvesting methods for both commercial and recreational harvesters. Therefore, due to the regular monitoring, patrolling and enforcement of the state's oyster regulations, Seafood Watch deems this factor as "highly effective."

Factor 3.5 - Stakeholder Inclusion

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Hand implements | United States | Rhode Island
Northwest Atlantic | Hand implements | United States | New York
Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | Delaware
Northwest Atlantic | Towed dredges | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Maryland
Northwest Atlantic | Towed dredges | United States | North Carolina

Highly effective
Meetings of the respective fisheries commissions in each of the east coast states are public processes. They include noticed, open meetings, and allow for the participation of fishers and seafood dealers. Through the Fisheries Management Council meetings, stakeholders can provide input on the individual state management processes. Some states have implemented joint efforts, like Maryland and Virginia, to increase management success. The management processes in each state are transparent, involve all major user-groups, provide mechanisms to address conflict, and encourage participation. Therefore, Seafood Watch rates Stakeholder Inclusion for all states as "highly effective."

Criterion 4: Impacts on the Habitat and Ecosystem

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

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

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	FORAGE SPECIES?	SCORE
Northwest Atlantic | Hand implements | United States | Maryland	Score: 3	+.5	Low Concern		Green (3.742)
Northwest Atlantic | Hand implements | United States | New York	Score: 3	+.5	Low Concern		Green (3.742)
Northwest Atlantic | Hand implements | United States | North Carolina	Score: 3	+.5	Low Concern		Green (3.742)
Northwest Atlantic | Hand implements | United States | Rhode Island	Score: 3	+.5	Low Concern		Green (3.742)
Northwest Atlantic | Hand implements | United States | South Carolina	Score: 3	+.5	Low Concern		Green (3.742)
Northwest Atlantic | Hand implements | United States | Virginia	Score: 3	+.5	Low Concern		Green (3.742)
Northwest Atlantic | Towed dredges | United States | Delaware	Score: 2	+.5	Low Concern		Yellow (3.162)
Northwest Atlantic | Towed dredges | United States | Maryland	Score: 2	+.5	Low Concern		Yellow (3.162)
Northwest Atlantic | Towed dredges | United States | North Carolina	Score: 2	+.5	Low Concern		Yellow (3.162)
Northwest Atlantic | Towed dredges | United States | South Carolina	Score: 2	+.5	Low Concern		Yellow (3.162)
Northwest Atlantic | Towed dredges | United States | Virginia	Score: 2	+.5	Low Concern		Yellow (3.162)

Dredges are the most commonly used gear by total volume. Tongs and rakes also are important, especially in some states where dredges have been limited to certain areas or completely banned. Dredging has been identified in other fisheries to greatly impact bottom habitats (Johnson 2002)(Thrush and Dayton 2002), {Chuenpagdee et al. 2003}. However, some evidence from oyster fisheries in Virginia and Maryland showed that smaller dredges that are used in sandy and muddy bottom actually created a lower impact than those used for clams or other bivalves (Langan 1998) (Mercaldo-Allen and Goldberg 2011) {Powell et al. 2008} (Powell and Ashton-Alcox 2004). Dredges can destroy reefs, which affect the substrate for future oyster generations by reducing recruitment.

Although the impact of tonging and rakes is not as evident, detailed information about the impact of these gears is not conclusive (Lenihan and Micheli 2000). The level of mitigation that has been applied in most of the states focuses on reducing the areas where some of the gears can be used, as well as closing areas with demonstrated negative impacts to abundance and the status of the reef. Since oyster recruitment is directly related to substrate availability, some restoration efforts and mitigation actions are focused on improving the health of these structures.

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 - Physical Impact of Fishing Gear on the Habitat/Substrate

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Hand implements | United States | Rhode Island
Northwest Atlantic | Hand implements | United States | New York
Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Hand implements | United States | North Carolina

Score: 3

Lenihan and Micheli (2000) reported that harvesting with clam rakes and oyster tongs reduced the densities of live oysters by 50% to 80% compared with the densities of unharvested oyster reefs (Lenihan and Micheli 2000). Hand tonging was shown to reduce subtidal reef heights and increase mortality over control sites (Lenihan and Peterson 2004). However, Rothschild et al. (1994) concluded that due to their limited efficiency and area of coverage, hand tongs probably had only a minor effect on oyster bar structure {Rothschild, et al. 1994}. Harvesters are not likely to use hand tongs in areas where seagrasses are present because of the difficulty in using hand tongs in that habitat.

Typically, harvesters using hand tongs do not remove excessive amounts of substrate, and when shell and juvenile and sub-adult oysters are legally culled and shell returned to the reef, there is little need for additional mitigation {VanderKooy 2016}. Using the Seafood Watch scoring table for this criterion, hand rakes and tongs receive a score of 3.

Northwest Atlantic | Towed dredges | United States | Delaware
Northwest Atlantic | Towed dredges | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Maryland
Northwest Atlantic | Towed dredges | United States | North Carolina

Score: 2

Mercaldo-Allen and Golberg {2011} developed an extensive review of the ecological effects of dredging on the harvest of shellfish, including oyster harvesting. The report considered all potential effects of dredging on the physical habitat, local communities, and sediment alteration. The authors concluded that the effects of dredging are highly variable and depend on the local characteristics of the region. In general, physical effects of dredging are usually reverted through natural processes (tides or currents), and ecological recovery is linked to natural and ongoing seasonal recruitment processes (Mercaldo-Allen and Goldberg 2011). To mitigate the impacts of shellfish dredging, state managers established regulations that ban the use of this gear in certain areas (NCDMF 2016) (CBP 2012) (SCDNR-MRD 2015) (NCMFC 2015) in combination with the creation of no harvest areas (sanctuaries). Based on these studies and using the Seafood Watch scoring table, the impact of oyster dredges on the substrate receives a score of 2.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Hand implements | United States | Rhode Island
Northwest Atlantic | Hand implements | United States | New York
Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | Delaware
Northwest Atlantic | Towed dredges | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Maryland
Northwest Atlantic | Towed dredges | United States | North Carolina

+.5

All states have seasonal closures, catch limits, and habitat replacement measures, which reduce the intensity of the fishing footprint. Therefore, all states are deemed to have a "moderate" mitigation score of 0.5 points.

Factor 4.3 - Ecosystem-based Fisheries Management

Northwest Atlantic | Hand implements | United States | South Carolina
Northwest Atlantic | Hand implements | United States | Rhode Island
Northwest Atlantic | Hand implements | United States | New York
Northwest Atlantic | Hand implements | United States | Virginia
Northwest Atlantic | Hand implements | United States | Maryland
Northwest Atlantic | Hand implements | United States | North Carolina
Northwest Atlantic | Towed dredges | United States | Delaware
Northwest Atlantic | Towed dredges | United States | South Carolina
Northwest Atlantic | Towed dredges | United States | Virginia
Northwest Atlantic | Towed dredges | United States | Maryland
Northwest Atlantic | Towed dredges | United States | North Carolina

Low Concern

Oyster habitats provide a number of ecosystem services. They filter water that helps prevent eutrophication (Ulanowicz and Tuttle 1992) and also provide important habitat structure that maintains biodiversity (Harding and Mann 1999) (Lehnert and Allen 2002). Over 300 species were reported to be associated with oyster reefs in North Carolina (Wells 1961) .

One of the greatest threats to these areas was the overuse of mechanical gear that impacted and changed the size and dimension of these reefs (Mercaldo-Allen and Goldberg 2011). These changes decreased oyster recruitment and growth (Mercaldo-Allen and Goldberg 2011), which ultimately reduced the capacity of oyster reefs to provide ecosystem services.

Managers have considered these impacts when creating management policies and restoration projects. All states covered in this report employ some type of regulation to reduce, limit or completely ban fishing impacts on oyster reefs. In some cases they have implemented protected

areas where harvest is prohibited (for example, Virginia created more than 100 sanctuary reefs that prohibit oyster harvest) (CBP 2005). Rotation of harvest areas allows oysters to grow undisturbed and is a common mitigation technique. In addition, some states have designated shell bottom habitats as essential fish habitat (EFH) (Street et al. 2005) (NCDMF 2016).

Oyster reef restoration efforts include construction and/or restoration of reefs; however, these are complex processes that can be expensive and time consuming. The effectiveness of these actions also depends on environmental conditions (MacKenzie 1997) and the occurrence of diseases, which have decimated populations in the past.

Overall, managers in all states understand the vital importance of oysters and a wide-range of restoration efforts are in place. Policies consider the ecosystem function of oysters and some spatial management is in place in most of the states. For these reasons, this factor is rated as a "low" concern for all the states.

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.

Seafood Watch would like to thank the consulting researcher and author of this report, Gabby Bradt, as well as Dawn Kotowicz from Rhode Island Sea Grant and several anonymous reviewers for graciously reviewing this report for scientific accuracy.

References

Billion Oyster Project. New York. http://www.billionoysterproject.org/

CBP. 2005. 2004 Chesapeake Bay Oyster Management Plan. EPA No. 903-R-05-005, CPB No. CBP/TRS 277-06. Annapolis, MD. 58 pp. Online at http://www.chesapeakebay.net/content/publications/cbp_12889.pdf.

CBP. 2012 Chesapeake Bay Program native oyster abundance. Online at http://www.chesapeakebay.net/indicators/indicator/native_oyster_abundance

CBS Baltimore. 2011. http://baltimore.cbslocal.com/2011/04/11/3-e-shore-watermen-fined-for-oyster-poaching/

Coen L., N. Hadley, V. Shervette and B. Anderson. 2011. Managing oysters in South Carolina: A five year program to enhance/restore shellfish stocks and reef habitats through shell planting and technology improvements. A SC Saltwater recreational fishery license program final report. Marine Resources Center, SCDNR.

Cole, R., J. Coakley, and M. Greco 2010. Oyster management white paper 2004. Updates through 2009. Delaware Division of Fish and Wildlife.

Davis, J. Personal Communication.NC Sea Grant. February 3, 2017

DDFW. 2021. 2021 Survey of Natural Oyster Beds. Delaware Division of Fish and Wildlife.

DEC 2016a. New York State Department of Environmental Conservation http://www.dec.ny.gov/outdoor/29870.html

DEC 2016b. New York State Department of Environmental Conservation. http://www.dec.ny.gov/regulations/2437.html

DelmarvaNow.2016.http://www.delmarvanow.com/story/news/local/maryland/2016/07/06/nanticoke-waterman-charged-oyster-poaching/86766804/

Dietrich, T. 2015. Oyster Poachers will soon face stiffer penalties. Daily Press.http://www.dailypress.com/news/science/dp-nws-oyster-poaching-penalty-20150603-story.html

Eastern Oyster Biological Review Team. 2007. Status Review of the Eastern Oyster (Crassostrea virginica) Report to the National Marine Fisheries Service, Northeast Regional Office, February 16, 2007.

FAO (2012a). Fishery Statistical Collections Global Production. Food and Agriculture Organization of the United Nations, Rome, Italy. Accessed 2012. http://www.fao.org/fishery/statistics/global-production/en.

FAO 2004-2016. Crassostrea virginica. Cultured Aquatic Species Information Programme. Text by Kennedy, V. S. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 1 January 2004.

FAO. 2016. FAO - Fisheries and Aquaculture Information and Statistics Branch – Accessed 16/10/2016

Harding, J.M. and R. Mann. 1999. Fish Species Richness in relation to restored oyster reefs, Piankatank River, Virginia. Bulletin of Marine Science 65(1):289-300.

HighBeam. 2016. https://www.highbeam.com/doc/1G1-452187323.html

Interjurisdictional Fisheries Act (IJF). 1986. Title III of Public Law 99–659, Approved Nov. 14, 1986, 100 Stat. 3731.

Johnson, K. A. 2002. "A Review of National and International Literature on the Effects of Fishing on Benthic Habitats." NOAA Technical Memorandum NMFS –F/SPO–57. http://www.nmfs.noaa.gov/habitat/habitatprotection/essentialfishhabitat10.htm.

Kennedy, V. S. (1996). Biology of larvae and spat. Pages 371-421 in V.S Kennedy, R.I.E. Newell, and A. F. Eble, editors. The eastern oyster, Crassostrea virginca. Maryland Sea Grant College. College Park, MD.

Langan, R. 1998. The effect of dredge harvesting on eastern oysters and the associated benthic community, in: Dorsey, E.M. et al. Effects of fishing gear on the sea floor of New England. pp. 108-110

Lehnert, R. L. and D. M. Allen. 2002. Nekton use of subtidal oyster shell habitat in a Southeastern U.S. estuary. Estuaries 26(5): 1015-1024.

Lenihan H. S. and F. Micheli. 2000. Biological effects of shellfish harvesting on oyster reefs: resolving a fishery conflict using ecological experimentation. Fishery Bulletin 98:86–95

Lenihan, H. S. and C. H. Peterson. 2004. Conserving oyster reef habitat by switching from dredging and tonging to diver harvesting. Fishery Bulletin 102:298-305.

Lerberg, S. B., A. F. Holland, and D. M. Sanger. 2000. Responses of tidal creek macrobenthic communities to the effects of watershed development. Estuaries 23:838-853.

LISS. 2015. A partnership to restore and protect the sound. http://longislandsoundstudy.net/indicator/oyster-harvest/

Lively, J.A. (2016). Louisiana Sea Grant. Personal Communication. 10/2016

MacKenzie. Jr., C. L. 1997. The molluscan fisheries of Chesapeake Bay. In C. L. MacKenzie, Jr., V. G. Burrell, Jr., A. Rosenfield, and W. L. Hobart (eds). The history, present condition, and future of the molluscan fisheries of North and Central America and Europe, Volume 1, Atlantic and Gulf Coasts. NOAA Technical Report. NMFS. 127:141–169.

MDNR. 2016a. Oyster Management Review, 2010-2015. Maryland FMP report (July 2016). Maryland Department of Natural Resources, Annapolis, MD.

MDNR. 2016b. Maryland.gov. Department of Natural Resources (x/).

MDNR. 2018 A stock assessment of the Eastern oyster, *Crassostrea virginica*, in the Maryland waters of the Chesapeake Bay. Maryland Department of Natural Resources. Annapolis, MD.

MDNR. 2019. Maryland Chesapeake Bay oyster management plan (May 2019). Maryland Department of Natural Resources. Annapolis, MD.

MDNR. 2020. 2020 update: stock assessment of the Eastern oyster, *Crassostrea virginica*, in the Maryland waters of the Chesapeake Bay. Maryland Department of Natural Resources. Annapolis, MD.

Medley, T. 2010. Wild Oysters, Crassosstrea virginica, in the Hudson River Estuary: Growth, health and population structure. Thesis City University of New York. 146 pages.

Mercaldo-Allen R. and R. Goldberg. 2011. Review of the ecological effects of dredging in the cultivation and harvest of molluscan shellfish. NOAA Technical Memorandum NMFS-NE-220. December 2011.

MRC. 2016. Virginia Marine Resources Commission. http://mrc.virginia.gov/mp/leoverview.shtm

NCDMF. 2008. North Carolina Oyster Fishery Management Plan. June 2008.

NCDMF. 2015. Eastern Oysters 2015. http://portal.ncdenr.org/web/mf/35-eastern-oyster-ssr-2015

NCDMF. 2016. North Carolina Oyster Management Plan. Amendment 4. January 2016.

NCMFC. 2015. North Carolina Marine Fisheries Commission Rules May, 2015.

NCMFC. 2021. Fishery management plan update: Eastern oyster. North Carolina Marine Fisheries Commission. Raleigh, NC.

NMFS (2012b). Fisheries Statistics Foreign Trade. Accessed 2012. http://www.st.nmfs.noaa.gov/st1/trade/index.html

NMFS. 2016. Annual Commercial Landings. https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index. Accessed 9/13/16

NMFS. 2022. Annual Commercial Landings. https://www.fisheries.noaa.gov/foss/. Accessed 11/23/22

Oviatt, C.S. Olsen, M. Andrews, J. Collie, T. Lynch, and K. Raposa. 2003. A century of fishing and fish fluctuations in Narragansett Bay. Reviews in Fisheries Science 11(3): 221-242

Powell EN, Ashton-Alcox A. 2004. A comparison between a suction dredge anda traditional oyster dredge in the transplantation of oysters in Delaware Bay. J. Shellfish Res. 23(3):803-823

Powell, E. N. and H. Cummins (1985). "Are molluscan maximum life spans determined by long-term cycles in benthic communities?" Oecologia 67(2): 177-182.

Powell, E. N., J. M. K., Kathryn A. Ashton-Alcox, John N. Kraeuter (2009). "Multiple stable reference points in oyster populations: biological relationships for the eastern oyster (Crassostrea virginica) in Delaware Bay." Fisheries Bulletin 107: 109-132.

Rheault, R. 2008. Review of the Environmental impacts related to the Mechanical harvest of cultured shellfish. Prepared for: Cashin Associates for the Suffolk County Shellfish Aquaculture Environmental Study. July 2008

Rheault, R. East Coast Shellfish Growers Association. Personal Communication, 2017.

RIDEM. 2016. 2016 Shellfish Sector Management Plan. State of Rhode Island and Providence Plantations, Department of Environmental Management, Division of Fish and Wildlife, Marine Fisheries. 20 pp.

RIDEM. 2018. 2018 Shellfish sector management plan. State of Rhode Island and Providence Plantations, Department of Environmental Management, Division of Fish and Wildlife, Marine Fisheries.

RIDEM. 2022. Sector management plan 2022. State of Rhode Island and Providence Plantations, Department of Environmental Management, Division of Fish and Wildlife, Marine Fisheries.

Rothschild, B., J. Ault, P. Goulletquer, and M. Heral. 1994. Decline of the Chesapeake Bay oyster population: a century of habitat destruction and overfishing. Marine Ecology Progress Series 111: 29-39

SCDNR.2016. http://www.dnr.sc.gov/GIS/descoysterbed.html

SCDNR-MRD. 2015-2016. Summary of Commercial Shellfish laws.

Schieldrop, T. 2016. Arrests made in oyster poaching case. Narragansett Patch. http://patch.com/rhode-island/narragansett/arrests-made-oyster-poaching-case

Schulte, D.M. 2017. History of the Virginia Oyster Fishery, Chesapeake Bay, USA. Frontiers in Marine Science. 4:127.

SCSWAP. 2015. South Carolina State Wildlife Action Plan 2015. Supplemental Volume: Species of Conservation Concern. Eastern Oysters.

Shumway, S. E. (1996). Natural environmental factors. Pages 467-513 in V. S. Kennedy, R. I. E. Newell, and A. F. Eble, editors. The eastern oyster, Crassostrea virginica. Maryland Sea Grant College, College Park, MD.

Southworth, M. and R. Mann. 2013. The status of Virginia's public oyster resource, 2014. Molluscan Ecology Program, Virginia Institute of Marine Science, Gloucester Point, Virginia. 48 pp

Southworth, M. and R. Mann. 2015. The status of Virginia's public oyster resource, March 2016. Molluscan Ecology Program, Virginia Institute of Marine Science, Gloucester Point, Virginia. 48 pp.

Southworth, M. and R. Mann. 2021. The status of Virginia"s public oyster resource 2020. Molluscan Ecology Program, Virginia Institute of Marine Science, Gloucester Point, Virginia. 52 pp.

Starke, A., J. Levinton, and M. Doall. 2011. Restoration of Crassostrea virginica, to the Hudson River, USA: A spatiotemporal modelling approach. Journal of Shellfish Research 30 (3):671-684

Street, M.W., A.S. Deaton, W.S. Chappell, and P.D. Mooreside, 2005. Chapter 3 Shell Bottom, 201-256pp, In: North Carolina Coastal Habitat Protection Plan. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC.

The Nature Conservancy. 2016.
http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/rhodeisland/oysters-gone-wild.xml

Thrush, S. F., and P. K. Dayton.2002.Disturbance to Marine Benthic Habitats by Trawling and Dredging: Implications for Marine Biodiversity. Annual Review of Ecology and Systematics, Vol. 33, (2002), pp. 449-473

Ulanowicz R. and J. Tuttle. 1992. The trophic consequences of oyster stock rehabilitation in Chesapeake Bay. Estuaries 15(3):298-306.

VMRC. 2022. Pertaining to restrictions on oyster harvest. https://mrc.virginia.gov/regulations/fr720.shtm. Accessed on 12/2/22

Walker, R. 2005. South Carolina Shellfish Management Plan. South Carolina Department of Health and Environmental Control, Office of Ocean and Coastal Resource Management. Charleston, SC.

Wells, H. 1961. The Fauna of oysters beds, with special reference to the salinity factor. Department of Zoology, Duke University, Durham. North Carolina. Ecological Monographs.

Appendix A: 2022 Rating Review Changes

Overall rating changes

The overall rating for Maryland changed from yellow to red based on updated C1.2, C3.1, and C3.3 scores.

The overall rating for North Carolina changed from yellow to red based on updated C1.2, C3.1, and C3.3 scores.

The overall rating for Virginia changed from yellow to red based on updated C3.1 score.

These rating changes triggered an update from version 3 to version 4 of the standard in this rating review.

Delaware

C1.1 was updated with new stock survey data. C1.2 added information about the change in how quota is calculated.

Maryland

C1.1 was updated with new stock assessment information from the 2020 stock assessment. No score change.

C1.2 was updated with new stock assessment information and the score was changed to "High concern."

C3.1 was downgraded to "Ineffective" because the management plan in place has provisions for holding the stock stable, but does not have a rebuilding plan. Since C1 scores red, this indicates that a management plan aimed at holding abundance and fishing mortality to the current level is not an appropriate strategy.

C3.3 was downgraded to "Moderately effective" due to concerns with the stock assessment. The reference points are not appropriate and stock delineation methods imply that there are 36 separate stocks in the Chesapeake Bay.

North Carolina

C1.1 was updated with information about why stock assessments have not been used by the state. No score change.

C1.2 was updated to "high concern." Though there is still no stock assessment, the continued decline in the abundance indicates that current fishing practices are not helping the stock recover.

C3.1 was changed to "ineffective" because C1 is red.

C3.3 was changed to "ineffective." Stock assessments were attempted in 1999, 2006, and 2014. All failed because the data was insufficient. Yet data collection methods have not been improved.

South Carolina

No changes.

Virginia

C1.1 was updated with new abundance trend information. No score change. C1.2 was updated with new landings data.

C3.1 was downgraded to "Ineffective" because C1 scores red and the management plan in place has provisions for holding the stock stable, but does not have a rebuilding plan or reference points.

New York

No changes

Rhode Island

C1.1 and C1.2 had addition citations added. No score changes.

Appendix B: Rating Review Summary Tables

Criteria	Previous Report (2018, Delaware)	Current Review (2022, Delaware)
Who conducted the stock assessment?	Delaware Division of Fish and Wildlife	Same as previous
When was the stock assessment conducted?	2010	Same as previous
Where/what are the catch composition data source(s)?	Annual dredge surveys	Same as previous
Who manages the fishery?	Delaware Division of Fish and Wildlife	Same as previous
What is the date of the published management plan?	2004	Same as previous
Are there any amendments?	N/A	N/A

Criteria	Previous Report (2018, Maryland)	Current Review (2022, Maryland)
Who conducted the stock assessment?	Maryland Department of Natural Resources	Same as previous
When was the stock assessment conducted?	2016	2020
Where/what are the catch composition data source(s)?	Commercial harvest and effort data, fishery-independent surveys	Same as previous
Who manages the fishery?	Maryland Department of Natural Resources	Same as previous
What is the date of the published management plan?	1989, 1994, 2004	2019
Are there any amendments?	2010	New FMP was written and adopted

Criteria	Previous Report (2018, North Carolina)	Current Review (2022, North Carolina)
Who conducted the stock assessment?	N/A	N/A
When was the stock assessment conducted?	N/A	N/A
Where/what are the catch composition data source(s)?	N/A	N/A
Who manages the fishery?	North Carolina Division of Marine Fisheries	Same as previous
What is the date of the published management plan?	2001	2021
Are there any amendments?	2003, 2008, 2014, 2017	2021

Criteria	Previous Report (2018, South Carolina)	Current Review (2022, South Carolina)
Who conducted the stock assessment?	N/A	N/A
When was the stock assessment conducted?	N/A	N/A
Where/what are the catch composition data source(s)?	N/A	N/A
Who manages the fishery?	South Carolina Department of Natural Resources	Same as previous
What is the date of the published management plan?	2005	Same as previous
Are there any amendments?	N/A	N/A

Criteria	Previous Report (2018, Virginia)	Current Review (2022, Virginia)

Who conducted the stock assessment?	N/A	N/A
When was the stock assessment conducted?	N/A	N/A
Where/what are the catch composition data source(s)?	N/A	N/A
Who manages the fishery?	Virginia Marine Resources Commission	Same as previous
What is the date of the published management plan?	1989, 1994, 2004	2019
Are there any amendments?	2010	New FMP was written and adopted

Criteria	**Previous Report (2018, New York)**	**Current Review (2022, New York)**
Who conducted the stock assessment?	N/A	N/A
When was the stock assessment conducted?	N/A	N/A
Where/what are the catch composition data source(s)?	N/A	N/A
Who manages the fishery?	Department of Environmental Conservation of New York	Same as previous
What is the date of the published management plan?	N/A	N/A
Are there any amendments?	N/A	N/A

Criteria	**Previous Report (2018, Rhode Island)**	**Current Review (2022, Rhode Island)**

Who conducted the stock assessment?	N/A	N/A
When was the stock assessment conducted?	N/A	N/A
Where/what are the catch composition data source(s)?	Landings data	Same as previous
Who manages the fishery?	Rhode Island Department of Environmental Management	Same as previous
What is the date of the published management plan?	2016	2022
Are there any amendments?	No	Same as previous