MONTEREY BAY AQUARIUM®

Seafood WATCH

Eastern Oyster

Crassostrea virginica

Gulf Coast Region

October 23, 2012

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Final Seafood Recommendation

This report focuses on the United States (US) eastern oyster (*Crassostrea virginica*) wild-caught fishery, which for the purpose of this report, is defined as the commercial removal of oysters from leased or public bottom that is utilizing public and wild oyster seed. This report does not include any oyster production involving the off-bottom growing of oysters. While the commercial harvest of the eastern oyster occurs along the entire length of the eastern US coast, this report specifically addresses the Gulf of Mexico commercial dredge and tong oyster fisheries (Alabama, Mississippi, Florida, Louisiana and Texas), since these account for 87%–93% of all US wild-caught landings from 2004 to 2010. All of these sources are deemed a Best Choice.

Stock	Fishery	Impacts on the Stock Rank (Score)	Impacts on other Species Lowest scoring species Rank*, Subscore, Score	Manage-ment Rank Score	Habitat and Ecosystem Rank Score	Overall Recommendation Score
Eastern Oyster	AL Tong	Yellow 2.64	No other main species caught Green, 5,5	Yellow 3	Green 3.24	**BEST CHOICE 3.37**
Eastern Oyster	TX Dredge	Yellow 2.64	No other main species caught Green, 5,5	Yellow 3	Yellow 2.74	**BEST CHOICE 3.23**
Eastern Oyster	FL Tong	Yellow 2.64	No other main species caught Green, 5,5	Green 4	Green 3.24	**BEST CHOICE 3.62**
Eastern Oyster	MS Tong	Yellow 2.64	No other main species caught Green, 5,5	Yellow 3	Green 3.24	**BEST CHOICE 3.37**
Eastern Oyster	LA Dredge	Yellow 2.64	No other main species caught Green, 5,5	Yellow 3	Yellow 2.74	**BEST CHOICE 3.23**
Eastern Oyster	AL Dredge	Yellow 2.64	No other main species caught Green, 5,5	Yellow 3	Yellow 2.74	**BEST CHOICE 3.23**
Eastern Oyster	MS Dredge	Yellow 2.64	No other main species caught Green, 5,5	Yellow 3	Yellow 2.74	**BEST CHOICE 3.23**

Scoring note – scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact. *Rank and color in the 'Impacts on other Species' column is defined based on the Subscore rather than the Score. See scoring rules for more information.

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Executive Summary

The eastern oyster (*Crassostrea 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 Canada, the western United States, western Mexico, 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, which for the purpose of this report, is defined as the commercial removal of oysters from leased or public bottom that is utilizing public and wild oyster seed. This report does not include any oyster production involving the off-bottom growing of oysters. While the commercial harvest of the eastern oyster occurs along the entire length of the eastern US coast, this report specifically addresses the Gulf of Mexico commercial dredge and tong oyster fisheries (Alabama, Mississippi, Florida, Louisiana and Texas), since these account for 87%–93% of all US wild-caught landings from 2004 to 2010.

The eastern oyster has low inherent vulnerability to fishing pressure. It can reproduce within a few months of age, and grow to a harvestable size within one year in the warmer waters of the Gulf as long as it has suitable substrate, which it self-produces. Throughout its range from Canada to Mexico (with a few limited exceptions) oyster populations are not considered to be at risk now or in the foreseeable future. In the Gulf of Mexico, the greatest challenges in recent years have not been fishing mortality, but conditions such as an oil spill, drought, hurricanes, predation, disease and loss of substrate. Despite these challenges, populations throughout the Gulf are moderately abundant.

Because environmental factors and diseases are so important in determining adult mortality rate, and because they are not mobile once the larvae set, each reef may have different abundance requirements to support harvesting. Although Florida has set a per-reef abundance threshold for harvest, there are no state or regional reference points for determining harvests. Resource managers utilize partial closures of areas as needed to protect habitat and spawning, and to ensure human health concerns are addressed. None of the states have a total allowable catch. Only Florida has a standard abundance threshold for determining when a reef can be opened for harvesting. Although all of the states conduct some assessments, there is no estimate of the biomass of the fishery, either within a single state or Gulf-wide. The oyster fishery is highly selective, therefore, bycatch is negligible.

Eastern oysters are most abundant in shallow, tidally influenced waters. This places them almost exclusively in state waters, and as a result, there is no federal management of the fishery. However, as part of the Interjurisdictional Fisheries Act of 1986, the Gulf States Marine Fisheries Commission (GSMFC) has an FMP that includes management and science-based recommendations for the fishery Gulf-wide, and serves as a forum for collective research and utilization of the resource for the Gulf of Mexico.

While each Gulf state has slightly different management programs, they all utilize size limits, seasons, gear restrictions, and area-specific closures to support both oyster abundance and to meet human health standards for seafood consumption. Shellfish are highly regulated because they are eaten raw, and so health agencies as well as resource agencies are involved in monitoring the resource and related water quality. Regulations are enforced through active patrolling on the water and at the docks. All the Gulf States have programs to move seed oysters as needed and to return cultch to oyster beds as substrate. Because substrate for larvae is a key factor in supporting the fishery, habitat is a primary concern for oyster management in all the states. All states conduct fishery-independent research, as well as fishery-dependent research, such as tagging requirements for harvesters and buyers. All management bodies operate through public meeting processes, but there is not a designated stakeholder process outside of this for feedback. The GSMFC updated their 1991 FMP in March 2012. Eighty-nine percent of the management recommendations in the 1991 FMP had been adopted by the time the revised FMP was completed. As of 2009, states varied in their compliance regarding the adoption of science-based recommendations in the 1991 FMP. Many of the monitoring requirements for states changed after the 2010 British Petroleum oil spill, thus no up-to-date assessment of compliance with science-based recommendations exists. In the revised FMP, many of the recommendations focus on unifying individual state's management plans through shared season times, shared harvest sizes, and consideration of modeling tools that would allow for more regional biomass assessment. Additionally, the FMP recommends including shell loss and shell availability as an important part of oyster fishery assessments. The GSMFC is currently testing a potential model at two pilot locations to see if it might be a useful tool for the Gulf region. Because the Gulf States have only recently adopted a new FMP as well as revised monitoring guidelines, it is not known yet how well the Gulf States have complied with more recent science-based recommendations, or if the models being tested will assist in individual state or Gulf-wide biomass or shell assessments. Management in Florida is highly effective due to the standardized techniques used to determine overfishing, while the remaining states have moderately effective management due to the need for increased management precaution.

The Gulf of Mexico oyster fishery relies primarily on dredging and tonging as harvesting methods. While there is evidence that larger off-shore dredges have detrimental impacts on hard-bottom habitat, there is conflicting research about the effects of using oyster dredges on mud and sand bottom in the near-shore fishery, particularly in areas already dredged. In softer bottom, there is less evidence of long-term damage and increasing evidence of higher production compared to non-dredged bottom. However, observed degradation and lack of information about the full effects warrant caution. Hand tonging has also been documented to degrade reefs, but this gear is static and less efficient than dredging. There is less research on the impacts of tonging. There is minimal to moderate mitigation of these potential impacts, depending on each state's response. The revised FMP recognizes the oyster as a keystone species in a healthy estuarine environment includes a management goal of supporting oyster populations for their ecosystem benefit, but how individual states will implement strategies to meet this goal is unclear.

Introduction

Scope of the analysis and ensuing recommendation

The eastern oyster (*Crassostrea 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 (FAO 2012d, Wallace 2001). The eastern oyster has survived out-of-range transplantations to western Canada, the western United States, western Mexico, Fiji, Tonga, Japan, Mauritius-Indian Ocean, and possibly England (Ruesink 2005).

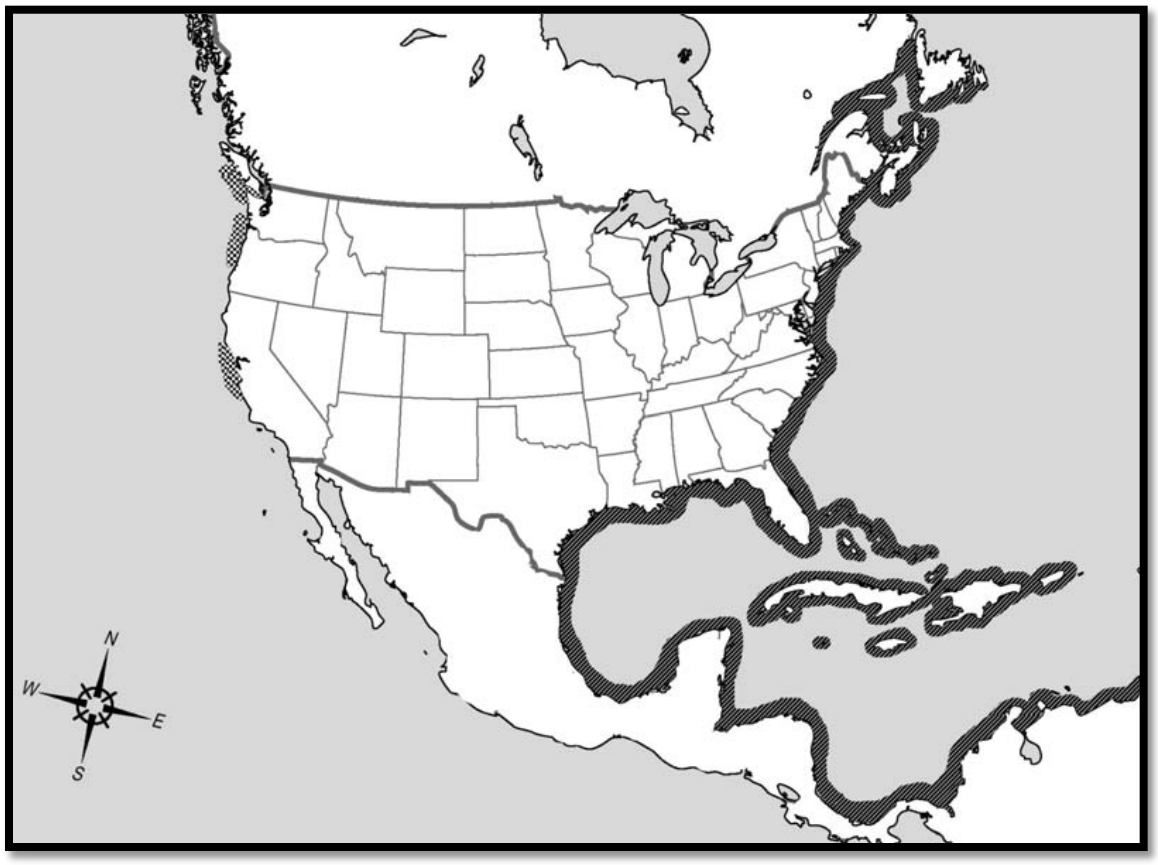

Figure 1. The distribution of the eastern oyster (*Crassostrea virginica*) throughout the Atlantic, Gulf of Mexico, Caribbean, and Pacific. Hatch pattern indicates the native range of eastern oysters (Atlantic coast) while stippling represents introductions outside their native range (Pacific coast). Figure from VanderKooy 2012a.

The eastern oyster supports both an aquaculture and wild-caught fishery. This report focuses on the United States (US) wild-caught fishery, which for the purpose of this report is defined as the commercial removal of oysters from public and leased bottom, and which does not involve the off-bottom growing of oysters.[1]

While the commercial harvest of the eastern oyster occurs along the entire length of the eastern US coast, this report specifically addresses the Gulf of Mexico commercial dredge and tong oyster fisheries (Alabama, Mississippi, Florida, Louisiana and Texas), since these account for 87%–93% of all US wild-caught landings from 2004 to 2010 (NMFS 2012a; Figure 1a).

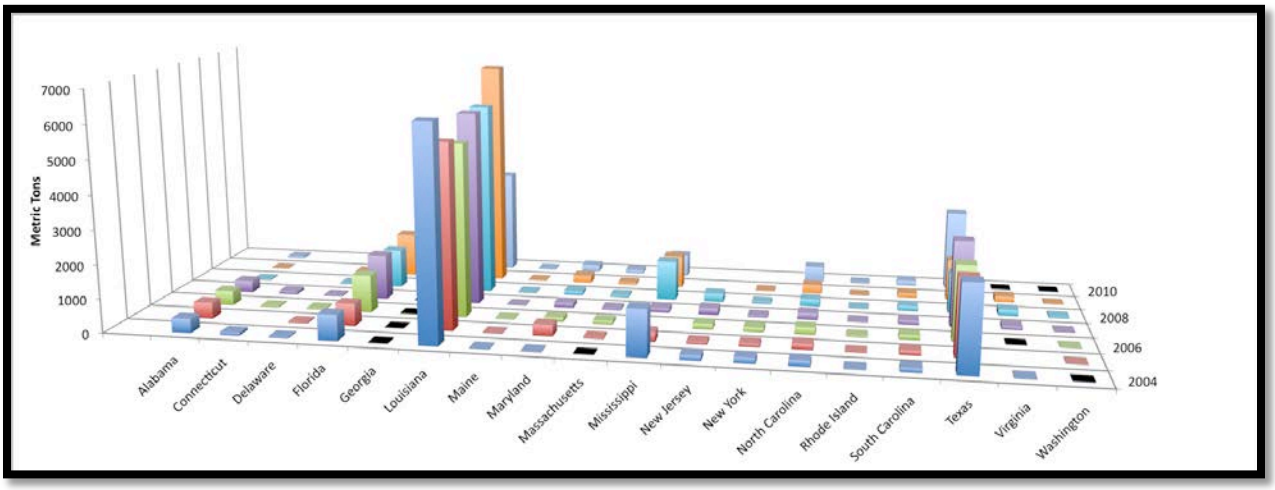

Figure 1a. U.S. oyster landings by state 2004-2010 Data from NMFS 2012

Species Overview

Overview of the species and management bodies

Since European colonization of the US, the presence of oysters has been reported from almost all estuaries along the Atlantic and Gulf coasts (EOBRT, 2007). Commercial oyster landings reached a harvest peak of around 160 million pounds (72, 575 metric tons) in the late 1800s and early 1900s with most of the harvest coming from the mid-Atlantic region of the US (MacKenzie 1996; Kirby 2004, Figure 2). From 1989 to 1940, overharvesting, habitat loss, market demand changes, and food safety concerns led to dramatic declines (Rothschild 1994; Mackenzie 2007; Kirby 2004; Figure 2). Since the 1950s, the fishery also has suffered from high disease mortality due to protozoan parasites such as *Haplosporidium nelsoni* (MSX) and

[1] Florida considers seeding and laying of cultch (substrate for oyster larvae) on leased bottom to be a form of "extensive aquaculture" because the stock is manipulated. If both the stock and environment are manipulated on leased bottom (versus public reefs), then Florida considers it "intensive aquaculture." However, landings from the approximately 600 acres of privately leased oyster bottom in Florida are: 1) <5% of Florida landings, and 2) are likely to be included as part of the commercial fishery statistics (Berrigan, pers. comm. 2012). Other Gulf States do not make this distinction, and therefore statistics for commercial landings are from both public and leased bottom landings, so this report accounts for both as part of the wild-caught fishery.

Perkinsus marinus (Dermo), as well as losses due to hurricanes and freshwater diversions related to oil spillage (Haskin 1966; Craig et al. 1989; Powell et al. 2011; Petterson 2006; Haby et al. 2009; VanderKooy 2012a).

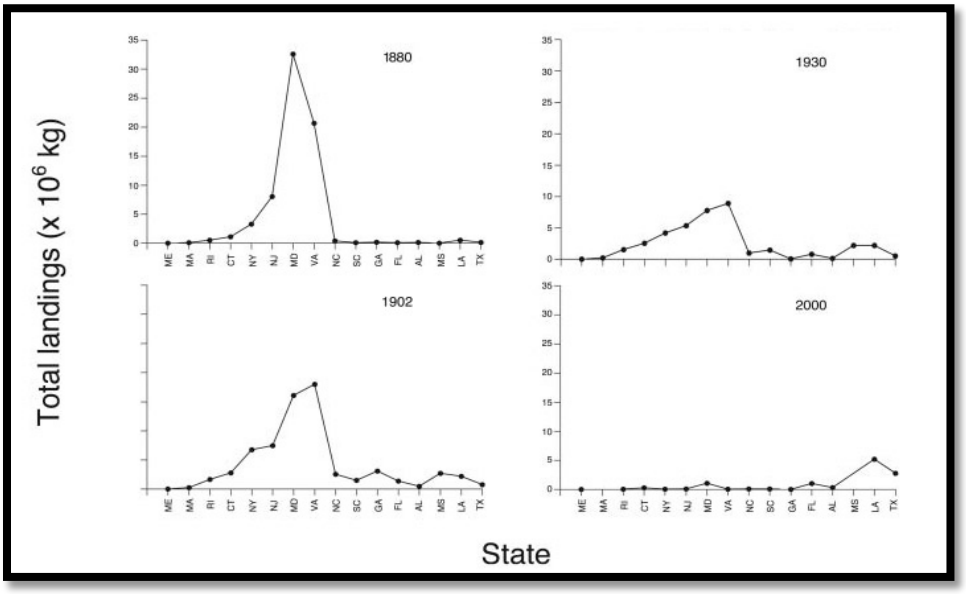

Figure 2. Landings of *C. virginica*, showing linear sequence of fishery expansion and decline along eastern North America between Maine and Texas. Some resurgence of northern states' fisheries in the early 1900s is likely due to influxes of seed oysters from the Chesapeake (Kirby 2004)

Eastern oysters are most abundant in shallow, semi-enclosed water bodies (<12 m deep) with salinities moderated by freshwater outfalls, optimally ranging about 16-27 parts per thousand (ppt) (VanderKooy 2012a; Butler 1949). This preference for relatively shallow, near-shore habitat means virtually all *C. virginica* fisheries are within state, rather than federal, waters (EOBRT, 2007). As a result, few federal regulations specifically address oyster management. However, if in-shore activities require consultation with a federal agency under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbor Act, then there may be resource protection recommendations from federal agencies such as the US Army Corps of Engineers, the National Marine Fisheries Service or the US Fish and Wildlife Service (EOBRT 2007).

While the eastern oyster is not federally managed, there are mechanisms that link the respective state fisheries. The Interjurisdictional Fisheries Act (IJF) of 1986 establishes and finances programs to gather information and conduct activities that support the management of US multijurisdictional fisheries. One IJF project is the cooperative development of the newly revised Oyster FMP for the five member states that comprise the Gulf States Marine Fisheries Commission (GSMFC). The GSMFC, established by the Gulf States Marine Fisheries Compact in 1949 under Public Law 81-66, serves as a forum for promoting better management and utilization of marine resources in the Gulf of Mexico (VanderKooy 2012a). This commission plays a key role in implementing the IJF, and the FMP is a coordinated effort to address disease control, shell movement, and provide a wealth of shared tools and knowledge for states to

utilize (VanderKooy, pers. comm. 2012).

Meanwhile, each state is responsible for its own oyster fishery management, which typically consists of regulations controlling harvest totals, effort, efficiency, and access; all designed to maintain some degree of sustainability (EOBRT 2007). Most harvest quotas are not based on any fishery-independent population census (Eastern Oyster Biological Review Team 2007). Management also typically involves replenishment of shell or substrate and designation of non-harvest areas due to water quality concerns, to maintain broodstock, to reseed adjacent areas, or provide benthic habitat (EOBRT 2007).

Production statistics

Globally, total oyster landings have tripled since 1990, but this is due to increased farmed production (FAO 2012a; Figure 3). As a result, wild-caught oysters have dropped from 12% of total landings to only 3% during this period (FAO 2012b). Of that total global wild capture, an average of 75% (since 1990) have been landings of *C. virginica,* with all landings coming from three locations: US (49% on average), Mexico (25% on average) and Canada (1.5% on average)(FAO 2012c; Figure 4). Also, from 1990 forward, there has been a moderate increase in Mexico's landings (up 6% from 1990 to 1999 average) and a decrease in US landings (down 6% from 1990-1999 average), with Canada landings remaining consistent.

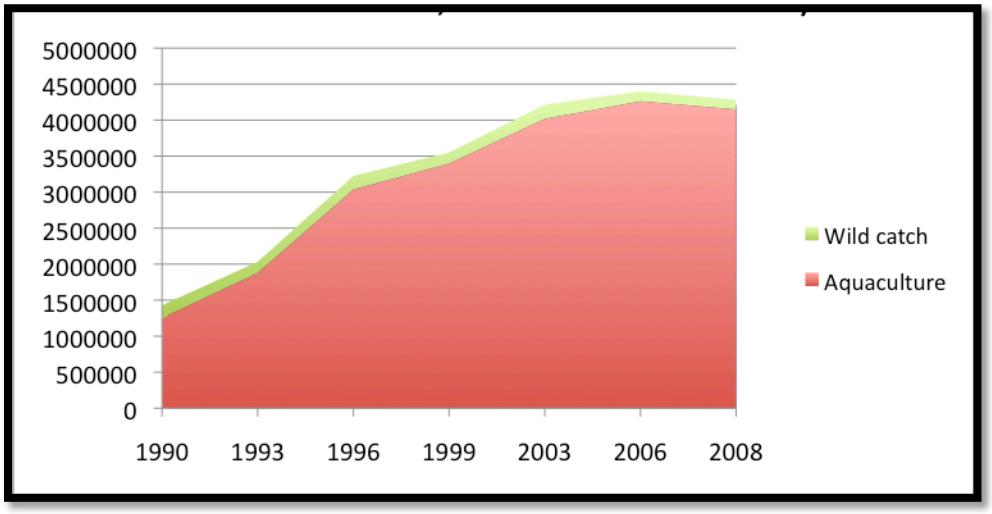

Figure 3. Global harvest of oysters 1990-2008. Data compiled from FAO 2012a, FAO 2012b and FAO 2012c

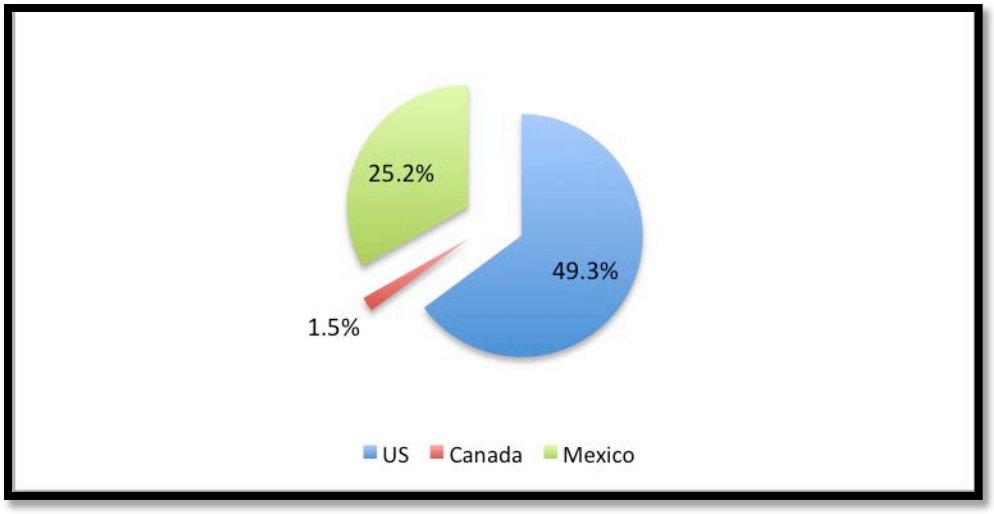

Figure 4. Average wild capture oysters by country 1990-2010. Data compiled by FAO 2012c

Import and Export Statistics

While imports of oysters to the US have varied from approximately 500 to 1000 metric tons (mt) annually from 1999 to 2011, 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 are regions that do not produce *C. virginica* (FAO 2012a; Figure 5). Of the farmed oyster imports, 55%–91% are from Canada, which produces both *C. gigas* and *C. virginica* (NMFS 2012b). Approximately 60% of Canada's farmed oysters come from British Columbia, which produces *C. gigas*, and 40% from Atlantic Canada, which grows *C. virginica* (CAIA 2012). The wild-caught imports (which average 59 metric tons annually over the last decade) are primarily from South Korea, Japan, Hong Kong and Canada, with Canada's portion averaging only 7.2% from 1999 to 2011 (NMFS 2012b).

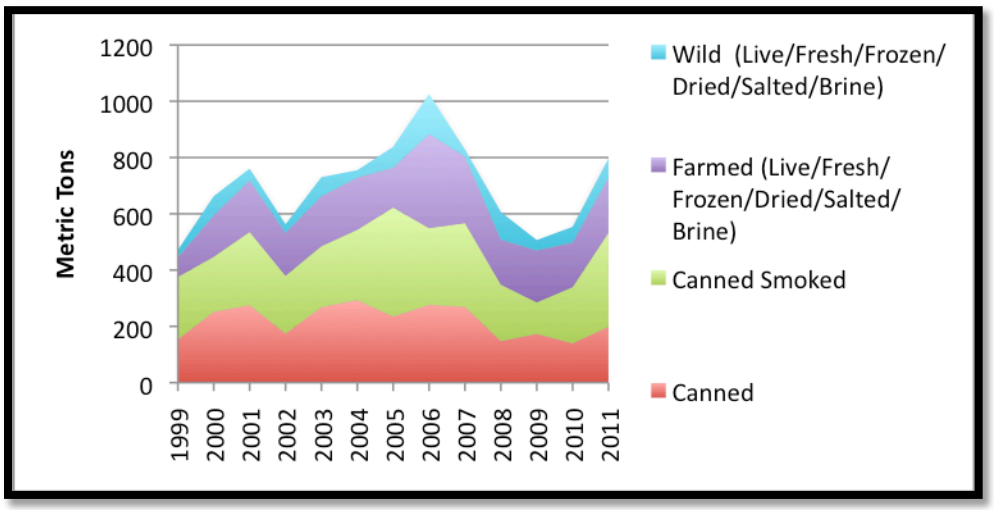

Figure 5. Oyster imports to US 1999-2011. Data from NMFS 2012b

Exports of US oysters have risen steadily over the last decade from 59 mt in 1991 to nearly 300 mt in 2010 even as total US commercial landings have been steady (NMFS 2012a; NMFS 2012b; Figure 6). All exported oysters are characterized as "live/fresh/frozen/dried/salted/brine" and there is no differentiation between wild and farmed or whether they are *C. virginica* or *C. gigas* (NMFS 2012b). The largest buyers have consistently been Canada, Hong Kong and Taipei. Even at 300 mt, exports are less than 3% of total US wild capture tonnage (NMFS 2012a; NMFS 2012b).

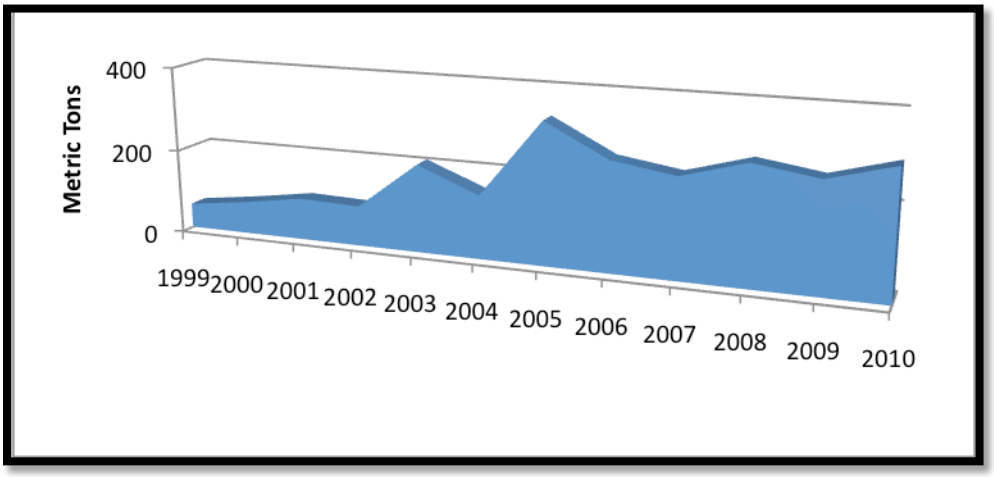

Figure 6. Exports of US oysters 1999-2010. Data from NMFS 2012b

Importance to the US/North American market

Since 2000, total *C. virginica* landings comprise an average of 62% 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, it is difficult to estimate a precise percentage of wild versus cultured oysters. The United Nations Food and Agriculture Organization estimates that approximately two-thirds of *C. virginica* landings in the US are wild-caught (FAO 2012e). As noted earlier, the majority of these landings currently come from the southeastern Gulf Coast region. Nearly all of the remaining US oyster landings are comprised of Pacific oyster landings (*C. gigas*), which are harvested from Oregon, Alaska, Washington and California (NMFS 2012a). Whereas some US commercial harvest of the European Flat and Olympia oysters occurs, these species comprise less than 1% of current US oyster landings (NMFS 2012a). In the last 20 years, the Gulf of Mexico fishery has been the dominant source of oysters for the US (see Figure 7 below).

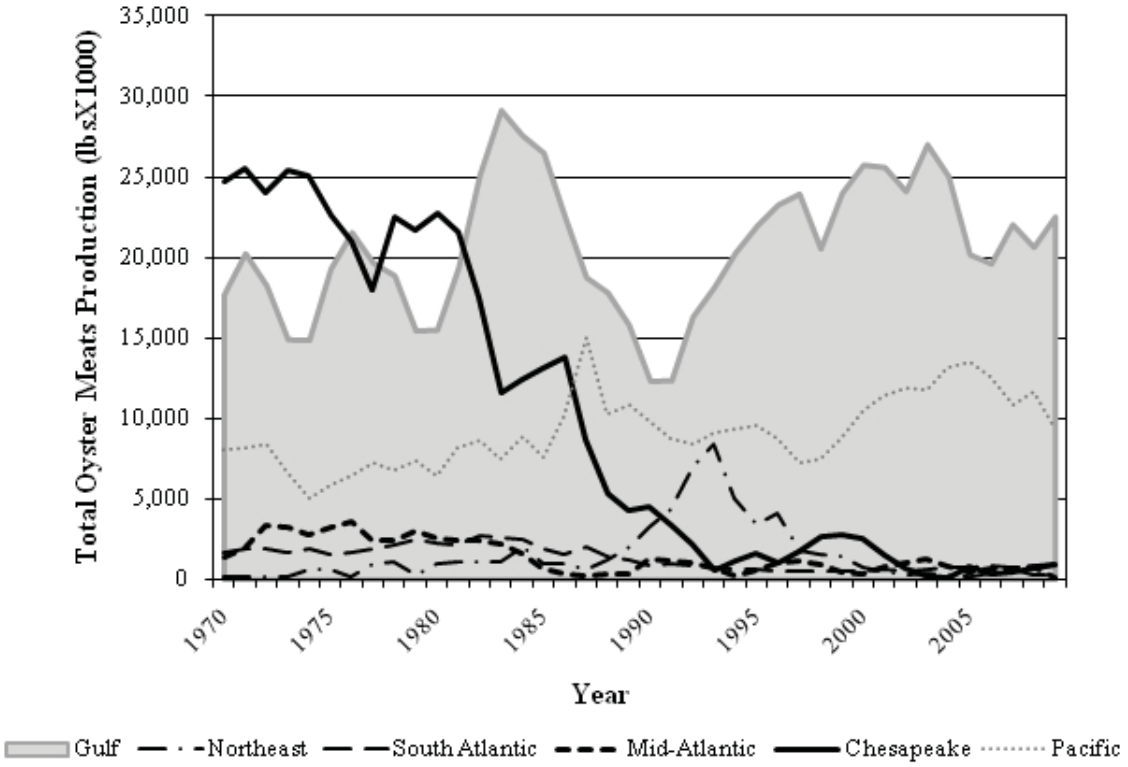

Figure 7. Total U.S. oyster landings for all species (Eastern, Pacific, European Flat, and Olympia) in lbs of meats by region from 1950 to 2009 (VanderKooy 2012a, compiled from NMFS landings data).

Common and market names.
The eastern oyster is also known as the American oyster, blue points oyster, common oyster, and American cupped oyster. Oysters are also named per place of origin (e.g., Gulf oyster, Virginia oyster, and Atlantic oyster).

Primary product forms
The eastern oyster is available fresh, frozen, dried, salted, smoked or canned in brine. It is available year-round.

Analysis

Scoring guide

- All scores result in a zero to five final score for the criterion and the overall final rank. A zero score indicates poor performance, while a score of five indicates high performance.
- The full Seafood Watch Fisheries Criteria that the following scores relate to are available on our website at www.seafoodwatch.org.

Criterion 1: Stock for which you want a recommendation

Guiding principles

- The stock is healthy and abundant. Abundance, size, sex, age and genetic structure should be maintained at levels that do not impair the long-term productivity of the stock or fulfillment of its role in the ecosystem and food web.
- Fishing mortality does not threaten populations or impede the ecological role of any marine life. Fishing mortality should be appropriate given current abundance and inherent resilience to fishing while accounting for scientific uncertainty, management uncertainty, and non-fishery impacts such as habitat degradation.

Stock	**Fishery**	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Criterion 1** Rank Score
Eastern Oyster	AL Tong	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Eastern Oyster	TX Dredge	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Eastern Oyster	FL Tong	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Eastern Oyster	LA Dredge	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Eastern Oyster	MS Tong	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Eastern Oyster	AL Dredge	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64
Eastern Oyster	MS Dredge	Low	Moderate Concern (3)	Moderate Concern (2.33)	Yellow 2.64

Synthesis

The eastern oyster has low inherent vulnerability to fishing pressure. It can reproduce within a few months of age, and grow to a harvestable size within one year in the warmer waters of the Gulf as long as it has substrate to grow on and is within its zones of tolerance for temperature and salinity. A recent study finds that throughout its range from Canada to Mexico (with a few limited exceptions), the eastern oyster is considered not to be at risk now or in the foreseeable future. However, studies reviewing global and historical abundance are more cautionary, noting that there have been general declines of reefs and biomass, and there are missed opportunities to improve reef abundance and promote a more sustainable fishery, particularly in the Gulf of Mexico. Here, the greatest challenges in recent years have not been fishing mortality, but conditions such as drought, hurricanes, freshwater diversions related to the BP oil spill, predation, disease and loss of substrate. Despite these challenges, populations throughout the Gulf are moderately abundant.

Because environmental factors and disease are dominant sources of adult mortality, and because oysters are not mobile once the larvae set, each reef may have different abundance requirements to support harvesting. Although Florida has set a per-reef abundance threshold for harvest, there are no state or regional reference points for determining harvests. Resource managers utilize partial closures of areas as needed to protect habitat and spawning, and to ensure human health conditions are met.

Factor 1.1 Inherent Vulnerability: Low

Key relevant information:

The eastern oyster is of low inherent vulnerability.

Detailed rationale

Table 1. Lifecycle attributes

Attribute	Data	Score	Source
Average age at maturity	As early as 4 weeks	3	Menzel 1951
Average maximum age	Rarely to 15 years; disease mortality typically limits from 2-5 years	2	Rothschild 1994; Powell and Cummins 1985; Berrigan, pers. comm. 2012
Reproductive strategy	Broadcast spawners that can spawn multiple times each spawning season	3	Kennedy 1996; Shumway 1996
Density dependence	No depensatory or compensatory dynamics demonstrated. Greatest limiting factor is amount of substrate; density may influence survival and growth	2	Powell et al 2009; Powell, pers. comm. 2012; Berrigan, pers. comm. 2012
Mean		**2.5**	

Factor 1.2 Stock Status: Moderate concern

Key relevant information:

According the Seafood Watch criteria, the health of the stock in all regions covered in this report is ranked a moderate concern due to lack of statewide reference points and biomass estimates.

Detailed rationale:

In 2007, the National Oceanic and Atmospheric Administration's National Marine Fisheries Commission convened a Biological Review Team (BRT) to assess a petition to list the eastern oyster as either threatened or endangered (EOBRT 2007). After reviewing the best available science and conducting telephone surveys of resource managers and oyster experts, the BRT concluded that the eastern oyster was not at risk now or in the foreseeable future (EOBRT 2007). BRT survey data strongly suggested that recruitment is sufficient to maintain viability of the oyster except in portions of the mid-Atlantic (Long Island Sound, Peconic Bay and the Hudson-Raritan Estuary) (EOBRT 2007). The BRT concluded that in the Gulf region, restoration activities were important to support a commercial fishery and conserve ecosystem services, but were not required to biologically sustain the Gulf population (EOBRT 2007).

A more recent review of wild oyster fisheries world-wide is more cautionary, noting that globally, native oyster fisheries continue to be unsustainable, with the exception of the Gulf of Mexico, which stands as one of the last areas of opportunity for both conservation and sustainable harvest (Beck et al., 2011). Another study investigates changes in both oyster reef area and biomass for United States estuaries over the last 100 years, and these findings show substantial declines, particularly in biomass, with the exception of Apalachicola Bay in Florida and Lake Sabine, shared by Texas and Louisiana, where biomass is higher now than it was historically (zu Ermgassen et al. 2012).

While the broader BRT report and global perspectives are helpful for general overview, it is also important to review the Gulf fisheries individually and assess each state's status and stock assessment practices, particularly in light of the Gulf States Oyster Fisheries Management Plan adopted in March 2012. For the Gulf region, oyster abundance and range are primarily limited through temperature/salinity regimes and available substrate (Berrigan et al. 1991; Powell et al. 2009). Whereas guidance exists regarding assessment processes for understanding total biomass, little information is available on stock status for oysters in the Gulf of Mexico. Most of these southern states survey abundance annually—or more frequently--but with high variability in both coverage and years (VanderKooy 2012a). The health and condition of oyster stocks vary substantially between and among reefs and estuarine systems. Oyster reefs are subject to a wide range of environmental factors that influence oyster population dynamics over short periods, and these variations make it extremely difficult to develop metrics which can be used to accurately describe oyster populations on individual reefs or estuarine systems. Accurately

determining harvestable oysters, new recruits and mortality are also challenging due to the size of spat and seed, and the great variability of boxes (dead oysters in articulated shells) from reef to reef. Box counts are especially important in understanding mortality, and accuracy is hampered in the Gulf by stone crabs that can disarticulate and crush the shells (VanderKooy 2012a; Berrigan, pers. comm. 2012).

Mortality numbers are complicated by the prevalence of diseases, which affect the population over long periods of time and vary according to environmental conditions. Among the many diseases affecting oysters, one in particular, Dermo, is prevalent in Gulf waters. This parasitic disease was first identified as the cause of high mortality in the Gulf of Mexico in the late 1940s (Ford and Tripp 1996). A 1986 survey of 49 growing areas along the Gulf of Mexico found only one location with less than 50% Dermo (Craig et al. 1989). Dermo-related mortality rates in Texas have been reported at 50% annually (Hofstetter 1977) and between 50% and 100% in Florida (Quick and Mackin 1971). Additional diseases, predation, and fluctuating environmental conditions are estimated to exceed 50%–95% mortality among subadult and adult oysters (Hoffstetter 1977; Quast et al. 1988; Berrigan 1990).

The Gulf States Marine Fisheries Commission (GSMFC) is testing a potential modeling tool for assessment that might prove useful for the Gulf States, and recommends surveying available shell as an assessment component, in addition to more typical measurements such as mortality, length and spat counts (VanderKooy 2012a). Including shell surveys into assessment models is currently practiced in Delaware Bay, though to date this approach has not yet been implemented in the Gulf (Powell et al. 2006; VanderKooy 2012a). Limitations in applying these methods include the quantity of acres that would need to be assessed, as well as technological challenges in accurately mapping underwater reefs (VanderKooy 2012a). In the FMP, the GSMFC recommends the use of a constant abundance/surplus production (CASP) model as the most feasible assessment tool for the Gulf States, since it has low data requirements and can be locally calibrated and used to estimate spat, juvenile, and adult oysters across a management unit (VanderKooy 2012a). Because of the importance of shell as a substrate, loss of shell would need to be included in the CASP model since removal at maximum sustainable yield is likely too high to conserve needed shell (VanderKooy 2012a). The GSMFC is testing the CASP model on two reefs as pilot projects for future applications in the Gulf (VanderKooy 2012a).

Despite challenges in assessing totals, as well as variances due to recent drought conditions, hurricanes and freshwater diversions, recruitment of most Gulf of Mexico populations is described as high and non-limiting to the population stability (VanderKooy 2012a). Whereas little information is available on total oyster biomass Gulf-wide, a fishery-independent survey is done by each Gulf state (see Table 2 below). Because oyster reproduction, growth and survival is highly dependent on salinity and temperature, population densities that can support fishing mortality vary from reef to reef (Herrmann, pers. comm. 2012; Randall pers. comm. 2012). This variance means population management is typically location-specific, without statewide reference points, and therefore metrics that address this are important. Florida currently is the only Gulf state that has developed reef-specific thresholds of abundance but there are no

regional thresholds because the environmental conditions which support growth and survival vary from reef to reef (VanderKooy 2012a; Berrigan pers. comm.).

In Alabama, stock status is described as "in recovery" after physical damage from Hurricanes Ivan and Katrina, and after heavy oyster drill predation due to drought-induced high salinity (See Figure 9 and Table 2 below). Because of the lack of resources, , the Alabama Marine Resources Division (AMRD) closed down all public oyster reefs to harvesting in Spring of 2009. Under recent management legislation, AMRD is able to open and close different public oyster reef areas based on resource abundance. This management strategy allows AMRD to have better accountability of which reefs oysters are harvested from, as well as which seafood dealers are buying and selling. AMRD implemented this recent legislation with great success during the oyster harvest in the fall of 2010 and the fall of 2011 (Herrman pers. comm. 2012). In Florida, landings are determined more by market demand than by population dynamics, as spatfall and growth rate are typically high (See Table 2 below). Louisiana landings fell due to hurricane impacts and the freshwater diversion that followed the BP oil spill, and after extensive closures, the fishery is rebuilding (See Figure 9 and Table 2 below). As with Florida, Louisiana harvesters are filling market orders rather than meeting allowable daily limits. Mississippi was also greatly impacted by hurricanes and the freshwater diversion that followed the BP 2010 oil spill. Their public fishery is closed and the oyster population is described as "moderately abundant" (See Figure 9 and Table 2 below). Mississippi may reopen areas in the fall of 2012 depending on summer environmental conditions. Texas was impacted by drought conditions, which supported the growth of predators such as oyster drills, and increased the prevalence of Dermo (see Table 2 below). After closing the fishery in the fall of 2011, nearly all public reefs have reopened to harvest, and the population is considered "stable and improving" (See Table 2 below).

Table 2. Gulf Coast Oyster Assessment Methods and Fishery Status

State	Assessment	Current Conditions of Fishery
Alabama Accounts for 3%-4% of Gulf landings from 2000-2010 (NMFS 2012a)	Leased bottom oyster provide >0.5% of harvest. Annual assessment on public reefs with divers sampling within quadrats. Assess for length frequency, mortality, spat, juveniles and adults. Do prior to hurricane season and may do some after, but typically once a year, and apply counts to most up-to-date maps to get density. Typically do 90-second hand dredge tows prior to laying shell or cultch (Herrmann, pers. comm. 2012)	Public reefs closed due to drought-related drill predation in 2009. Currently, the fishery is considered to be "in recovery" as lower salinity levels constrain drill predation and reef abundance is improving. Some landings from leased bottom (>0.5% of Gulf total). Limited re-openings of public fishery in 2010 and 2011, depending on sustainability of each public reef (Herrmann, pers. comm. 2012).
Florida Accounts for about 9% of the Gulf landings from 1986-2010 (NMFS 2012a)	Leased acreage contributes about 5% of landings (Berrigan, pers. comm. 2012). Ninety-eight percent of Florida's landings come from Florida's west coast (FWC 2010). Samples collected since 1982 by divers in quadrats to determine predation, length frequency, mortality, spat, juveniles and adults as well as condition of the reef. Data are applied to predict population trends, identify adverse impacts, and monitor population dynamics. Under the FL Standard	Florida reefs typically have abundant spatfall and rapid growth (Berrigan, pers. comm. 2012) Harvest limited by market demand more than abundance (Arnold and Berrigan 2002). Natural mortality in summer due to Dermo creates substrate for fall spat set (Berrigan, pers. comm. 2012). Most management is based on putting substrate back on oyster beds, since shell leaves with harvesting (Berrigan, pers. comm. 2012) After sharp declines in 1985 due to Hurricane Elena, west coast landings varied from 1.4 to 2.6 million pounds until 2005, and have increased to 3 million pounds in

	Oyster Resource Management Protocol, estimated production exceeding 400 bags of oysters per acre indicates healthy reefs that can sustain harvest. Limited harvest can be allowed if production is over 200 bags per acre, and the reef is considered depleted if marketable stocks are less than 100 bags per acre (Berrigan 1990).	2007, then decreased slightly in 2008-9 (FWC 2010). Landings rates (pounds-per-trip) increased in 1992 and 1994 and remained at historic highs through 2005 (between 80 and 90) with 3-4 year fluctuation cycles, and have decreased to 70 pounds-per-trip from 2006-2009 (FWC 2010).
Louisiana Accounts for 50-60% of Gulf landings (NMFS 2012a)	Leased ground oysters provide 50-80% of landings, and are supported through programs providing public seed and cultch (LDWF 2010a). Annual assessment of public reefs with divers sampling within quadrants. Assess for length frequency, mortality, spat, juveniles and adults. Long-term population abundance data indicates oyster seed on public grounds was low from 1982 to 1991, increased through 2001, and variable decline since 2002 (LDWF 2010a; Figure 7, below).	Landings fell in 2006 likely due to impacts of Hurricanes Katrina and Rita. Harvests rebounded in 2007-2009 until extensive closures occurred following the British Petroleum oil spill in 2010 to allow fishery to rebuild after freshwater diversions produced extreme freshwater kills (VanderKooy 2012a; LDWF 2010b). Those closures reduced Louisiana landings below 7 million pounds for only the third time since 1950. Harvest is sometimes more limited by market needs rather than allowable catch, as harvesters fill orders from buyers rather than meet allowable bag limits (VanderKooy 2012a). Current stock size of public bottom is under long-term average of 1982-2010, and leased bottom contributed 77% of landings in 2010. (LDWF 2010a).
Mississippi Accounts for almost 9% of Gulf landings from 1986-2005(NMFS 2012a)	Very little leased bottom (less than 1%). Square meter diver sampling and 1-minute dredge tows typically before and after season, but also throughout season. Can sample reefs monthly as needed. Assess for length frequency, mortality, spat, juveniles and adults. (Randall, pers. comm. 2012).	Public fishery closed in 2006 due to hurricane effects. Reopened in 2007 to small harvest, then landings returned to 9%–11% of total Gulf harvest (NMFS 2012a; VanderKooy 2012a). Recent hypoxia and freshwater diversion following the British Petroleum oil spill led to current closure of public fishery to allow assessment of human health and abundance. Current population considered moderately abundant. Possible limited opening in October and more in November, depending on environmental conditions over summer (Randall, pers. comm. 2012).
Texas Accounts for about 23% of Gulf landings from 1998-2007 (NMFS 2012a)	90% of bottom acreage is public reefs (TPW 2012), though 22% of the landings were from leased bottom from 1994 to 2008 (VanderKooy 2012a). Monthly dredge surveys sample spat catch-per-unit effort (CPUE); small (25.4mm – 76 mm) and market-size (>76mm) oyster CPUE; length frequency; and water quality conditions (Robinson, pers. comm. 2012).	Annual landings fell in 2008 due to loss of habitat from Hurricane Ike. The resulting sediment loss of 8000 acres of bottom in Galveston Bay led to partial closure of the Galveston Bay fishery. (VanderKooy 2012a; Robinson, pers. comm. 2012). Unprecedented drought in 2011 led to high mortalities due to drill and crab predation as well as increased incidence of Dermo. In the fall of 2011, Texas closed the oyster fishery due to red tide-related human health concerns, but by March 2012, nearly all public reefs were opened for harvesting (TPW 2012). Current populations are stable and improving (Robinson, pers. comm. 2012).

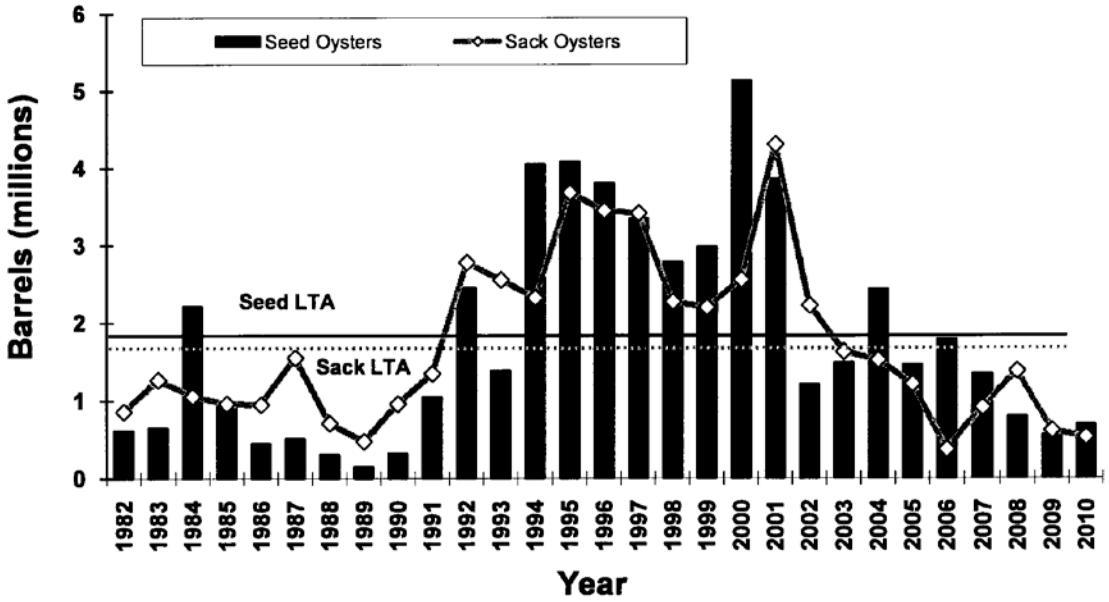

Figure 8. Historical Louisiana oyster stock size on the public oyster areas. LTA denotes the long-term average of 1982-2009 (LDWF 2010a)

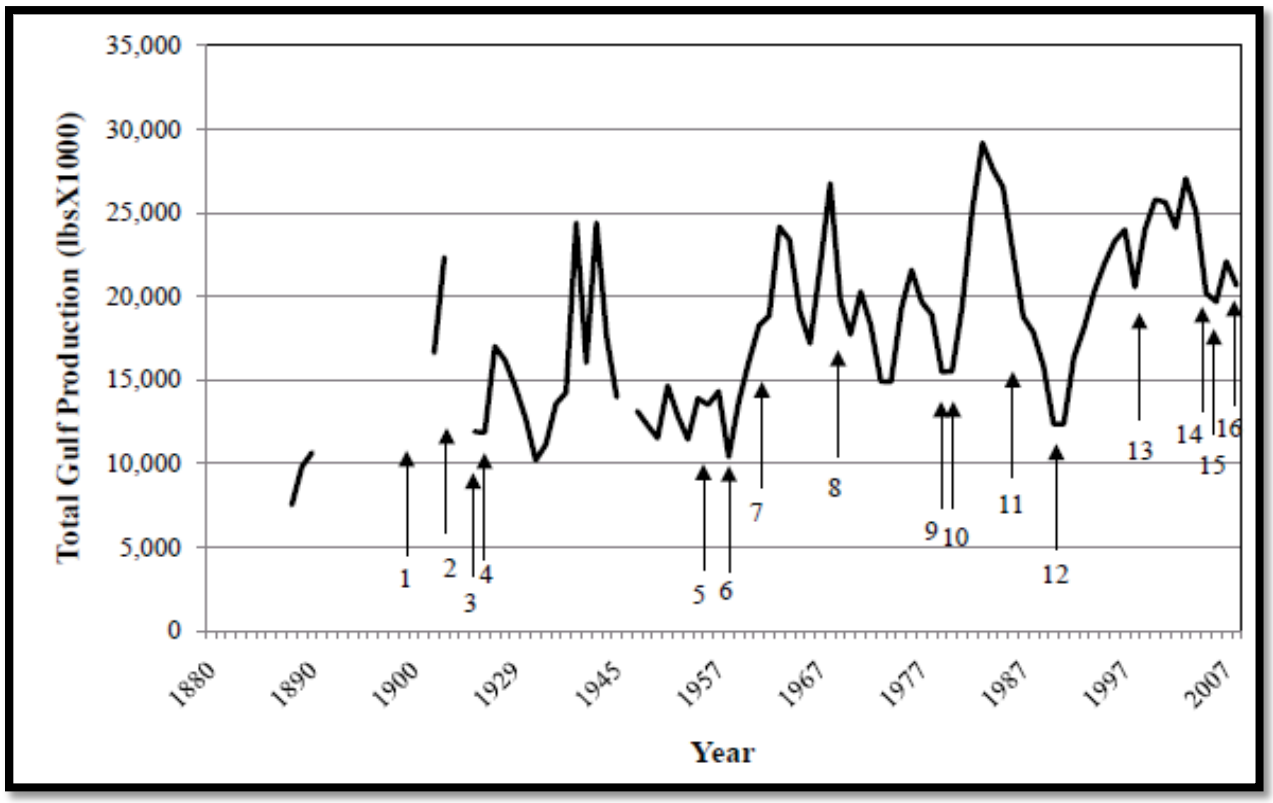

Figure 9: Gulf of Mexico oyster landings with hurricane events notes (VanderKooy 2012a). Hurricanes associated with numbers listed below.

1 1900 Galveston TX	Cat. 4	9 1979 Hurricane Frederic	Cat. 3
2 1909 Grand Isle LA	Cat. 4	10 1980 Hurricane Allen	Cat. 5
3 1915 New Orleans LA	Cat. 4	11 1985 Hurricane Elena	Cat. 3
4 1915 Galveston TX	Cat. 4	12 1992 Hurricane Andrew	Cat. 4
5 1957 Hurricane Audrey	Cat. 4	13 1998 Hurricane Georges	Cat. 3
6 1961 Hurricane Carla	Cat. 4	14 2004 Hurricane Ivan	Cat. 3
7 1965 Hurricane Betsy	Cat. 3	15 2005 Hurricanes Katrina/Rita	Cat. 4
8 1969 Hurricane Camille	Cat. 5	16 2008 Hurricane Ike	Cat. 4

Factor 1.3 Fishing mortality: Moderate concern

Key relevant information:
According to the Seafood Watch criteria, fishing mortality in all regions covered in this report is a moderate concern due to lack of reference points.

Detailed rationale:

Although Florida does have a reference number for abundance per acre for each reef, there is no maximum sustainable yield established for any of the Gulf Coast oyster fisheries (VanderKooy 2012a). Managers conduct fishery-independent assessments in all Gulf States, and use this information to determine abundance and harvest allowances for each estuary and even from reef to reef. These local assessments allow for partial closures to protect human health as well as to protect stock abundance (See Table 2 above). For Gulf Coast states, where oysters reach maturity in one year (given suitable substrate, salinity and temperature), some of the greatest limiting factors on population abundance are crab and drill predation, disease mortality, hypoxia, weather events, water quality, and availability of substrate (EOBRT 20007; Powell et al. 2009; Mann et al. 2009; VanderKooy 2012a; Berrigan, pers. comm. 2012; VanderKooy, pers. comm. 2012). Natural mortality is so high on some reefs that it precludes commercial use (VanderKooy 2012a).

Public fisheries in many of the Gulf States have experienced or are currently experiencing closures related to these factors, and because of fishing mortality, but managers are able to close and open reefs accordingly (see Table 2, above). Alabama's public fishery will have limited openings while the stock recovers from heavy drill predation (See Table 2 above). Louisiana and Mississippi have had extensive closures of the public fishery due to hurricanes and the freshwater diversions following the 2010 oil spill, so their fishing mortality has been reduced (See Table 2 above). Texas only recently reopened its public fishery in the last part of March after closures due to red tide-related human health concerns (See Table 2 above). Only Florida has maintained landings, but still reduces or closes areas based on reef abundance (see Table 2 above). Therefore, fishing mortality is likely at a level that will either maintain current abundance or allow for recovery where abundance is low. For the Gulf, abundance will likely remain highly variable due largely to factors outside of fishing pressure.

Criterion 2: Impacts on other retained and bycatch stocks

Guiding principles

- The fishery minimizes bycatch. Seafood Watch® defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, pre-catch mortality and ghost fishing. All discards, including those released alive, are considered bycatch unless there is valid scientific evidence of high post-release survival and there is no documented evidence of negative impacts at the population level.
- Fishing mortality does not threaten populations or impede the ecological role of any marine life. Fishing mortality should be appropriate given each impacted species' abundance and productivity, accounting for scientific uncertainty, management uncertainty and non-fishery impacts such as habitat degradation.

Synthesis

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore* discard modifier)	**Rank** (based on subscore)
No other main species caught				5.00	5.00	Green

In the Gulf of Mexico, the eastern oyster is harvested primarily with hand tongs and small dredges. Due to the type and size of gear used, and the fact it is used typically on oyster reefs in sandy or silted bottom, there is little captured other than the target species. However, if environmental conditions support their proliferation, oyster drills, a predator which attaches to oysters, can at times, be landed, although this is highly variable. In order to capture a financial benefit from this typically troublesome predator, there is some effort to create a niche market to promote the consumption of the oyster drill as a food similar to escargot. Neither the 1991 nor the 2012 Gulf of Mexico FMP addresses bycatch in the oyster fishery or discusses this topic in any recommendations or research.

Key relevant information

Both gear types target bottom that is typically covered by nearly 100% oyster shell, living and dead, therefore there is no bycatch.

Justification of Ranking

The eastern oyster is harvested primarily with tongs and dredges (VanderKooy 2012a). Tonging involves the use of hand tongs, sometimes called "rakes," from the side of a small vessel. The heads of the rakes are attached at the end of long handles or stales and are typically 14-16 feet long (See Figure 10-A). In shallower tidal areas, tongs with 8-foot stales and 8-12 inch rake heads called "nippers" may be used (VanderKooy 2012a). Oyster dredges for the oyster fishery

uses one or more wire mesh baskets (Figure 1B) that are pulled from a vessel (VanderKooy 2012a). The size and weight vary from state to state, but typically dredges are approximately one meter wide and weigh about 120 pounds (VanderKooy 2012a).

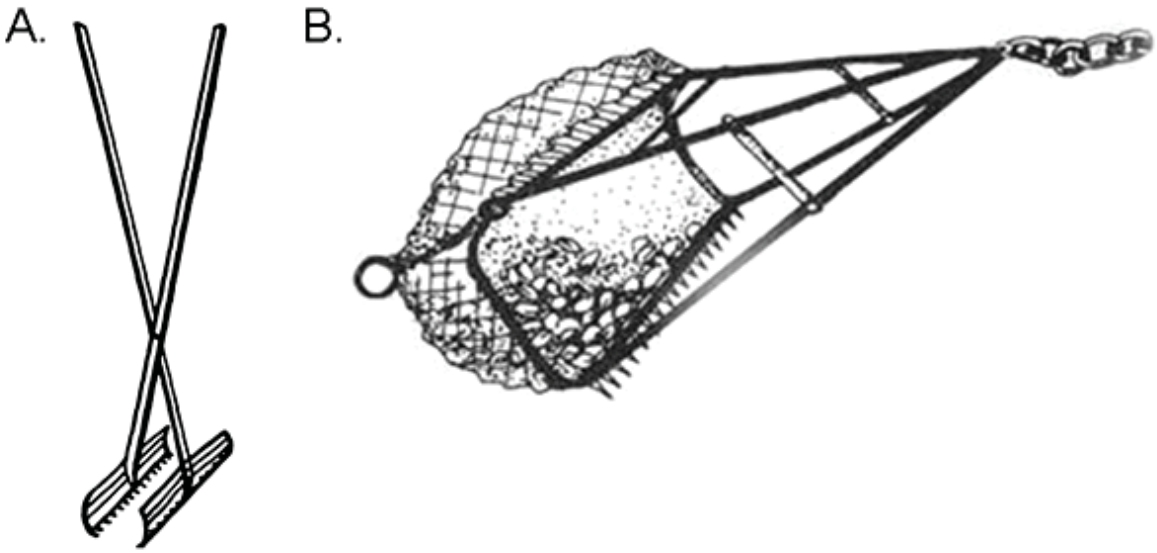

Figure 10 A&B. Harvesting gear used in the Gulf of Mexico. A. Oyster tongs and B. Oyster dredge (VanderKooy 2012a).

Although use of larger off-shore dredges (4-4.5 meters wide) have been associated with bycatch and habitat damage in the scallop and clam dredge fisheries (Chuenpadgee et al. 2003), there is no discussion of bycatch concerns for the Gulf eastern oyster fishery in either the 1991 or the 2012 FMPs because there is no bycatch in the oyster fishery (Berrigan et al. 1991; VanderKooy 2012a). The size of an oyster dredge (1/4th the width of off-shore dredges) and the habitat fished (typically soft bottom versus hard, rocky substrate) means bycatch in fisheries using larger dredges is not comparable to that of oyster dredging (VanderKooy pers. comm. 2012). Both gear types target bottom that is typically covered by nearly 100% oyster shell, living and dead. While hand tongs and oyster dredges may impact grasses if they are applied to areas other than sandy bottom, the capture of grasses is discussed as a habitat, rather than a bycatch concern (see Criterion 4 below). The gear is efficient at targeting the size and shapes of articulated oysters, allowing smaller material to pass either between the tines of the rake heads or out the mesh of the dredge bag (VanderKooy pers. comm. 2012).

While there has not been a management concern with the capture of non-target species, there is some bycatch in dredges of oyster drills (*Stamonita haemostoma*), which are a predator of great concern for Gulf oysters (White and Wilson 1996). Oyster drills attach themselves to oyster shell and are harvested along with the oyster. Normally drills are removed and tossed on land to die, but there is an effort to market them as a food similar to escargot, providing a financial benefit to their typically undesired presence (Walsh 2011).

Factor 2.4 Overall discard rate: <20%

Discards in the eastern oyster fisheries are thought to be minimal and is therefore scored as 0%–20% (VanderKooy pers. comm. 2012).

Criterion 3: Management Effectiveness

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.
- Management should be appropriate for the inherent resilience of affected marine life and should incorporate data sufficient to assess the affected species and manage fishing mortality to ensure little risk of depletion.
- Measures should be implemented and enforced to ensure that fishery mortality does not threaten the long-term productivity or ecological role of any species in the future.

Fishery	**Management: Harvest Strategy** Rank (Score)	**Management: Bycatch** Rank (Score)	**Criterion 3** Rank Score
AL Tong	Moderate Concern (3)	All species retained (N/A)	Yellow 3
FL Tong	Low Concern (4)	All species retained (N/A)	Green 4
LA Dredge	Moderate Concern (3)	All species retained (N/A)	Yellow 3
MS Tong	Moderate Concern (3)	All species retained (N/A)	Yellow 3
TX Dredge	Moderate Concern (3)	All species retained (N/A)	Yellow 3
AL Dredge	Moderate Concern (3)	All species retained (N/A)	Yellow 3
MS Dredge	Moderate Concern (3)	All species retained (N/A)	Yellow 3

Factor 3.1 Management of fishing impacts on retained species: Florida – Low concern. All other states – Moderate concern.

Fishery	Mgmt Strategy and Implement	Recovery of Stocks of Concern	Scientific Research and Monitoring	Sci. advice	Enforce	Track Record	Stakeholder Inclusion
AL Tong	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
FL Tong	Highly Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
LA Dredge	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
MS Tong	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
TX Dredge	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
AL Dredge	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective
MS Dredge	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective

Synthesis

Eastern oysters are most abundant in shallow, tidally influenced waters. This places them almost exclusively in state waters, and as a result, there is no federal management of the fishery. However, as part of the Interjurisdictional Fisheries Act of 1986, the GSMFC has an FMP that includes management and science-based recommendations for the fishery Gulf-wide, and serves as a forum for collective research and utilization of the resource for the Gulf of Mexico.

While each Gulf state has slightly different management programs, they all utilize size limits, seasons, gear restrictions, and area-specific closures to support both fishery abundance and to meet human health standards for seafood consumptions. Shellfish are highly regulated because they are eaten raw, and so health agencies as well as resource agencies are involved in monitoring the resource and related water quality. Regulations are enforced through active patrolling on the water and at the docks. All the Gulf States have programs to move seed oysters as needed and to return cultch to oyster beds as substrate, but none have quantitative assessments of shell resource trends. Because substrate for larval settlement is a key factor in supporting the fishery, habitat is a primary concern for oyster management in all the states. All the states conduct fishery-independent research, as well as fishery-dependent research, such as tagging requirements for harvesters and buyers. All management bodies operate through public meeting processes, but there is not a designated stakeholder process outside of this for feedback.

None of the states have a total allowable catch. Only Florida has a standard abundance threshold for determining when a reef can be opened for harvesting. While all of the states conduct assessments, there is no estimate of the biomass of the fishery either within a single state or Gulf-wide.

The GSMFC updated their 1991 FMP in March 2012. Eighty-nine percent of the management recommendations in the 1991 FMP had been adopted by the time the revised FMP was completed. As of 2009, states varied in their compliance regarding the adoption of science-based recommendations in the 1991 FMP. Many of the monitoring requirements for states changed after the 2010 British Petroleum oil spill, and currently there is not an up-to-date assessment of compliance with science-based recommendations. In the revised FMP, many of the recommendations focus on unifying individual state's management through shared season times, shared harvest sizes, and consideration of modeling tools that would allow for more regional biomass assessment. Additionally, the FMP recommends including shell loss and shell availability as an important part of oyster fishery assessment. The GSMFC is currently testing a potential model at two pilot locations to see if it might be a useful tool for the Gulf region.

Because the Gulf States have only recently adopted a new FMP as well as revised monitoring guidelines, it is not known yet how well they have complied with more recent science-based recommendations, or if the models being tested will assist in individual state or Gulf-wide biomass or shell assessments. Because of these uncertainties, the Gulf state fisheries management is considered to be a moderate concern, with the exception of Florida, which is assessed as a low concern due to its area-specific measures of abundance.

Key information and detailed rationale:

Management Strategy and Implementation: Florida – Highly effective. All other states – Moderately effective

For the Gulf States, loss of oyster reef habitat (both human and naturally caused) is likely the most serious and chronic problem (VanderKooy 2012a; Powell, pers. comm. 2012). Each state manages the resource not only to support the fishery, but also to ensure oysters are safe for human consumption. Each state has programs that provide shell substrate (cultch) and move seed oysters to suitable locations in an effort to support the fishery and to protect against human health concerns (VanderKooy 2012a). However, none of the states incorporate the loss of oyster shell in data collection or management (Powell, pers. comm. 2012). Each of the states has size limitations, gear restrictions, seasons and bag limits (See Table 3 below). Texas recently lowered its bag limit from 90 to 50 sacks per day due to the industry's desire to preserve more shell substrate (Robinson, pers. comm. 2012). Whereas there is a standard harvest size for wild-caught oysters across all states, leaseholders (with some exceptions) can harvest smaller oysters. Additionally, stock assessment practices differ from state to state (VanderKooy 2012a).

Fishery closures often occur in the Gulf due to environmental events (see Table 2). Manager of the partially or completely closed public fisheries consider them either moderately abundant or in recovery (see Table 2)(Randall pers. comm. 2012; Herrmann pers. comm. 2012; Robinson pers. comm. 2012).

Florida is the only state that has a standard threshold for evaluating whether or not a reef can support the current level of fishing. If the reef's capacity falls below 100 bags of 3-inch oysters per acre, it is considered depleted. If counts show 400 or more bags per acre, the reef is considered healthy. Counts between 100 and 400 bags per acre mean limited harvesting (Berrigan 1990). Florida receives a **highly effective** ranking due to the standardized techniques used to determine overfishing, while the remaining state receive a score of **moderately effective** due to the need for increased management precaution. The current FMP recommends that Gulf States consider more Gulf-wide standards to support both enforcement and resource protection. This recommendation applies as well to shared gear restrictions and season openings (VanderKooy 2102). Additionally, the FMP recommends that future assessments include shell budgets, and the GSMFC is currently testing the CASP model for biomass assessment. As new data and practices emerge, they may become important tools for managers concerned with protecting habitat. Managers need to consider new data and models for assessment as they become viable for applications in the Gulf, particularly regarding shell assessment and its loss, as an important predictor/factor in setting fishing mortality (Powell et al. 2009).

Recovery of stocks of concern: N/A
Currently there are no species of concern retained in any of the eastern oyster fisheries.

Scientific Research and Monitoring: Moderately effective
Each of the Gulf of Mexico states collects fishery-independent data (see Table 2). All states routinely pull their own dredges on the production reefs to determine the health and density of oysters. All shellfish harvesting waters are monitored to ensure that they meet National Shellfish Sanitation Program (NSSP) requirements for fecal coliform (VanderKooy 2012a). Fishery-dependent data is also regularly gathered and utilized in management, and tagging information is deemed particularly important due to the necessity of tracing any health issues linked to a particular harvest (VanderKooy 2012a). Since the 2010 British Petroleum oil spill, there have been a number of changes to monitoring programs in the Gulf, including additional sampling stations for all gear-types. These protocols have not yet been assessed by the GSMFC Technical Coordinating Committee (VanderKooy, pers. comm. 2012).

There are no observers in the Gulf oyster fishery for several reasons. On the small vessels used in this in-shore fishery, most harvesters would be unable to meet minimum Coast Guard requirements to allow for additional passengers, and the fishermen would typically not be able to afford the insurance required to cover observers. Even given sufficient room and insurance, due to the short duration of trips and the remote locations of the home ports, including observers would be impracticable (VanderKooy, pers. comm. 2012).

Whereas fishery-independent and dependent data regularly are gathered, no comprehensive biomass estimate for the Gulf oyster fishery exists (VanderKooy 2012a). As the GSMFC reviews applicable models that can be adapted for use in the Gulf of Mexico, managers can consider using them and addressing data gaps that would allow a broader understanding of the region's biomass. Additionally, no recent assessment has evaluated how well states have integrated both previous- and post-2010 monitoring recommendations/requirements.

Scientific Advice: Moderately effective
There are a number of science-based recommendations in both the 1991 and 2012 FMP. Every few years, the GSMFC Technical Coordinating Committee regularly reviews these recommendations and determines how to what extent each state has met them (if applicable). The most recent assessment was conducted in 2009 and showed high (93%–100%) compliance with reef monitoring and public health recommendations, significant (53%–66%) compliance with replanting; depuration and relaying; limited access and tagging requirements; and lower (26%–33%) compliance with freshwater flow restoration (GSMFC 2012). The 1991 recommendations, however, do not reflect current benchmarks for sustainability, and the revised FMP and recommendations stand as better tools by which to measure contemporary standards for a healthy fishery (VanderKooy, pers. comm. 2012).

Enforcement: Highly effective
Molluscan shellfish are a highly regulated food in the United States (NSSP 2009). This is due to public health controls to protect against human pathogens in raw oysters. In addition to closures related to stock abundance, reefs are subject to closures due to human health concerns (VanderKooy 2012a). Regardless of whether an area can support a harvest, it can remain closed if it does not meet NSSP standards (VanderKooy 2012a). Management of each state fishery includes agency oversight by two entities to allow for review of both fishery-related and human health concerns (see Table 3). Region-specific closures are regularly used to protect abundance and human health (see Table 2). All states have product tagging requirements. Harvested sacks must be tagged with information such as date, time, area fished, gear, vessel identification and harvester. Wholesale purchasers must also maintain similar records (VanderKooy 2012a). In addition to rigorous enforcement to protect against human health concerns, each state also has regular patrolling of oyster harvesting areas and docks to enforce regulations regarding where to harvest, when to harvest, how much to harvest and any other gear-specific restrictions.

In Alabama, the Marine Resources Division is tasked with the biological management of oysters as well as the management enforcement. Officers routinely patrol areas that are open to the harvest of oysters as well as those that are closed; this is done via boat patrol and shore patrol day and night. They conduct surveillance with thermal imaging devices, remote camera systems (a series of cameras accessed and controlled via a laptop) and the use of digital video equipment (Bannon, pers. comm. 2012). When the public reefs are open, officers randomly conduct check points with each boat or catcher that is working that day to ensure compliance with all harvest regulations. By utilizing new oyster management stations, officers track all sacks of oysters and make sure they are labeled correctly and delivered to properly certified

shops. Only specific areas are opened, and harvesters must leave a card with enforcement agents when they go onto the reef, and they must pick it up from officers when they return. If there is a person unaccounted for, the enforcement personnel will locate them at the end of the day (Bannon, pers. comm. 2012).

In Florida, oyster harvesters must submit trip tickets which report their landings. The trip tickets are used to compile landing statistics. Trip tickets are compiled by the Fishery Statistics Section at the Florida Fish and Wildlife Research Laboratory. Enforcement of oyster fishery regulation is performed primarily by the Office of Law Enforcement in the Florida Fish and Wildlife Conservation Commission (FWCC). Regulating size limits is performed primarily on the water so that unlawful landings (oysters below the legal size limit) can be returned to the reefs. The FWCC also enforces the boundaries for shellfish harvesting areas to prevent harvesters from catching oyster in closed waters or out of season. All actions by FWCC law enforcement officers are logged and recorded (Berrigan, pers. comm. 2012).

In Louisiana, officers patrol harvesting areas and docks 24-hours a day, seven days a week using both patrol boats and sea planes. In addition to checking on size and catch limits, officers also check the area of origin to ensure oysters are not taken from closed locations (Bourgeouis, pers. comm. 2012).

In Mississippi, enforcement agents patrol the harvest areas and docks seven days a week, and a patrol boat passes through each harvest area daily. If a harvester is going to take landing from a site other than his/her lease, the harvester has to call enforcement agents the day before, and officers send out a boat to ensure the harvester is working at the correct location (Hester, pers. comm. 2012).

In Texas, enforcement of oyster fishery regulations consists of on-the-water boardings by Texas Department of Parks and Wildlife (TPWD) Game wardens, dockside intercepts, and in some rare cases, undercover actions. Texas has also incorporated the use of trip tickets for all of its fisheries, which provides harvest information on a trip and vessel basis. There is also a $0.33 per sack landings fee that is paid to the Texas Comptroller of Public Accounts and is used to support state health department activities associated with the oyster fishery. The TPWD wardens provide trip ticket data to the State Comptroller, and they in turn provide their data to TPWD so they can identify any significant discrepancies between what is reported to TPWD and what is reported to the Comptroller (Robinson, pers. comm. 2012).

Track Record: Moderately effective
For the Gulf, abundance of oysters is highly variable and will likely remain highly variable due to factors largely outside of fishing pressure (hurricanes, etc.), making it difficult to determine if management actions have resulted in long-term maintenance of the stock. Due to the high variability of oyster populations, management's track record on maintaining stocks is uncertain.

Stakeholder inclusion: Highly effective

Meetings of the respective fisheries commissions in each of the Gulf States are public processes, and include noticed, open meetings. The recently adopted FMP was available for review and comment prior to adoption (VanderKooy undated). In the Gulf of Mexico, stakeholders have opportunities to provide input in the individual state management processes. Each of the Gulf States encourages the oyster stakeholders to participate in management decisions that affect oyster resources. Some states, such as Louisiana and Mississippi, have an Oyster Task Force comprising commercial harvesters and processors who are encouraged to attend open public meetings and provide input directly to the state marine agency. Some states also have Oyster Stewardship Programs that provide the fishing industry, and other interested entities, input to the management agencies (VanderKooy, pers. comm. 2012).

Table 3: State Regulations

Management Agency	Size Limits	Season Limits	Gear	Harvest Limits	Source
Alabama Dept. of Conservation and Natural Resources (ADCNR) and Alabama Dept. of Public Health (ADPH)	3" (5%–10%) tolerance Less than 3" from leased bottom	October 1–April 30th for public; no season limits for leased. All limited by ADPH closures.	No seines allowed on public or private bottom. Tongs only on public bottom with special exceptions on some public reefs. Dredges allowed on leased bottom. Only 1 dredge per boat. Dredge limited to 16 teeth, 3" apart.	Determined seasonally. Dredges limited to 12 sacks daily. (*See Table 4 below for sack conversions for each state.*)	VanderKooy 2012a; Herrmann, pers. comm. 2012; (ADCNR 2010)
Mississippi Department of Marine Resources (MDMR) and the Mississippi Commission on Marine Resources (MCMR)	3" (10%) tolerance Less than 3" from leased bottom	MDMR sets the opening, sack limits, and both MDMR and MCMR determine specific closures as needed to protect the resource and public health.	Tonging and dredging. Cannot dredge on tonging bars.	As determined by both MDMR and MCMR.	VanderKooy 2012a
Louisiana Department of Wildlife and Fisheries (LDWF) and Louisiana Wildlife and Fisheries Commission (LWFC)	3" (15%) tolerance Less than 3" from leased bottom	Determined by LWFC based on stock data and recommendations from LA Oyster Task Force. Public grounds may be opened the second Monday in October–April 30.	Tongs, dredges and scrapers allowed. Special limitations on dredge size on Calcasieu Lake.	LWFC can set limits for public grounds. 25-sack limit for Calcasieu Lake and Sabine Lake. No limit on leased grounds.	VanderKooy 2012a
Texas Parks and Wildlife Department (TPWD) and Texas Parks and Wildlife	3" (15%) tolerance Less than 3" from leased bottom,	November 1 – April 30. No season limit for leased bottom. All subject to closures by DSHS.	Dredges – limited to 1 dredge whose width does not exceed 48 inches during public season; 2 dredges allowed on leases during	50 sacks per day (sack = 110 lbs)	VanderKooy 2012a; Robinson, pers. comm.

Commission (TPWC) and Texas Dept. of State Health Services (DSHS)	except during public season, when also held to 3"		other times.		2012
Florida Fish and Wildlife Conservation Commission (FWC); Florida Dept. of Agriculture and Consumer Services (FDACS); Division of Aquaculture (in FL, aquaculture includes on-bottom and off-bottom growing of oysters on leases)	3" (5% for unattached and 15% for attached) tolerance.	Opening and closing of season codified in Florida Administrative Code and are the same each year unless emergency rule enacted.	Only tongs except on certain kinds of leased bottom, where dredges are allowed.	20 bags per day (bag = 60 lbs)	VanderKooy 2012a; Berrigan, pers. comm. 2012

Table 4. Sack volume conversions for Gulf states, from VanderKooy 2012a.

	AL	FL	LA	MS	TX
1 AL Sack 2119.6 in^3 (1.23 ft^3)		0.79 FL Sacks	0.66 LA Sacks	0.62 MS Sacks	0.79 TX Sacks
1 FL Sack 2688.0 in^3 (1.56 ft^3)	1.27 AL Sacks		0.83 LA Sacks	0.79 MS Sacks	0.996 TX Sacks
1 LA Sack 3225.6 in^3 (1.87 ft^3)	1.52 AL Sacks	1.20 FL Sacks		0.94 MS Sacks	1.19 TX Sacks
1 LA Sack 3225.6 in^3 (1.87 ft^3)	1.61 AL Sacks	1.27 FL Sacks	1.06 LA Sacks		0.79 MS Sacks
1 TX Sack 2700.0 in^3 (1.56 ft^3)1.27 AL SacksΩ	1.27 AL Sacks	1.004 FL Sacks	0.84 LA Sacks	0.79 MS Sacks	

Factor 3.2 Management of fishing impacts on bycatch species: N/A

Key relevant information:

Based on current research and existing management plans, bycatch is minimal in the eastern oyster fishery. One researcher has noted that culling regulations should account for any attached undersized oysters that may be harvested with market-sized ones (Powell, pers. comm. 2012), but there are no studies showing significant mortality due to this. Therefore, this criterion is not applicable.

Criterion 4: Impacts on the habitat and ecosystem

Guiding principles

- The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.
- Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity.

Fishery	**Impact of gear on the substrate** Rank (Score)	**Mitigation of gear impacts** Rank (Score)	**EBFM** Rank (Score)	**Criterion 4** Rank Score
AL Tong	Low Concern (3)	Moderate mitigation (0.5)	Moderate Concern (3)	Green 3.24
FL Tong	Low Concern (3)	Moderate mitigation (0.5)	Moderate Concern (3)	Green 3.24
LA Dredge	Moderate Concern (2)	Moderate mitigation (0.5)	Moderate Concern (3)	Yellow 2.74
MS Tong	Low Concern (3)	Moderate mitigation (0.5)	Moderate Concern (3)	Green 3.24
TX Dredge	Moderate Concern (2)	Moderate mitigation (0.5)	Moderate Concern (3)	Yellow 2.74
AL Dredge	Moderate Concern (2)	Moderate mitigation (0.5)	Moderate Concern (3)	Yellow 2.74
MS Dredge	Moderate Concern (2)	Moderate mitigation (0.5)	Moderate Concern (3)	Yellow 2.74

Synthesis

The Gulf of Mexico oyster fishery relies primarily on dredging and tonging as harvesting methods. Whereas larger off-shore dredges can have detrimental impacts on hard-bottom habitat, there is evidence that using the smaller oyster dredges on mud and sand bottom in the near-shore fishery, particularly in areas already dredged and with cultch replenished, does not significantly impact the stock or habitat. However, observed degradation on constructed oyster reefs and how this translates to geological reefs warrants caution. There is less research on the impacts of hand tonging, and given varying conclusions of studies to date and their limited efficiency and area of coverage, hand tongs, most likely, have a low impact on oyster bar structure. There is moderate mitigation of these potential impacts, depending on each state's

response. The mitigation discussed here is aimed toward reducing habitat impacts by replenishing oyster cultch. The revised FMP recognizes the oyster as a keystone species in a healthy estuarine environment and includes a management goal of supporting oyster populations for their ecosystem benefit, but how individual states will implement strategies to meet this goal is unclear.

Dredging

Factor 4.1 Impact of the fishing gear on the substrate: Moderate concern

Key relevant information:

Oyster dredges operated in oyster shell habitat are considered to be similar in resilience to sand/mud and shallow, gravel bottom habitat.

Detailed Rationale:
Oysters in the Gulf of Mexico are harvested primarily from shallow bays with bottoms covered in oyster shell, sand, mud and some submerged aquatic vegetation (SAV) (Barnette 2001). However, managers and enforcement officers report that in the Gulf region, areas dredged for oysters typically do not include SAV habitat and most oyster fishing is done on 100% shell (Robinson, pers. comm. 2012; Berrigan, pers. comm. 2012; Hester, pers. comm. 2012). Although studies show that larger, off-shore dredges have detrimental impacts on habitat, especially on hard substrates (Chuenpagdee et al. 2003), there is conflicting research about the effects in using smaller dredges on sand and mud bottom. The use of dredges has been associated with high oyster mortality and steep declines in reef height that can reduce interstitial spaces that are habitats for small invertebrates and juvenile fish (Lenihan and Peterson 1998; Barnette 1999; Lenihan and Peterson 2004). However, these studies were done on constructed reefs, which are more easily disturbed by dredging, and their data cannot be accurately extrapolated to naturally occurring (geological) reefs (Powell, pers. comm. 2012). Other studies have shown that after a reef has been fished, further dredging has less impact, and dredged and control sites did not show significant differences in mortality, growth or disease pressure (Powell et al. 2001). Direct effects of dredging can include loss of habitat and population mortality, and will vary according to the habitat being fished and the structure of the gear (Lenihan and Peterson 1998; Lenihan and Peterson 2004). Managers can help to mitigate potential gear impacts through areas closures (reserves) and careful selection of bottom less likely to be impacted by dredging (Barnette 2001). A South Carolina review of oyster dredging impacts related to turbidity, contaminants, nutrients, infauna and smothering found minimal effects of shellfish dredging of unvegetated sandy, muddy subtidal and intertidal bottom (Coan 1995). These data suggest that on geological reefs, the use of smaller oyster dredges does not have significant impacts on oyster habitat or abundance. However, conflicting data from constructed reefs notes dredges can significantly impact habitat, particularly for non-oyster species (Lenihan and Peterson 1998; Lenihan and Peterson 2004).

Hand Tonging

Factor 4.1 Impact of the fishing gear on the substrate: Low concern

Key relevant information:
Lenihan and Micheli (2000) reported that the harvesting with clam rakes and oyster tongs reduced the densities of live oysters by 50%–80% compared with the densities of unharvested oyster reefs. Hand tonging was shown to reduce subtidal reef heights and increase mortality over control sites (Lehihan and Peterson 2004). Conversely, 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. 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. Oyster tongers will move to more productive locations when densities of legal oysters become too low to efficiently harvest since it is less efficient to spend time on unproductive reefs or substrate (Berrigan, pers. comm. 2012).

Typically, harvesters using hand tongs do not remove excessive amounts of substrate, and when shell and juvenile and subadult oysters are legally culled and shell returned to the reef, there is little need for additional mitigation. Some argue that, proper hand tonging and culling practices can be beneficial to the reef and oyster populations by removing sediment, exposing clean shell to spat, and reducing competition (Berringer, pers. comm. 2012).

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts: Moderate mitigation

Key relevant information:
Because harvesting does not typically occur on SAV beds or hard substrate (which would engender the greatest adverse effects), the mitigation efforts discussed below are directed toward supporting stock abundance through the replenishment of cultch habitat. All states have programs to replenish cultch in harvest areas to support spat production and species abundance (See Table 5 below). All states have seasonal closures and catch limits (see Table 3 above). Texas and Alabama have recently instituted measures to further reduce effort, increase closed areas or reduce landings (see Table 5 below). Because Texas and Alabama have only just implemented their newest effort reductions, there is not yet evidence of success in how well these measures translate into improved harvests. In addition to regulatory limits, closures have occurred due to drill predation, disease prevalence, hurricane impacts, freshwater kills and drought, so there has also been a *de facto* reduction without that reduction coming from regulations. Because of the habitat (cultch) replacement measures, which reduce the intensity of the fishing footprint, all states are deemed to have “moderate” mitigation.

Detailed rationale:

Table 5. Gear Types and Mitigation

State	Gear	Mitigation	Sources
Alabama	89% tonging 11% dredging	Shell/cultch replenishment program. Reduced landings from 16 sacks total daily to 6 sacks per person, maximum 12 sacks total per boat. Major closures due to drill predation and to protect reproduction.	NMFS 2012a; Bannon, pers. comm. 2012; ADCNR 2002; ADCNR 2010
Florida	97% of landings from tonging	Shell/cultch replenishment program. Hand tongs only on public bottom. Dredges allowed on private leased bottom. Only one dredge per boat. Dredge limited to 16 teeth, 3" apart	VanderKooy 2012a
Louisiana	Approximately 100% of landings from dredging	Shell/cultch replenishment program. Special limitations on dredge size on Calcasieu Lake.	VanderKooy 2012a; LDWF 2004.
Mississippi	60-90% dredging, rest is tonging	Shell/cultch replenishment program. Partial closures due to oil spill.	VanderKooy 2012a
Texas	All dredging	Shell/cultch replenishment program. Limited entry since 2008. In last 2 years, closed strategic reefs as larval seed grounds; in 2011 passed Senate Bill 932 which reduced daily quota from 90 to 50 sacks per day, allows for quick (w/in 3 days) emergency closure when area determined to have been overworked, and adopted 20-cent per sack shell recovery fee to support cultch replacement.	NMFS 2012a; Robinson, pers. comm. 2012

Factor 4.3 Ecosystem and Food Web Considerations: Moderate concern

<u>Key relevant information:</u>

Oysters are greatly valued for their ecosystem services such as filtering water and thereby protecting against eutrophication (Officer et al. 1982; Ulanowicz and Tuttle 1992). Oyster reefs create habitat structure and maintain biodiversity by providing essential fish habitat for a number of species (Harding and Mann 1999; Lehnert and Allen 2002). The newly adopted FMP specifically notes that one of the management goals is "the maintenance of ecosystem services provided by healthy oyster reef within the management unit." One of the management

objectives is listed as “Recognize that oysters are a keystone species in healthy estuarine systems and incorporate oysters as habitat, a biological resource, and a fishery resource in any ecosystem management” (VanderKooy 2012a). Because the FMP is specifically targeting the ecosystem value of oysters, this may, in the future, translate into policies that support this objective. This is particularly true as managers increasingly recognize the importance of available shell in supporting the overall population, another FMP recommendation (VanderKooy 2012a). Because oysters are exceptional species, but polices are not fully in place to account for their ecologic role, the fishery is deemed “moderate” in its consideration of ecosystems and food web considerations. It remains to be seen if the FMP goals will be integrated into actions, but because the FMP was a collaborative effort among the Gulf States, and previous management recommendations have been implemented, it seems likely these goals will be considered.

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

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Appendix A: Review Schedule

This review of the eastern oyster follows the adoption of a new Fisheries Management Plan (FMP) for the Gulf of Mexico as well as significant environmental events for this region. The last assessment of how well states in the Gulf of Mexico had adopted science-based recommendations was in 2009, while the most recent review of how well states had adopted management measures was in 2012. In the last decade, the majority of the US harvest is from the Gulf of Mexico region.

There are several recommended triggers for a new review of this species: 1) When the Gulf States Fisheries Management Commission again assesses how well both new management and science-based recommendations have been implemented; 2) If the long-term source of landings shifts significantly, and 3) If additional storm or other (such as an oil spill) events change or significantly affect the ecosystem within the Gulf of Mexico.

Regarding #2 above, North Carolina landings data showed a slow, but steady increase in landings from 2000 to 2009, then a 100% increase from 2009 to 2010 to 472 metric tons (mt), which was 5.7% of the *C. virginica* landings that year (NMFS 2012a). According to Craig Hardy, section chief for North Carolina's Department of Marine Fisheries, the trend is likely due to a decade of restoration efforts involving the creation of sanctuaries to protect older, disease-resistant broodstock; high-relief substrate in areas where hypoxia regularly endangered on-bottom lower-relief reefs; and some incentives to shift fishing effort toward more hand harvesting (tongs and rakes). Another factor in the surge in 2010 was economic conditions that may have pushed unemployed residents of eastern North Carolina towards oyster fishing as a means to derive some income when construction and manufacturing jobs disappeared (Hardy, pers. comm. 2012). It appeared that 2011-12 would be another strong season until a hurricane in August 2011 severely impacted the fishery and left many of the reefs smothered with debris. The landings estimate for 2011-12 will likely be significantly reduced. However, as North Carolina continues its restoration efforts and if weather events preclude further degradation, the present spat set bodes well for continued increase in the fishery (Hardy, pers. comm. 2012). Therefore North Carolina may be a good addition to the future review of the US eastern oyster fisheries.

About Seafood Watch®

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

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Guiding Principles

Seafood Watch™ defines sustainable seafood as originating from sources, whether fished[2] 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 capture fisheries must possess to be considered sustainable by the Seafood Watch program:

- *Stocks are healthy and abundant.*
- *Fishing mortality does not threaten populations or impede the ecological role of any marine life.*
- *The fishery minimizes bycatch.*
- *The fishery is managed to sustain long-term productivity of all impacted species.*
- *The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.*
- *Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts, or reduction of genetic diversity.*

Based on these guiding principles, Seafood Watch has developed a set of four sustainability **criteria** to evaluate capture fisheries for the purpose of developing a seafood recommendation for consumers and businesses. These criteria are:

1. Impacts on the species/stock for which you want a recommendation
2. Impacts on other species
3. Effectiveness of management
4. Habitat and ecosystem impacts

Each criterion includes:

- Factors to evaluate and rank
- Evaluation guidelines to synthesize these factors and to produce a numerical score
- A resulting numerical score and **rank** for that criterion

Once a score and rank has been assigned to each criterion, an overall seafood recommendation is developed on additional evaluation guidelines. Criteria ranks and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide:

Best Choices/Green: Are well managed and caught or farmed in environmentally friendly ways.

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

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

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