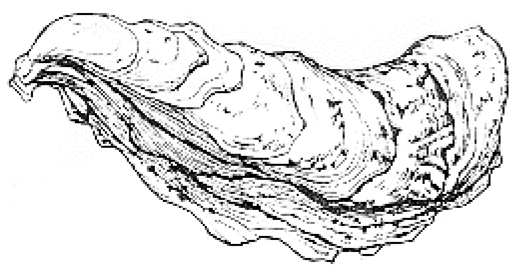
Seafood Watch
Seafood Report

MONTEREY BAY AQUARIUM®

Eastern oyster
Crassostrea virginica



(Image © The Mariners' Museum, Newport News, VA, 2002)

Southeast Region

Final Report
04/21/04

Jesse Marsh
Fisheries Research Analyst
Monterey Bay Aquarium

About Seafood Watch® and the Seafood Reports

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 that originating from species, wild-caught or farmed, that can exist into the long-term through maintained or increased stock abundance and conservation of the structure, function, biodiversity and productivity of the surrounding ecosystem. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from the Internet (www.montereybayaquarium.org) or obtained from the program by emailing seafoodwatch@mbayaq.org. The program's goals are to raise awareness of important ocean conservation issues and to shift the purchasing habits of consumers, restaurateurs and other seafood purveyors to support sustainable fishing and aquaculture practices.

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", "Proceed with Caution" or "Avoid". 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® Fishery 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 831-647-6873 or emailing seafoodwatch@mbayaq.org.

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Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fishery 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.

Seafood Watch® and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation.

Executive Summary

The eastern oyster (*Crassostrea virginica*) is a historically important commercial species harvested in the United States. While a major fishery once existed in Chesapeake Bay, the majority of eastern oyster landings are now from the Gulf of Mexico. In 2002, Louisiana, Texas, Mississippi, and Florida produced 88% of U.S. landings, while Alabama contributed only 3%. The eastern oyster exhibits life history characteristics that make it inherently resilient to fishing pressure; however, overharvesting, habitat destruction, and the introduction of diseases in Chesapeake Bay have severely reduced the population there. Similar declines have occurred in other systems from Delaware Bay to Pamlico Sound, NC. As the eastern oyster is not found in federal waters, there is neither a federal classification of the fishery, nor a federal fishery management plan. Each state has the authority to manage the oyster fishery within its state waters, and the Gulf States Marine Fisheries Commission provides a regional management approach through the 1991 Gulf of Mexico Oyster Fishery Regional Management Plan. While management agencies actively manage the fishery through time and area closures, and gear, size, and catch limits, there are limited data concerning the status of oyster stocks. Dredges and hand tongs are the most common gears used to harvest oysters. There is no evidence of bycatch in the Gulf of Mexico oyster dredge fishery. Dredging and tonging have severe habitat impacts, as excessive removal of oysters from the estuarine ecosystem has the potential to impact water quality and habitat for other commercially important species. This combination of factors results in a rank of "Proceed with Caution" for wild-caught eastern oysters.

Table of Ranks

	Conservation Concern			
Sustainability Criteria	Low	Moderate	High	Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Nature of Bycatch	√			
Habitat Effects			√	
Management Effectiveness	√(LA, FL, TX)	√(MS, Canada)		

OVERALL SEAFOOD RANK:

Avoid

Proceed with Caution

Best Choices

Introduction

The eastern oyster, *Crassostrea virginica*, is an important commercial species ranging from the Gulf of St. Lawrence to the Gulf of Mexico, and along the coasts of Argentina and Brazil (Carriker and Gaffney 1996). In 2002, Louisiana, Texas, Mississippi, and the west coast of Florida produced 88% of U.S. landings[1], worth approximately U.S. $66 million (NMFS 2004a). Louisiana and Texas are the largest sources of eastern oysters in the Gulf of Mexico (Figure 1). Eastern oysters are also imported from Canada, where they are primarily harvested in the provinces of Prince Edward Island and New Brunswick (DFO 2000; DFO 2001).

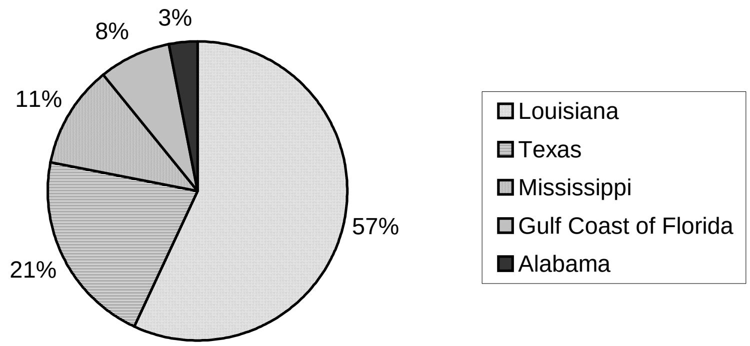

Figure 1. Eastern oyster commercial landings in the Gulf of Mexico in 2002; Louisiana and Texas contributed 78% of the landings (NMFS 2004a).

Eastern oysters are the dominant oyster species harvested from natural reefs and aquaculture operations in the U.S., providing 77.8% of the total U.S. oyster landings in 2002; pacific oysters contributed 22.1%, and European flat oysters and Olympia oysters combined contributed the remaining 1% (NMFS 2004a). Eastern oysters are harvested using gear such as dredges or tongs, or harvested by hand. In the Louisiana and Texas fisheries, dredging is the most common harvesting method. In 2002, dredging accounted for 99% of the harvest in Louisiana and 85% of the harvest in Mississippi (NMFS 2004a). Dredges have historically been the primary gear used in Texas; other harvesting methods generally account for less than one percent of the total oyster catch (Berrigan et al. 1991). In Florida, harvesting oysters with tongs or by hand are the only harvesting methods allowed on public reefs (Arnold and Berrigan 2002).

Aquaculture accounts for 95% of global oyster production; wild-caught oysters account for 5% (FAO 2003). The eastern oyster is both wild-caught and cultured on the east coast of the U.S. For the purposes of this analysis, a wild-caught oyster fishery is defined as harvest that occurs on public reefs, and does not involve the off-bottom farming of oysters. Laying of cultch (suitable substrate for larval setting) and seeding of public/private reefs are not considered aquaculture — in most states, oyster fisheries depend on some level of enhancement, such as laying cultch or seeding of both public reefs and leased-bottom reefs. Although bottom leasing is an integral

[1] Landings are reported as metric tons of meat (excluding shell weight).

component of the oyster fishery, it is not examined in depth in this report, as it does not impact the sustainability ranking of the fishery. In many states, leased areas are used for depuration[2] or aquaculture, and are not primary sources of wild-caught oysters. In the Gulf of Mexico, the oyster fishery is managed by the individual states, but the Gulf States Marine Fisheries Commission (GSMFC) provides a regional management approach for the fishery. In Canada, the oyster fishery is managed by the Department of Fisheries and Oceans (DFO).

The Chesapeake Bay oyster fishery

While Gulf of Mexico landings have remained relatively stable over the past 50 years, Chesapeake Bay landings have exhibited a substantial decline (Figure 2). Similar declines have occurred in Delaware Bay, Long Island Sound, Pamlico Sound, NC, and in South Carolina waters. Chesapeake Bay has historically been an important source of oysters, but disease, habitat destruction, and overharvesting have depleted oyster stocks there (Kennedy and Breisch 1981; Rothschild et al. 1994; Dew et al. 2003). At the height of the oyster fishery in 1884, the Maryland oyster harvest totaled 615,000 metric tons (mt); however, by 1900 oyster landings had declined to approximately 200,000 mt (Figure 3) (Rothschild et al. 1994). As disease was not prevalent until the 1960's, this decline was likely caused by the mechanization of harvesting gear (e.g., mechanical dredges) in the fishery (Rothschild et al. 1994). Oyster dredging along with tonging has removed 50% of reef habitat in Chesapeake Bay (Rothschild et al. 1994). In 2002, combined total landings for Maryland and Virginia were only 301.3 mt (NMFS 2004a). The yield per habitable area in 1991 was 96% lower than it was in 1884 (Rothschild et al. 1994).

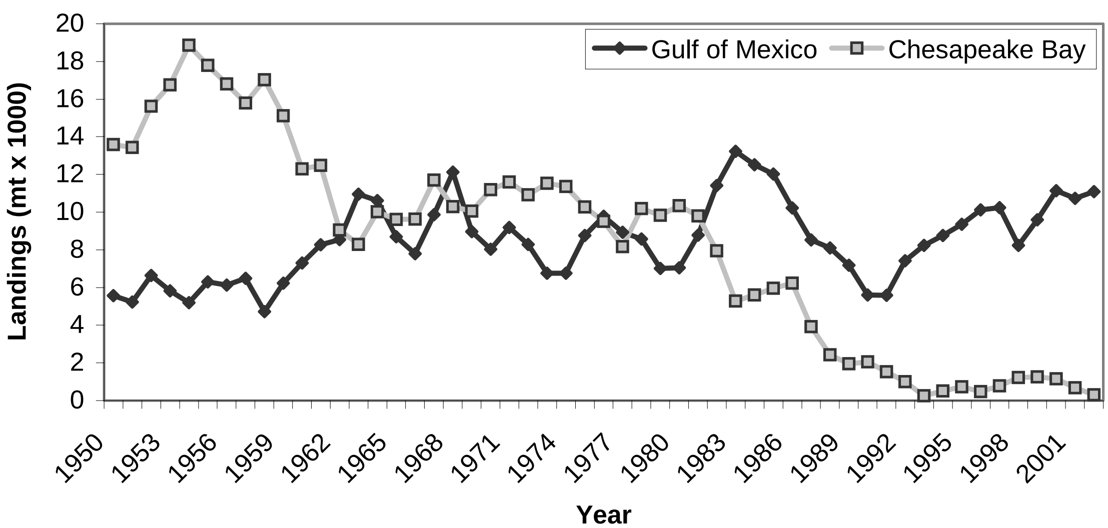

Figure 2. The decline of Chesapeake Bay landings since 1950, compared with the relative stability of Gulf of Mexico landings (NMFS 2004a).

The Chesapeake Bay oyster fishery is managed by the Maryland Department of Natural Resources (MDNR) and the Virginia Marine Resources Commission (VMRC) (COMP 2002).

[2] Depuration involves relaying moderately polluted oysters to approved waters where they may be harvested after meeting approved classification status (Keithly et al. 2000).

Stock assessments have been conducted in Maryland by the MDNR since 1989 (Homer et al. 1996). A Chesapeake Bay Oyster Management Plan was adopted in 1989 and revised in 1994 (COMP 2002); a 2002 draft Comprehensive Oyster Management Plan is available. The Chesapeake Bay oyster fishery is currently classified as overexploited with a low/depressed relative abundance (D. Orner, pers. comm.). A bay-wide stock assessment has been conducted, but no coastal stock assessment has been completed. Both fishery dependent and independent data contribute to estimates of population abundance and stock status in Maryland, but Virginia landings are too low to use as fishery dependent data (Jordan et al. 2002a). Estimates of total oyster abundance for Chesapeake Bay from harvest years 1991 to 2001 range from 2.66 to 6.29 x 10^8 individuals, with a mean of 4.78 x 10^8 (Jordan et al. 2002b). Annual exploitation rates for harvest years 1986 to 2001 were 21% to 72% of the market oyster stock, with an average of 51% over 16 years (Jordan et al. 2002b). Research has also shown that the number of market-sized oysters is declining; in 1999 less than 15% of the oysters on an oyster bar in most places were of marketable size (Southworth et al. 2000). Based on data from Rothschild et al. (1994), the decline of the Chesapeake Bay oyster fishery was caused by a combination of factors, but it is probable that if the resource had not been overharvested, the onset of diseases such as MSX and Dermo would not have had such a severe effect on the fishery. Prior to the onset of the oyster disease MSX, landings had already decreased by 83% from 1884.

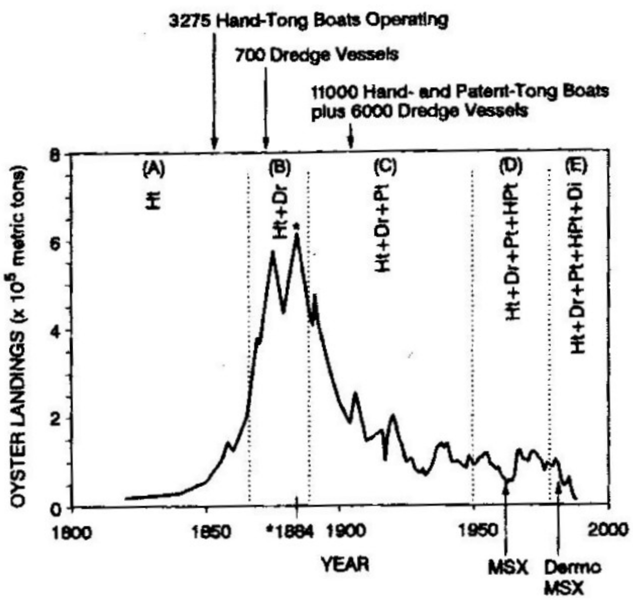

Figure 3. Decline of the Maryland oyster fishery due to overharvesting (Figure from Rothschild et al. 1994).

Scope of the analysis and the ensuing recommendation:

The following analysis encompasses the Gulf of Mexico fisheries of Louisiana, Texas, Mississippi, and the west coast of Florida as they contribute the majority of total U.S. landings. Although imports from Canada contribute only a small amount of oysters to the U.S. market, they are discussed in this analysis due to the issue of foreign seafood imports in the U.S. market.

Availability of Science

There is adequate life history information for the eastern oyster, as it is a historically important commercial species and has been studied extensively. Estimates of growth, fecundity, and other life history characteristics vary, however, by geographic location and research study. While there has been much scientific research conducted in Chesapeake Bay, addressing specifically disease and oyster culture, there is less scientific literature focusing on the Gulf of Mexico, possibly due to the relative stability of the Gulf of Mexico stocks. Fishery information is available for the U.S., although the landings data for eastern oysters are not distinguished as wild-caught or farmed. Management information is available as grey literature; the GSMFC Oyster Fishery Management Plan (FMP) was written in 1991, and will be revisited within the next several years. As oysters do not inhabit federal waters, there is no federal FMP or classification for the fishery.

Market Availability

Common and market names:
The eastern oyster is also known as the American oyster, blue points oyster, common oyster, Gulf oyster, or Apalachicola Bay oyster.

Seasonal availability:
Eastern oysters are available year-round.

Product forms:
Oysters are available fresh, frozen, dried, salted, smoked, or canned in brine.

Import and export sources and statistics:
In 2002, U.S. landings contributed the largest percentage (59%) of all species of oysters to the U.S. market (NMFS 2004a). Imports of all oysters composed 33% of the U.S. market (NMFS 2004b). In 2002, oyster imports to the US included wild (10.2%), farmed (22.5%), and canned and smoked oysters (67.3%) (NMFS 2004b). The primary sources of all species of wild, imported oysters are South Korea (47.4%) and Canada (37.4%) (Figure 4) (NMFS 2004b). However, eastern oysters are not found in South Korea; the primary species harvested there is the pacific oyster, *Crassostrea gigas* (Ha Park et al. 1988; NACA 1988). Commercial landings data from Canada's DFO show that all of Canada's commercial oyster catch is from the Atlantic coast, where eastern oysters are found (DFO 2004). Canada is the primary importer of eastern oysters to the United States. Over the past five years, there has been an increase in oyster imports from Canada; in 2002 imports totaled 330 mt, worth U.S. $1.5 million (Figure 5) (NMFS 2004b). This trend does not appear to be related to U.S. catch levels. While import data are distinguished as farmed or wild, export data are only distinguished as "seed" or "live/fresh/frozen/dried/salted/brine". In 2002 the U.S. exported 68% of non-seed oysters to Canada, 20% to China, and 12% to other countries (NMFS 2004b). U.S. landings and imports from Canada are the primary sources of eastern oysters in the U.S. market.

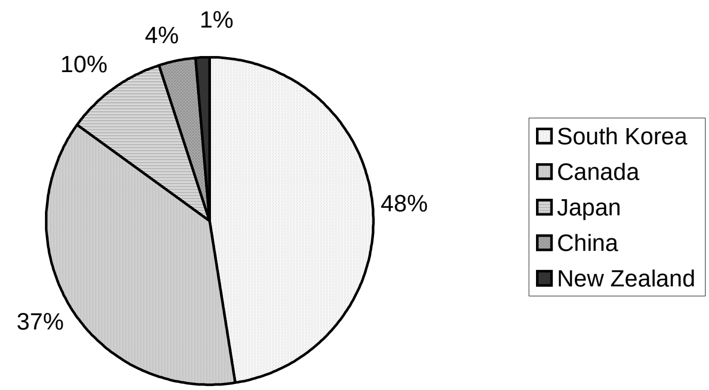

Figure 4. Imports of wild-caught oysters (all species) in 2002 (NMFS 2004b).

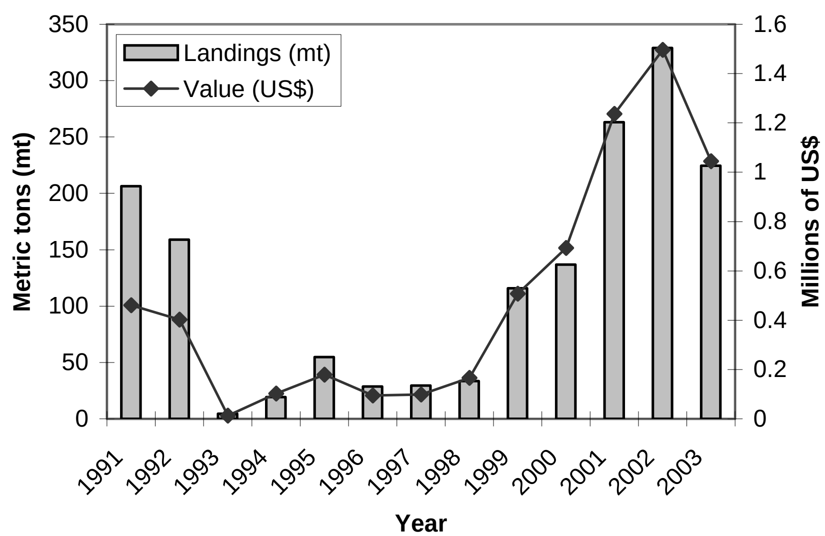

Figure 5. Imports of all oyster species from Canada, 1989 – 2003 (NMFS 2004b).

Analysis of Seafood Watch® Criteria

Criterion 1: Inherent Vulnerability to Fishing Pressure

Growth & Longevity

Adequate life history data for the eastern oyster facilitates the classification of this species as inherently resilient to fishing pressure (Table 1). Like most bivalves, eastern oysters grow rapidly for the first year, and then experience a decrease in growth rate as their size increases.

Eastern oysters can grow to a marketable size, 7.6 centimeters (cm), in 18 – 24 months in the Gulf of Mexico, while it may take four to five years for an oyster to reach the same size farther north in cooler waters (Carriker 1996; Shumway 1996; Lenihan 1999; Arnold and Berrigan 2002). Maximum observed sizes range from 18.5 cm to 30.0 cm (Rothschild et al. 1994). Eastern oysters are highly fecund; production ranges from 2 million eggs for an oyster approximately 4 cm in length, to 45 million eggs for an oyster approximately 7 cm in length (Thompson et al. 1996). Most oysters may be harvested or perish from disease before they are six to ten years of age (Lenihan and Peterson 1998; Lenihan 1999; Lenihan et al. 1999; V. Kennedy, pers. comm.).

Spawning
Eastern oysters spawn several times during a spawning season. In the Gulf of Mexico, oysters spawn from late March to early October (Shumway 1996). Eastern oysters spawn first as males, as early as 6 weeks after the larvae have settled; between spawning seasons the males will eventually switch and become functional females for the remainder of their lifespan (Thompson et al. 1996). In their first year, larger oysters are likely to be females, and the proportion of females in each age class increases over time (Thompson et al. 1996).

Feeding
Adult oysters are suspension, or filter feeders, using gills to filter plankton from the water column. Feeding rates, and subsequently growth, reproduction, and survival rates are higher when water flow and water quality are sufficiently high (Lenihan et al. 1996; Lenihan 1999; Lenihan et al. 1999).

Table 1. Life history characteristics of the eastern oyster.

Growth Rate/ Max Size	Age at Maturity	Fecundity	Species Range	Sources
vBgf[3]: L_∞ = 15.0 cm, K = 0.28 Max observed size 23 – 30 cm	As early as 6 wks	Multiple spawn/season; ranges from 2 mil (4 cm oyster) - 45 mil eggs (7 cm oyster)	Gulf of St. Lawrence to Gulf of Mexico, Argentina & Brazil	Rothschild et al. 1994; Carriker & Gaffney 1996; Shumway 1996; Thompson et al. 1996

INHERENT VULNERABILITY RANK
Eastern oysters spawn several times per season, are highly fecund, and reach sexual maturity at an early age (< 5 years). Eastern oysters have a limited species range, as they are found only in the western Atlantic, but do not exhibit any special behaviors that increase ease of capture. Eastern oysters are therefore considered inherently resilient to fishing pressure.

Inherent Vulnerability Rank: Vulnerable Neutral **Resilient**

[3] vBgf = a commonly used growth function in fisheries science to determine length as a function of age. L_∞ is maximum length, K is body growth coefficient.

Criterion 2: Status of Wild Stocks

Stock status for the eastern oyster fishery varies with harvesting location (Table 2). Maximum sustainable yield (MSY) has not been calculated for the Gulf of Mexico due to lack of data (Berrigan et al. 1991). Optimum yield (OY) is defined as:

> All the adult oysters of practical value and use that can be harvested from a given reef area provided: 1. The shell (or an equal or greater amount of other cultch material proven to be as effective as the whole oyster shells in catching and retaining spat) are returned to the reef in the same areas that harvest occurred; and 2. Freshwater from natural stream sources and runoff to the reef are maintained or restored in a manner that, a) eliminates contamination from harmful substances to the oyster or man (as a result of consumption) and b) optimizes salinity, temperature, water flow and nutrient conditions for oyster setting, growth and survival. (Berrigan et al. 1991)

Trends in population abundance and availability of data vary by state, and there are insufficient data to determine the status of the current age, size, or sex distribution of the stock relative to natural condition in most states.

Louisiana

In Louisiana, public reefs are important sources of seed oysters (<7.6 cm) for leaseholders to transplant to privately leased areas, and also yield a supply of sack oysters (>7.6 cm) that are sold directly to the market (LDWF 2003). Fishery independent and fishery dependent data have been collected yearly in Louisiana since 1982. However, catch per unit effort (CPUE) data are not regularly analyzed and used by management. Long term data on population abundance indicates the stock was stable at relatively low levels from 1982 to the early 1990s, and then increased until 2001; there was a sharp drop in both seed and sack oysters in 2002 and 2003 (LDWF 2003). Short-term data on population abundance also indicate the stock size was increasing until 2001 (Figure 6) (LDWF 2003). Over the past 10 years, sack oysters have been more abundant than seed oysters every year except for 2000 and 2003. The increase in stock size observed beginning in 1991 was accompanied by an increase in harvest from public reefs (Figure 7). However, when there was a sharp drop in the stock size from 2001 to 2002, landings from public reefs continued to increase. Traditionally, the largest proportion of landings has been from leased bottomland (Deseran and Riden 2000); however, in 2002, oyster production from public waters accounted for 55% of the total oyster harvest (LDWF 2003). It is unknown if overfishing is occurring in the Louisiana oyster fishery. CPUE data from 1961 – 1986 do not exhibit a strong trend; effort in the Louisiana oyster fishery has remained stable over this period. The number of vessels has ranged from 220 to 230 annually, with the number of tons per dredger averaging 3.6 to 5.4 mt annually (Berrigan et al. 1991). The availability of reliable fishery dependent and independent data suggest there is a relatively low degree of uncertainty in the stock status.

Table 2. Stock status of the eastern oyster by harvesting location.

Region	Classification Status	Occurrence of Overfishing	Population Status	Abundance Trends/CPUE	Age/Size/Sex Distribution	Degree of Uncertainty in Stock Status	Sources
Louisiana	Unknown	Unknown	B_{MSY}[4] not established	Variable/ Unknown	Unknown	Low	Berrigan et al. 1991
Texas	Unknown[5]	Unknown	B_{MSY} not established	Unknown/ Unknown	Unknown	Unknown	Berrigan et al. 1991
Mississippi	Unknown	Unknown	B_{MSY} not established	Unknown/ Unknown	Unknown	Unknown	Berrigan et al. 1991
West coast of Florida	Underutilized[6]	Unknown	B_{MSY} not established	Variable & Increasing/ Variable	Unknown	Unknown	Berrigan et al. 1991; Arnold and Berrigan 2002; DOA 2003
Canada	Unknown	Unknown	B_{MSY} not established	Unknown/ Unknown	Unknown	Unknown	DFO 2000; DFO 2001

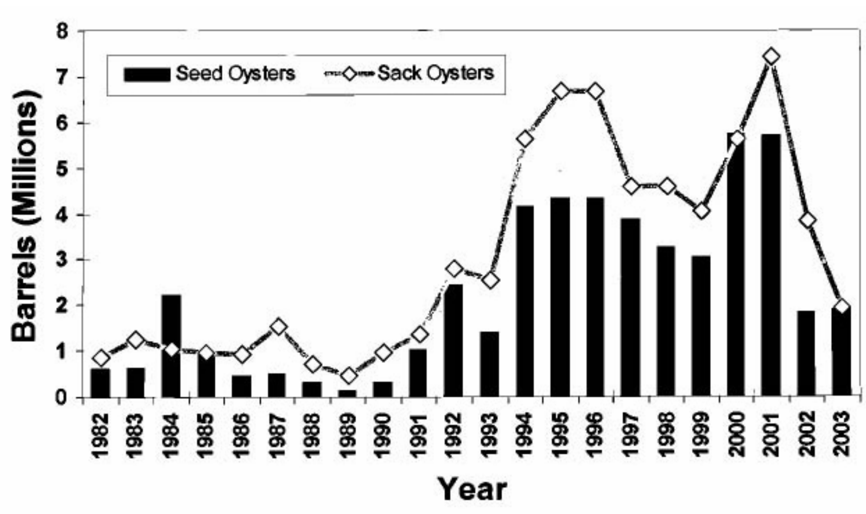

Figure 6. Historical Louisiana oyster stock size, 1982 – 2003[7] (Figure from LDWF 2003).

[4] B_{MSY} is the biomass that would produce maximum sustainable yield.
[5] The oyster fishery in Texas was classified as overfished in 1988.
[6] Inferred from Arnold and Berrigan 2002; not an official classification of the fishery.
[7] One barrel is approximately 95.3 kg.

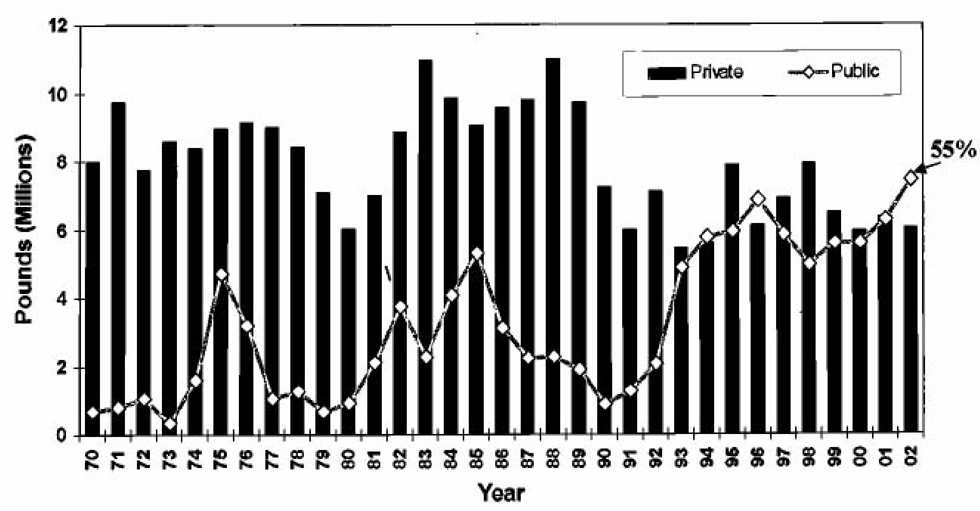

Figure 7. Historical Louisiana oyster landings from public and private reefs, 1970 – 2002 (Figure from LDWF 2003).

Texas

CPUE data indicate an increasing trend in oyster production per fisher from 1961 – 1985 (Berrigan et al. 1991). From 1961 to 1965, an average of 537 oystermen were dredging from 135 boats and 83 vessels. From 1981 to 1985, the number of oystermen declined to 349, and the number of boats declined to an average of 54 (Berrigan et al. 1991). The number of vessels increased to an average of 106 from 1981 to 1985 (Berrigan et al. 1991). The Texas Parks and Wildlife Department (TPWD) is mandated by the Texas Oyster FMP to annually assess and publish the status of the oyster stock; fishery independent monitoring from 1956 – 1984 exhibit a variable long term trend (Quast et al. 1988). While there was a steep increase in the mean number of market oysters per 35 liter (L) oyster dredge sample from 1981 to 1982, the mean number of market oysters in 1984 was lower than 1981 levels (Quast et al. 1988). More recent fishery independent data indicate that although the trend in small oysters (26-75 mm) increased from 1984 – 1997, the trend in market oyster abundance varied (Hensley et al. 2000).

Mississippi

The Shellfish Strategic Plan includes regulations and objectives related to management of the oyster fishery. Seafood Watch® was unable to obtain a copy of the Shellfish Strategic Plan to analyze fishery independent data. Historical data are available from the Gulf of Mexico Oyster FMP. Effort declined during the 1960s and 1970s, which is reflected in the downward trend of CPUE data for dredgers (Figure 8). The increase in oyster production per dredger observed in the early 1980s is likely due to increased oyster production in 1979 due to flooding (Berrigan et al. 1991). The lack of available recent data limits any conclusions regarding the short term trends in population abundance.

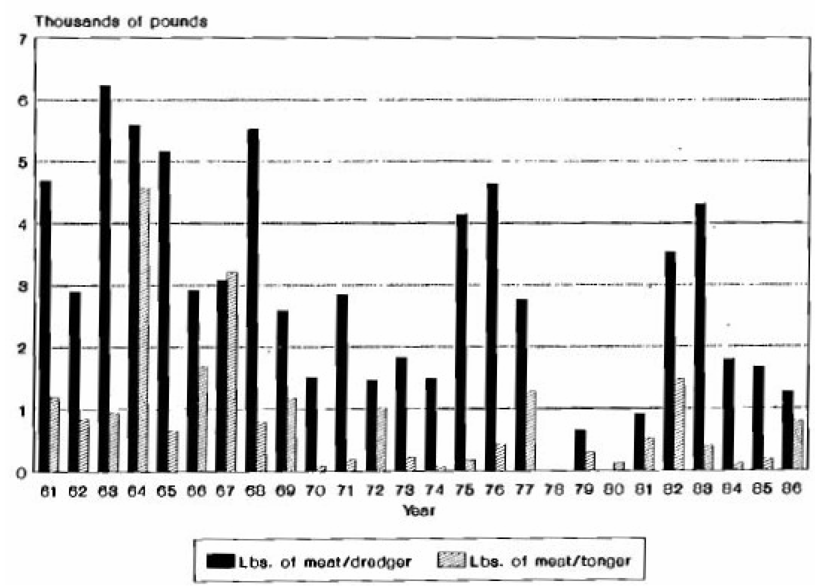

Figure 8. Long term CPUE decline in Mississippi, 1961 – 1986
(Figure from Berrigan et al. 1991)

West Coast of Florida

The majority of Florida oyster landings (98%) occur along the west coast of Florida (FMRI 2003), with Apalachicola Bay historically contributing 90% of the oysters harvested in Florida (Berrigan et al. 1991; Dugas et al. 1997). The long term and short term trends in abundance, as estimated from CPUE data, are variable. Annual harvest from 1961 – 1987 ranged from 1.2 – 3.8 mt per tonger (Berrigan et al. 1991). There was a sharp drop in CPUE from 1986 to 1988, with no increases in CPUE until 1991, after which CPUE remained at relatively high levels until it began to decrease again in 1997 (FMRI 2003). There was a steep increase in CPUE in 1999, which remained high in 2000 and 2001 (Figure 9) (FMRI 2003). Although commercial landings have remained relatively stable over the last 13 years, biological assessments of oyster populations indicate there is an abundance of market-sized oysters in Apalachicola Bay (Arnold and Berrigan 2002). This suggests that the oyster resource there is underutilized. Commercial landings statewide decreased sharply after 1985, partially due to hurricane damage, and have remained relatively stable since (Figure 10) (FRMI 2003). Total landings in 2001 were 31% higher than the five-year average, but 8% lower than the average historical landings from 1982 to 2001 (FRMI 2003). The short term trend in population abundance is variable on Cat Point Bar (an oyster reef complex in St. George Sound); production estimates from Cat Point Bar are generally the most accurate indicator of oyster production in Apalachicola Bay (Figure 11) (DOA 2003). However, the short term trend in abundance is increasing on Dry Bar (an oyster reef complex in western Apalachicola Bay) (DOA 2003). Management has developed a scale to determine the relative condition of oyster resources based on production estimates; estimated production exceeding 400 bags/acre is an indicator of healthy oyster reefs capable of sustaining commercial harvesting (DOA 2003). Oyster populations are capable of supporting limited commercial harvesting when stocks exceed 200 bags/acre, and considered depleted when marketable stocks are below 100 bags/acre (DOA 2003). The size-frequency distributions for Cat Point Bar and Dry Bar in 2003 are skewed toward oysters in the smaller size classes, although there was an increase in the number of oysters in the 50 mm – 75 mm size class (DOA 2003). The percentage of oysters larger than 75 mm on Cat Point Bar has varied over the last 14 years (Figure 12) (DOA 2003). The current stock assessment suggests improved production based on an overall increase in the number of oysters (DOA 2003).

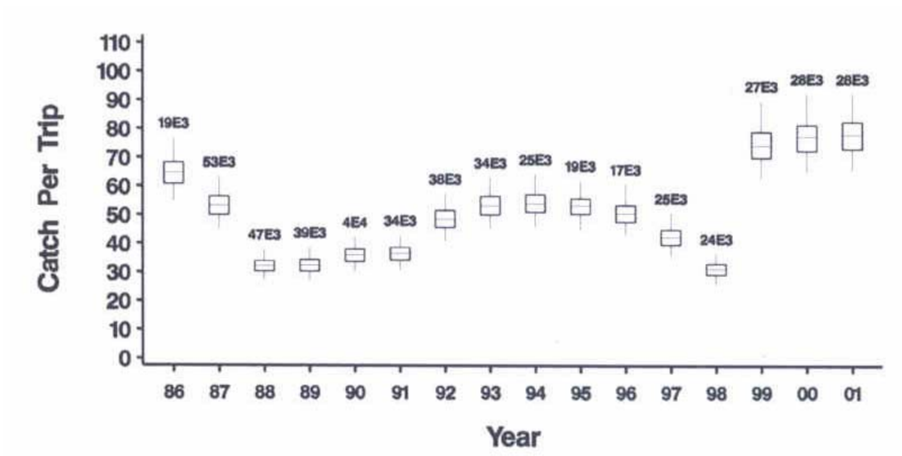

Figure 9. Annual standardized commercial catch rates, in pounds, for eastern oyster on the GOM coast of Florida, 1986 – 2001 (Figure from FRMI 2003).

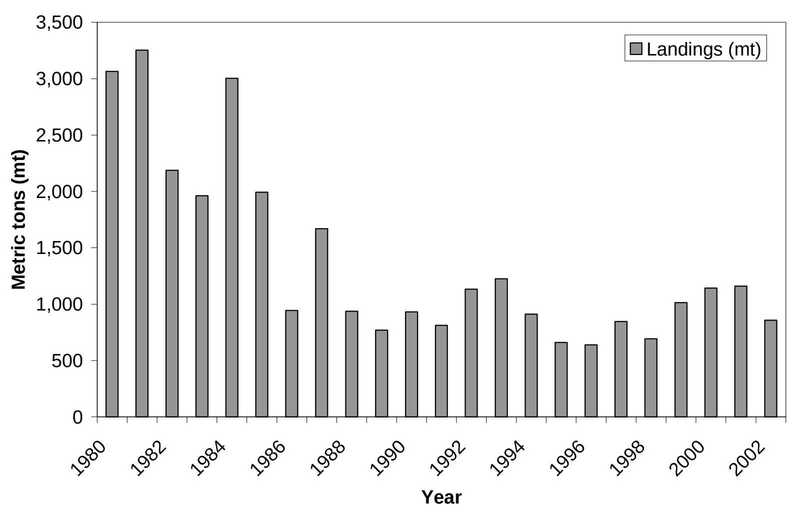

Figure 10. Total annual commercial landings of eastern oyster on the west coast of Florida, 1980 – 2002 (NMFS 2004a).

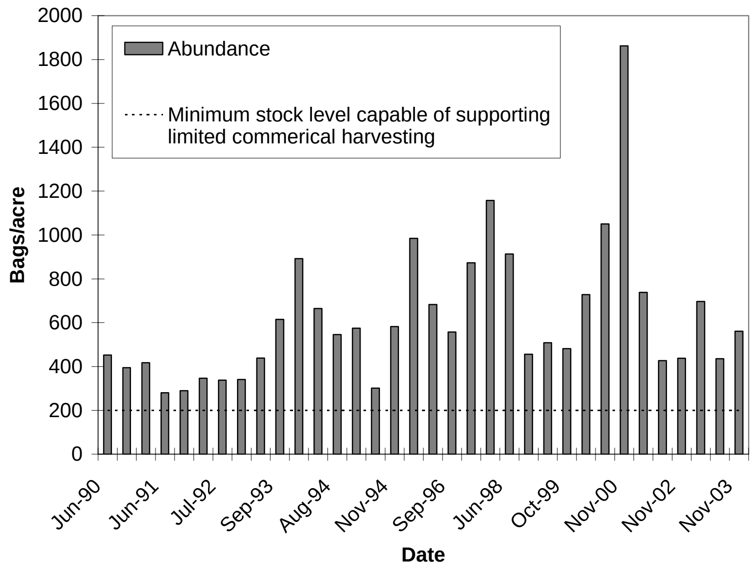

Figure 11. Population estimates demonstrating a variable abundance trend from field surveys on Cat Point Bar, a winter harvesting Apalachicola Bay oyster bar, 1990 – 2003 (DOA 2003).

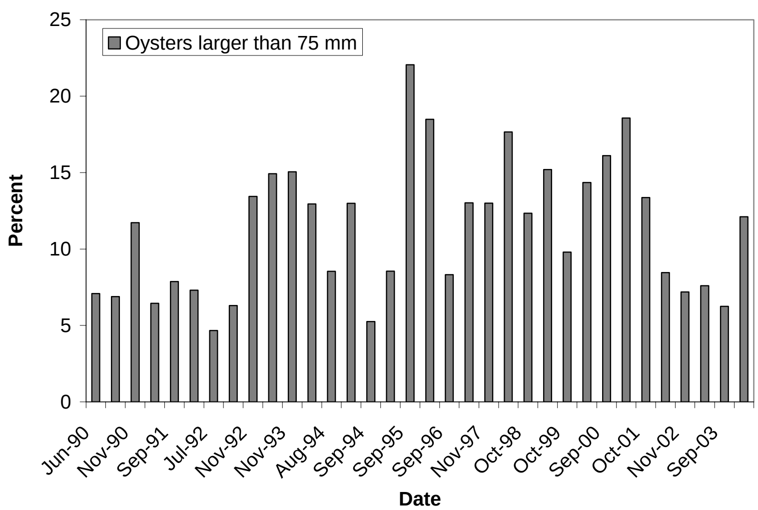

Figure 12. Percentage of oysters larger than 75 mm on Cat Point Bar, Apalachicola Bay, 1990– 2003 (DOA 2003).

Canada

The Department of Fisheries and Oceans (DFO) does not have an official classification for the eastern oyster fishery. Although B_{MSY} has not been established, one objective of the New Brunswick Integrated Fishery Management Plan is "sustainable development through a precautionary and ecosystem-based approach" (DFO 2001). New Brunswick stock assessments were conducted in 1974, 1979, 1988, and 1999. The 1999 assessment of the Caraquet Bay stocks in New Brunswick indicate the population is approaching a critical state similar to that following a disease outbreak in the 1960s (DFO 2001). Landings had been relatively stable in the Gulf of St. Lawrence until they began increasing in 1999 (Figure 13). There are no data concerning the current age, size, or sex distribution of the stock relative to the natural condition. According to the Prince Edward Island Integrated Fisheries Management Plan, "population abundance and available fishable biomass should stay at current levels" (DFO 2000). The level of uncertainty in the Gulf of St. Lawrence stock status is undetermined.

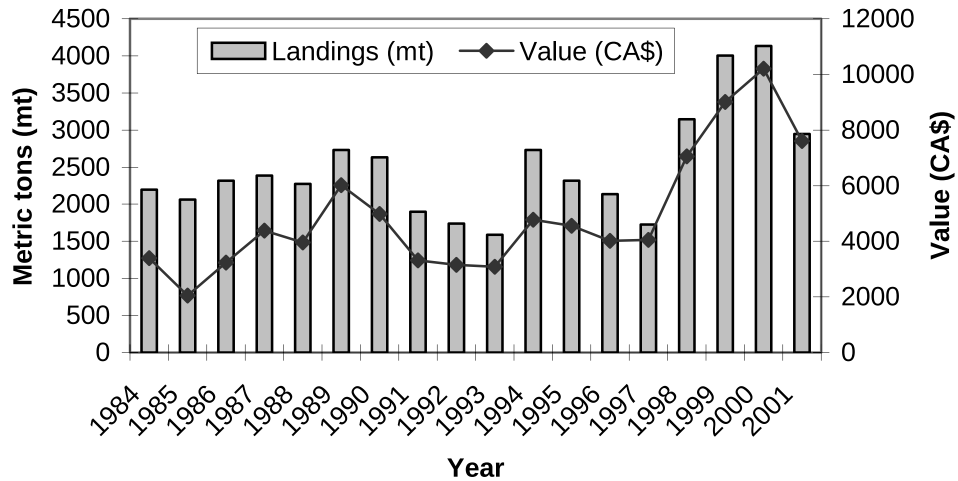

Figure 13. Eastern oyster landings in the Gulf of St. Lawrence, Canada, 1984 – 2001. Landings remained relatively stable until an increase in 1999 (DFO 2004).

STATUS OF THE STOCKS RANK

There is no classification of the oyster fishery in any state or province from which oysters are harvested, and B_{MSY} has not been established for any oyster population. Long term fishery independent data are available for Texas and Louisiana, while short term fishery independent data are available for Texas, Louisiana, and Florida. Long term CPUE data are available for each state; however, the trends vary by geographic location. Florida is the only state for which short term CPUE data are available. It is unknown whether overfishing is occurring in any of the states, as there is no established threshold for overfishing. Due to this lack of available data, the stock status of the eastern oyster is ranked as "unknown".

Status of the Stocks Rank: Poor **Unknown** Healthy

Criterion 3: Nature of Bycatch

The primary gears used to harvest eastern oysters are dredges and tongs. An oyster dredge consists of a bag-shaped net of metal rings attached to a metal rectangular frame. The frame's lower end is called the raking bar, and is often equipped with metal teeth used to dig up the bottom (Figure 14) (Barnette 2001). Oyster tongs are similar to two rakes fastened together and are used by fishermen from the deck of the boat (Barnette 2001). Although dredging has been shown to impact marine habitats (see Criterion 4 below), there is no evidence of bycatch in the Gulf of Mexico oyster dredge fishery. There have, however, been concerns of sponge, aquatic vegetation, and bottom fish bycatch and habitat damage in the scallop and clam dredge fisheries (Collie et al. 1997; Chuenpagdee et al. 2003). Offshore scallop dredges consist of a metal frame that supports tickler chains and a metal ring bag to collect the scallops (Barnette 2001). The results of an expert workshop concluded that dredges have “very high” habitat impacts, and result in “high” shellfish and crab bycatch and “low” finfish bycatch (Chuenpagdee et al. 2003). While most dredges are 4 – 4.5 meters (m) wide, the maximum allowable width for an oyster dredge is 1.8 m in Louisiana, and 1.2 m in Texas (Berrigan et al. 1991; Chuenpagdee et al. 2003). The standard dredge has an opening 80 cm wide and a capacity of approximately 2.5 bushels (about 46 L) (Jordan et al. 2002b). Oyster dredges have shorter tow-times (2 – 5 min) than scallop dredges (10 – 20 min), which may also explain why oyster dredges do not collect much other than oyster shell, and a small number of oyster drills, tunicates, and toad fish (N. Blake, pers. comm.). Lenihan and Micheli (2000) found that densities of live oysters were 2 – 4.5 times lower on study sites where oyster tonging occurred, and densities of dead oysters were 2 – 2.5 times higher on these sites. While Berrigan et al. (1991) list several problems associated with the oyster fishery, it does not include bycatch, and states that “present fishing activities for oysters are not known to adversely affect any threatened or endangered species”.

Figure 14. Oyster dredge (Figure from Berrigan et al. 1991).

NATURE OF BYCATCH RANK

There is no evidence of bycatch in the Gulf of Mexico oyster fishery, although there are concerns about bycatch in the scallop and clam dredge fisheries. Due to differences in habitat and gear, oyster dredge bycatch cannot be compared to bycatch in other dredge fisheries. The quantity and composition of bycatch in the oyster fishery is unknown, but is thought to have little or no impact on bycatch species population levels. Bycatch is minimal for the eastern oyster fishery in the Gulf of Mexico and rates as a low conservation concern.

Nature of Bycatch Rank: High Moderate **Low**

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

In the Gulf of Mexico, oysters are most commonly found as reefs in shallow bays and on mud flats (Galtsoff 1964). Dredges are the primary gear used in Louisiana, Texas, and Mississippi, while tongs are the only allowable gear in Florida and Prince Edward Island; these two gear types have similar habitat effects (Table 3). According to Rothschild et al. (1994), tonging is thought to have limited habitat effects due to the smaller area covered, and the intensity and efficiency of the gear. Other studies have shown that oyster tongs have a massive impact on oyster reef habitat by reducing the vertical height of the reef (Barnette 1999; Lenihan and Peterson 2004). Chuenpagdee et al. (2003) rated dredges a 67 on a 100-point scale as a result of the relative severity of the natural collateral impacts of this gear type. While some studies suggest that oyster reefs that have already become fished beds are not further impacted by repeated dredging (Powell et al. 2001), other research has shown that repeated dredging does indeed impact the habitat and ecosystem (Lenihan and Peterson 1998; Jackson et al. 2001; Lenihan et al. 2001; Lenihan and Peterson 2004). According to a National Marine Fisheries Service (NMFS) essential fish habitat workshop, oyster dredges potentially have a moderate impact on mud, sand, and rubble bottoms and a severe impact on submerged aquatic vegetation and oyster reefs (Barnette 1999). Direct effects of dredging include population mortality and habitat loss (Lenihan and Peterson 1998, 2004; Lenihan et al. 1999), while indirect effects include changes in community structure and ecosystem processes (Lenihan and Peterson 1998; NRC 2002; Lenihan and Peterson 2004). The effects of dredging on benthic habitats will vary according to factors such as the configuration of gear and the type of habitat being fished (Lenihan and Peterson 1998; NRC 2002; Lenihan and Peterson 2004). As filter feeders, oysters play an important role in maintaining water quality by controlling eutrophication; decreases in oyster populations due to overfishing results in deleterious effects on water quality and increases in the frequency and severity of algal blooms (Officer et al. 1982; Newell 1988; Ulanowicz and Tuttle 1992). Oyster reefs also create habitat structure and maintain biodiversity, and the destruction of oyster reefs has a major negative impact on other species assemblages (Bahr and Lanier 1981; Thrush et al. 1998; Coen et al. 1999; Lenihan et al. 2001). Oyster shell accumulation plays an important role in estuarine ecosystems, for instance, by providing essential fish habitat for a number of commercially important species (Harding and Mann 1999; Lenihan et al. 2001; Lehnert and Allen 2002). A decrease in the height of oyster reefs may result in sediment accumulation, decreases in oyster growth and survival, and increased susceptibility to hypoxia (Lenihan and Peterson 1998; Lenihan 1999).

Table 3. Habitat effects of oyster harvesting gear.

Gear Type	Effect of Fishing Gear on Habitats	Habitat Resilience to Disturbance	Geographic Extent of Fishery Effects	Evidence of Food Web Disruption	Evidence of Ecosystem Changes	Sources
Dredges	Severe damage	Moderate	Moderate area	Yes	Science is uncertain	Bahr and Lanier 1981; Thrush et al. 1998; Coen et al. 1999; Barnette 2001; Lenihan et al. 2001; NRC 2002
Tongs	Moderate/severe damage	Moderate	Limited area	Science is uncertain	Science is uncertain	Rothschild et al. 1994; Barnette 1999; Lenihan and Micheli 2000

EFFECT OF FISHING PRACTICES RANK

Although the geographic extent of an oyster dredge is moderate, dredges have been shown to have a considerable impact on marine habitats and ecosystems. However, the oyster dredges used in Louisiana are small (maximum allowable size 1.8 m) compared to those used in other fisheries (4 – 4.5 m). Oysters generally occur on reefs surrounded by muddy bottoms. Muddy bottoms are moderately resilient to disturbances caused by dredging, however oyster reefs are severely impacted by dredging and tonging. There is evidence demonstrating that the removal of oysters may also substantially disrupt the food web. Excessive removal of oysters from estuarine ecosystems has the potential to impact water quality and habitat for other commercially important species. As both tongs and dredges have an impact on oyster reef habitat, fishing effects are considered severe.

Effect of Fishing Practices Rank: **Severe** Moderate Benign

<u>**Criterion 5: Effectiveness of the Management Regime**</u>

In 1988, the GSMFC determined that an FMP was needed for the oyster fishery due to the decline of the resource, habitat loss, pollution effects, and overharvesting (Berrigan et al. 1991). Regulations governing minimum size requirements, allowable gear, fishing season, culling of undersize oysters, bag limits, leases, and commercial landings reporting were implemented in each of the Gulf of Mexico states and Canadian provinces, although regulations vary by location (Table 4) (Berrigan et al. 1991). The minimum size limit for all U.S. states and Canadian provinces is 7.6 cm. The GSMFC Oyster FMP recommends the implementation of gear restrictions to reduce reef damage and season and area closures to prevent overharvesting (Berrigan et al. 1991). Various problems associated with the oyster fishery are related to habitat, public health, regulations, enforcement, and social and economic issues (Berrigan et al. 1991). Another management focus, which is not addressed here, is enhancing production of natural reefs by laying cultch.

Louisiana

Stock assessments have been conducted yearly in Louisiana since 1982, and the results of the 2003 assessment have been compiled and published by LDWF. Although CPUE data are collected, there is no regular analysis with respect to fishing pressure and stock abundance. Since 1984, management has addressed the habitat effects of dredging by only allowing tonging in Calcasieu Lake (LDWF 2004). Since 1991, the abundance of market-sized oysters has remained stable in Calcasieu Lake despite fluctuations in the number of sacks harvested (Figure 15). Due to the bottom characteristics of Calcasieu Lake, dredging has been deemed detrimental to the reef structure. There is also a bag limit of no more than 10, 1 ½ bushel sacks of oysters per boat per day in Calcasieu Lake (LDWF 2004). In addition, management has established oyster seed reservations in Louisiana waters (LDWF 2004). Overall, management has maintained stock productivity and limited changes to the ecosystem, and can be characterized as highly effective.

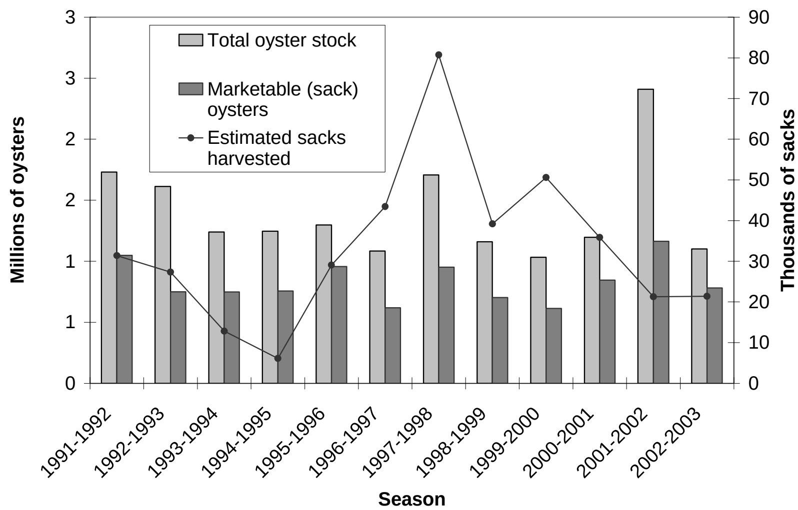

Figure 15. The stability of oyster stocks in Calcasieu Lake, Louisiana despite fluctuations in harvest, 1991 – 2003 (LDWF 2003).

Texas

The Texas Parks and Wildlife Department (TPWD) Oyster FMP was written in 1988, and has not been updated since. TPWD is responsible for management and enforcement of the oyster fishery (Quast et al. 1988). Fishery independent stock assessments have been conducted by TPWD in Galveston Bay since 1956 utilizing a dredge sampling program, and statewide since 1986 (Quast et al. 1988). Galveston, Matagorda, and San Antonio Bays provide 93% of the public reefs in Texas waters (Quast et al. 1988). In 1988, the Texas oyster fishery was considered overfished according to the TPWD Oyster FMP, partially due to the open-access nature of the fishery (Quast et al. 1988). By 1988, overall oyster abundance had declined, the survival of small oysters had been compromised by fishing pressure, and "the current levels of oyster abundance [could no longer] support increasing fishing effort" (Quast et al. 1988). For several years prior to 1988, harvest was at an all-time high, while TPWD data indicated that abundance had been decreasing since 1983 (Quast et al. 1988). The TPWC closed Galveston Bay to oystering for the first time in 1979; Galveston Bay was closed four more times between 1979 and 1988, after determining that oyster reefs in the Bay were overworked or damaged (Quast et al. 1988). Area closures are implemented when an area is designated as overworked, damaged, being reseeded or restocked (Quast et al. 1988). However, no mitigative measures have been implemented to specifically address the habitat effects of dredging. TPWD is mandated to annually assess and publish the status of the oyster population (Quast et al. 1988). In 2003, there were 325 licensed commercial oyster boats, 60% of which were located in the Galveston Bay complex (L. Robinson, pers. comm.). Discussions are taking place regarding the development of an Oyster License Management Program that would create a limited entry program and voluntary license buybacks (L. Robinson, pers. comm.). Management in Texas is deemed highly effective.

Mississippi
The Department of Wildlife, Fisheries, and Parks administers the management of coastal fisheries through the Mississippi Department of Marine Resources (MDMR). The oyster fishery is managed under the Shellfish Strategic Plan, but Seafood Watch® was unable to obtain a copy of this document.

West Coast of Florida
The Florida Department of Agriculture and Consumer Services, Division of Aquaculture conducts stock assessments of the oyster resource, while the Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries is responsible for setting regulations (Berrigan et al. 1991; DOA 2003). Management has addressed the habitat effects of dredging by allowing only tonging or harvesting by hand on the public reefs (Berrigan et al. 1991). Over the past 15 years, fishery independent stock assessments have been conducted in Apalachicola Bay, and have served as an indicator in predicting production trends (Arnold and Berrigan 2002). There is regular collection and assessment of both fishery independent and dependent data; overall, management has maintained stock productivity and limited ecosystem change. Management in Florida is considered highly effective.

Canada
The Prince Edward Island and New Brunswick oyster fisheries are currently managed under five-year fishery management plans (2000 – 2004, and 2001 – 2006 respectively). In 2002, Prince Edward Island and New Brunswick contributed 8% and 88% of the Gulf of St. Lawrence landings, respectively; Nova Scotia contributed 4% (DFO 2004). There is regular collection of fishery dependent data, but the DFO estimates that landings data in New Brunswick is underestimated by about 50%; as a result log books were required beginning in 2001 (DFO 2001). No stock assessments were conducted for the New Brunswick stock between 1988 and 1999. Preliminary results of the 1999 assessment estimated stable landings for the 2001 season with low recruitment (DFO 2001). Measures in place to mitigate habitat effects include limited dredging in New Brunswick, and the prohibition of dredging on Prince Edward Island. Seafood Watch® was unable to obtain stock assessment data used in the Integrated Fishery Management Plans. Due to the limited data related to management of the oyster fishery, Canada's management of the oyster fisheries rates as moderately effective.

Table 4. Eastern oyster commercial harvest regulations for public reefs.

Region	Mgt Jurisdiction & Agencies	Total Allowable Catch Limits	Size Limits	Gear Restrictions	Trip Limits	Closed Seasons/Areas	Sources
Louisiana	Dept. of Wildlife & Fisheries	For Calcasieu Lake: no more than 10, 1½ bushel sacks/ boat/day	Minimum size of 7.6 cm	Dredges cannot be >1.8 m as measured along the tooth bar	None	May – Aug; Calcasieu Lake closed to dredging to protect reefs	Berrigan et al. 1991; LDWF 2004
Texas	Parks & Wildlife Dept.; Parks & Wildlife Commission	150 sacks/day	Minimum size of 7.6 cm	Oyster dredges may not be > 35.5 cm	None	May 1 – Oct 31 in most areas; closed areas established if resource is deemed overworked or damaged	Berrigan et al. 1991; TPWD 2004
Mississippi	Dept. of Marine Resources; Commission of Wildlife, Fisheries & Parks	Limits set seasonally (30 sacks/day from dredging, 20 sacks/day from tonging in 2003)	Minimum size of 7.6 cm	Dredges may not weigh >52 kg, or have >16 teeth; number of allowable dredges established seasonally	None	Regulated by legal notice of the MCWFP	Berrigan et al. 1991; MDMR 2004
West coast of Florida	Division of Aquaculture, Department of Agriculture & Consumer Services; Division of Marine Fisheries	20 bags/person (vessel limit varies with season)	Minimum size of 7.6 cm	No dredging on public reefs	None	Open year-round in Apalachicola Bay; closed Jul – Aug/Sep in other waters	Berrigan et al. 1991; Arnold and Berrigan 2002; DOA 2003
Canada	Department of Fisheries and Oceans	NB: 181 kg daily catch in the fall	Minimum size of 7.6 cm	NB: Rakes in summer months only; single dredge in the fall (≤ 79 cm) PEI: tongs and rakes only	NB: 1 daily trip in the fall	Dec – Apr, Jul – Sep; closed areas to limit effort	DFO 2000; DFO 2001

EFFECTIVENESS OF MANAGEMENT RANK

The effectiveness of the management regime is determined by analyzing such factors as stock status, assessing the extent of scientific monitoring and enforcement of regulations, and determining whether management has properly addressed the impact to the marine habitat from harvesting methods. Recent stock assessments were obtainable for only Louisiana, Texas, and Florida. All states were determined to have adequate enforcement, while only three states were found to close areas to dredging or prohibit dredging entirely. Management in Louisiana, Texas, and Florida is ranked as highly effective based on several factors, specifically the availability of a recent stock assessment, and their response to issues regarding habitat effects. The management regimes in Mississippi and Canada are ranked as being moderately effective.

Effectiveness of Management Rank:

Ineffective	**Moderately effective**	**Highly effective**
	MS, Canada	LA, TX, FL

Overall Evaluation and Seafood Ranking

Eastern oysters are inherently resilient to fishing pressure as they spawn several times per season, are highly fecund, and mature rapidly. Despite this resilience, however, overfishing, habitat destruction, and disease have led to declines in eastern oyster populations throughout their range. The current status of eastern oyster stocks is unknown. Bycatch in the dredge and tong oyster fisheries is considered low, but the impacts to marine habitats and ecosystems from these gear types are severe. Management schemes are in place and considered highly effective in Louisiana, Florida and Texas, but only moderately effective in Mississippi and Canada. This combination of factors leads to an overall seafood recommendation of "Proceed with Caution" for the wild-caught eastern oyster fisheries in the Gulf of Mexico and Canada.

Table of Ranks

	Conservation Concern			
Sustainability Criteria	Low	Moderate	High	Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Nature of Bycatch	√			
Habitat Effects			√	
Management Effectiveness	√ (LA, FL, TX)	√ (MS, Canada)		

OVERALL SEAFOOD RANK:

Avoid

Proceed with Caution

Best Choices

Supplemental Information

Although potential health effects are not included in the overall seafood recommendation, the consumption of raw oysters may be a health concern for certain individuals. As oysters are filter feeders, they naturally accumulate any toxins or metals present in the water. A Gulf of Mexico Program Report found that the mean level of methylmercury in eastern oysters was 0.08 ppm (Ache et al. 2000). Gulf of Mexico eastern oysters are not listed on the FDA's consumer advisory list, as the U.S. Food and Drug Administration (FDA) advisory level is 1.0 ppm (Ache et al. 2000; USFDA 2004). However, a report by the Environmental Working Group (EWG) recommends that GOM oysters be included on the advisory list for pregnant women (Houlihan et al. 2001), and EWG filed a lawsuit against the FDA in December 2003 challenging the strength of the advisory. The more common health concern associated with consuming raw oysters is the presence of *Vibrio vulnificus* bacteria in the tissue of the oyster. Most healthy individuals are not affected by the ingestion of *V. vulnificus*l; however, high-risk individuals are those with cancer, diabetes, liver disease or disorders, cancer, and individuals with compromised immune systems. The Interstate Shellfish Sanitation Conference (ISSC) recommends that high-risk individuals eat thoroughly cooked oysters, or only eat raw oysters labeled "Processed to reduce *Vibrio vulnificus* to non-detectable levels" (ISSC 2004).

Acknowledgements

Seafood Watch® thanks Dr. Sandra Shumway, Dr. Tom Soniat, and two anonymous reviewers who graciously reviewed this paper for scientific accuracy. Scientific review 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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