

APPENDICES

Appendix 2: Pamlico Sound Oyster Mechanical Harvest Management

ISSUE

Addressing management for the mechanical fishery for subtidal oyster stocks in Pamlico Sound North Carolina.

ORIGINATION

The Division of Marine Fisheries.

BACKGROUND

The North Carolina Eastern Oyster Fishery Management Plan Amendment 5 is focused on the management of wild oyster stocks, and this issue paper does not pertain to farm raised or private cultured oysters.

North Carolina's wild oyster stocks are composed of both intertidal (exposed to air during portions of the tidal cycle) and subtidal (continuously submerged) populations. In North Carolina, oyster harvesting through mechanical means is primarily achieved using oyster dredges and is limited to subtidal oyster reefs in specific areas of Pamlico Sound. Although some hand harvest of subtidal oysters does occur, the primary harvest method for oysters in Pamlico Sound has been mechanical gear (Figure 1). While mechanical harvest gear like oyster dredges may offer an efficient means of harvesting oysters, their use requires careful management and consideration of their potential negative impacts on both oyster stocks and habitat.

Currently, large scale abundance estimates and a traditional stock assessment for North Carolina Oysters is not possible. The division is unable to assign a stock status or determine sustainable harvest limits for Pamlico Sound oysters. Oysters pose a unique management problem as they are simultaneously a stock that is harvested as a fishery resource, and the essential habitat for that same fishery resource. Oysters need suitable hard substrate (cultch) for juvenile oyster (spat) to settle on and grow. Shells of living or dead oysters provide the appropriate hard substrate for juvenile oysters to settle on, creating self-sustaining oyster reefs. If living oysters or dead shell material is removed from a reef through fishery effort at a rate faster than it can naturally replenish, both the oyster resource and habitat will eventually disappear. An approach to manage oyster fisheries which considers this balance of shell gain and loss (Shell Budget Model) has been developed and employed in the Gulf of Mexico (Soniati et al. 2022, Soniat 2016).

A key component for Pamlico Sound mechanical oyster harvest management is to balance the value of utilizing oysters as a fishery resource while maintaining their role as an essential habitat for themselves as well as a wide range of estuarine species. To minimize damage to oyster habitat through mechanical harvest, decreases in bushel limits and larger area or seasonal closures implemented via fishery monitoring have been established through time. Dredges are subject to weight and size restrictions and are

required to be towed from the side of the vessel to mitigate habitat impacts by not removing excess cultch material and sub-legal oysters from their areas of origin. To limit excessive effort impacts, mechanical harvest is only allowed from sunrise to 14:00 Monday through Friday. To ensure excess reef material and undersized oysters are not removed from their respective reefs, culling of cultch material and undersized oysters must occur at the harvest location with a 5% culling tolerance. Additionally, extensive cultch planting efforts have occurred in mechanical harvest areas to mitigate harvest impacts to oyster reefs by adding cultch material.

The first oyster harvest limits for the mechanical fishery were introduced in 1947 at 75 bushels per vessel per day, remaining until 1984. From then until 1989, the daily limit was lowered to 50 bushels per vessel. In 1989, the daily limit for commercial operations was capped at 50 bushels per vessel, but with added flexibility for the director to set lower limits as needed. In 1990 the bushel limit was dropped to 20 then further reduced to 15 bushels due to declining populations attributed to Dermo disease. The 2001 Eastern Oyster FMP changed the criteria for where mechanical harvest would be allowed in the bays of Pamlico Sound. The 2008 Amendment 2 to the Oyster FMP outlined a strategy for Pamlico Sound and its tributaries, setting a 15-bushel limit per commercial fishing operation in open waters of the sound, and limiting harvest to a six total possible week season with a 10 bushel per vessel limit in the bays. In 2010, Supplement A to Amendment 2 of the Oyster FMP established the trigger for closing areas to mechanical harvest when sampling indicates the number of legal-sized oysters in the area has declined below the threshold. Additionally, this management strategy was re-adopted into Amendment 4 of the FMP in 2016. Beginning in 2017, the six-week open period for bays was split into two potential open periods. The first begins on the Monday of the week prior to Thanksgiving and runs 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. For more detailed information on the management history of the Pamlico Sound mechanical oyster fishery see the previous Oyster Management Plan, Amendments, and Supplement.

The current mechanical oyster fishery is limited to the subtidal open water regions of Pamlico Sound as well as specified subtidal regions of its surrounding bays. The mechanical harvest season has the potential to occur between the third Monday in November to 31 May in the subtidal, open water areas of Pamlico Sound; however, the actual season length is ultimately determined by a harvest monitoring program. In bays where harvest is allowed, the season is capped to a total of six possible weeks. If the area in which the bay is located is closed due to harvest monitoring the season may be shorter than six weeks. There is a 15 bushel-per-day limit in the deeper portion of Pamlico Sound and a 10 bushel-per-day limit in the bays.

Annual landings from mechanical harvest in North Carolina have significantly declined since 2010. This peak in landings from the 2010-2011 oyster season reflects the highest participation and landings in the mechanical oyster fishery between 1994 and 2021. During the 2010-2011 oyster season, high market demand caused by the closure of harvest areas in the Gulf of Mexico from the Deepwater Horizon oil spill drew a large

amount of effort and participation into the North Carolina mechanical harvest oyster fishery. Landings in this fishery are strongly tied to participation and effort, and declining trends in participation mirror the trend in landings (Figures 1 & 2). Prior to 2012, mechanical harvest of oyster required only a Shellfish Commercial License. This license is not capped to a total amount of participants, unlike the Standard/Retired Commercial Fishing License (SCFL/RSCFL) and is potentially available at a relatively low cost to all residents of the state. The large and rapid increase in effort in the mechanical fishery observed leading up to the 2010-2011 harvest season was primarily driven by new entrants into the fishery obtaining Shellfish licenses. In response to this, a SCFL/RSCFL has been required to participate in this fishery since the 2011-2012 season.

Weather and water quality events have also directly influenced effort and landings in the mechanical oyster fishery. After major hurricanes, low dissolved oxygen events, or extreme temperature events, the oyster resource in the mechanical harvest areas may be impacted, and only sustain harvest for weeks before NCDMF closes areas to mechanical harvest. The actual length of time mechanical harvest for oysters can occur each year in North Carolina is determined by the monitoring program and is variable depending on the status of the oyster resource and fishery effort.

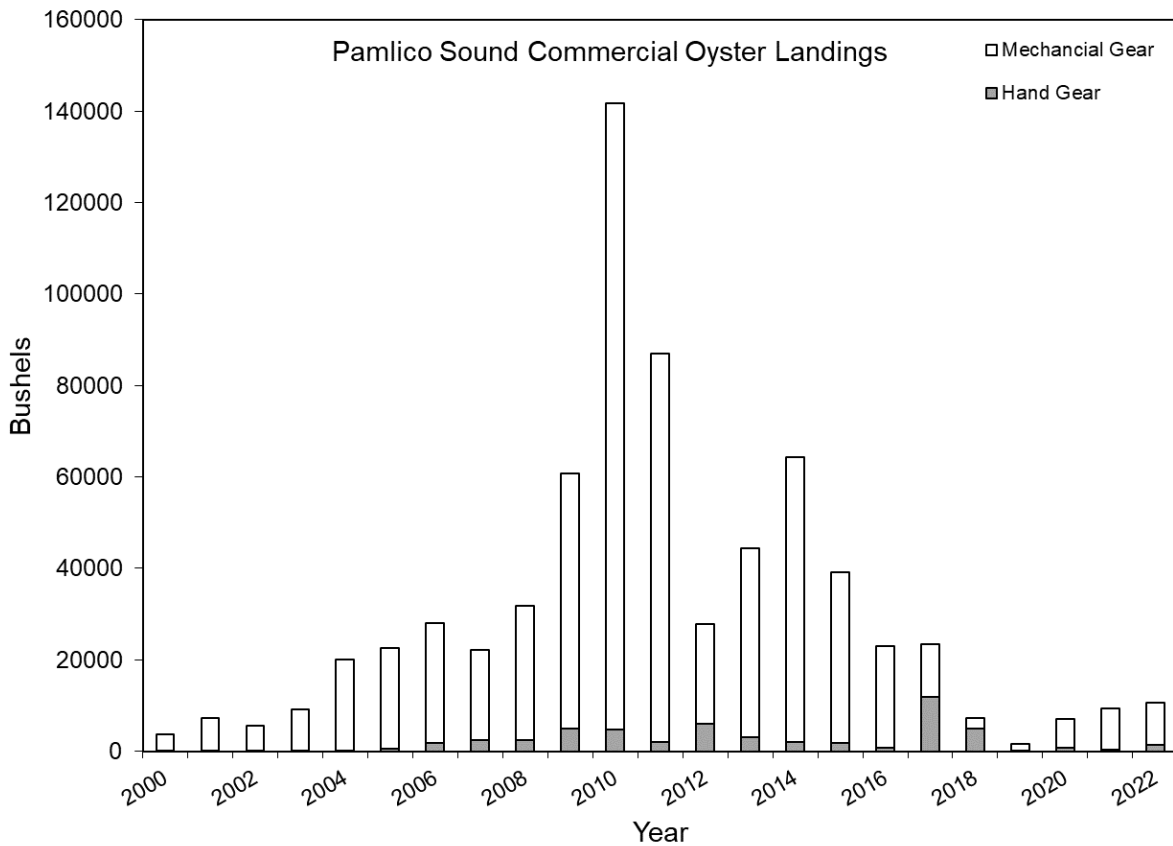


Figure 1. Commercial landings of oysters from Pamlico Sound in North Carolina from 2000 to 2022, showing the total annual landings (entire bar height) and the

proportion of landings contributed by hand gear (rakes, tongs, hand) as dark gray, and proportion from mechanical gear (dredges) as white.

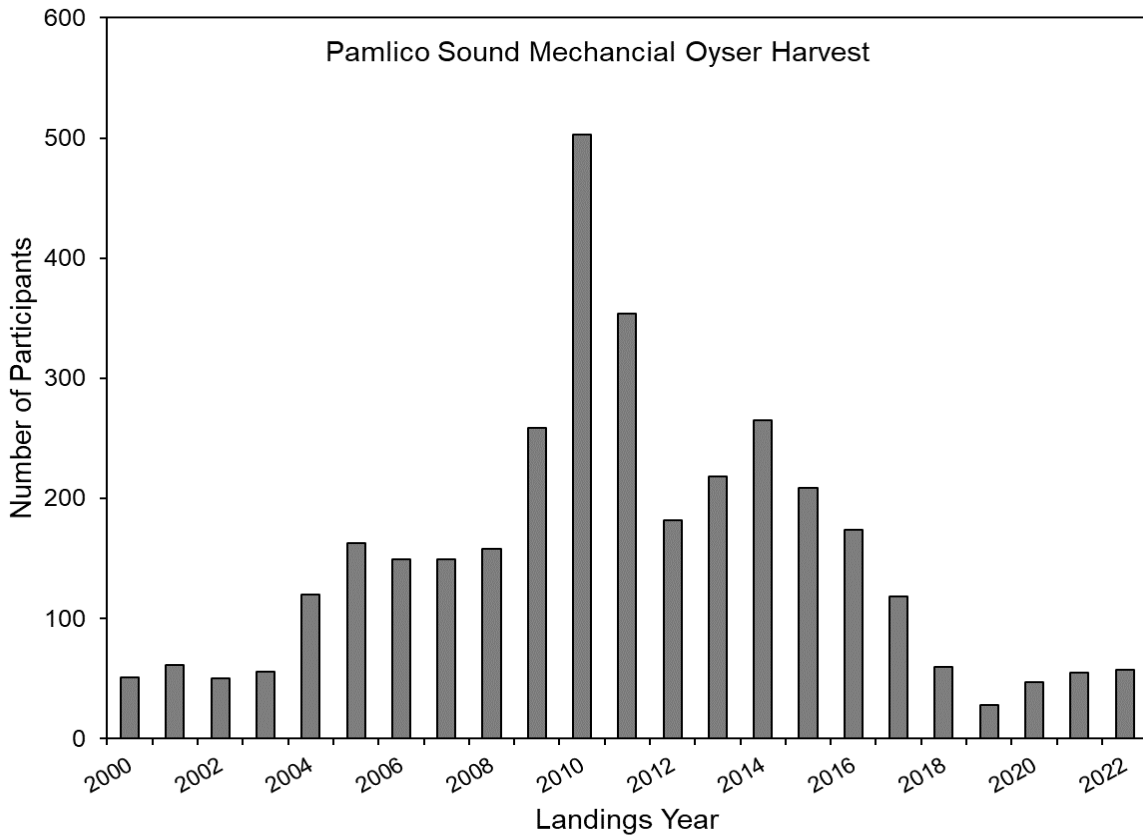


Figure 2. Annual number of participants with landings of oyster using mechanical gear in Pamlico Sound.

The current harvest monitoring program serves as a habitat protection framework to manage fishery effort in the Pamlico Sound mechanical oyster fishery and has been in place since 2010. The Sound is divided into four Management Areas based on geographic region: the Neuse River Area, Pamlico River Area, Northern Hyde Area, and Northern Dare Area (Figure 3). The division samples oyster reefs in each management area once before the opening of the mechanical harvest season, and then biweekly once mechanical harvest is open. Sampling sites are chosen based on the current (or previously known) presence of commercial harvesting in the area. Areas are selected where commercial harvest occurs with the goal of assessing localized depletions and addressing habitat protection concerns. A threshold of 26% legal-size live oysters (3" shell length or greater) in pooled samples for each sampling event and Management Area was established as the management trigger. In the development of this management framework, the effect of the effort required to harvest a limit of legal oysters on reef habitat was considered. When an area oyster population reaches 26% or lower legal oysters, it was determined that the impacts to reef habitat through the removal of shell material outweighed the fishery benefit from harvest. If the pooled samples collected across a management area for a sampling event show 26% or less legal oysters, the management trigger is tripped for that area. If two consecutive sampling events result in the

management trigger being tripped, the entire management area is closed to mechanical harvest. An area may re-open if two additional consecutive sampling events show above 26% legal oysters. There is no minimum threshold of percent legal for the initial opening of an area to mechanical harvest, and a management area will open even sampling before the season shows an area is below the 26% legal. Biweekly sampling beginning during the first week of the mechanical harvest season results in areas starting below 26% legal taking three weeks to trip the management trigger to close.



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 3. Pamlico Sound Mechanical Oyster Harvest Management Areas from south to north: the Neuse River Area, Pamlico River Area, Northern Hyde Area, and Northern Dare Area

Oyster mortality from Hurricane Irene in 2011 and a low dissolved oxygen event in 2012 resulted in the 2012-2013 mechanical harvest season being closed by the management trigger months shorter than in previous seasons. In 2018, Hurricane Florence caused significant damage to the Pamlico Sound oyster resource, and Hurricane Dorian in 2019 further impacted oysters in Western Pamlico Sound. Since these storm events, the mechanical harvest trigger has taken on average three weeks into the mechanical harvest season to be tripped across all management areas over five years (Table 1). As the oyster resource recovered, mechanical harvest closures have occurred later in the potential season for the Neuse and Pamlico Management Areas in recent years. The longer time

taken to trip the management trigger in Neuse and Pamlico areas is driven by higher populations of oyster in the 10 bushel-per-day bays, which are capped at a six-week total possible season. While the deep-water regions and bays of a Management Area are not treated separately for the calculation of the management trigger, the deep-water reefs which were sampled in the Pamlico and Neuse Areas, were found to have very few legal sized oysters during harvest monitoring in recent years. When the bays are examined separately, they have averaged above the management trigger (Table 2).

Table 1. The number of open weeks into the mechanical harvest season before the 26% legal management trigger tripped for each Mechanical Harvest Management Area by oyster season years.

	2019-20	2020-21	2021-22	2022-23	2023-24
Dare Management Area	1	10	3	3	2
Hyde Management Area	4	1	3	3	3
Pamlico Management Area	1	2	6	6	6
Neuse Management Area	1	1	6	6	6

Table 2. Percentage of legal sized (3" shell length or greater) live oysters sampled during the first harvest monitoring program sampling event each year for Pamlico and Neuse Management Areas by deep-water areas and bays.

	2019-20	2020-21	2021-22	2022-23	2023-24
Pamlico Management Area Deep	13%	0%	0%	0%	0%
Pamlico Management Area Bays	44%	45%	49%	18%	41%
Neuse Management Area Deep	0%	0%	0%	0%	0%
Neuse Management Area Bays	8%	26%	33%	28%	39%

NCDMF has one of the longest running and expansive oyster restoration and enhancement programs in the United States. North Carolina's Cultch Planting Program began in 1915 to replace shell material which was removed by harvest. Since its inception, over 21 million bushels of cultch material have been planted in the form of small-scale, low-relief, harvestable oyster reefs. Today, the NCDMF Cultch Planting Program creates oyster reefs which provide both habitat restoration and alleviation of public harvest pressure from natural reefs. Over the last ten years, 624 acres of harvestable oyster reefs have been created on public bottom through this program, with the ongoing goal of creating an additional 50 acres per year into the future. In addition, over 563 acres of protected oyster reef have been permitted and constructed across 15 separate no-take Oyster Sanctuaries in Pamlico sound. For more detailed information about these two programs see Appendix 4: Habitat Enhancement Programs. In areas open to mechanical harvest, cultch planting efforts have been focused primarily in the bays of the Neuse and Pamlico areas as well as in the eastern portion of the sound in Dare and Hyde areas (Figure 4). Between 2000 and 2022, a total of 2,167,638 bushels

of cultch material were planted in the mechanical harvest areas of Pamlico sound, and 452,112 bushels of oyster were mechanically harvested. This resulted in 4.8 times more bushels of cultch being planted than oysters were mechanically harvested over this time. Since 2018, 36 times more bushels of cultch have been planted compared to bushels of oysters commercially harvested and removed (Figure 5). The return in commercial harvest per unit of cultch planted in North Carolina remains unknown and likely varies across different planting sites. The impact of cultch plantings on oyster landings isn't immediate, as it typically takes between one and three years after planting for new cultch material to yield legal-sized oysters. While some cultch planting sites have relatively short lifespans, others have been observed to continue yielding harvests for decades. The current management of the harvest of oysters in North Carolina does not distinguish between division constructed cultch planted reefs and wild naturally occurring reefs.

Pamlico Sound Cultch Planting Sites

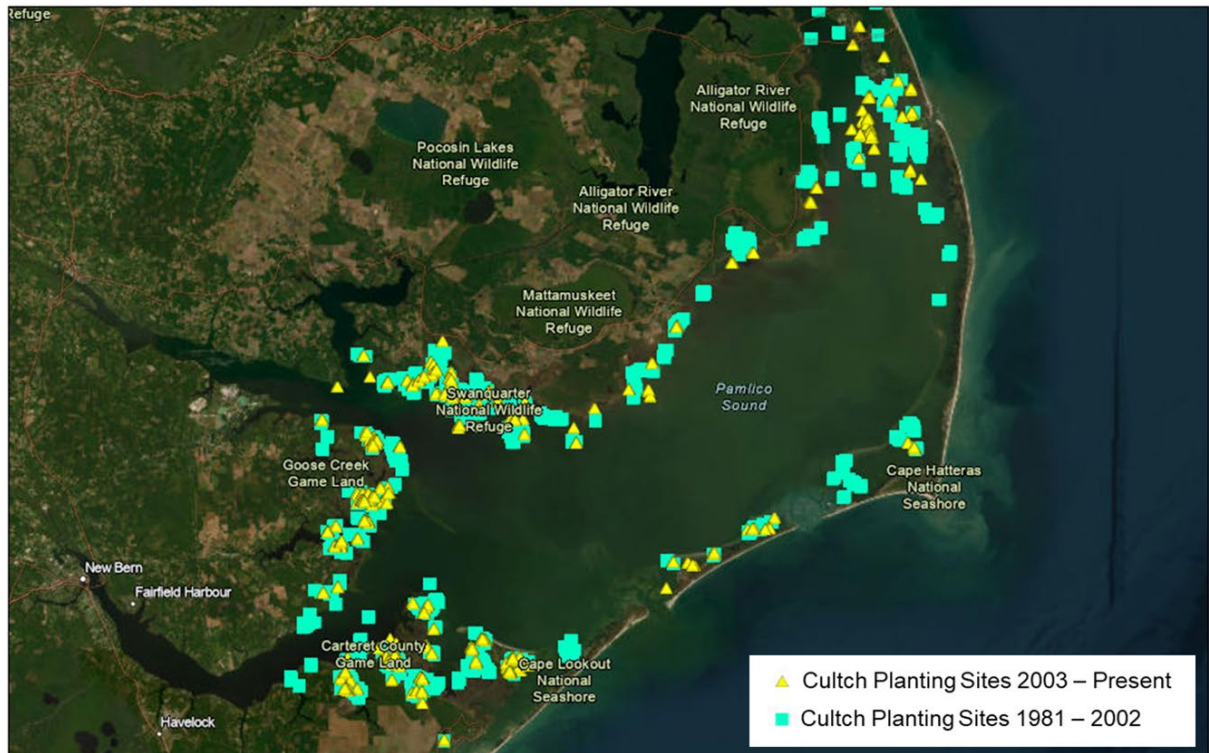


Figure 4. A map showing cultch planted reefs in Pamlico Sound 1981 to present.

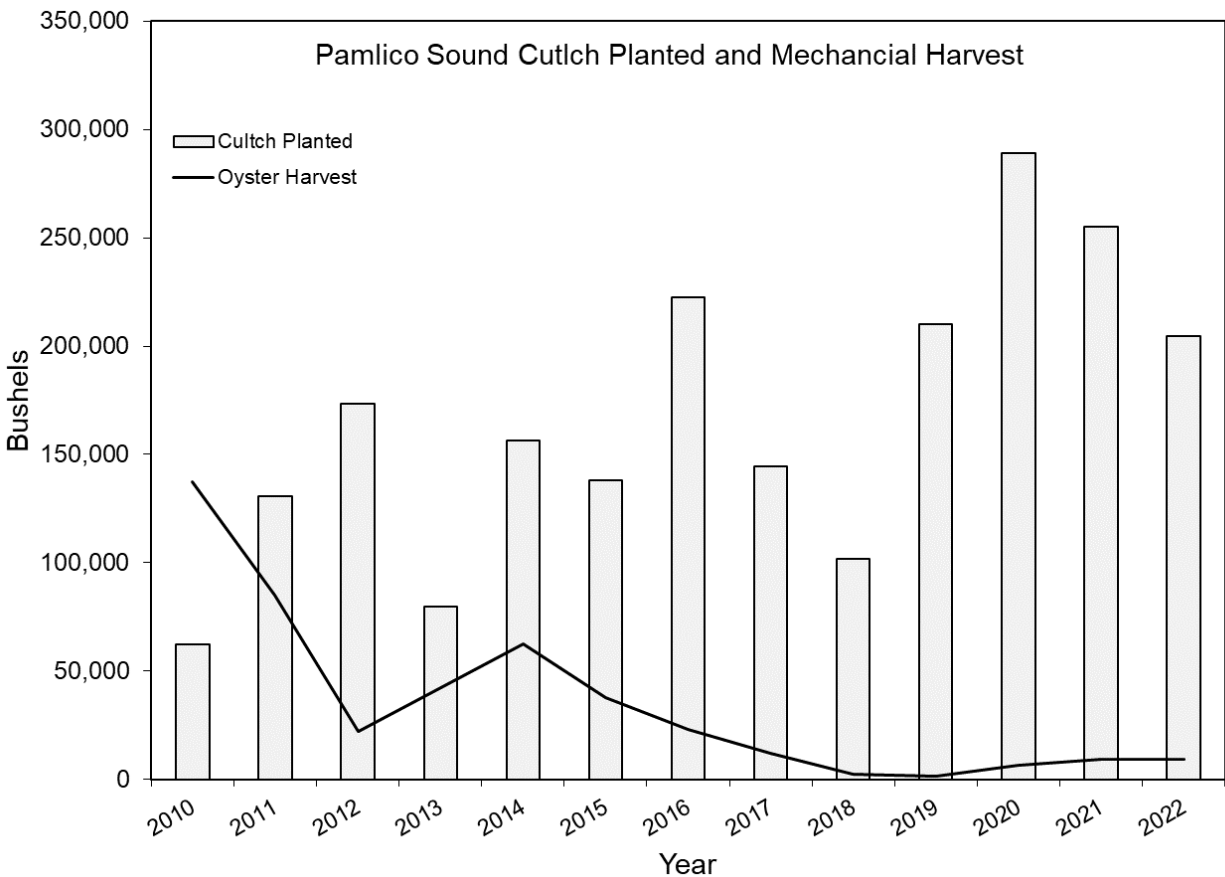


Figure 5. Annual amounts of cultch planted (shown as light grey bars) and amount of oyster mechanically harvested (shown as black line) in bushels for the mechanical harvest areas of Pamlico Sound.

AUTHORITY

N.C. General Statutes

113-134 Rules.

113-182 Regulation of fishing and fisheries.

113-182.1 Fishery Management Plans

113-201 Legislative findings and declaration of policy; authority of Marine Fisheries Commission.

113-221.1 Proclamation; emergency review.

143B-289.52 Marine Fisheries Commission – powers and duties.

N.C. Marine Fisheries Commission Rules (15A NCAC)

03K .0201 Oyster Harvest Management

DISCUSSION

The existing mechanical harvest management strategy for oysters in Pamlico Sound aims to monitor in real time the habitat conditions of oyster reefs where mechanical harvest is actively occurring, and then close broad management areas once the condition of the oyster resource reaches a point where the effort required to harvest legal oysters causes excessive damage to the reef habitat. When this management strategy was developed and adopted, participation in this fishery was approximately five times greater than participation has been in recent years. This drop in participation has often made it problematic for division staff to find areas where there is active fishing activity to sample, particularly with the bays of the Neuse and Pamlico Areas. When active mechanical harvest areas are not encountered by staff, knowledge of past harvesting areas or localized areas of current oyster abundance are chosen for trigger sampling locations using their best judgment. Additionally, during pre-season sampling events, or when areas are either closed due to the management trigger being tripped or the break in the 6-week season for the bays and there is no mechanical harvest occurring, staff are again required to make judgment call decisions on where to sample. Given the sometimes-varying conditions between oyster reefs in the region, mechanical harvesters may view sampling locations selected by the division as not representative of areas they fish.

While the potential mechanical harvest season for oyster could run from November through March, the actual length that each mechanical harvest is allowed in each Management Area is ultimately dictated by results of the trigger sampling and opened or closed via proclamation. With fluctuations in the oyster resource often impacted by storm events, the season length for a given area may vary widely between years. If sampling indicated that the management trigger has tripped, a proclamation is issued closing that area effective no sooner than 72 hours from issuance. After the impacts from multiple hurricanes, the mechanical harvest season in the Pamlico and Neuse Management Areas was only open to mechanical harvest for 10 days in the 2019-2020 season, yet in the 2021-2022 season it was open eight weeks. At the opening of each mechanical harvest season, harvesters are unaware of how long each area will be open and rely on monitoring proclamations for closures. This uncertainty and variability in season length is often viewed unfavorably by harvesters.

The current management trigger uses the percentage of live legal sized oyster as a metric to determine fishery effort impact on oyster reef habitat. While this has been a proactive approach to close mechanical harvest at a point which ensures cultch material and live oysters remain on reefs, it does not consider oyster abundance when triggering area openings or closures. If an area that was being sampled had very few (low oyster abundance) but very large (high percent legal) oysters, the management trigger would not be tripped and remain open to harvest. However, with such a low abundance of oysters, this area may be vulnerable to overharvesting, and damage to the habitat from the effort required to harvest would be high. Conversely, if an area has a healthy and abundant mature oyster population which is experiencing a period of high recruitment (heavy spat set), the relatively high number of spat counted in the live oyster sample would drive down the percentage of legal live oysters and trip the management trigger. The trigger sampling program is designed to monitor impacts from the mechanical fishery

as a habitat protection measure and does not currently allow for the estimation of oyster population or abundance.

The Neuse, Pamlico, and Hyde management areas all contain bays which are capped at a total possible 6-week season and are limited to 10 bushels per vessel a day. The condition of the oyster resource in the bays is often significantly different than what is found in the deep open water areas of the management area. The bays and deep portions of the management areas are not considered separately during calculation of the management trigger, or during management area closures from the results of trigger sampling. In recent years the Pamlico and Neuse River area bays have had oyster resources to sustain the full 6-week possible season in the bays, while there have been few legal oysters found in the deeper areas. The entire management area remained open due to the greater abundance of legal oysters in the bays, leaving the deeper portions of the management area vulnerable to damage from potential dredge effort. The deep-water reefs and shallow reefs in the bays likely were impacted differently from storm events, with oysters in the bays not suffering the mass mortality observed in those found in the deeper portions of western Pamlico Sound (Table 2).

Historically these deep-water reefs of western Pamlico Sound were reported to reach up to 4 m in height. In the Neuse River, high relief deep water oyster reefs were shown to suffer mass mortality at depths greater than 6 meters due to low oxygen, while low relief reefs between 3 and 4 meters in depth did not experience these die offs (Lenihan and Peterson 1998). The historical mounded structure of reefs in Pamlico Sound provided increased habitat complexity for a wide variety of invertebrates and fish and the upper portion of the mounds provided refuge for benthic organisms when lower portions of the reef were hypoxic. Research has shown that oysters at the base of subtidal reefs have a greater proportion of oyster mortality, significantly lower abundance of organisms, and higher incidence of disease occurrence, compared to the crest of reefs (Lenihan and Peterson 1998; Lenihan et al 1999). The survival and recovery of deep-water oyster reefs is contingent on their ability to gain vertical height.

In Pamlico Sound, changes in the abundance of historic oyster reefs since the 1880s were documented by Ballance (2004). Using new technologies to locate subtidal reefs reported by Winslow (1889), Ballance (2004) found many formerly productive high-profile reefs now consisted of low-profile shell rubble, low density reefs, or buried reefs. Ballance (2004) also found that the larger shallow reefs had less live oysters, which he attributed to the ease of locating those reefs by fishermen. Similarly, Lenihan and Peterson (1998) resurveyed natural oyster reefs in the deeper (>5 meters depth) portions of the Neuse River Estuary that had been marked in an 1868 US Coast and Geodetic Survey, finding that reefs that were 1.8 to 2.4 meters tall in 1868 were only 0.3 to 0.9 meters tall in 1993, and that no reefs in the 1993 survey were taller than 1.2 meters. Lenihan and Peterson (1998) reported that it was “probable that reduction in reef heights in the Neuse River estuary is due to decades of fishery-related disturbances caused by oyster dredging” and suggested that reefs in heavily fished waters in NC would need to be restored every 3-4 years.

The NCDMF oyster restoration and enhancement program has focused significant effort into creating cultch reefs in areas open to mechanical oyster harvest in Pamlico Sound, with the volume of cultch material planted into the sound greatly exceeding the volume of oysters commercially harvested. Cultch plantings form low relief harvestable reefs and are not planted over areas of existing oyster reefs. No cultch planting or oyster restoration has been documented in the deeper portions of the sound to restore the historic high-relief reefs found at the mouth of the Pamlico and Neuse Rivers. The division's cultch planting efforts have been focused in the bays surrounding the western sound and the area between Stumpy Point and Oregon Inlet and have likely supported a significant portion of the fishery effort. While landings from cultch planted reefs are not currently separated in Trip Ticket landings from wild reefs, division sampling and harvester feedback indicates cultch reefs are used for harvest areas. Since 2018, 36 times more bushels of cultch have been planted compared to bushels of oysters commercially harvested and removed. Given this large disparity and the distribution of cultch planting sites in Pamlico Sound, the current harvest management approach, which does not differentiate between cultch and wild reefs, is not best using the cultch planting program.

To continue to maintain harvestable oyster populations in Pamlico Sound, and to better balance the value of oysters as both a fishery resource and essential habitat, a three-tiered approach is proposed for the Pamlico Sound oyster mechanical harvest management:

- Deep-Water Reef Conservation Areas
- Cultch Supported Managed Harvest Areas
- Open Harvest Rotational Cultch Sites

Deep-Water Reef Conservation Areas

The remnant deep water natural oyster reefs in the Pamlico River and Neuse River have suffered mass mortality from water quality impacts. These reefs have likely not supported much fishery effort since 2018 and have had very few live or legal oysters sampled during division monitoring efforts. Additionally, no cultch planting effort is occurring in these areas. To allow these reefs to accumulate shell material to gain the height necessary to be resilient to storm events, mechanical harvest would not be opened for these areas. For ease of enforcement the proposed Deep Water Reef Conservation areas could potentially be the 15 bushel per day areas in the current Neuse and Pamlico Management Areas (Figures 6 & 7). Deep areas outside of the bays contain very little past cultch planting effort. Any recent cultch planting sites in these areas will be addressed by the large open rotational cultch site strategy. Alternatively, discrete Deep Water Reef Conservation Areas can be created in the Pamlico and Neuse rivers to target potential remnant deep-water reefs and avoid past cultch planting efforts (Figures 8 & 9). Deep Water Reef Conservation areas would prioritize the habitat value of these oyster reefs over the potential fishery resource they could provide.

Cultch Supported Managed Harvest Areas

Significant cultch planting effort has gone into creating harvestable reefs, and replenishing cultch material lost in areas open to mechanical harvest in Pamlico Sound. Some of these reefs may be over 40 years old and still produce harvestable oysters. Over time, extensive cultch planting initiatives have blurred the distinction between 'natural' reefs and those that have been created by the division. Proposed Cultch Supported Managed Harvest Areas include the portions of the Neuse and Pamlico areas not designated as Deep-Water Reef Conservation Areas, and the entire Northern Dare and Northern Hyde Management Areas (Figures 6 – 9). Cultch planting effort will continue in these areas as long as the cultch planting program remains funded and operational. Cultch Supported Managed Harvest Areas will be subject to the previously established bushel limits (15-bushel open water, 10-bushel bays) (Figures 10 & 11) and the bays will continue to be capped to a total 6-week possible season. The primary change from previous management is that season lengths will be predetermined and based on division pre-season sampling of the oyster resource in these areas. This will eliminate the unpredictability experienced by harvesters of how long mechanical harvest will occur in given season. However, by eliminating active monitoring and creating fixed season lengths, areas will not re-open if oyster condition improves through the season.

Past trigger sampling data can be used to examine the relationship between conditions of the oyster resource during pre-season sampling and how many weeks of mechanical harvest occurred prior to sampling reaching the management trigger of having two consecutive sampling events below 26% legal. Harvest rates are driven by effort in the fishery, and steep declines have been observed since the implementation of the trigger sampling program in 2010. Effort after the 2016-17 season has stabilized at a relatively low level, and data from that point forward can be considered reasonably representative of the current mechanical fishery. Any significant changes in effort and or participation in the future would require adaptive management to potentially address.

Using trigger sampling program data from the oyster mechanical harvest seasons between November 2017 and May 2023, the pre-season condition (percent legal oyster) of each Management Area was compared to the number of weeks into the season it took for the management trigger to trip and close mechanical harvest in that area (Figure 12). This relationship was used to assign potential season lengths for starting conditions by Management Area. Two options for determining fixed season lengths based on trigger sampling program data have been developed. Option one uses pre-season sampling condition annually by Management Area and considers how many weeks into the mechanical harvest season it took for areas to be sampled one time at 26% legal or less (Table 3). This option takes a conservative approach using one sampling event at 26% to determine season closure and sets a minimum threshold for opening at 15% legal. Option two uses pre-season sampling data which the two samples with the lowest percent legal oyster per management area are dropped before calculating overall condition and compares it to how long it took for two consecutive sampling events to be at 26% legal or less (current trigger to close a management area) (Table 4). Dropping the sites in poorest

condition, which may have not been used by harvesters, prevents them from impacting the overall area condition. However, the typical difference when these sites were dropped was an increase of less than five percentage points. A 10% minimum threshold is set for opening in option 2. Proposed season lengths in both options for the Pamlico and Neuse areas reflect that the primary location for mechanical oyster harvesting occurs in the 10 bushel per-day bays which are capped to a six-week possible season.

Table 3. Proposed weeks of oyster mechanical harvest for management areas by results of pre-season sampling, option 1. These season lengths

Starting Condition	Weeks of Mechanical Harvest Season	
	Pamlico and Neuse Areas	Hyde and Dare Areas
<15%	0	0
15-19%	1	1
20-24%	2	2
25-29%	3	3
30-34%	4	4
35-39%	5	5
40-44%	6	6
45-49%	6	10
50-54%	6	14
55-59%	6	16
>60%	6	18

Table 4. Proposed weeks of oyster mechanical harvest for management areas by results of pre-season sampling, option 2.

Starting Condition	Weeks of Mechanical Harvest Season	
	Pamlico and Neuse Areas	Hyde and Dare Areas
>10%	0	0
10-14%	2	2
15-19%	3	3
20-24%	4	4
25-29%	5	5
30-34%	6	6
35-39%	6	8
40-44%	6	10
45-49%	6	13
50-54%	6	16
>55%	6	18

Proposed season lengths under option one underestimate the actual time it took to reach 26% legal during trigger sampling by an average of 5 days across the entire period examined (Figure 13). Season lengths under proposed option two underestimated the actual time it took to have two consecutive sampling trips at 26% or below and trip the current management trigger two times by an average of 1.75 days across the entire period (Figure 13). Proposed season lengths under both options have a minimum threshold for opening. Proposed season lengths in option one would have resulted in openings not occurring six times, and option two would have resulted in openings not occurring two times when they did under current management between 2017 and 2023.

Pre-season sampling would occur prior to the mechanical harvest season for all four management areas. At least ten sites would be sampled per management area (with potentially more if resources allowed). As in the previous trigger sampling, the percentage of legal live oysters for each management area would be calculated for samples pooled for each management area. The bottom 20% of sites sampled with the lowest percent legal for each management area would be dropped from calculating the pre-season percentages. This would prevent errant sites with poor oyster resources which would likely not be fished by mechanical harvesters from impacting potential season length.

Once pre-season sampling occurred the season length for each management area would be determined by using Table 3 or 4 to see the corresponding number of weeks for the pre-season conditions present in each area. Any areas in the 10-bushel bays would continue to follow the split open period of the 6-week possible season (the first opening on Monday of the week prior to Thanksgiving through the Friday after Thanksgiving, and the second opening on the Monday two weeks before Christmas) as adopted in Amendment 4 of the Oyster FMP.

To better sample mechanical harvest areas which fishers actively oyster or plan to oyster, the division will create an industry-based survey to inform sampling locations. This would allow fishers the opportunity to direct division staff to pre-season sampling locations which would be used to determine the season length. Harvesters would have the opportunity via an online form or physical mail-in paper to report sites which they feel are productive and likely areas to be fished in the upcoming season. Currently the Cultch Planting Program mails out an annual survey to commercial license holders who have had any oyster landings over the past three years, to solicit feedback and input on cultch planting locations. Additional information and directions on how to provide site information will be provided regarding mechanical harvest management in Pamlico Sound. Participation from the industry will be critical. The division will use input provided to inform pre-season sampling locations. Without input from mechanical harvesters, the division will rely on knowledge of prior fishing activity and known locations of oyster resources. However, without industry input pre-season sampling locations may not be representative of potential in-season harvest locations.

Cultch Supported Managed Harvest Areas place equal value on the fishery and habitat value of oysters in these areas. The amount of cultch material planted in these areas has exceeded the amount of oyster harvested since 2010, and many of these plantings have formed oyster reefs which have persisted for decades. Given the long history of cultch

planting in North Carolina, many older cultch plantings in Pamlico Sound are considered “naturalized” and may be hard to distinguish from wild reefs. The purpose of setting season lengths in these areas is to protect oyster habitat from excessive damage caused by harvest, and to maintain substrate for juvenile oysters to recruit to. The cultch planting program will continue to supplement oyster populations in these areas by providing hard substrate.

Open Harvest Rotational Cultch Sites

The Cultch Planting Program has implemented a reef building strategy in Pamlico Sound to create large 10-acre cultch planting sites in areas open to mechanical harvest, with the goal of having at least 16 sites planted by 2026. These sites are distributed across the sound with four planned for each management area (Figures 8-11). As of 2024 there have been 10 of these large sites constructed. To better take advantage of the Cultch Planting Program, a new fishery management approach is proposed for these large cultch sites. Currently, cultch sites are available to harvest from as soon as they are planted. Typically, it takes three years for a new cultch site to produce legal oysters, and when fishing first occurs on these sites is ultimately left to the harvesters. The proposed management strategy for a Large Open Harvest Rotational Cultch Site is to not allow harvest to occur for three years post-construction, and then open to harvest on the fourth year. After one season of harvest, the site would then be closed to harvest for the following 3 years. Immediately after the harvest season, a site which was harvested would be evaluated by the division and replenished with additional cultch material as needed during annual cultch planting activities. The site would open and close via proclamation on a four-year rotational schedule. With at least 16 sites constructed, there would be at least one large rotational cultch site open per management area each season. Large Open Harvest Rotational Cultch Sites would not be subject to the season lengths set for Cultch Supported Managed Harvest Areas. The open large sites in a management area would open to mechanical harvest on the third Monday of November, and close on May 31st. Rotational Cultch Sites would be limited to 15 bushels per day per vessel. This strategy focuses on the fishery value of these reefs and gives harvesters relatively open access to these cultch plantings.

Without a stock assessment or metrics of abundance for oysters in Pamlico Sound, management focused on protecting oyster habitat and cultch planting to restore hard substrate will ensure ongoing populations of harvestable oyster. The proposed three tier approach seeks to balance the habitat and fishery values of oysters in Pamlico Sound. Deep-Water Reef Conservation Areas identify and protect reefs where continued shell loss will prevent remnant natural reefs from recovering. The habitat value of these areas is prioritized over their potential function as a harvestable fishery resource. Cultch Supported Managed Harvest Areas aim to allow harvest but prevent damage to oyster habitat through excessive removal of cultch material. Effort is limited by setting season lengths by management area according to conditions of the oyster resource. Additionally, cultch planting in these areas helps mitigate substrate loss via oyster harvest. Open Harvest Rotational Cultch Sites are constructed with the goal of supporting the mechanical harvest oyster fishery. The fishery value of these sites is prioritized. Sites will

be evaluated at the end of the harvest season and replenished with cultch before being allowed to re-grow harvestable sized oysters. The division will modify sampling and data collection protocols to better incorporate abundance indices into future management to be addressed in a subsequent fishery management plan.

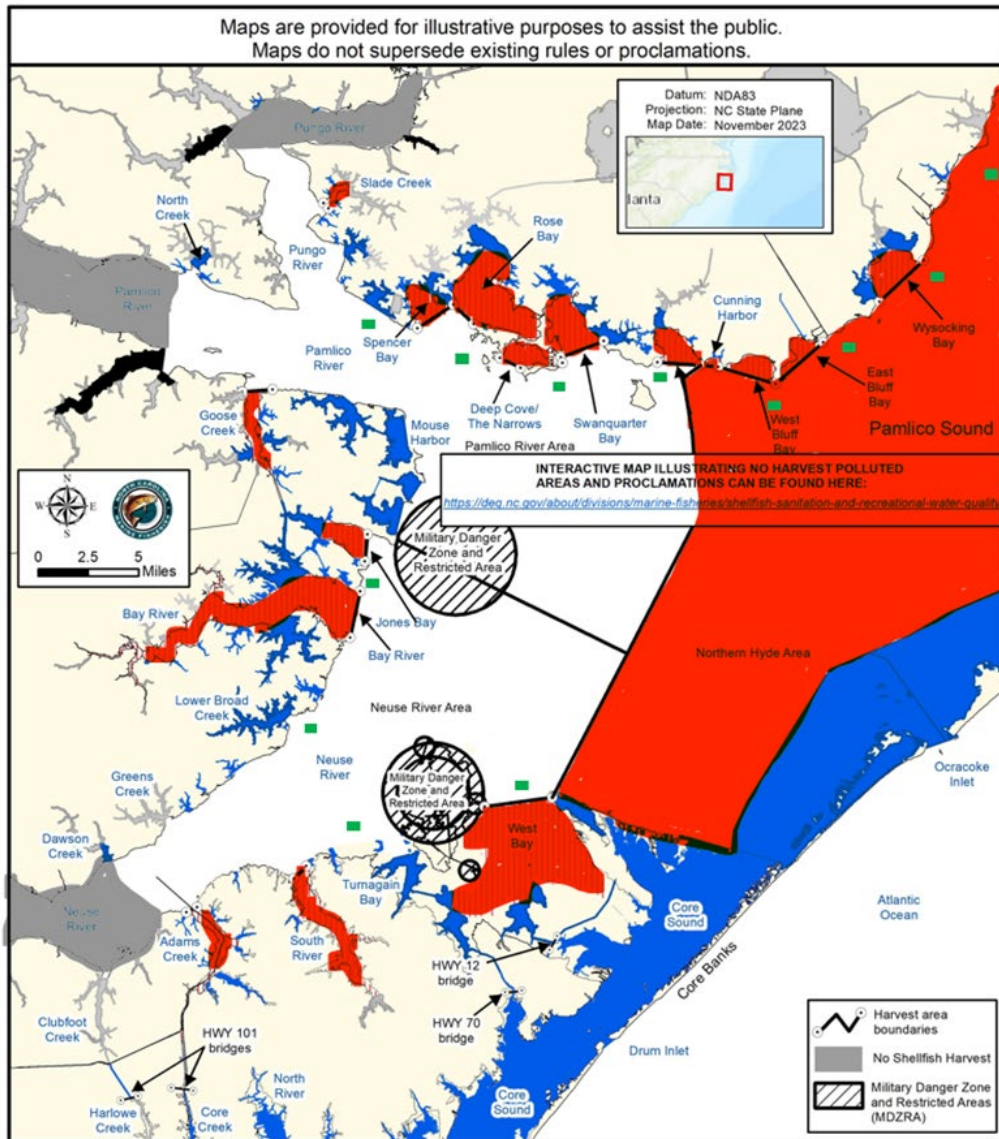


Figure 6. A map illustrating potential boundaries for proposed management approaches in western Pamlico Sound. Locations of Open Harvest Rotational

Management Areas are for illustrative purposes, and actual locations are determined via the public cultch planting site selection process.

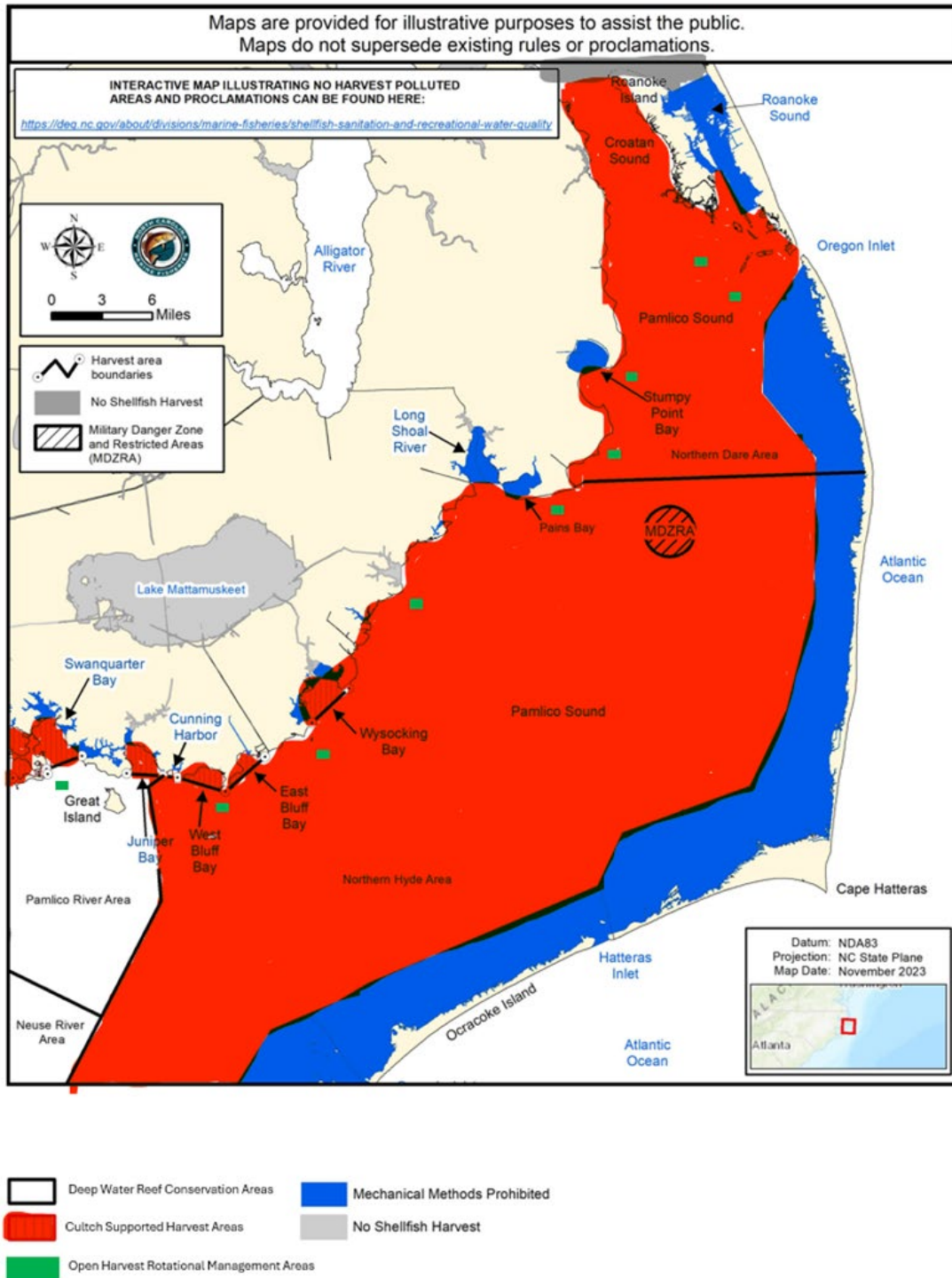


Figure 7. A map illustrating potential boundaries for proposed management approaches in eastern Pamlico Sound. Locations of Open Harvest Rotational

Management Areas are for illustrative purposes, and actual locations are determined via the public cultch planting site selection process.

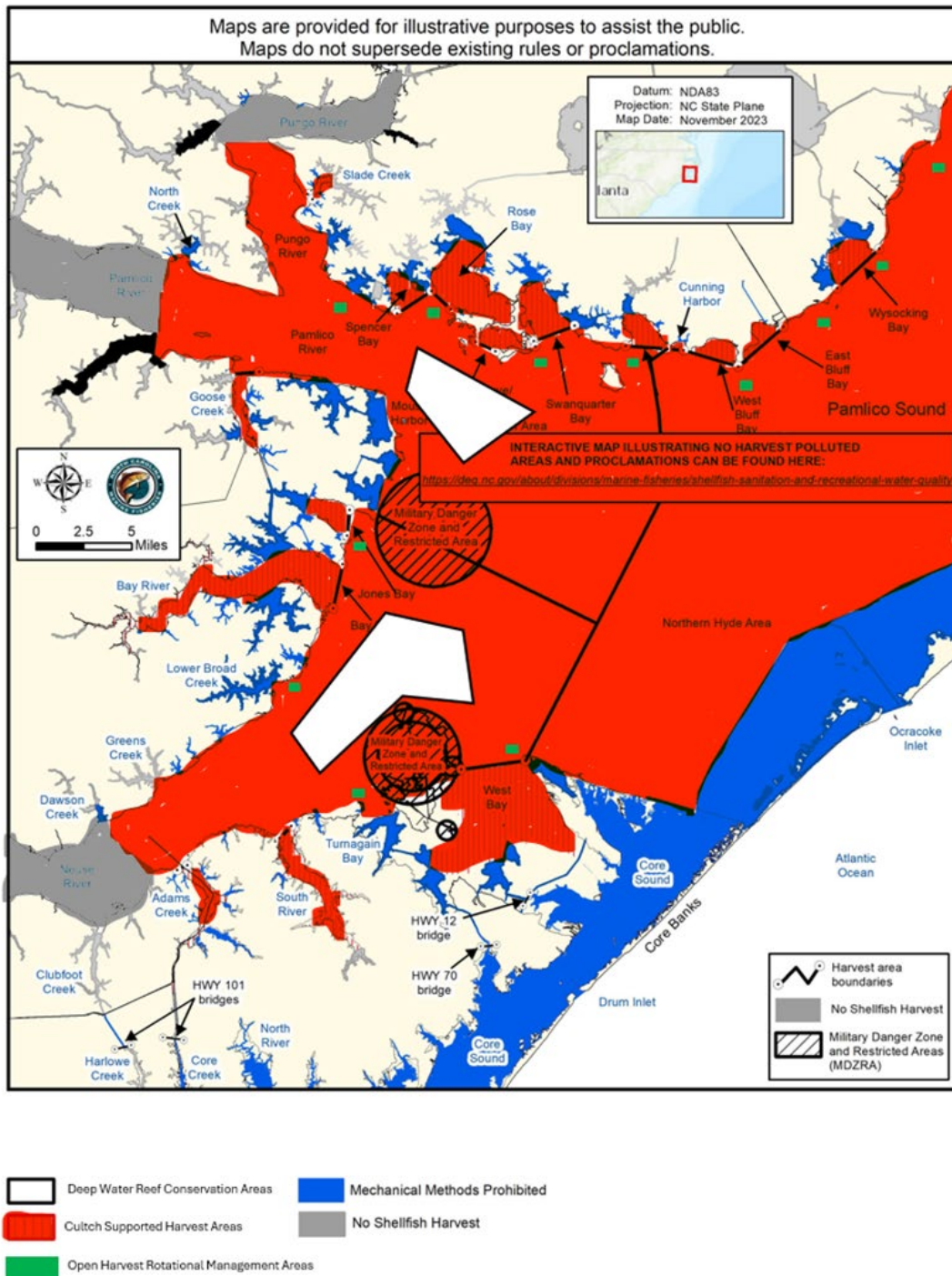


Figure 8. A map illustrating potential boundaries for proposed management approaches in eastern Pamlico Sound. Locations of Open Harvest Rotational

Management Areas are for illustrative purposes, and actual locations are determined via the public cultch planting site selection process.

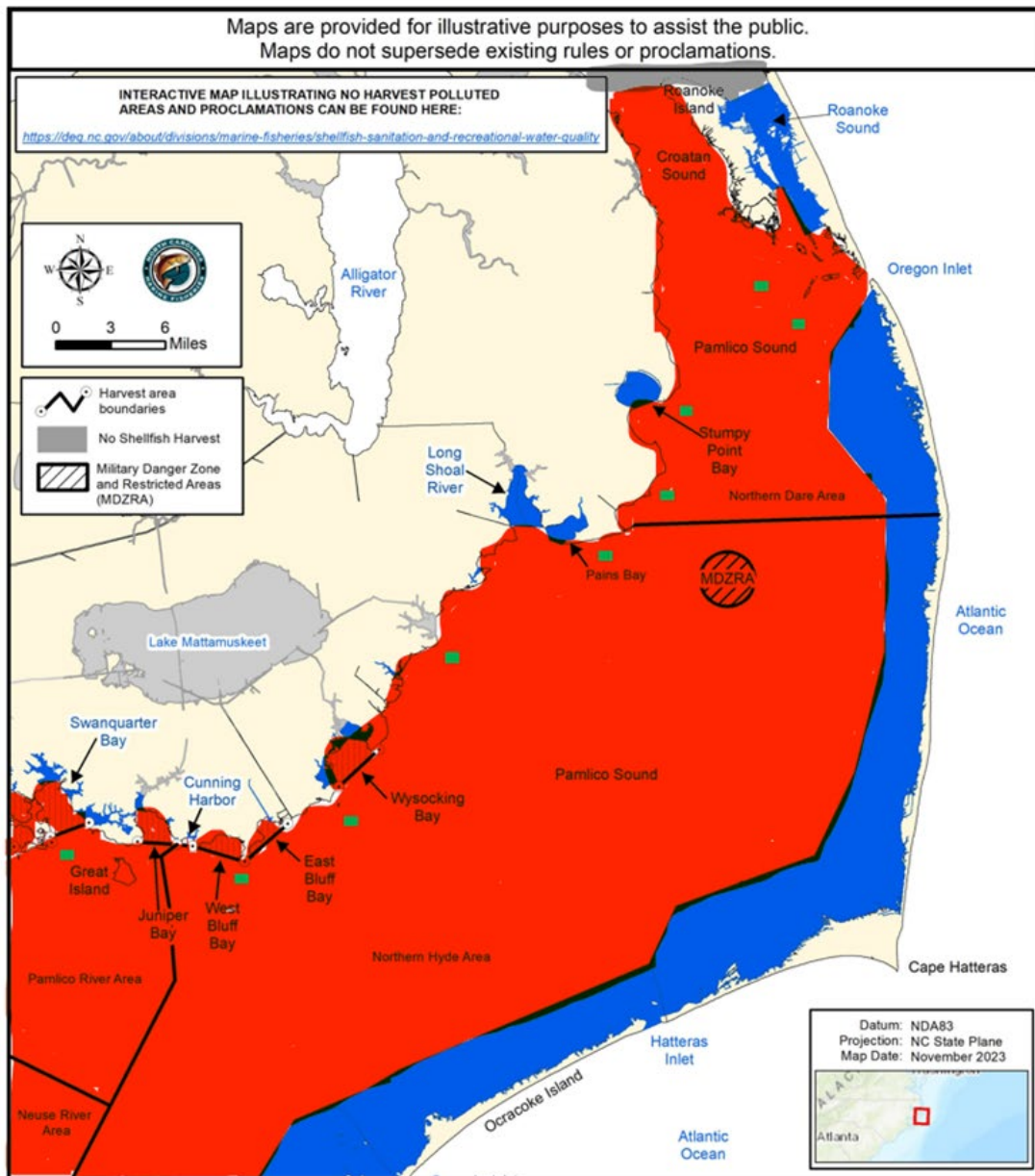
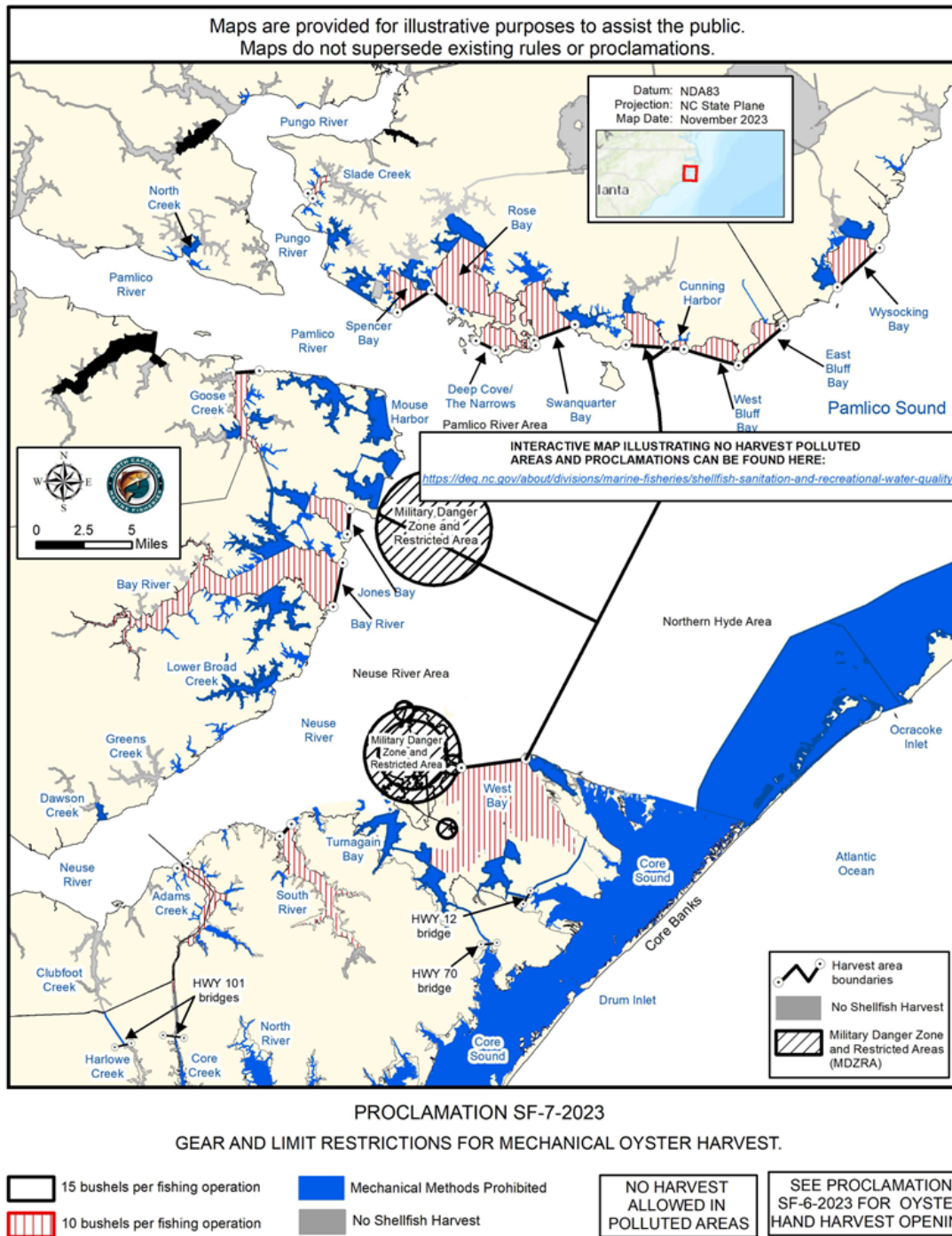


Figure 9. A map illustrating potential boundaries for proposed management approaches in eastern Pamlico Sound. Locations of Open Harvest Rotational

Management Areas are for illustrative purposes, and actual locations are determined via the public cultch planting site selection process.



Map 1

Figure 10. A proclamation map showing bushel limits for bays and deep-water areas of western Pamlico Sound.

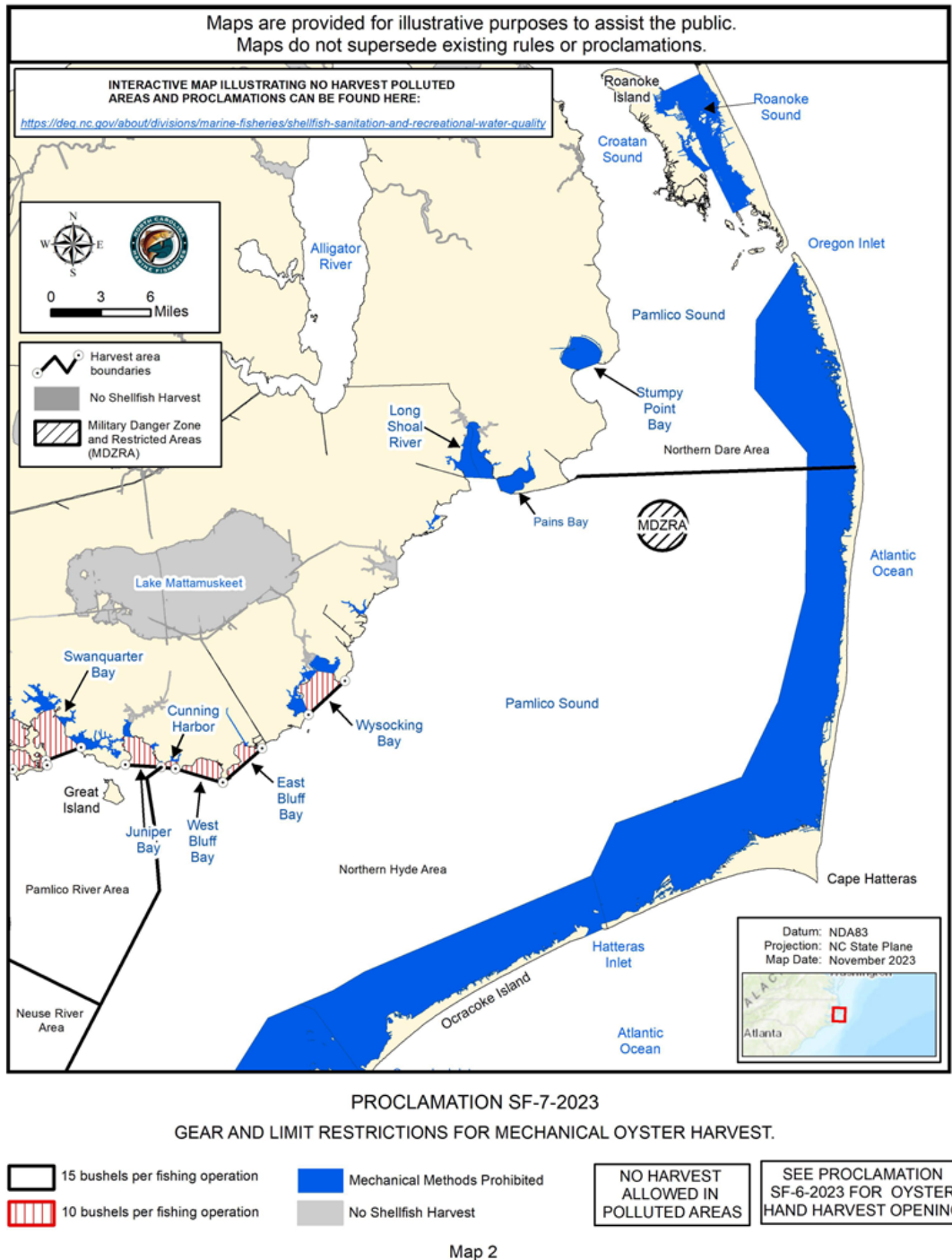


Figure 11. A proclamation map showing bushel limits for bays and deep-water areas of western Pamlico Sound.

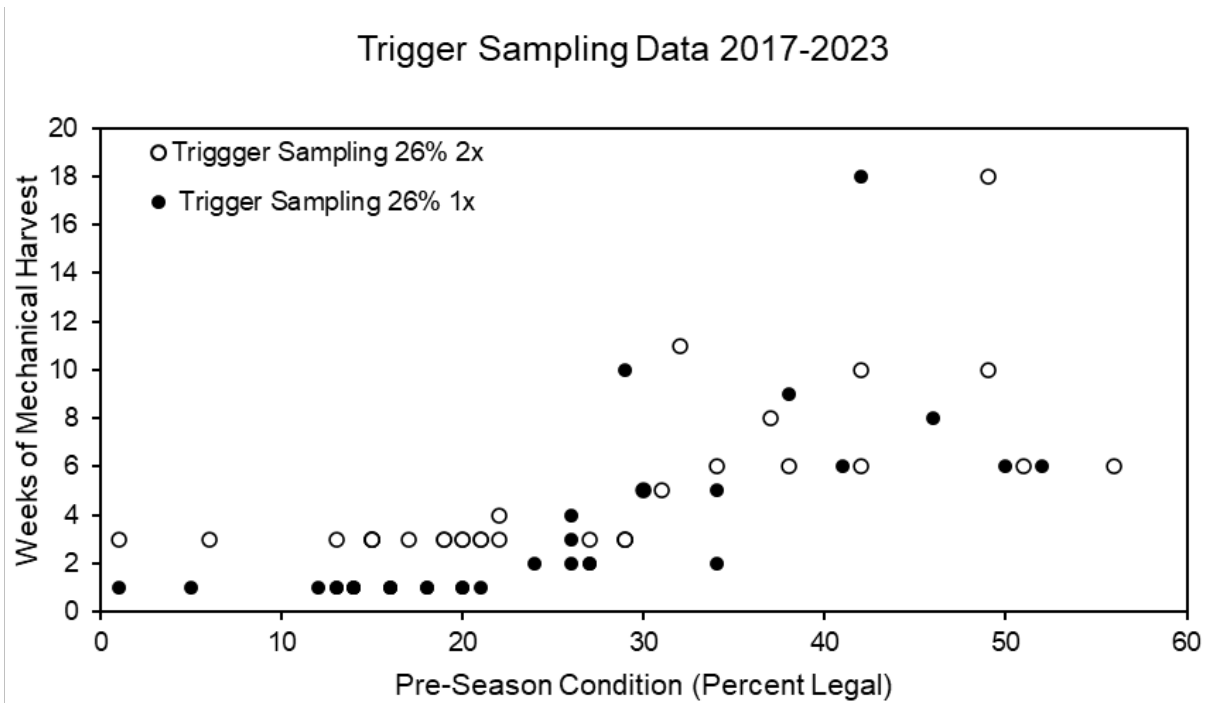


Figure 12 Pre-season condition (percent legal) of oysters in management areas sampled during mechanical harvest monitoring and the number of weeks into the harvest season for that management area to be sampled at 26% legal or less for two consecutive sampling events shown as open circles, and the number of weeks into the season to be sampled at 26% legal or less one time shown as black circles. Pre-season condition for black circles was calculated using all samples for an area, while the calculation for open circles dropped the two lowest percent legal samples.

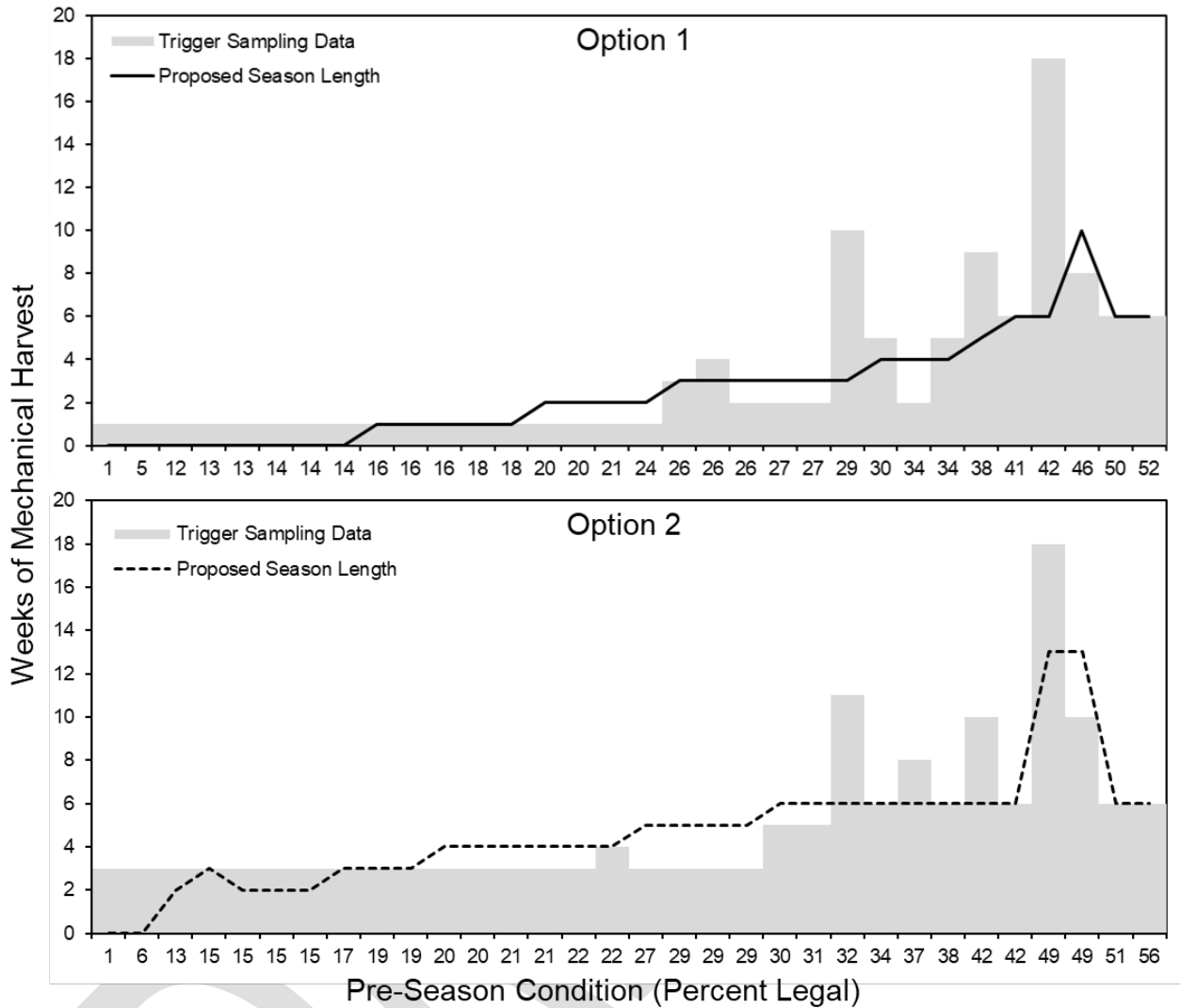


Figure 13 Option 1: Pre-season condition (percent legal) of oysters sampled during mechanical harvest monitoring between 2017 and 2023, and the number of weeks into the harvest season for an area to be sampled at 26% legal or less one time shown as grey bars. The black solid line represents how many weeks of mechanical harvest would be allowed for the pre-season condition based on proposed option 1. Option 2: Pre-season condition (percent legal) of oysters sampled during mechanical harvest monitoring between 2017 and 2023, calculated with the lowest two samples per management area per year excluded, shown as grey bars. The black dashed line represents how many weeks of mechanical harvest would be allowed for the pre-season condition based on proposed option 2.

Adaptive management

The fixed mechanical season lengths for Cultch Supported Managed Harvest Areas developed in this issue paper used fishery monitoring data for the five oyster mechanical harvest seasons between November 2018 and May 2023. Any large changes in effort

would potentially result in these fixed season lengths becoming either inadequate to provide protection to the oyster resource with increased participation in the fishery, or too restrictive with decreased fishery participation. The average number of participants with landings in the mechanical oyster fishery between 2018 and 2023 was 93. If the three-year running average of participants in the mechanical oyster fishery changes by more than 25%, fixed season lengths (Table 3 or 4) may be revised in consultation with the Shellfish/Crustacean Advisory Committee. Additionally, if post-season sampling of a Management Area results in two consecutive years below 15% legal, or two consecutive years above 30% legal, fixed season lengths (Table 3 of 4) may be revised.

- Three year running average of participants less than 70 or greater than 116 (calculated during annual FMP Update), triggers examination of oyster sampling data and potential adjustment to fixed season lengths for Cultch Supported Managed Harvest Areas. Any changes made will be done in consultation with the Shellfish/Crustacean Advisory Committee.
- Post-season sampling is below 15% legal, or above 30% legal for two consecutive years in any Management Area, triggers potential adjustment to fixed season lengths for Cultch Supported Managed Harvest Areas.

MANAGEMENT OPTIONS

Need FMP Advisory Committee Input and Feedback to develop.

Potential options to explore and refine with AC:

- Yes/No Deep-Water Reef Conservation
 - Various Boundaries for Deep-Water Reef Conservation Areas
 - Areas in Hyde or Dare?
- Yes/No new approach to setting season length for Cultch Supported Management Areas
 - Adaptive management considerations
 - How to solicit and incorporate industry feedback into pre-season sampling
 - Season Lengths (option 1, 2, other)
 - minimum threshold for opening
- Yes/No Large Open Harvest Rotational Cultch Sites
 - When to open
 - Bushel Limits
- Status Quo

RECOMMENDATIONS

*This section will be completed as PDT recommendations and then replaced with DMF recommendations and other appropriate levels. Final version will be MFC recommendations and reference the Summary of Recommendations Appendix

REFERENCES

DRAFT