FISHERY MANAGEMENT PLAN UPDATE
EASTERN OYSTER
AUGUST 2019

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	August 2001
Amendments:	Amendment 1 – January 2003 Amendment 2 – June 2008 Amendment 3 – April 2014 Amendment 4 – February 2017
Revisions:	None
Supplements:	Supplement A to Amendment 2 – November 2010
Information Updates:	None
Recommended Schedule Change:	None
Next MFC Scheduled Review:	July 2022

The original N.C. Oyster Fishery Management Plan (FMP) was adopted by the North Carolina Marine Fisheries Commission (NCMFC) in 2001. This FMP set up a process for designation of additional areas limited to hand harvest methods around Pamlico Sound and recommended several statutory changes to the shellfish lease program including higher fees, training requirements, and modified lease production requirements (NCDMF 2001). The N.C. Oyster FMP Amendment 1 simply changed one of the criteria for designation of hand harvest areas from waters generally less than 10 feet deep to waters less than six feet deep (NCDMF 2003). Highlights of the management measures developed in the N.C. Oyster FMP Amendment 2 included adopting a 15-bushel harvest limit in Pamlico Sound and a 10-bushel harvest limit for all gears (hand and mechanical) in designated areas around the sound, reducing the available harvest season, changing the way lease production averages were calculated, limited lease applications to five acres and had a recommendation to expand oyster sanctuary construction efforts (NCDMF 2008). Supplement A raised the potential harvest limit in Pamlico Sound to 20 bushels and created a monitoring system for determining when to close mechanical harvest in that area (NCDMF 2010). The N.C. Oyster FMP Amendment 3 created two seed oyster management areas in Onslow County. Amendment 4 was adopted in February 2017 with selected management measures including: the continuation of the monitoring system for when to close mechanical harvest off public bottom in an area, a reduction of the culling tolerance from ten to 5% in the commercial fisheries off public bottom, a reduction of the daily harvest limit for holders of the Shellfish License off public bottom to two bushels per person per day maximums

four bushels per vessel, the continuation of the six-week open season to mechanical harvest off public bottom in the bays with changes in the timing of the six-week opening, modifications to shellfish lease provisions, and adding convictions of theft on shellfish leases and franchises to the types of violations that could result in license suspension or revocation.

Management Unit

The management unit includes the eastern oyster (*Crassostrea virginica*) and its fisheries in all waters of coastal North Carolina.

Goal and Objectives

The goal of the N.C. Oyster FMP is to manage the state's oyster population so that it achieves sustainable harvest and maximizes its role in providing ecological benefits to North Carolina's estuaries. To achieve this goal, it is recommended that the following objectives be met:

1. Identify, restore, and protect oyster populations as important estuarine habitat.
2. Manage and restore oyster populations to levels capable of maintaining sustained production through judicious use of natural oyster resources, enhancement of oyster habitats, and development and improvement of oyster production on shellfish leases and franchises.
3. Minimize the impacts of oyster parasites and other biological stressors through better understanding of oyster disease, better utilization of affected stocks, and use of disease resistant and biological stress resistant oysters.
4. Consider the socioeconomic concerns of all oyster resource user groups, including market factors.
5. Recommend improvements to coastal water quality to reduce bacteriological-based harvest closures and to limit other pollutants to provide a suitable environment for healthy oyster populations.
6. Identify and encourage research to improve understanding of oyster population ecology and dynamics, habitat restoration needs, and oyster aquaculture practices.
7. Identify, develop, and promote efficient oyster harvesting practices that minimize damage to the habitat.
8. Initiate, enhance, and continue studies to collect and analyze economic, social, and fisheries data needed to effectively monitor and manage the oyster resource.
9. Promote public awareness regarding the ecological value of oysters and encourage public involvement in management and enhancement activities.

STATUS OF THE STOCK

Life History

The eastern oyster (*Crassostrea virginica*) is a non-moving, filter feeding shellfish occurring naturally along the western Atlantic Ocean from the Gulf of St. Lawrence off Quebec, Canada to the Gulf of Mexico and the Caribbean Islands. The eastern oyster has been called the ultimate estuarine animal. It can tolerate a wide range of salinity, temperature, turbidity and dissolved oxygen levels, making it well adapted to the ever-changing conditions of the estuary. The

distribution and survival of eastern oysters within habitat types is influenced by abiotic factors such as salinity, tide, oxygen levels and flow, as well as biotic factors such as disease, shell erosion caused by other species and predation. North Carolina's oyster stocks are composed of both intertidal (oysters growing between the mean high and low tide levels) and subtidal (oysters growing below the mean low water level) populations.

Oysters are typically dioecious but can change their sex (hermaphroditic) once each year. Researchers have found that natural oyster populations maintain relatively balanced sex ratios, but exposure to stress, such as food limitation and pollution, results in a higher ratio of males. Gonads may develop in oysters two to three months old. Fully developed oysters entering their first summer season may spawn, but large portions of these young oysters are not sexually mature. Age or size selective mortality from disease and harvest pressure can alter oyster population demographics and result in a shift from male to female. The rate of oyster growth is highest during the first six months after the spat (juvenile oyster) sets and gradually declines throughout the life of the oyster. Seasonally, adult oysters grow most rapidly during spring and fall in North Carolina, reaching market size (3 inches) in about three years. Growth rates in other East Coast and Gulf Coast regions produce market size oysters in time periods ranging from 18 to 24 months in the Gulf of Mexico to four to five years in Long Island Sound.

Stock Status

There are insufficient data to conduct a traditional stock assessment for the eastern oyster in North Carolina, therefore population size and the rate that oysters are removed from the population could not be determined. North Carolina commercial oyster landings have been in decline for most of the past century. This decline was likely initiated by overharvest and compounded by habitat disturbance, pollution, and biological and environmental stressors. Oysters are believed to be more vulnerable to overharvest because these other factors negatively impact their survival.

Stock Assessment

An oyster stock assessment was attempted in 1999, but the necessary data were lacking to determine levels of sustainable harvest (NCDMF 2001). Since there were no significant changes in the types and quantity of data collected, an oyster stock assessment could not be achieved in 2006 and again in 2014 (NCDMF 2008; NCDMF 2017). Collection of appropriate data is needed in order to conduct a stock assessment and determine levels of sustainable harvest (NCDMF 2008).

Data are not available to perform a traditional assessment so it was not possible to estimate population size, demographic rates, or removals from the population in the latest FMP adopted in 2017. The only data representative of the stock were the commercial landings and associated effort. For this reason, the most recent analysis focused on trends in catch rates in the commercial oyster fishery. These catch rates could not be considered an unbiased representation of trends in population size; fisheries-dependent data are often not proportional to population size due to a number of caveats and should be interpreted with caution if the interest is relative to changes in the population. In order for a fisheries-dependent index to be proportional to

abundance, fishing effort must be random with respect to the distribution of the population and catchability must be constant over space and time (NCDMF 2017). Other factors affecting the proportionality of fishery-dependent indices to stock size include changes in fishing power, gear selectivity, gear saturation and handling time, fishery regulations, gear configuration, fishermen skill, market prices, discarding, vulnerability and availability to the gear, distribution of fishing activity, seasonal and spatial patterns of stock distribution, changes in stock abundance, and environmental variables. Many agencies, such as the NCDMF, do not require fishermen to report records of positive effort with zero catch; lack of these "zero catch" records in the calculation of indices can introduce further bias.

The North Carolina commercial oyster fishery is subject to trip limits, which could bias catch rates (Mike Wilberg, University of Maryland Center for Environmental Science, personal communication; John Walter, National Oceanic and Atmospheric Administration Fisheries, personal communication). The trip limits affect the amount of catch that is observed per unit effort, preventing the true value of this variable from being observed. A censored regression approach was attempted to calculate an index of relative abundance (numbers harvested per transaction) using data collected from a fishery with trip limits.

Data were obtained from the North Carolina Trip Ticket Program for 1994 through 2013. The censored response variable (catch per unit effort) was fit within a Generalized Additive Models for Location Scale and Shape framework using the 'gamlss.cens' (Stasinopoulos et al. 2014) and 'survival' (Therneau 2014) packages in R (R Core Team 2014). Catch rates were estimated for both hand harvest and mechanical harvest in each of the major water bodies from which eastern oysters are harvested where sufficient data were available. Data were summarized by fishing year (October through March for hand harvest and November through March for mechanical harvest). Only landings from public bottom were examined.

Catch rates were expressed as bushels harvested per transaction. The censored regression approach failed for both hand and mechanical harvest data despite trying three different distributional assumptions (lognormal, gamma, t). This failure was believed to be due to the large number of trips (transactions) that meet or exceed the trip limit in both fisheries. Similar work found that when about 50% or more of the trips equaled or exceeded the trip limits, there was not enough information from the uncensored trips to produce a reliable model. Here, 51.4% of trips by hand gears equaled (39.3%) or exceeded (12.1%) the trip limits over all water bodies and fishing years combined; the number of trips equaling or exceeding the trip limits for mechanical gears was 43.5% (42.9% equaled and < 1% exceeded).

Available data were considered insufficient for estimating reliable fishing mortality rates.

A pilot project is underway over the next three years by The Nature Conservancy and North Carolina State University, with guidance from NCDMF, to develop a subtidal oyster population survey with the potential to become a long-term biological sampling program in NCDMF. Concurrent with these efforts and outside the scope of this pilot project, The Nature Conservancy is collaborating with the NCDMF and commercial oystermen to refine the collection of harvest data to gather more accurate information on harvest levels and effort, as well as discard mortality from dredges. The NCDMF is developing a biological sampling program for intertidal oysters

using existing bottom mapping sampling program data to delineate oyster reefs and evaluate changes over time for intertidal oysters in the southern region of the state.

STATUS OF THE FISHERY

Current Regulations

Oysters cannot be taken from any public or private bottom in areas designated as prohibited (polluted) by proclamation except for special instances for: Shellfish Management Areas (NCMFC Rule 15A NCAC 03K .0103), with a permit for planting shellfish from prohibited areas (NCMFC Rule 15A NCAC 03K .0104), and for the depuration of shellfish (NCMFC Rule 15A NCAC 03K .0107). Beginning in April 2014, time and temperature control measures were initiated for oysters to prevent post-harvest growth of naturally-occurring *Vibrio* sp. bacteria that can cause serious illness in humans between April 1 and September 30 of each year. Oysters cannot be taken between the hours of sunset and sunrise of any day. Beginning in the 2017-2018 season the culling tolerance was reduced from 10% to 5% off public bottom based on management measures adopted in Amendment 4 of the N.C. Oyster Fishery Management Plan.

Public Bottom

The minimum size limit for oysters from public bottom is three-inch shell length. Both the hand and mechanical oyster harvest season from public bottom are opened annually by proclamation. It is unlawful to sell oysters taken on Saturday and Sunday from public bottom. The hand-harvest season for commercial and recreational harvest begins on October 15 each year with commercial harvest limited to Monday through Friday each week and recreational harvest allowed seven days a week. Hand-harvest methods to take oysters are allowed in all areas found suitable for shellfish harvest by the Shellfish Sanitation and Recreational Water Quality Section of the NCDMF during the open season. Beginning in 2013 through statutory changes, the Shellfish License was restricted to hand harvest only, and harvest by mechanical methods was prohibited. Recreational harvest is only allowed by hand methods. The hand harvest season typically continues until closed by rule on March 31 although some locations close earlier due to perceived excessive harvest. Brunswick County is the only area frequently closed early due to this concern and it closed prior to March 31 sixteen times between the1996-1997 and 2018-2019 seasons.

The daily hand harvest limit for oysters in Pamlico Sound outside the bays is 15 bushels per day per commercial fishing operation and 10 bushels per day per commercial fishing operation in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound. Areas from Core Sound south have a daily hand harvest limit of five bushels per person not to exceed 10 bushels in any combined fishing operation regardless of the number of persons, license holders, or boats involved. Recreational daily harvest limits in 2018-2019 were one bushel per person per day not to exceed two bushels per vessel per day.

Beginning in October of the 2017-2018 season, hand harvest for Shellfish License holders was limited to two bushels per person per day not to exceed four bushels per vessel per day if two or more Shellfish License holders are on board the vessel (NCDMF 2017). Hand harvesters with

the Standard Commercial Fishing License could continue landing the higher daily harvest limits in all areas.

The mechanical harvest season for oysters in 2018-2019 was opened November 12, 2018, and was restricted to deeper portions of the sounds, rivers and bays north of Pamlico Sound. These mechanical harvest areas are designated by rule (NCMFC Rule 15A NCAC 03R .0108). Mechanical methods for oysters were only allowed to operate from sunrise to 2:00 p.m. during the 2018-2019 season (November 12 – March 31). Beginning in the 2017-2018 harvest season, the six-week open period for the bays was split into two potential open periods. The first opening in the bays could begin on the Monday of the week prior to Thanksgiving and run through the Friday after Thanksgiving. The second opening of the bays could begin two weeks before Christmas and remain open for the remining four weeks.

Areas outside the bays open to mechanical harvest were limited to a daily harvest limit of 15-bushels of oysters per operation and limited to 10-bushels of oysters per operation within the bays.

The mechanical harvest season can close sooner for areas in Pamlico Sound if sampling by NCDMF indicates that oysters of legal size have been reduced to below 26% of the live oysters sampled for two consecutive sampling trips, as directed by Amendment 4 of the Oyster FMP. Mechanical harvest was closed on December 13, 2018 in the Neuse River, Pamlico River, and Northern Dare and Hyde County areas (Table 1; Figure 1). All mechanical harvest areas remained closed until the season ended on March 31, 2018, which also prevented the re-opening of the bays for the second period.

There are also further restrictions for mechanical oyster harvesters to make sure that cultch material and culled oysters are either put back into the water where they were taken or remain on the existing rocks. North Carolina has a rule in place (NCMFC Rule 15A NCAC 03K .0202) requiring culling on site. The following restrictions were put in place beginning with the 2012-2013 oyster season to discourage harvesters from not culling and removing extra cultch material.

> It is unlawful to possess more than five bushels of unculled catch onboard a vessel. Only material on the culling tray is exempt from culling restrictions.
>
> It is unlawful to possess unculled catch or culled cultch material while underway and not engaged in mechanical harvesting.

Some harvesters did not have vessels or dredges rigged for circular dredging patterns which work best with towing points over the side of the vessel or for short tows to allow for culling between pickups. The following restrictions were put in place to encourage circular dredging patterns and shorter tows to keep the cultch and culled oysters on the existing rocks.

> It is unlawful for the catch container (bag, cage) attached to a dredge to extend more than two feet in any direction from the tooth bar.

> It is unlawful to tow a dredge unless the point where the tow line or cable exits the vessel and goes directly into the water is on the port or starboard side of the vessel forward of the transom.

Private Bottom

There is a specific application process and public comment period required for an individual to obtain a franchise or lease for the culture of oyster on private bottom. Owners of shellfish leases and franchises must provide annual production reports to the division. Failure to furnish production reports can constitute grounds for termination, and cancellation proceedings will begin for failure to meet production requirements and interfering with public trust rights. Public bottom must meet certain criteria to be deemed suitable for leasing for shellfish cultivation and there are specific planting, production, and marketing standards for compliance to maintain a shellfish lease or franchise. There are also management practices that must be adhered to while the lease is in operation, such as: marking poles and signs, spacing or markers, and removal of markers when the lease is discontinued.

The minimum size limit for oysters from private bottom is a three-inch shell length with a 5% culling tolerance, that only is required during the open public harvest season. During the rest of the year there is no minimum size or culling requirement for oysters taken from private bottom. There is no daily maximum harvest limit applied to the taking of oysters from private bottom. Permits are required to use mechanical methods for oysters on a lease or franchise.

Possession and sale of oysters by a hatchery or aquaculture operation and purchase and possession of oysters from a hatchery or aquaculture operation are exempt from the daily harvest limit and minimum size restrictions. The possession, sale, purchase and transport of such oysters must be in compliance with the Aquaculture Operation Permit. Leases that use the water column must also meet certain standards as outlined in G.S. 113-202.1 in order to be deemed suitable for leasing and aquaculture purposes.

Commercial Landings

Landings in the North Carolina oyster fishery are impacted by the both biotic and abiotic factors that influence oyster survival and growth.

Data on landings from public bottom by gear indicate that, prior to 1960, most of the oysters were taken by dredge when compared to all hand methods. Chestnut (1955) reported that 90% of the oysters landed in North Carolina came from Pamlico Sound. The Pamlico Sound area is largely dependent on dredging. The resurgence of the dredge landings in 1987 was due, in part, to increased oyster populations and in part to increased effort, as displaced mechanical clam harvesters turned to oyster dredging due to closure of southern clam areas by a red tide. The red tide was a neurotoxic dinoflagellate bloom (*Karenia brevis*) that caused closure of over 361,000 acres of public bottom to shellfish harvest from November 1987 to May 1988. Hand harvest landings of oysters failed to reach their potential that same year since the majority of the hand-harvest-only areas were also closed because of the red tide. Hand harvest landings are the most consistent contributor to the state's oyster fishery. Hand harvest landings have exceeded dredge

landings for significant periods between 1961 and 1970 and between 1989 and 2008 (NCDMF 2017).

The oyster parasite *Perkinsus marinus*, also known as Dermo disease, has been responsible for major oyster mortalities in North Carolina during the late 1980s to mid-1990s. Once infected with this protist, oysters suffer reduced growth, poor condition, diminished reproductive capacity and ultimately mortality (Ford and Figueras 1988; Ford and Tripp 1996; Haskin et al. 1966; Ray and Chandler 1955). Chestnut (1955) may have been the first to report its occurrence in North Carolina. However, no extensive assessments were attempted until large-scale oyster mortalities prompted investigations during the fall of 1988, and Dermo infection was determined to be the cause by the Virginia Institute of Marine Science (VIMS) and the Cooperative Oxford Laboratory (NCDMF 2008).

NCDMF observed in the southern estuaries, while the Dermo infections were on the rise, that during late summer, moderate and high Dermo infection levels did not reduce oyster populations. Hand harvest landings in the south from 1991 through 2002 did not decline in the same manner as landings from Pamlico Sound during the same time. It is suspected that the small, high salinity estuaries may inhibit mortality by flushing out parasites at a higher rate or by exceeding the salinity tolerance of the Dermo parasite, allowing for a higher survival rate compared to Pamlico Sound. The link between low dissolved oxygen, increased availability of iron and increased parasite activity may also be a factor in the different mortality rates as the smaller, high salinity estuaries are less prone to low dissolved oxygen events than the Pamlico Sound (Leffler et al. 1998). Dermo infection intensity levels since 2005 have remained low; however, prevalence appears to be increasing (NCDMF unpublished data; Colosimo 2007). Dermo infection intensity has remained low and mechanical harvest landings in Pamlico Sound continued to recover from the extremely high Dermo mortality levels and hurricane impacts of the mid-1990s until additional environmental impacts (i.e., low dissolved oxygen & hurricanes) began affecting the fishery in 2011 (Figure 2).

Bioeroders (organisms that tunnel into oyster shell), in particular boring sponge (*Cliona* sp.), are also of concern for their impacts to oyster reefs in North Carolina. These sponges can chemically etch out canal systems within oyster reefs, as well as encrust and smother them. Boring sponges can cause mortality by weakening the shell, preventing the oyster from protecting itself from predators. Once the oyster reef has been compromised, there is a loss of material for spat attachment and eventually a reduction in the vertical height of the reef. Boring sponges are linked to salinity gradients with some species found in high salinity waters while other species are found in the low to mid-range salinities but typically are not found in waters with less than 10 parts per thousand. Intertidal oysters have some refuge from boring sponge. Dunn et al. (2014) examined the distribution and abundance of oyster reef bioerosion by *Cliona* sp. in North Carolina. The study examined levels of boring sponge infestations across salinity gradients in multiple oyster habitats from New River through the southern portions of Pamlico Sound. The study found boring sponge infestations in all oyster communities sampled, with the exception of those found in the upper reaches of some tidal creeks in the Newport and North rivers in Carteret County. Low salinity areas had mean salinity levels of 15 parts per thousand while the higher salinity areas had a mean salinity of 20 parts per thousand or greater. High salinity areas were

infested by the high salinity tolerant boring sponge *Cliona celata*. The study found that as salinities increased, infestations increased.

Commercial oyster landings from private bottom have generally been increasing annually while landings off public bottom have been much more variable (Figure 2). Over the last five years an increasing trend in landings from production on private bottom coupled with decreasing landings from public bottom has led to landed bushels from private culture exceeding public landings in both 2017 and 2018 (Figure 2). Hand harvest landings exceeded the mechanical landings from public bottom in 2007 to 2008, 2012 to 2013, and 2015 to 2018 (Figure 3). The most significant increase in oyster landings from public bottom in the past ten years occurred in the mechanical harvest fishery in Pamlico Sound during the 2009-2010 and 2010-2011 seasons (Figures 2 and 3). There was a high abundance of oysters in some areas in Pamlico Sound that had not been seen in over 20 years, high market demand, and an increase in new participants in the fishery likely influenced these higher landings. In 2013, General Statute 113-169.2 limited the use of the Shellfish License to hand harvest methods only, this license is available to all residents of North Carolina for a lower fee than the Standard Commercial Fishing License. Hand harvest landings are relatively stable across years when compared to the fluctuations in landings from the mechanical fishery and are an important component of the public bottom oyster fishery. In 2018, hand harvest commercial landings off public bottom were 15 times higher than mechanical harvest landings off public bottom (Figure 3).

Mechanical Harvest Fishery Off Public Bottom

During the early 2009-2010 mechanical harvest oyster season, the Narrows area between Great Island and the mainland in Hyde County in Pamlico Sound experienced intensive oyster harvest (Figures 1, 2 and 3). Some of the operations were harvesting the 15-bushel limit, offloading then returning to the area with a new crew and harvesting an additional limit the same day. The 2010-2011 season began with a 2:00 p.m. time limit on dredging to attempt to stop the two-trips-per-day loophole. This added time limit likely had little impact on overall mechanical harvest landings, as experienced dredgers could take their limit in a few hours and there appeared to be many new entrants into the fishery. The traditionally harvested oyster rocks in the deeper waters of western Pamlico Sound contributed greatly to the increased landings in the 2009-2010 and 2010-2011 seasons but the Middle Ground area in 2010-2011 provided another unexpected source of significant oyster production much like the Great Island Narrows did in 2009 (Figures 2 and 3). Interest in taking advantage of expected high market demand caused by closure of oyster harvest areas in the Gulf of Mexico due to the Deepwater Horizon oil spill lengthened the season slightly with a November 1 mechanical harvest season opening in the fall of 2010.

Hurricane Irene hit the North Carolina coast on August 27, 2011 and had major impacts on the mechanical harvest area for oysters. Many deep-water oyster areas in Pamlico Sound were damaged or covered. Oyster resources in the Neuse and Pamlico rivers did not appear to suffer much damage, but did not show any growth during the following months. These factors had a pronounced effect on the mechanical harvest oyster season in 2011-2012 and the mechanical harvest area in western Pamlico Sound was closed in January. Mechanical harvest landings declined to near 2008-2009 levels during the 2011-2012 season (Figure 3). Regular sampling of oyster sizes to fulfill the requirements of Amendment 4 to the N.C. Oyster FMP has made it clear that oyster growth during the harvest season is essential to sustain acceptable harvest levels.

In the summer prior to the 2012-2013 mechanical harvest season, a severe low dissolved oxygen event occurred in the Neuse River that caused virtually a 100% mortality of the oyster resources at 18 feet or greater depths. The Pamlico River area also had not recovered from the effects of Hurricane Irene at this time. There still was little evidence of any recovery of the Neuse River oyster resources prior to the 2013-2014 season but the Pamlico River area appeared to be recovering and growth indicators were good during the season. The Northern Dare area in Pamlico Sound also supported some significant mechanical harvest activity throughout the 2013-2014 season.

During the 2014-2015 mechanical harvest season effort was still consistently low in the Neuse River, with effort peaking in all areas in mid-December. Closures of the Northern Hyde and Dare areas resulted in declines in harvest in January and foul weather increased these declines in February. Staff continued to sample and Northern Dare was re-opened in early March and closed by rule on March 31, 2015. The fleet encountered what was described as a "crust" covering much of the oyster rocks fished on re-opening day and took several days to break up this "crust". Effort was high for the re-opening with approximately 50 boats fishing on the first day and dropping off to around 20 boats after a few days.

Water temperatures were quite warm throughout the 2015-2016 season and not a lot of new growth was observed until January on the oysters. Some areas in Northern Hyde were covered in tunicates the previous year and little spat was seen in these locations during this season. The Neuse River area was limited in locations to harvest oysters and closed early during this season. Effort was highest in the Pamlico River at the beginning of the season and then after Christmas effort shifted to areas off Northern Hyde.

Like the previous season, water temperatures were quite warm and little growth was observed in the oysters until January in the 2016-2017 season. In the Neuse River live oysters were present in only a few locations. A confirmed low dissolved oxygen event occurred earlier that summer over a prolonged period near the mouth of the Neuse River which may have had an impact on oysters in this area. Within a few weeks of the season opening, only a few oyster harvesters were working in the Neuse River area, and most live oysters were found in shallow water (less than 20 feet deep). By late December the few oyster harvesters seen on the water were having to move around a lot to find oysters. Mechanical harvest was closed for the remainder of the season in mid-January for the Neuse River and Northern Dare areas. The Pamlico River and Northern Hyde areas remained open for the entire 2016-2017 season, but only a few fishermen remained harvesting oysters in early February and by mid-February no effort was seen in the open areas while sampling.

Pre-season sampling in October-November 2017 showed a lot of spat and small oysters in all areas, and two areas (Neuse River and Northern Dare) came in below the threshold (<26%) of legal-sized oysters in the samples. The 2017-2018 mechanical harvest season began Monday, November 13, 2017, and the six-week open period in the bays was split into two. The culling tolerance was also reduced from 10 to 5% following the latest management strategies. Oysters were small according to the dealers at the beginning of the season and showed little growth. The Neuse River only had a few areas with live oysters available and closed on December 7, 2017

after reaching the legal-sized threshold for closure. Small oysters that would not grow into legal-size this season were also pre-dominant in the Pamlico River and Northern Dare areas sampled early in the season. Both Pamlico River and Northern Dare areas were closed to mechanical oyster harvest on December 25, 2017. Only Northern Hyde County remained open into 2018 but closed to mechanical harvest by late January. All mechanical harvest areas for oysters remained closed for the rest of the season. In addition, starting the first week of January 2018 and for the next two weeks, coastal North Carolina experienced record low temperatures, with at least one consecutive 72-hour period where air temperatures were below freezing. Most inshore areas and some of the deeper water areas had ice. Some areas maintained ice for two weeks. In mid-January reports were coming in that some of the subtidal oysters in Pamlico Sound had been impacted by the freezing. Particularly in shallow water areas where oysters are exposed to the air for a period of time caused by wind-driven tides.

In September 2018, Hurricane Florence made landfall in North Carolina and caused significant impacts on the oyster resource. Extended periods of hypoxic or anoxic conditions occurred in in many of the deep-water areas of Pamlico sound during the following weeks. Dive surveys of reefs on the Middle Grounds were conducted by NC state researches, and they observed large-scale oyster mortality due to Hurricane Florence. Observations by their team did not suggest that oyster reefs in the shallow bays were as impacted. During initial sampling, the Neuse River, Pamlico River, and Northern Dare areas all showed low numbers of living oysters and were all below the 26% legal size threshold. The initial sampling at Northern Hyde areas showed a legal percentage of 27%, just above the threshold. Mechanical fishing effort was relatively low due to poor catch, and the mechanical season was closed in all management areas on December 13, 2018. This closure prevented the second opening period of the bays to mechanical harvest. Impacts from Hurricane Florence are reflected in both reduced mechanical and overall oyster landings for the 2018-2019 season (Figures 2 and 3).

Hand Harvest Fishery Off Public Bottom

Hand harvest gear accounts for the majority of the landings and has been the dominant harvest gear for oysters in North Carolina since the 1960s. Hand harvest oyster landings are also less variable than landings from mechanical gears (Figure 3). These higher, more consistent landings come from Core Sound south to the state line. The hand harvest areas in the northern region of the state are exclusively subtidal reefs with depths of two to six feet in which hand tongs are used. Hand harvest gear has not been extensively used in the northern area since oyster dredging was allowed in 1887. In Amendment 2 to the N.C. Oyster FMP in 2008, the MFC adopted the strategy to promote a more habitat friendly fishery by increasing the hand harvest limits to match dredging limits in the Pamlico Sound bay areas. Amendment 2 put in place a 15 bushel per day hand/mechanical harvest limit per commercial fishing operation in Pamlico Sound mechanical harvest areas outside the bays, a 10 bushel per day hand/mechanical harvest limit per commercial fishing operation in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound. This management option raised the limits of hand harvest to encourage less destructive harvest methods in those particular bays and open waters.

Hand harvest limits are five bushels per person, not exceeding 10 bushels per commercial fishing operation from Core Sound south to the North Carolina-South Carolina border for holders of the

Standard Commercial Fishing License. As of October 2018, harvesters holding a Shellfish License statewide are limited to two bushels of oysters per person per day no more than four bushels per vessel, following the selected management strategy adopted by the NCMFC in Amendment 4 of the N.C. Oyster FMP. Areas in the southern region from Core Sound south are closed to mechanical harvest of oysters.

Other factors affecting the hand harvest fishery are the loss of harvest area due to pollution closures. Many shellfish waters in North Carolina are permanently or conditionally closed due to bacterial contamination associated with urban development (Table 2). The greatest proportion of closed shellfish waters occur in the southern district (Onslow, Pender, New Hanover, and Brunswick counties) where over half of the waters are closed and can be attributed to small, narrow waterbodies and more developed watersheds. The area north of Core Sound with the higher hand harvest limits does not have the same problem with large percentages of the available harvest area closed by pollution so oyster harvest is not impacted.

Hand-harvest oyster landings have generally increased in recent years (Figure 3). Oyster hand harvest south of the Highway 58 Bridge generates a significant amount of the overall oyster landings even though the area only encompasses 5% of the total area open to shellfishing in the state.

The 2017-2018 the intertidal oysters in the southern region of the state were impacted by record low temperatures that lasted over two weeks in early January. Reports were received that the cold temperatures and low tides during this period caused the oysters to die. In September 2018, Hurricane Florence caused oyster mortality in many of the hand harvest areas south of the Highway 58 Bridge. Market demand for local North Carolina oyster early in the 2018-2019 season in the southern region of the state was low due to public perception of water quality issues which may have been caused by the storm.

The oyster season typically closes 15 days early in Brunswick County due to public comment and management's concerns of excess harvest pressure on an ever-decreasing area open to shellfishing. Brunswick County continues to be closed more often during the season because of temporary shellfish closures after rainfall events, compressing harvest into small areas and decreasing the number of legal-sized oysters available to harvesters much quicker than in most other areas.

Permanent and Temporary Shellfish Closures

Microbial contamination from fecal matter is important to NCDMF because it affects the opening and closing of waters to shellfish harvest. Fecal coliform bacteria occur in the digestive tract of, and are excreted in the solid waste from, warm-blooded animals including humans, wildlife and domesticated livestock (Mallin 2009). Because consumption of shellfish containing high levels of fecal coliform bacteria and associated pathogens can cause serious illness in humans, shellfish growing waters must be closed to shellfish harvest when fecal coliform counts increase above the geometric mean standard of 14 MPN/100mL [NCMFC Rules 15A NCAC 18A Section .0900 Classification of Shellfish Waters], where MPN denotes "most probable number." The NCDMF closes waters where a high potential for bacterial contamination exists,

such as around marinas and point source discharges. Shellfish harvest closures have continued to occur over time, which has led to a reduction in available shellfish harvest areas. Long term shellfish closures due to bacterial contamination remove available harvest area for shellfish and concentrate those activities on remaining resources compounding harvest related impacts on the oyster habitat in those areas.

Between 2007 and 2014, there were 1,427 acres of water permanently closed to shellfish harvesting in North Carolina, while between 2015 and early 2019, 6,876 additional acres were closed (Table 2). On February 4, 2015, approximately 314,710 acres were closed administratively in lower resource areas because of the inability to sample due to budget constraints. The areas closed to shellfish harvest because of the inability to meet federal sampling requirements caused by funding cuts were approximately 11,834 acres in the Neuse River, approximately 3,042 acres in the Pungo River, and approximately 299,107 acres in Albemarle Sound.

In addition to the areas that are permanently closed to shellfishing, other areas are temporarily closed during periods of high rainfall due to runoff. The rainfall closure threshold varies by growing area as detailed in each management plan and can vary from 1 inch to 2.5 inches of rain in a 24-hour period. Closures last from several days to more than a month and reopen when bacteriological water sample results show the area has returned to normal conditions. Large storms, such as hurricanes, result in harvest closures covering much larger areas, sometimes including all of North Carolina's estuarine waters. The conditionally approved areas are concentrated in the Core-Bogue, New-White Oak, and Southern Estuaries management units. Within these watersheds, permanent closures are most common in the upper reaches of tidal creeks and rivers, with conditionally approved areas occurring downstream of those areas or in the upper portions of less degraded creeks. As temporary closures have increased in frequency and duration, they have become an issue of great concern to the public, particularly in the southern area of the coast. For 2019, an additional classification of “restricted” was adopted for “areas that do not meet approved area criteria but is not grossly polluted” and can be used for limited shell fishing activities such as relay.

2018 was a record year for rainfall amounts throughout the North Carolina coast, with the landfall of Hurricane Florence contributing greatly to the total amounts. Temporary closures during the beginning of the oyster season were directly attributed to that event, with some area closures in the southern portion of the state lasting for over 30 days past the storm.

Private Culture

Authority to lease bottomland for private shellfish cultivation can be traced back to a state statute adopted in 1909. The NCDMF administers the shellfish lease program whereby state residents may apply to lease estuarine bottom and water columns for the commercial production of shellfish. The NCDMF does not differentiate between clam, oyster, bay scallop, and mussel leases; therefore, allowing shellfish growers to grow out multiple species simultaneously or as their efforts and individual management strategy allows. For the period of 2003-2013, roughly 40% of all private culture operations harvested only oysters (NCDMF 2017).

Since 1994 there has been an overall increase in oyster harvest from private culture operations. Oyster harvest from private culture operations in the period from 1994 to 2013 only account for 12% of all oyster landings (NCDMF 2017). However, due to increase interest in private culture of oysters and lower landings off public bottom, private culture harvest accounted for 65% of the total oyster landings in 2018 (Figure 2).

As of 2019, the lease program had 354 leases, and 36 bottom lease and 46 water columns amendment applications during the year. Currently shellfish leases take up about 2,020 acres of bottom (M. Graven; Lease Program Coordinator, NCDMF; June 2019).

Recreational Landings

Recreational landings for oysters in North Carolina are unavailable because there are no license requirements to take shellfish for personal consumption and therefore no way to fully determine the user group to collect their harvest information. Since 2011, the division has collected effort and catch data from the recreational oyster harvesters by surveying those individuals that indicate participation when purchasing a recreational fishing license. This survey does not include recreational oyster harvesters that do not purchase a recreational fishing license. Effort continues to produce state wide estimates of recreational oyster harvest.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Currently, the only data available for the stock in all areas are the commercial landings and associated effort from the Trip Ticket Program. No fishery dependent monitoring programs occur for oysters.

Fishery-Independent Monitoring

There are two independent programs for oysters. One is an indicator for habitat disturbance and damage of the commercial dredge fishery on public bottom to determine closure of the season for habitat protection of oyster rocks (Program 627). The second program. is a long-term spatfall sampling program conducted by the Habitat and Enhancement section to estimate recruitment of spat (Program 610).

<u>Public Bottom Mechanical Harvest Area Oyster Sampling</u>

Supplement A to Amendment 2 established the trigger for closing areas to mechanical harvest to protect the resource and habitat, which was approved to continue under Amendment 4 of the Oyster FMP. The management trigger was established and defined as when the sampling indicates the number of legal-sized (three-inch) oysters in the area has declined to 26% of the live oysters sampled. The management areas are divided geographically into four areas; the Neuse River Area, Pamlico River Area, Northern Hyde Area, and Northern Dare Area (Figure 1). Sampling targets areas and oyster rocks being worked by commercial oystermen, directly before the opening of and throughout the mechanical harvest oyster season. The sampling sites

are selected based on the presence/absence of commercial oystermen working in the area. Only areas where commercial oystermen are working are sampled to determine localized depletion and address habitat protection. From each sample, the first 100 live oysters, including spat and any boxes, are collected for workup. Each oyster, up to a maximum of 100, is measured to the nearest mm and inspected for any damage. Shell damage is denoted as none, minor, or substantial for further evaluation.

Sampling began on September 23, 2009 with pre-season oyster sampling, in four management areas, using mechanical harvesting methods. Sampling has consistently continued with a target of 10 sites per management area, throughout the four management areas. All sampling is conducted using NCDMF vessels and standard oyster dredges with comparable construction to those used by commercial oystermen. Samples are collected at least bi-monthly in each management area (weather permitting) before, during, and after the open mechanical oyster harvest season. More intensive sampling is conducted if samples are near the trigger percentage. Sampling continues after an area is closed to assess the possibility of reopening. Sampling is discontinued when it is apparent that reopening is not likely to occur. Mean oyster shell height (commonly referred to as length) is calculated for each 100-oyster sample. The number of legal-sized (≥76 mm; ≥ 3 inches) and undersized (<76 mm; < 3 inches) oysters is determined for each sample. The total legal-sized oysters for all the samples taken in a management area on a sampling trip is divided by the total of all oysters sampled on that trip to calculate the percentage used to assess compliance with the harvest closure trigger. Oyster sizes are also sorted into five-mm size bins and the size distribution for the area is presented as a bar graph. Sampling results are reported to interested dealers/fishermen and staff after each sampling event.

This sampling is not intended for use as a species abundance index, but instead to reflect the conditions of the habitat during the open oyster mechanical harvest season to determine closure of an area as a protection measure. The 2018-2019 mechanical harvest season trigger sampling revealed low abundance and percent legal in all mechanical harvest management areas (Table 1; Figure 1) and following the steps in the selected management strategy the season was closed by proclamation on December 13, 2018.

Spatfall Evaluation

NCDMF conducts spatfall sampling annually (Program 610), on cultch planting sites from the previous three years during January, but samples may be collected through April if required. Subtidal sites are sampled by towing a standard oyster dredge over the planting site until, at a minimum, 30 pieces of cultch are collected. Patent tongs and hand tongs may also be used to obtain cultch samples. Intertidal sites are sampled by hand at low tide in all applicable intertidal areas of the Southern District and patent or hand tongs are used in the more northerly subtidal areas of Stump Sound and New River. Three tong grabs per location are usually taken to obtain the minimum amounts of cultch required. Gear type and any other valuable gear parameters are recorded. Prior to 2005, data was not collected south of New River.

Thirty pieces of cultch are randomly selected from each sample and the type of cultch (oyster, calico scallop, surf clam, sea scallop, or marl) is noted. The total number of spat on each piece of cultch is counted, with each spat being measured to nearest millimeter shell length. The average

number of spat per piece of cultch is calculated by summing the number of spat per cultch piece, divided by the total number of cultch pieces sampled. An annual spatfall index is calculated as the average number of spat per site and then averaged across all sites within that year. The 10-year average is calculated by averaging the annual index over the last 10 years.

The spatfall index has been somewhat variable from year to year in the early years of the time series, but overall showing a declining trend for the past 10 years (Figure 5). The 2018 and 2019 indices were the lowest and below the 10-year average (Annual average number of spat across all sampling sites) (Figure 5).

MANAGEMENT STRATEGY

There are no management triggers or methods to track stock abundance, fishing mortality, or recruitment between benchmark reviews in the current FMP.

Amendment 4 was adopted in February 2017 and implementing rule changes became effective May 1, 2017. The selected management strategies of the NCMFC in Amendment 4 for oysters taken from public bottom include:

- the continuation of the monitoring system to determine when to close mechanical oyster harvest in an area;
- aligning the maximum daily harvest limit for oysters with current management;
- continuing the six-week open mechanical harvest in the bays, but close the bays to mechanical harvest for two weeks after Thanksgiving and then re-open two weeks before Christmas for the remainder of the six-week open mechanical harvest in the bays;
- a reduction of the culling tolerance from 10% to 5% for the possession of sublegal oysters; and
- a reduction of the daily harvest limit for Shellfish License holders to two bushels per person not to exceed four bushels per vessel.

For private culture of oysters, the selected management strategies in Amendment 4 include:

- adding convictions for theft of shellfish from leases or franchises to the list of convictions that may result in revocation of fishing licenses to implement stronger deterrents to shellfish theft and intentional aquaculture gear damage;
- clarifying how production and marketing rates are calculated for shellfish leases and franchises to meet minimum production requirements;
- expanding the maximum proposed lease size to 10 acres in all areas; and
- specifying criteria that allow a single extension period for shellfish leases of no more than two years per contract period to meet production and marketing requirements in the case of unforeseen circumstances and reorganize the rules for improved clarity.

Amendment 4 also included the expansion of oyster enhancement activities.

The selected management recommendations and implementation status can be found in Amendment 4 of the FMP adopted by the NCMFC in February 2017 (Table 3).

RESEARCH NEEDS

The specific research recommendations from Amendment 4, with its priority ranking are provided below. The prioritization of each research recommendation is designated either a HIGH, MEDIUM, or LOW standing. A low ranking does not infer a lack of importance but is either already being addressed by others or provides limited information for aiding in management decisions. A high ranking indicates there is a substantial need, which may be time sensitive in nature, to provide information to help with management decisions.

Amendment 4

Many environmental considerations are applied throughout the Coastal Habitat Protection Plan (CHPP) and are not part of this list but are still considered very important to oyster. Specifically, the proposed implementation actions on sedimentation within the CHPP are considered a high priority.

Proper management of the oyster resource cannot occur until some of these research needs are met, the research recommendations include:

- Support all proposed implementation actions under the priority habitat issue on sedimentation in the CHPP – HIGH (Ongoing through the CHPP)
- Improve the reliability for estimating recreational shellfish harvest – HIGH (Ongoing)
- Survey commercial shellfish license holders without a record of landings to estimate oyster harvest from this group – HIGH (Needed)
- Develop regional juvenile and adult abundance indices (fisheries-independent) – HIGH (Pilot study in progress with the Nature Conservancy and NC State University)
- Complete socioeconomic surveys of recreational oyster harvesters – MEDIUM (Needed)
- Continue to complete socioeconomic surveys of commercial oyster fishermen – LOW (Needed)
- Determine alternative substrates for reef development and monitoring of intertidal and subtidal reefs (cost-benefit analysis for reefs and cultch planting) – HIGH (Ongoing)
- Identify number and size of sanctuaries needed – LOW (Ongoing)
- Identification of larval settlement cues which influence recruitment to restored reefs (i.e. sound, light, current, etc.) – LOW (Ongoing)
- Support collaborative research to more efficiently track bacterial sources for land-based protection and restoration efforts - MEDIUM (Ongoing)
- Quantify the impact of current fishing practices on oyster habitat suitability in North Carolina – HIGH (Needed)
- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (e.g., docks, bulkhead sections) - MEDIUM (Needed)
- Develop peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments – MEDIUM (Needed)
- Further studies on the effects of dredge weight and size on habitat disturbance and oyster catches – LOW (Needed)
- Develop a program to monitor oyster reef height, area and condition – HIGH (Ongoing)
- Estimate oyster mortality associated with relay - LOW (Needed)

- Estimate longevity and yield of oysters on cultch planting sites - HIGH (Needed)
- Develop methods to monitor abundance of the oyster population – HIGH (Pilot study in progress with the Nature Conservancy and NC State University)

FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATION

Recommend maintaining the current timing of the next MFC scheduled review to being in July 2022. Amendment 4 of the N.C. Oyster FMP was adopted by the NCMFC in February 2017 with rule changes in effect May 1, 2017.

LITERATURE CITED

Chestnut, A. F. 1955. A report of the mollusc studies conducted by the University of North Carolina Institute of Fisheries Research, 1948-1954. University of North Carolina, Institute of Fisheries Research. 66 pp.

Colosimo, S.L. 2007. Comparison of Perkinsus marinus infection and oyster condition in southeastern North Carolina tidal creeks. Masters of Science Thesis. University of North Carolina Wilmington. Wilmington, North Carolina. 86 pp.

Dunn, R. P., D. B. Eggleston and N. Lindquist. 2014. Oyster-Sponge Interactions and Bioerosion of Reef-Building Substrate Materials: Implications for Oyster Restoration. Journal of Shellfish Research 33: 3. 727-738.

Ford, S. E. and A. J. Figueras. 1988. Effects of sublethal infection by the parasite *Haplosporidium nelsoni* (MSX) on gametogenesis, spawning, and sex ratios of oysters in Delaware Bay, USA. Diseases of Aquatic Organisms. 4(2): 121-133.

Ford, S. E. and M.R. Tripp. 1996. Diseases and defense mechanisms. p. 581-660 in Kennedy, V. S., Newell, R. I. E., and Eble (eds.), A. F. The eastern oyster *Crassostrea virginica*. Maryland Sea Grant, College Park, Maryland.

Haskin, H. H., L.A. Stauber, and G. Mackin. 1966. *Minchinia nelsoni* n. sp. (Haplosporida, Haplosporidiidae): causative agent of the Delaware Bay oyster epizootic. Science. 153: 1414-1416.

Leffler, M., J. Greer, G. Mackiernan, and K. Folk. 1998. Restoring Oysters to U.S. Coastal Waters: A National Commitment. UM-SG-TS-98-03, www.mdsg.umd.edu/MDSG/ or VSG-98-05, www.people.Virginia.EDU/~gmsc-web/. 21 pp.

Mallin, M. A. 2009. Chapter 4: Effect of human land development on water quality. P. 64-94 *in* S. Ahuja (ed.) Handbook of Water Quality and Purity. Elsevier.

North Carolina Coastal Federation. 2015. Oyster restoration and protection plan for North Carolina: Blueprint for action 2015-2020. North Carolina Coastal Federation.

http://www.nccoast.org/wp-content/uploads/2015/03/Oyster-Restoration-Blueprint-2015-2020_FINAL.pdf . 8 pp

NCDMF (North Carolina Division of Marine Fisheries). 2017. North Carolina Oyster Fishery Management Plan. Amendment 4. North Carolina Department of Environmental Quality. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 370 pp.

NCDMF. 2014. North Carolina Oyster Fishery Management Plan. Amendment 3. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 14 pp.

NCDMF. 2010. Supplement A to Amendment 2 of the North Carolina Oyster Fishery Management Plan. Changing Management Measures for Harvest Limits in the Mechanical Harvest Oyster Fishery. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 14 pp.

NCDMF. 2008. North Carolina Oyster Fishery Management Plan. Amendment 2. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 283 pp.

NCDMF. 2003. North Carolina Oyster Fishery Management Plan. Amendment 1. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 3 pp.

NCDMF. 2001. North Carolina Oyster Fishery Management Plan. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 192 pp.

Ray, S. M. and A.C. Chandler. 1955. Parasitological reviews: *Dermocystidium marinum*, a parasite of oysters. Experimental Parasitology. 4: 172-200.

R Core Team. 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Stasinopoulos, M., B. Rigby, and N. Mortan. 2014. gamlss.cens: fitting an interval response variable using gamlss.family distributions. R package version 4.2.7.

Therneau, T. 2014. A package for survival analysis in S. R package version 2.37-7.

TABLES

Table 1. Percentage of legal-sized oysters and status (denoted by color) by management area for the 2018-2019 season in the mechanical oyster fishery trigger sampling program. Weeks with a - represent time before sampling occurred in that area. *Signifies the area was closed to mechanical harvest by proclamation SF-8-2018 on December 13, 2018 for the remainder of the oyster season.

	Status as of week				
Management Area	11/12/2018	11/19/2018	11/26/2018	12/3/2018	12/10/2018
Neuse River	-	16.9%	5.8%	5.8%	*
Pamlico River	-	-	13.1%	16.0%	*
N. Hyde	27.0%	27.0%	17.5%	14.9%	*
N. Dare	13.0%	13.0%	23.4%	17.3%	*

Color Codes	
	Open
	Less than 26% Trigger Tripped: Open
	Two Consecutive Less Than 26% Triggers Tripped: Closed

Table 2. Classification of shellfish waters in acreage from 2008-2019 From NCDMF Shellfish Sanitation & Recreational Water Quality Section.

	Open Area		Closed Area		
Year	Approved	Conditionally Approved Open	Conditionally Approved Closed	Prohibited	Restricted
2008	1,734,192	43,281	12,788	428,739	
2009	1,734,246	43,531	12,552	428,724	
2010	1,734,938	43,054	12,552	428,414	
2011	1,734,938	43,054	12,552	428,414	
2012	1,732,902	44,632	11,834	429,664	
2013	1,733,067	44,282	11,832	429,852	
2014	1,733,118	43,849	11,739	430,363	
2015*	1,418,373	43,849	11,739	745,169	
2016	1,416,960	44,784	12,008	745,597	
2017	1,414,709	44,425	12,209	747,759	
2018	1,414,626	43,926	12,031	748,606	
2019**	1,413,906	43,148	12,836	781,036	748,606

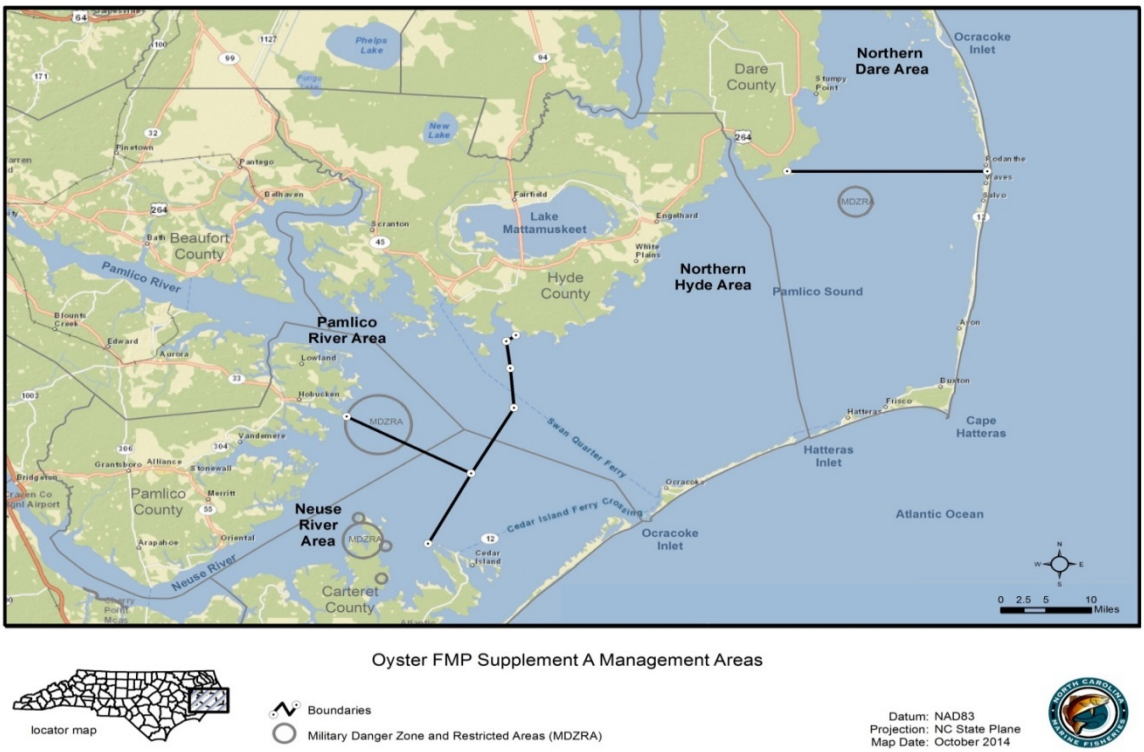
* 314,710 acres administratively closed on 2/4/15 due to budget cuts and office closures.
** First year of use for Restricted classification.

Table 3. Summary of the NCMFC management strategies and their implementation status for Amendment 4 of the N.C. Oyster FMP adopted February 2017.

Management Strategy	Implementation Status
OYSTER MANAGEMENT	
Maintain the cost of the Shellfish License, establish a daily limit of two bushels of oysters per person with a maximum of four bushels of oysters per vessel off public bottom with the Shellfish License.	Existing proclamation authority
Increase efforts to plant and monitor cultch material.	Ongoing
Implement a 5% cull tolerance for oysters	Rule change to 15A NCAC 03K .0202 in effect on May 1, 2017
Pursue elimination of the Shellfish License for oysters only and require all oyster harvesters to have a Standard or Retired Commercial Fishing License with a shellfish endorsement to harvest commercially.	Amend G. S. 113-169.2
Allow Shellfish License holders to be eligible to acquire a Standard Commercial Fishing License after they show a history of sale of shellfish. Continue to allow commercial harvest of all other shellfish as currently allowed.	No action required; Process already in place
Status quo (Maintain the shallow bays (less than 6 feet) as defined in 15A NCAC 03R .0108)	No action required
Recommend a six-week opening timeframe for deep bays to begin on the Monday of the week prior to Thanksgiving week through the Friday after Thanksgiving. Reopen two weeks before Christmas for the remainder of the six-week season.	Existing proclamation authority; Completed in 2017-2018 season
Status quo (Maintain the 15-bushel hand/mechanical harvest limit in Pamlico Sound mechanical harvest areas outside the bays, 10-bushel hand/mechanical harvest limit in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound)	Existing proclamation authority
Adopt the provisions of Supplement A – a flexible harvest limit up to 20 bushels, a trigger of 26% legal-sized oysters for closing an area to mechanical harvest and set the upper harvest limit of 20 bushels in rule (rule change required).	Existing proclamation authority and rule change to 15A NCAC 03K .0201 on May 1, 2017
Attempt to develop and ground-truth a fishery dependent metric of effort to better inform management decisions in the future	Additive to NCDMF monitoring; Working with the Nature Conservancy
PRIVATE CULTURE	
Support modification of G.S. 113-208 and G.S. 113-269 to add minimum fines for violations on shellfish leases and franchises. With minimum fines set at $500 for the first violation and $1,000 for the second violation	Amend G.S. 113-208 and G.S. 113-269
Support modification of G.S. 113-269 to include protection to all shellfish leases and franchises, not just those with water column amendments	Amend G.S. 113-269
Modify Rule 15A NCAC 03O .0114, regardless whether statute changes occur, so that a first conviction under G.S. 113-208 or G.S. 113-269 the Fisheries Director shall revoke all licenses issued to the licensee	Rule change to 15A NCAC 03O .0114 in effect on May 1, 2017
Status quo (Adhere to Regional Conditions of U.S. Army Corps of Engineers Nationwide Permit 48 with no adverse effect to submerged aquatic vegetation from shellfish leases and following measure identified in the interim)	No action required
Continue the moratorium of shellfish leases in Brunswick County	No action required
Establish a rule to support extensions for where “Acts of God” prevent lease holder from making production, with a two-year extension and only one extension allowed per term	Rule change to 15A NCAC 03O .0201 in effect on May 1, 2017

Management Strategy	Implementation Status
Allow leases returned to the state to remain delineated for a period of one year to allow the pre-existing leased bottom to be re-issued to other shellfish growers	Amend G.S. 113-202
Improve public notice of proposed lease applications on the physical lease, at fish houses, and/or through electronic notices	Ongoing
Allow a maximum of 10 acres in both mechanical methods prohibited areas and mechanical methods allowed areas	Rule change 15A NCAC 03O .0201(a)(3) in effect on May 1, 2017

FIGURES



Oyster FMP Supplement A Management Areas

locator map

Boundaries

Military Danger Zone and Restricted Areas (MDZRA)

Datum: NAD83
Projection: NC State Plane
Map Date: October 2014

Figure 1. Mechanical harvest management areas from Amendment 4 of the Oyster Fishery Management Plan.

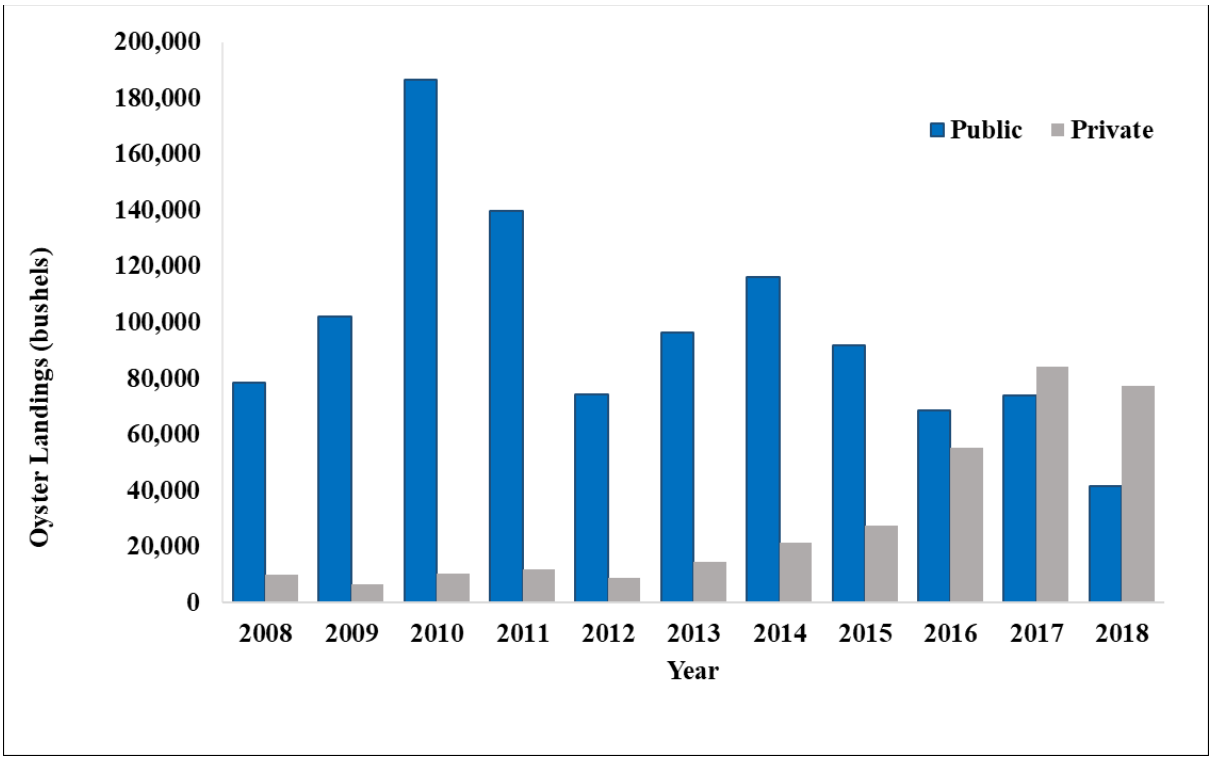


Figure 2. Annual commercial oyster landings (bushels) separated by private and public bottom in North Carolina, 2008-2018 (NCDMF Trip Ticket Program).

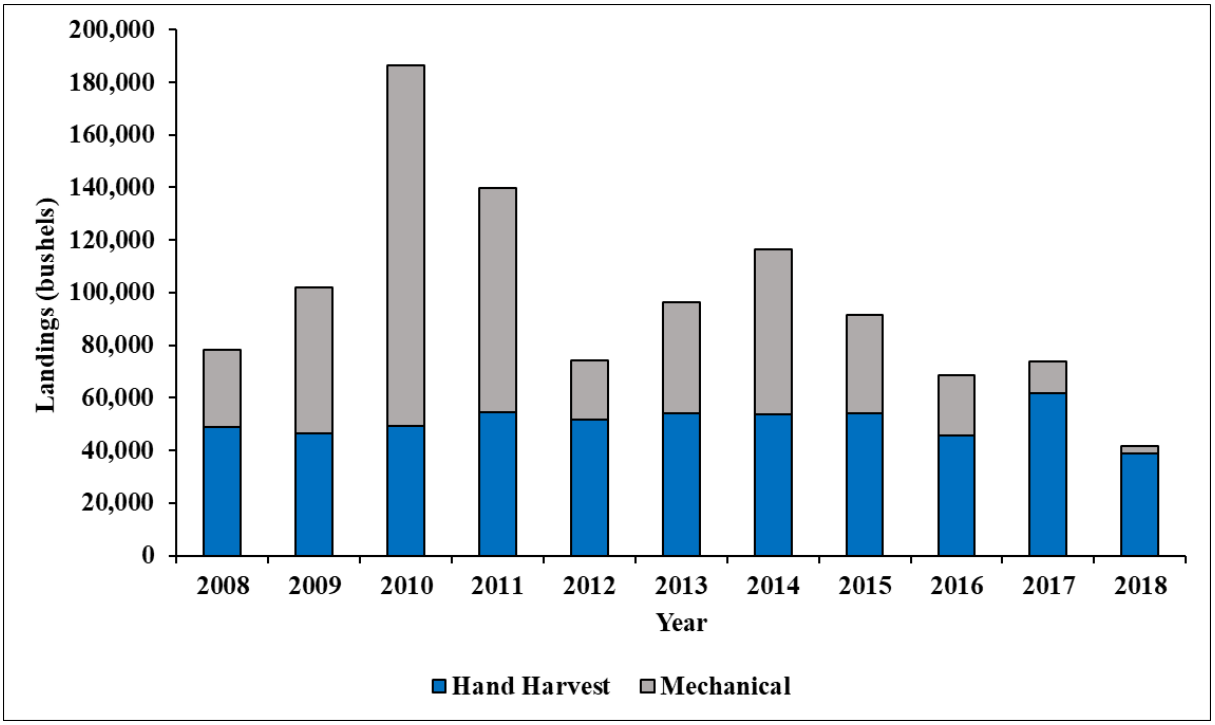


Figure 3. Annual commercial oyster landings (bushels) from public bottom separated by mechanical and hand harvest methods 2008-2018 (NCDMF Trip Ticket Program).

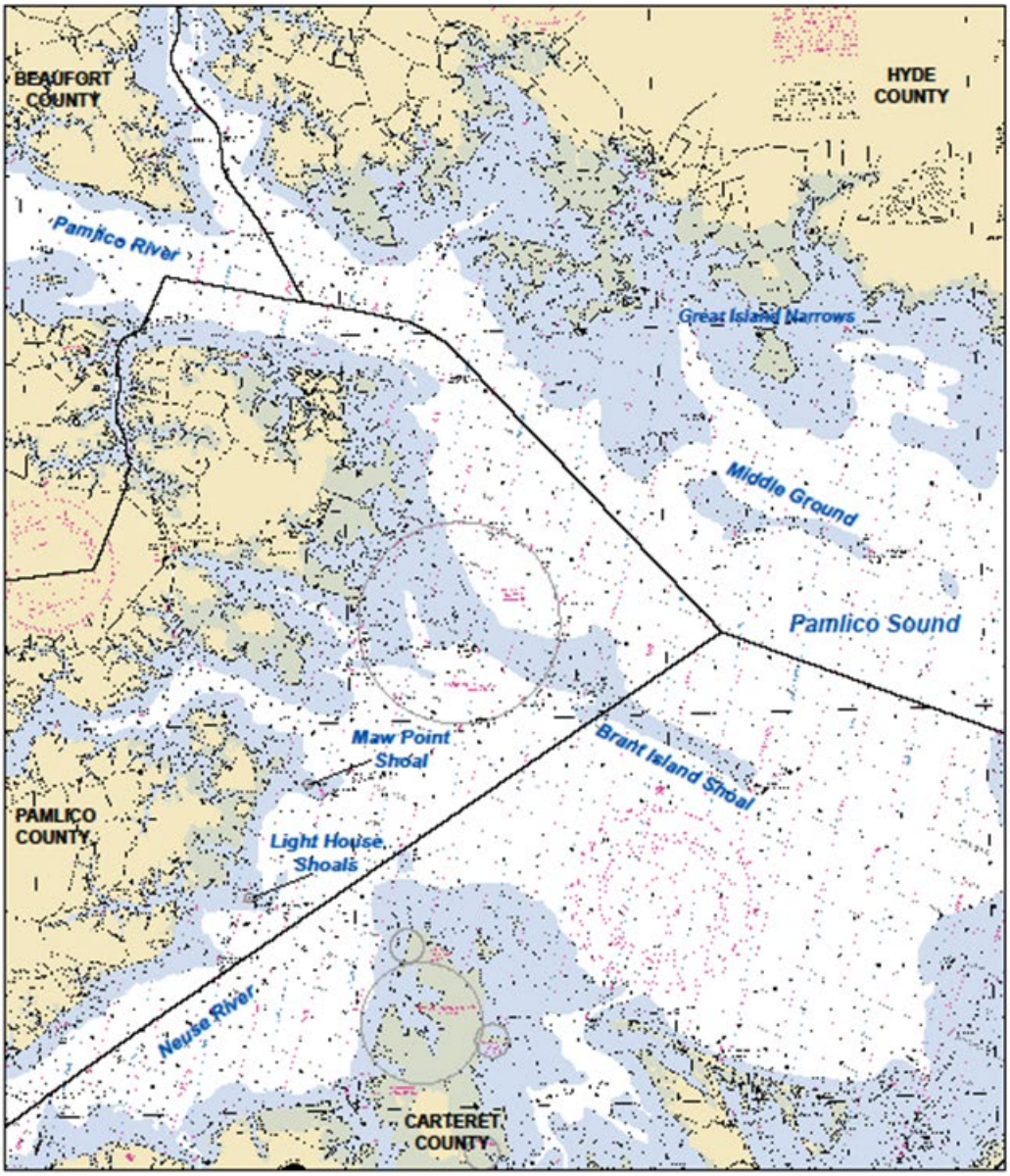


Figure 4. Map of areas referenced in the commercial landings section NCDMF Geographical Information System database).

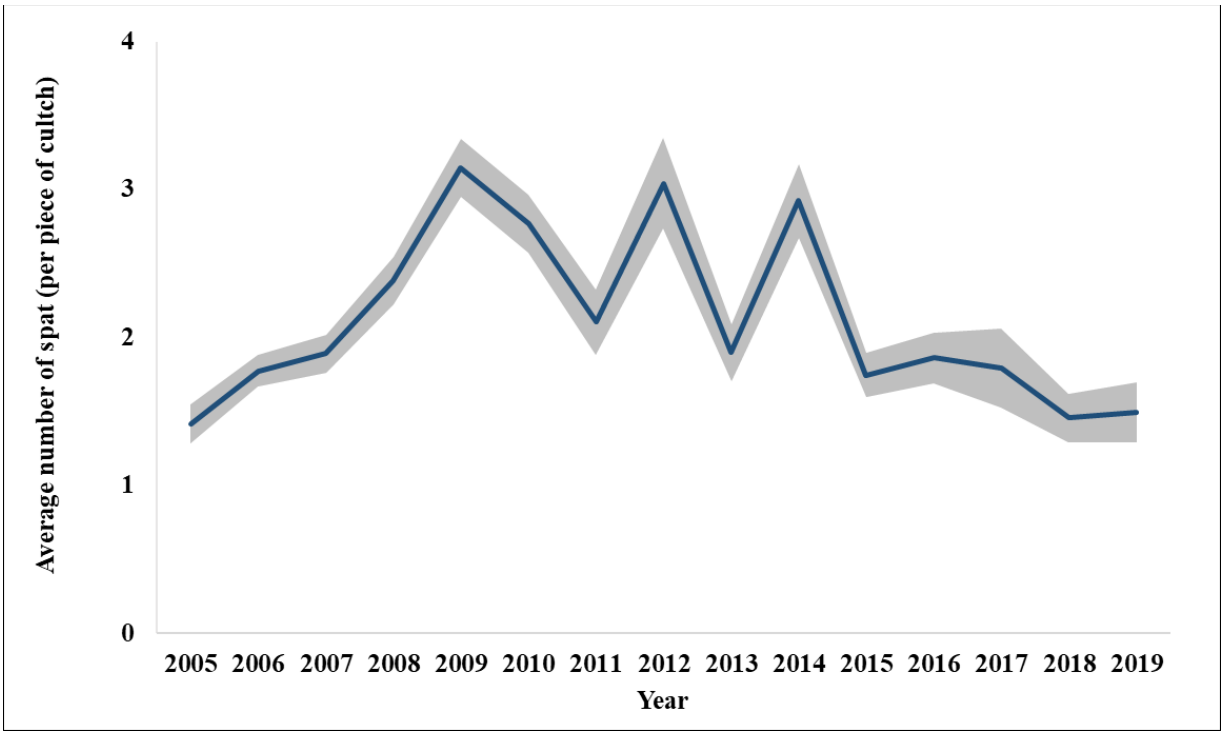


Figure 5. The annual average number of oyster spat across all sampling sites with standard error shaded in gray, 2008-2019 (NCDMF Habitat and Enhancement Section).