FISHERY MANAGEMENT PLAN UPDATE
EASTERN OYSTER
AUGUST 2024

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	
Schedule Changes:	None	
Comprehensive Review:	Amendment 5 is currently in development.	

The original Oyster Fishery Management Plan was adopted by the North Carolina Marine Fisheries Commission (MFC) 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 Oyster FMP Amendment 1 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 Oyster FMP Amendment 2 included adopting a 15-bushel harvest limit in the 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 the Pamlico Sound to 20 bushels and created a monitoring system for determining when to close mechanical harvest in that area (NCDMF 2010). The Oyster FMP Amendment 3 created two seed oyster management areas in Onslow County (NCDMF 2014). Amendment 4 was adopted in February 2017 with selected management measures that included: 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 10 to five percent 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 (NCDMF 2017).

The Eastern Oyster Fishery Management Plan (FMP) Amendment 5 is currently in the process of development and is scheduled for final review and adoption in 2025. Previous Eastern Oyster FMPs managed the harvest of wild shellfish stocks, as well as address issues specific to the private

cultivation of shellfish in aquaculture. The ending of the relay program and the transition into the use of farming cages and hatchery sourced seed, have reduced reliance on wild shellfish. These changes to private culture practices reduce the need to consider aquaculture in the management of wild oyster stocks. The amendment under development and future FMP updates will only focus on managing wild harvest in both mechanical and hand oyster fisheries.

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 Amendment 5 is to manage the oyster resource to maintain oyster populations that provide long-term harvest and continue to offer protection and ecological benefits to North Carolina's estuaries. To achieve this goal, it is recommended that the following objectives be met:

- Use the best available biological, environmental, habitat, fishery, social, and economic data to effectively monitor and manage the oyster fishery and its environmental role.
- Support and implement the restoration and protection of oyster populations as both a fishery resource and an important estuarine habitat through the actions of the Cultch Planting and Oyster Sanctuary programs.
- Coordinate with DEQ and stakeholders to implement actions that protect habitat and environmental quality consistent with the Coastal Habitat Protection Plan (CHPP) recommendations.
- Manage oyster harvesting gear use to minimize damage to habitat.
- Promote stewardship of the resource through public outreach to increase public awareness regarding the ecological value of oysters and encourage stakeholder involvement in fishery management and habitat enhancement activities.

DESCRIPTION OF THE STOCK

Biological Profile

The eastern oyster (*Crassostrea virginica*) is a sessile filter feeding bivalve mollusk occurring naturally along the western Atlantic Ocean from the Gulf of St. Lawrence to the Gulf of Mexico (Bahr and Lanier 1981; Carlton and Mann 1996; Jenkins et al. 1997; MacKenzie et al. 1997). Recent research suggests several related oyster species are distributed throughout the Caribbean and coastal South America; however, the eastern oyster's southern range extends only to the northern Yucatan Peninsula Caribbean (Gaffney 2005; Amaral and Simone 2014). Initial molecular analysis indicated that North Carolina's stock is part of the Atlantic coast stock, which extends from Maine to Key Biscayne, Florida (ASMFC 1988). Additional genetic analyses suggest a second population division occurs in the Mid-Atlantic region, subdividing the Atlantic coast stock into northern and southern groups (Wakefield and Gaffney 1996; Hoover and Gaffney 2005; Varney and Gaffney 2008). North Carolina represents a transition zone within the Atlantic stock of eastern oyster, with a shift between northern and southern types occurring approximately at the southern boundary of the Pamlico Sound (Sackett 2002).

Eastern oysters inhabit varied habitat types in waters that may reach between 0 to 32 °C annually (Butler 1954). While their optimum salinity range varies between 14 and 28 ppt, oysters can

tolerate extreme salinities (as low as 5 ppt and as high as 40 ppt) depending on temperature (Galtsoff 1964; Wallace 1966; Shumway 1996; Loosanoff 1965; Rybovich 2014). The distribution and survival of eastern oysters is further influenced by abiotic factors such as oxygenation, flow, and tide (Stanley and Sellers 1986; Roegner and Mann 1995; Kennedy et al. 1996; Lenihan 1999), as well as biotic factors such as disease, bioeroders, and predation (Barnes et al. 2010; Johnson and Smee 2012; Pollack et al. 2012; Dunn et al. 2014).

North Carolina's oyster stocks are composed of both subtidal populations (below the mean low tide water level, up to 8 meters deep) and intertidal populations (between the mean high and low tide levels) (MacKenzie et al. 1997). Throughout the Croatan, Roanoke and Pamlico Sounds, oyster resources are almost exclusively subtidal. This region is primarily influenced by wind driven tides, with intertidal oysters found occasionally near the inlets. Scattered subtidal populations may be found in larger systems farther south (Newport, White Oak, and New River systems). Conversely, intertidal populations are predominantly observed south of Cape Lookout and throughout estuaries extending to the state's southern border. The horse or crested oyster, (*Ostrea equestris*), may be confused with small eastern oysters, and can be locally abundant in both intertidal and subtidal habitats in southeastern North Carolina (Markwith et al. 2009).

Eastern oyster bodies (meats) have a small foot, a relatively small adductor muscle, fillibranch gills with interlamellar junctions, and lack a siphon (Galtsoff 1964). The interior of the eastern oyster shell contains a purple-pigmented adductor muscle scar that does differentiate eastern oysters from other similar species within its range. The left valve is generally more cupped than the right that is normally found on top and there is no gap between the shells when the valves are completely closed (Yonge 1960; Galtsoff 1964). Shell morphology can vary greatly depending on substrate and habitat conditions. For instance, shells tend to be elongated and thin and have few radial ridges in intertidal and in high salinity areas. Shells of oysters grown in subtidal and lower salinity environments tend to be rounded and thick with visible radial ridges (Stanley and Sellers 1986). In the presence of predators, oysters may allocate more energy to shell growth, resulting in thicker and heavier shells (Johnson and Smee 2012; Lord and Whitlatch 2012). Shell thickness has also been found to correlate with latitude and water temperature along the Atlantic coast, with warmer southern locations having oysters with thicker shells than colder northern locations (Lord and Whitlatch 2014).

Oysters are typically hermaphroditic, first developing and spawning as males in the first few years and may develop as females as individuals get larger and older (Galtsoff 1964; Kennedy 1983). Oysters may change sexes once each year when the gonad is undifferentiated (Thompson et al. 1996). Research suggests that natural oyster populations maintain balanced sex ratios (Kennedy 1983). However, certain environmental conditions, such as such limited food availability and extreme salinity gradients, have been attributed to skewing sex ratios to high abundances of males (Bahr and Hillman 1967; Davis and Hillman 1971; Powell et al. 2013). The sex of nearby oysters may also influence individual oyster sex determination (Smith 1949; Menzel 1951). Furthermore, age or size selective mortality, from disease and harvest pressure can alter oyster population demographics and result in an earlier shift from male to female gonads (Harding et al. 2012).

The formation of eggs and sperm is initially stimulated by increasing water temperatures during the spring (Galtsoff 1964; Kennedy et al. 1996). In North Carolina, oyster broadcast spawning peaks twice—once in June at 20°C, with a second spawning event in August at 25°C (Chestnut 1954). Salinities greater than 10 ppt are also typically required for mass spawning. Gonads may be developed in oysters only two to three months old, but a majority of young-of the-year oysters

will not be sexually mature (Kennedy 1983; Galtsoff 1964). Fecundity estimates range from 2 million eggs for a 4 cm (1.5 in) oyster to 45 million for an oyster 7 cm (2.8 in) in length (Kennedy et al. 1996). These estimates range widely as oysters can spawn several times per season and gonads may expand into other tissues (Kennedy et al. 1996). However, it's accepted that larger oysters allocate greater energy towards egg production, and therefore have increased fecundity (Kennedy et al. 1996). For instance, oysters collected from North Carolina's no-take sanctuaries have demonstrated that fecundity increases exponentially with size, reaching the highest levels in May (Mroch et al. 2012).

Under normal conditions, male oysters spawn first in response to various physical stimuli and environmental conditions. Female oysters are stimulated to spawn specifically by the presence of oyster sperm. Fertilization must take place shortly thereafter in the surrounding waters, or the unfertilized eggs lose their viability. Fertilized eggs develop into a free-swimming larva, which can migrate vertically in the water column in response to temperature and salinity changes (Hopkins 1931; Galtsoff 1964). Oyster larvae have also been documented to travel up to 30 miles, with dispersion strongly dependent on prevailing winds (Bahr and Lanier 1981; Andrews 1983). Patterns of larval distribution in North Carolina estuaries remain relatively unstudied; however, predictive models of Pamlico Sound larval dispersal from oyster sanctuaries have been developed (Haase et al. 2012).

An oyster larva may visit several sites before it cements itself to the substrate (Kennedy et al. 1996). Several environmental factors, including light, salinity, temperature, acoustic signature, and current velocity may influence the setting of larvae (Lillis et al. 2013; Hidu and Haskins 1971). Oyster larvae also respond positively to a protein on the surface of oyster shells as well as other recently set spat (Kennedy et al. 1996). Larval oysters tend to set in the intertidal zone where salinities are above 20 ppt whereas in subtidal areas they set when salinities are below 20 ppt (Mackin 1946; Loosonoff 1965; Menzel 1955). Generally, spatfall is higher in intertidal areas and in areas boasting salinities in the upper range of tolerance (Bahr and Lanier 1981).

Chestnut (1954) reported recruitment peaks generally occurring in June, the latter part of August and possibly another peak in October. Ortega et al. (1990) found recruitment in western Pamlico Sound to be continuous, concentrated in one or two peaks depending on the year and location. Generally, peaks occurred in June (lesser) and September-October (greater). Munden (1975) reported that spat monitors located in Morehead City and Wilmington did not show a decline in availability of spat during the summer of 1972 until September.

Oyster growth is highest during the first six months after setting and gradually declines throughout the life of the oyster (Galtsoff 1964). Seasonally, adult oysters grow most rapidly during spring and fall in North Carolina. Shell growth was found to cease when water temperatures reach 28°C and slowed when temperatures decreased to 5°C (Chestnut 1954). Ortega et al. (1990) examined data from 1979-1989 and found that spat from all western Pamlico Sound sites attained lengths of 10-40 mm during the first year and reached marketable size (76 mm) by the end of three years. Varying growth rates have been observed between and within different regions of North Carolina and also under different environmental conditions (Godwin 1981; Puckett & Eggleston 2012; Kennedy & Breisch 1981; Roegner & Mann 1995).

Stock Status

There are insufficient data to conduct a traditional stock assessment to determine population size and the rate of removals for the eastern oyster in North Carolina. Without a stock assessment,

management is focused on habitat protection and enhancement measures that maintain harvestable oyster populations.

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, 2017). Collection of appropriate data is needed 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 several caveats and should be interpreted with caution if the interest is relative to changes in the population. 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 DMF, 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.

DESCRIPTION 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 Oyster FMP (NCDMF 2017).

<u>Public Bottom (Wild Harvest)</u>

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 DMF 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 twenty times between the 1996-1997 and 2022-2023 seasons.

The daily hand harvest limit for oysters in the 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 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 onboard the vessel (NCDMF 2017). Hand harvesters with the Standard Commercial Fishing License (SCFL) could continue landing the higher daily harvest limits in all areas.

The mechanical harvest season for oysters in 2022-2023 was opened November 15, 2021, and was restricted to deeper portions of the sounds, rivers, and bays north of the 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 2021-2022 season (November 15 – 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 remaining 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 the Pamlico Sound if sampling by DMF 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.

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 Culture (Shellfish Farms and Aquaculture)

There is a specific application process and public comment period required for an individual to obtain a franchise or lease for the culture of oysters. 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 five percent culling tolerance, which is only 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 to be deemed suitable for leasing and aquaculture purposes.

Previous Eastern Oyster FMPs managed the harvest of wild stocks, as well as addressed issues specific to the private cultivation of oysters in aquaculture. The ending of the relay program in 2024 and the transition into the use of farming cages and hatchery sourced seed, have reduced reliance on wild shellfish for private culture. These changes in practices eliminate the need to consider aquaculture in the management of wild oyster stocks. The Eastern Oyster FMP Amendment 5 under development will only focus on wild harvest. For more information on the private culture of oyster in North Carolina visit the NCDMF Shellfish Lease and Franchise webpage at https://www.deq.nc.gov/about/divisions/marine-fisheries/licenses-permits-and-leases/shellfish-lease-and-franchise.

Commercial Fishery

Landings in the North Carolina oyster fishery are impacted by 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

percent 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 many 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 (Ray and Chandler 1955; Haskin et al. 1966; Ford and Figueras 1988; Ford and Tripp 1996). 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).

Throughout the 1990s, DMF sampling indicated that Dermo infections were on the rise in southern estuaries. However, moderate and high Dermo infection levels during late summer 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 the 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 the 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 the 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 and hurricanes) began affecting the fishery in 2011.

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. 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. 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 the Pamlico Sound. The study found boring sponge infestations in all oyster communities sampled, except for 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.

Current Commercial Fishery

Commercial oyster landings from private bottom (oyster farms) have generally been increasing annually while landings off public bottom (wild harvest) have been much more variable (Figure 1). Over the last seven years an increasing trend in landings from production on private bottom coupled with decreased landings from public bottom has led to landed bushels from farmed private culture exceeding public wild harvest landings every year since 2017 (Figure 1). Hand harvest landings exceeded the mechanical landings from wild harvest public bottom in all years except 2014 (Figure 2). 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 SCFL. 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 2019, due to hurricane impacts to subtidal oyster populations in mechanical harvest area, commercial landings by hand harvest were over 30 times higher than mechanical harvest landings off public bottom (Figure 2).

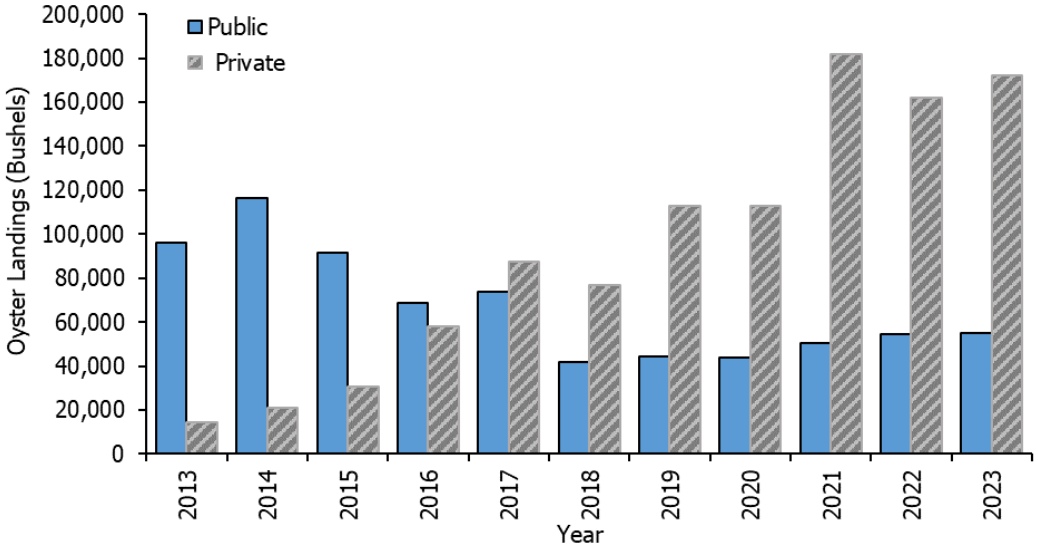

Figure 1. Annual commercial oyster landings (bushels) separated by private (farmed) and public (wild) bottom in North Carolina, 2012–2022 (Source: DMF Trip Ticket Program).

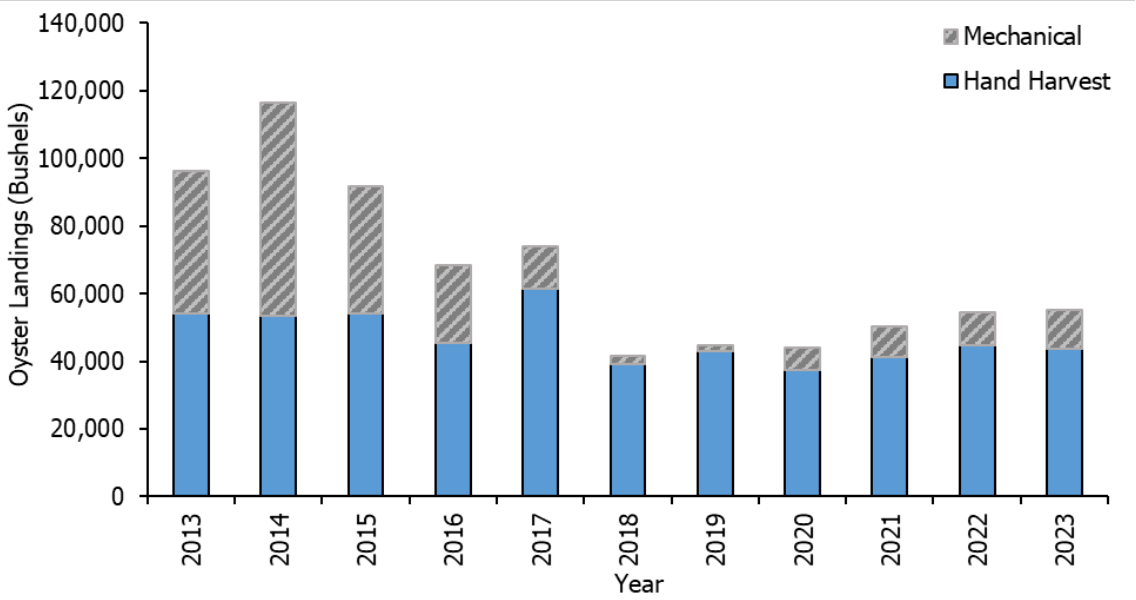

Figure 2. Annual commercial oyster landings (bushels) from public bottom separated by mechanical and hand harvest methods 2011–2021 (Source: DMF Trip Ticket Program).

Mechanical Harvest Fishery Off Public Bottom

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 County area in the 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 County areas resulted in declines in harvest in January and foul weather increased these declines in February. Staff continued to sample, and the Northern Dare County area 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 County 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 outside of Northern Hyde area.

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 County 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 County) 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 five percent following the adoption of Amendment 4. 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 County areas sampled early in the season. Both Pamlico River and Northern Dare County 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 and some areas retained 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 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 (dissolved oxygen < 2-3 mg/L) or anoxic (dissolved oxygen = 0 mg/L) 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 University researchers 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 County areas all showed low numbers of living oysters and were all below the 26% legal size threshold. The initial sampling at Northern Hyde County 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 1 and 2).

In September 2019, a decline in water quality from Hurricane Dorian negatively impacted the already reduced subtidal oyster populations in Pamlico Sound. All mechanical harvest management areas were below the 26% legal management trigger during pre-season sampling in 2019. The percentage of legal oysters in both Neuse River and Dare County management areas was lower in the 2019-2020 pre-season sampling than it was at the close of the 2018-2019 mechanical season, showing the deep-water oyster mortality that occurred in these areas from

the storm event. Following the protocol established in Amendment 4 of the Oyster FMP (NCDMF 2017), the mechanical harvest season was opened on November 18, 2019, and closed on November 29, 2019, for all areas except Northern Hyde County, which closed January 6, 2020. While open to mechanical harvest, the small amount of effort and landings occurred in the shallow water bays where oyster populations were not as significantly reduced by the storm events of 2018-2019 season. Mechanical landings for 2019 were the lowest reported during the last 25 years (Figure 2).

Pre-season sampling in the deep-water areas in both the Neuse and Pamlico management areas showed very low percentages of legal oyster prior to the start of the 2020-2021 mechanical harvest season, and these areas both tripped the management trigger twice and closed to mechanical harvest on December 14, 2020. The bays in the Pamlico Management area maintained relatively high legal percentages for the entire possible six-week season, and harvesters reported harvesting a full limit before noon, even up to the last few days of the possible season. The Northern Dare management area remained above the management trigger threshold for a relatively long time when compared to the previous three oyster seasons and remained open to mechanical harvest until February 14, 2021.

The Northern Hyde and Dare Management areas started the 2021-2022 mechanical harvest season below the management trigger and were closed to mechanical harvest on December 13, 2021, after the management trigger was tripped during first in-season trigger sampling event. Abundance and size of oysters in the deep-water areas of the Neuse and Pamlico River Management areas continued to be very low. Mechanical harvest in these two Management Areas was supported by oysters found in the bays during the six-week season.

The Neuse River, Pamlico River, Northern Hyde, and Northern Dare Management areas were all below 26% legal management trigger during the 2022-2023 pre-season sampling. However, due to no fishery effort occurring at the time of data collection, pre-season sampling did not originally count towards the management trigger at the onset of this sampling program. In 2018, the Director made the decision to count the pre-season data towards the management trigger. This decision was made in response to impacts to the sub-tidal oyster population from hurricane and storm events. For the 2022-23 mechanical oyster season, after several years of recovery post major impact events, the Director made the decision to revert to the original management approach of not including the pre-season sampling data to better align the management trigger with fishery effort.

The Northern Hyde and Northern Dare Management areas started the 2023-2024 mechanical harvest season below the management trigger and closed to mechanical harvest the first week of 2024. Abundance and size of oysters in the deep-water areas of the Neuse and Pamlico River have continued to be very low since 2017. Mechanical harvest in these two Management Areas was supported for the full six-week possible season by high percentages of legal oysters found in the bays.

Hand Harvest Fishery Off Public Bottom

Hand harvest gear accounts for most 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 2). 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 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 bay areas of the Pamlico Sound (NCDMF 2008). Amendment 2 put in place a 15 bushel per day hand/mechanical harvest limit per commercial fishing operation in the 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 the 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 SCFL. 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 MFC in Amendment 4 of the Oyster FMP (NCDMF 2017). 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 1). 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.

Table 1. Classification of shellfish waters in acreage, 2013–2023 (Source: DMF Shellfish Sanitation and Recreational Water Quality Section).

	Open Area		Closed Area		
Year	Approved	Conditionally Approved Open	Conditionally Approved Closed	Restricted	Prohibited
2013	1,733,069	44,649	11,834		429,531
2014	1,733,155	44,261	11,827		429,796
2015*	1,418,373	43,849	11,739		745,169
2016	1,416,960	44,785	12,008		745,597
2017	1,414,709	44,425	12,209		747,759
2018**	1,414,525	44,122	11,859	18,933	729,761
2019	1,415,007	43,216	12,721	20,260	730,550
2020	1,416,683	43,085	9,919	18,117	736,128
2021	1,459,163	42,801	9,917	18,168	736,690
2022	1,415,971	43,309	5,914	6,683	752,266
2023	1,413,846	45,326	5,798	6,463	752,687

* 314,710 acres administratively closed on 2/4/15 due to budget cuts and office closures.
** First year "Restricted" waters were differentiated from "Prohibited" waters.

Hand-harvest oyster landings have generally increased in recent years (Figure 2). Oyster hand harvest south of the Highway 58 Bridge generates a significant amount of the overall oyster landings even though the area only encompasses five percent of the total area open to harvest of shellfish 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 oysters 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 the harvest of shellfish. 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 DMF 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/100 mL [NCMFC Rules 15A NCAC 18A Section .0900 Classification of Shellfish Waters], where MPN denotes "most probable number." The DMF 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 2011 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 1). 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 the harvest of shellfish, 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.

Throughout the North Carolina coast, 2018 was a record year for precipitation, with the landfall of Hurricane Florence contributing greatly to the total rainfall 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 DMF administers the shellfish lease program whereby state residents may apply to lease estuarine bottom and water columns for the commercial production of shellfish. The DMF 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 accounted 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 76% of the total oyster landings in 2023 (Figure 2).

Recreational Fishery

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.

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

Public Bottom Mechanical Harvest Area Oyster Sampling

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 (NCDMF 2017). 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 3). 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

recently deceased oysters (known as "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.

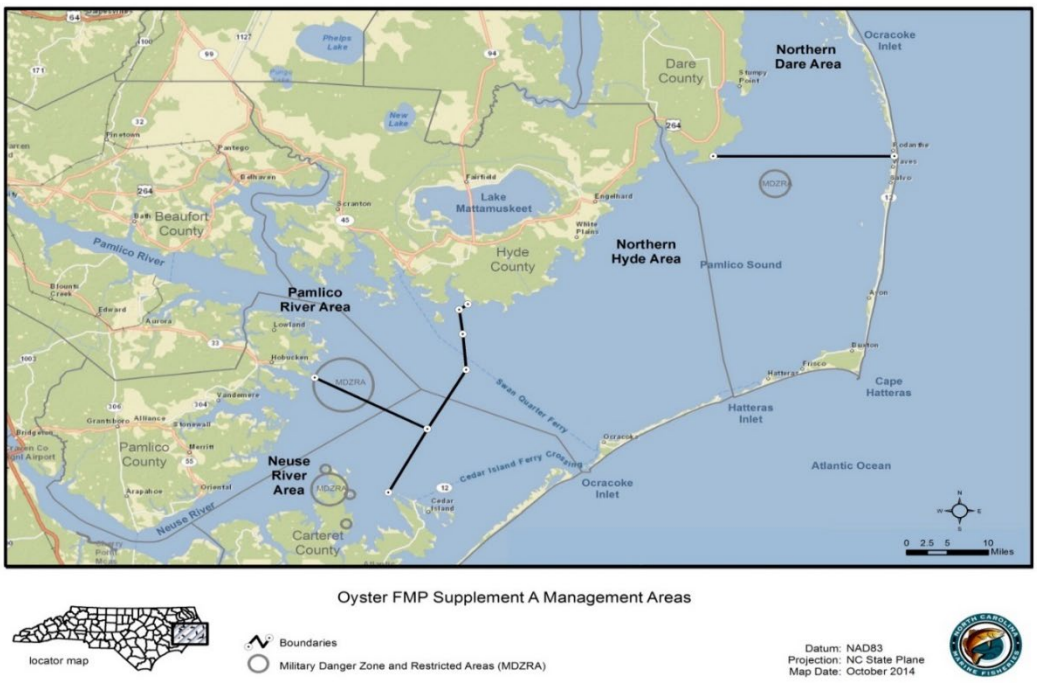

Figure 3. Mechanical harvest management areas from Amendment 4 of the Oyster Fishery Management Plan.

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 DMF 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 (> 3 inches) and undersized (< 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.

Spatfall Evaluation

DMF 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, but overall showing a declining trend for the past 10 years (Figure 4). The 2018 and 2019 indices were the lowest and below the 10-year average (annual average number of spat across all sampling sites; Figure 4). The spatfall evaluation program was discontinued in 2020. Beginning in 2021, new methodology was adopted to better quantify recruitment and abundance of oysters on cultch planting sites.

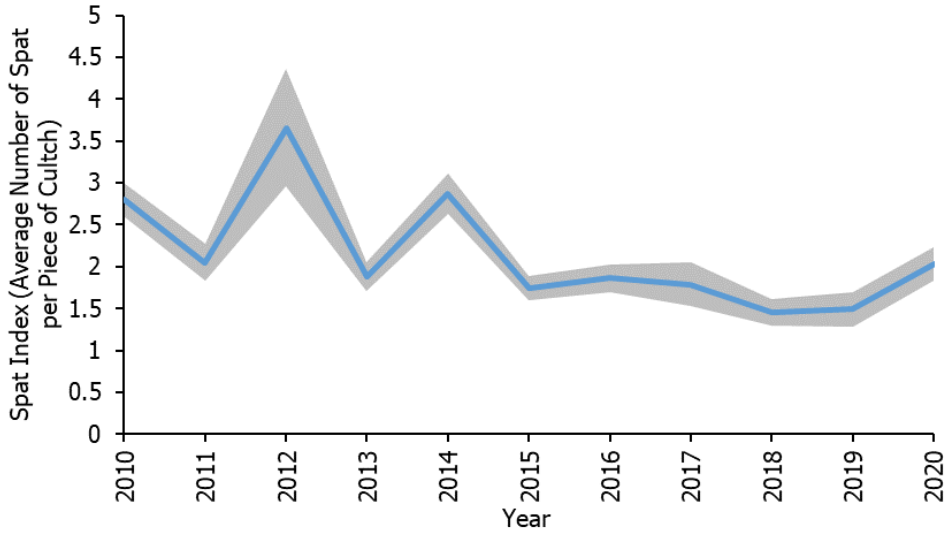

Figure 4. The annual average number of oyster spat across all sampling sites with standard error shaded in gray, 2010–2020 (Source: DMF Habitat and Enhancement Section). Shaded area represents + one standard error. This sampling program was discontinued and replaced with improved methodology in 2021.

HABITAT AND ENHANCEMENT PROGRAMS

To improve and preserve the diverse ecosystem functions provided by oyster reef habitat, and support and maintain the oyster fishery, reef enhancement and restoration is essential component of management in North Carolina. In recognition of this need, DMF's Habitat and Enhancement section coordinates ongoing habitat enhancement activities to improve statewide oyster populations and subsequently enhance the ecosystem services they provide. These efforts began with the Cultch Planting program in 1915 with the goal to rebuild oyster beds on public bottom

by planting shells for substrate, thereby creating state-subsidizing harvest areas for the fishery. Over 21 million bushels of cultch material have been planted in the form of small-scale, low-relief, harvestable oyster reefs. Since the 1980s, over 2,000 cultch sites have been planted throughout North Carolina's coastline, with each area ranging in size from 0.5 to 10 acres. In 1996, the Oyster Sanctuary Program was established to construct large, no-take reserves that support oyster brood stock and supply both wild and cultch planting sites with oyster larvae. As of 2023, over 395 acres are protected across 14 no-take Oyster Sanctuaries.

RESEARCH NEEDS

The specific research recommendations from Amendment 4 to the North Carolina Oyster FMP (NCDMF 2017). The list below outlines the specific needs and highlights the priority and status of each. 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.

High

- Support all proposed implementation actions under the priority habitat issue on sedimentation in the CHPP — Ongoing through the CHPP
- Improve the reliability for estimating recreational shellfish harvest — Ongoing
- Survey commercial shellfish license holders without a record of landings to estimate oyster harvest from this group — Needed
- Develop regional juvenile and adult abundance indices (fisheries-independent) — Pilot study in progress with The Nature Conservancy and N.C. State University)
- Determine alternative substrates for reef development and monitoring of intertidal and subtidal reefs (cost-benefit analysis for reefs and cultch planting) — Ongoing
- Quantify the impact of current fishing practices on oyster habitat suitability in North Carolina —Needed
- Develop a program to monitor oyster reef height, area, and condition — Ongoing
- Estimate longevity and yield of oysters on cultch planting sites — Needed
- Develop methods to monitor abundance of the oyster population — Pilot study in progress with the Nature Conservancy and N.C. State University

Medium

- Complete socioeconomic surveys of recreational oyster harvesters — Needed
- Support collaborative research to track bacterial sources more efficiently for land-based protection and restoration efforts — Ongoing
- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (e.g., docks, bulkhead sections) — Needed
- Develop peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments — Needed

Low

- Continue to complete socioeconomic surveys of commercial oyster fishermen — Needed

- Identify number and size of sanctuaries needed — Ongoing
- Identification of larval settlement cues which influence recruitment to restored reefs (i.e., sound, light, current, etc.) — Ongoing
- Further studies on the effects of dredge weight and size on habitat disturbance and oyster catches — Needed
- Estimate oyster mortality associated with relay — Needed

MANAGEMENT

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

Amendment 4 was adopted in February 2017 and associated rule changes became effective May 1, 2017. The selected management strategies adopted by the MFC in Amendment 4 of the Eastern Oyster FMP can be found in Table 2.

Table 2. Summary of the N.C. Marine Fisheries Commission management strategies and their implementation status for Amendment 4 of the Oyster Fishery Management Plan 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 five percent 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

Management Strategy	Implementation Status
Adopt the provisions of Supplement A – a flexible harvest limit up to 20 bushels, a trigger of 26 percent 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 DMF 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
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

FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS

The division recommends maintaining the current timing of the scheduled review.

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