Contents

Chapter 5
Shellfish Industry in the White Oak River Basin

5.1. Oyster Industry in North Carolina

During the late 1880's, the North Carolina oyster industry was especially prolific. Oysters were harvested and shipped by train to New York and San Francisco. The industry peaked in 1902 with the harvesting of 800,000 bushels of oysters, or the equivalent of 5.6 million pounds of oyster meat. Since the peak year in 1902, industry harvest reached a low of 35,000 bushels in 1994, and the 2017 harvest was 158,000 bushels. The primary reasons for the decline are over harvesting, natural disasters, shellfish diseases, and unsuitable water quality. The monetary value of the oyster industry is about $5 million dollars (NC Coastal Federation, 2021). Although, this figure is significant, the oyster industry in Virginia is valued at about $18 million. Interest in shellfish growing along the North Carolina coast is clearly on the rise.

Oyster habitat in North Carolina includes deep subtidal water reefs in the Pamlico Sound, and low relief intertidal patch and fringing reefs. North Carolina is the only state with this broad range of habitats. Oysters and the reefs they form provide ecological, economic, and social benefits. Oysters are considered a "keystone species" since their health serves as an indicator of the overall health of the coastal ecosystem. Oysters provide food, filter water, and create fish habitat.

(Coastal Review Online)

The Division of Marine Fisheries (DMF) in the North Carolina Department of Environmental Quality (DEQ) has worked since the 1950s to enhance reef habitat. To this end, DMF annually deposits tens of thousands of bushels of oyster shell, marine limestone, and clam shell, called "cultch", in shellfish waters from the Shallotte River to the Pamlico Sound. The cultch is colonized by oyster larvae, called "spat", that attach to the cultch and grow to harvestable size in 18-24 months.

In 2003, a group of oyster stakeholders formed the North Carolina Oyster Blueprint - -An Action Plan for Restoration and Protection (https://ncoysters.org/). Their vision is to see North Carolina become the "Napa Valley of Oysters". The North Carolina Oyster Blueprint partners with several different groups (https://ncoysters.org/who-we-are/partners/). Reports from these groups may be found here: https://ncoysters.org/news-resources/publications/.

5.2 Shellfish Sanitation Program

The Shellfish Sanitation and Recreational Water Quality Section of the DEQ's Division of Marine Fisheries (DMF) is responsible for monitoring and classifying coastal waters as to their suitability for shellfish harvesting for human consumption. Shellfish includes clams, oysters, and mussels. Shellfish growing areas (SGA) are classified as Approved, Conditionally Approved, Restricted, or Prohibited. Approved areas are consistently open, while Prohibited areas are permanently closed. Conditionally Approved areas can be open to harvest under certain conditions, such as dry weather when stormwater runoff is not having an impact on surrounding water quality. Restricted waters can be used for harvest at certain times as long as the shellfish are subjected to further cleansing before they are made available for consumption. The Shellfish Sanitation Section maintains a map that shows which shellfish growing areas are currently open or closed (NC DMF, n.d.;, A. Haines, pers. comm. February 5, 2020). Shellfish growing areas and their classification in the White Oak River basin are shown in Figure 5-1 and Figure 5-2.

Figure 5-1 Shellfish Growing Areas (SGAs) in the White Oak River Basin (DMF)

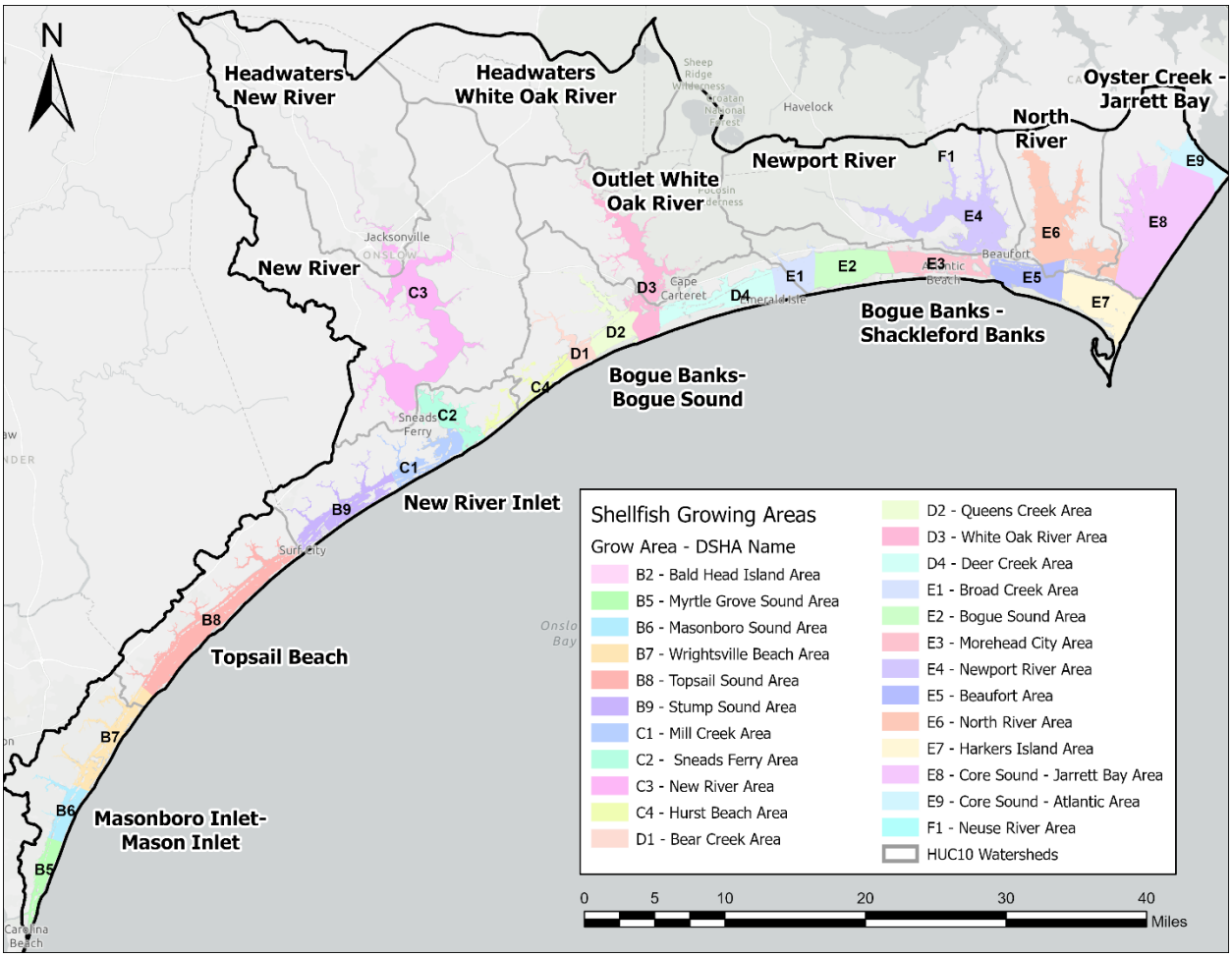
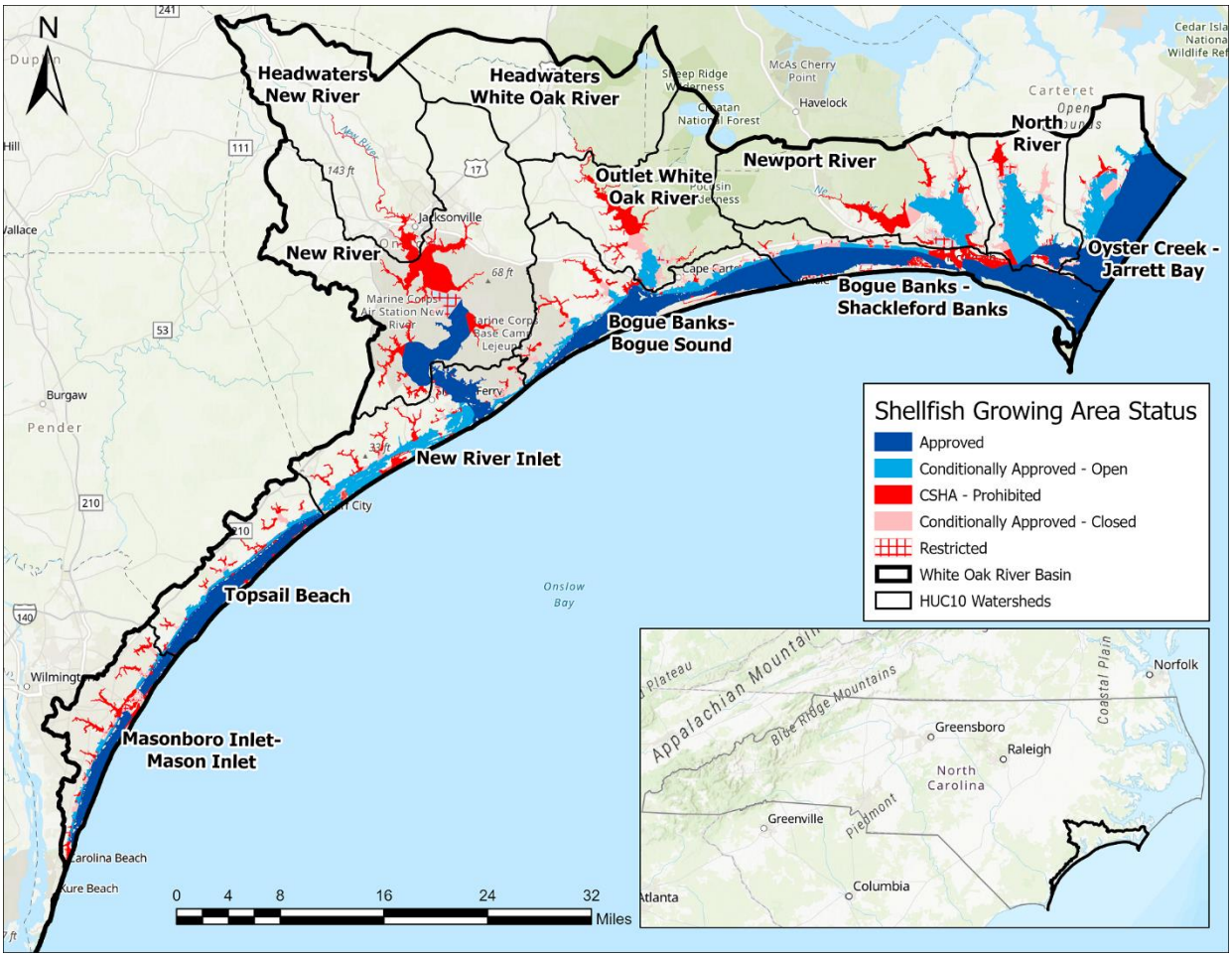


Figure 5--2 White Oak River Basin Shellfish Growing Areas (SGA) Status (2018)



The Shellfish Sanitation Program is conducted in accordance with the guidelines set by the Interstate Shellfish Sanitation Conference and contained in the National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish Model Ordinance. This National Shellfish Program is administered by the U.S. Food and Drug Administration. A Sanitary Survey for each shellfish growing area is done every three years. The survey includes a shoreline survey of all existing or potential pollution sources, a hydrographic and meteorological survey, and a bacteriological survey of the shellfish growing waters. Shoreline surveys assess the impacts of potential pollution sources like marinas, multi-slip docks, agricultural areas, subdivisions, septic tanks, wastewater treatment plants, or ditching on surrounding water quality. The hydrographic and meteorological survey is used to evaluate the factors that may affect the distribution of pollutants within a growing area, such as prevailing winds, tidal amplitude and type, water circulation patterns, and the amount of freshwater. Rainfall patterns and intensity can also affect the distribution of pollutants by increasing volume and duration of pollutant delivery and flooding.

Bacteriological surveys are the collection of water samples from all shellfish growing areas. A minimum of six sets of water samples are collected from each sampling station on a random schedule to assess overall quality of the waters for classification. Approved shellfish waters must meet a bacteriological standard over the survey period of a median or geometric mean of not more than 14 Most Probable Number

(MPN)/100 mL or a 90th percentile not to exceed 43 MPN/100 mL. Sanitary Survey Reports include an analysis of the data to determine the appropriate shellfish water classification. Additionally, bacteriological data is reviewed annually to ensure that the classification remains appropriate (NC DMF, n.d.;, A. Haines, pers. comm. February 5, 2020).

5.2.1 Potential Pollution Sources

Shellfish harvesting in coastal waters is subject to both point and nonpoint sources of pollution. Point sources of pollution enter surface waterbodies through "any discernable, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel, conduit, discrete fissure, or container" (US EPA, 2019). Point sources are primarily associated with wastewater and stormwater discharges from municipal (city and county) and industrial wastewater treatment plants. They can also originate from small, domestic wastewater systems that serve schools, commercial properties, residential subdivisions, and individual homes. Point sources are regulated through the National Pollutant Discharge Elimination System (NPDES) Program. The program sets monitoring and treatment requirements for wastes being discharged directly into surface waterbodies.

Nonpoint source (NPS) pollution is defined as "any source of water pollution that does not meet the legal definition of 'point source' in Section 502(14) of the Clean Water Act (CWA)" (US EPA, 2020). NPS can result from any number of activities and land uses. Construction and land clearing activities, agriculture, golf courses, mining operations, solid waste disposal sites, urban landscapes, and on-site wastewater treatment systems (septic systems) all contribute to NPS and can add sediment, nutrients, bacteria, heavy metals, oil, and grease to a waterbody.

Marinas and boating activities are also considered a NPS of pollution. Chemicals used to maintain and repair boats and poorly maintained sanitary waste systems or pump-out stations can contribute chemical and biological contaminants to surface waterbodies (NOAA, n.d.). In North Carolina, marinas are defined as "any water area with a structure (dock, basin, floating dock, etc.) which is utilized for docking or otherwise mooring vessels and constructed to provide temporary or permanent docking space for more than 10 boats" (15A NCAC 18A .0901). Marinas are evaluated as part of the shoreline survey because of their potential to affect the suitability of adjacent shellfish areas for harvesting. Consequently, waters enclosed by a marina are classified as Prohibited for shellfish harvesting. An additional area beyond the marina may also be classified as Prohibited depending on the number of boat slips that are present.

It is difficult to monitor and identify sources of NPS.. The DWR works with several state and local agencies to identify potential NPS pollution and the types of activities that may be impacting water quality in the area, but data gaps exist. These unknowns include, but are not limited to, the amount of fertilizers, pesticides, herbicides, and animal waste applied to land, as well as the level at which these same pollutants may be reaching surface waters through groundwater seepage and atmospheric deposition. Seepage from septic drainfields and leaky wastewater pipes can contribute bacteria and other pollutants to ground and surface waters.

To identify areas of higher concentration of potential sources of pollution relative to the shellfish growing areas, a spatial analysis was conducted using data provided by DMF and tools available in ArcGIS Pro. Point data were available for the following categories of concern: animals, dockage, golf courses, stormwater, subdivisions, and wastewater. Stormwater points were separated from the rest of the data for three reasons: (1) a larger number of stormwater outfalls are in the basin when compared to the other

point data that as provided by DMF; (2) stormwater is a constant concern in coastal basins due to topography and growing urban areas; and (3) the stormwater data could be weighted based on the overall relative contribution of a stormwater conveyance to the total bacterial load within the shellfish growing area.

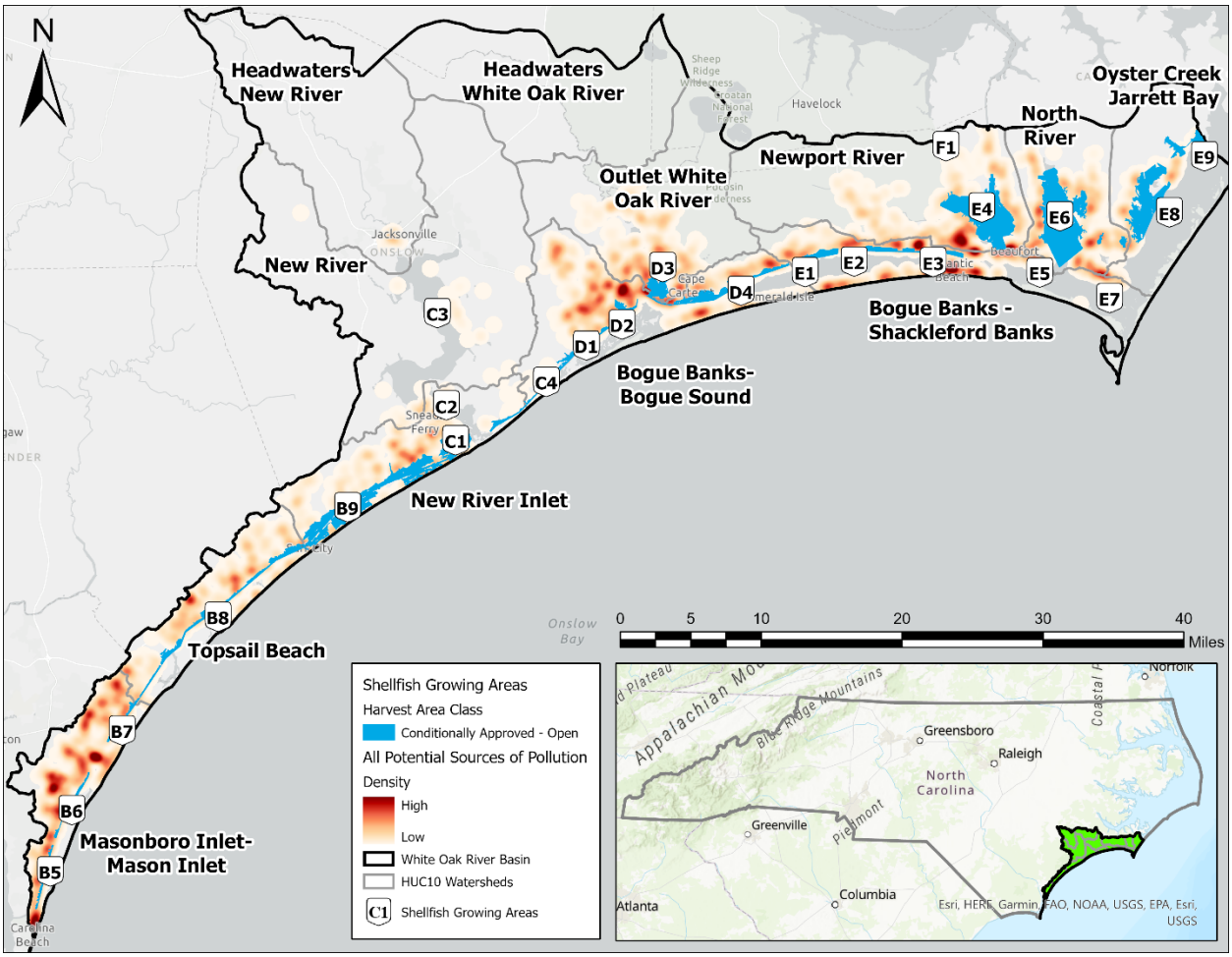
The Kernel Density tool was used for the spatial analysis, and it was used to determine areas of high concentration of potential pollution sources in shellfish growing areas of the White Oak River basin. This method is commonly used in analyzing the density of occurrences and calculates the density of features in a set radius around the identified features. For all pollution source density maps, the analysis used a 1,000-meter radius to obtain greater detail of localized areas where pollution may be occurring. For the stormwater maps, each outfall was weighted based on its relative contribution. This information was pulled from the Shellfish Sanitary Survey Reports and was initially described as a low, medium, or high contribution. These were then changed to numerical values (low = 1, medium = 2, high = 3) that were then used to weight stormwater outfall points and allow for the density layer to be calculated.

Maps for each of the subbasins and the basin include color gradients. These color gradients represent densities with darker colors indicating areas of higher density of pollution sources and lighter colors indicating a lower density of pollution sources. These maps are intended to provide a general idea of areas within the basin that may be impacted greater by pollution sources and does not provide quantitative values of pollution or indicate that an area is polluted (ArcPro, n.d.).

5.2.2 Conditionally Approved Shellfish Growing Areas

Per North Carolina's Administrative Code (NCAC), "an area may be classified as conditionally approved if the sanitary survey indicates that the area will meet approved area classification criteria for a reasonable period of time and the factors determining these periods are known and predictable" (15A NCAC 18A .0905). DMF develops "conditional area management plans" for Conditionally Approved shellfish growing areas. The management plan for each growing area includes instructions on when the area will be closed. Because heavy rainfall can rapidly transport biological and chemical contaminants to the growing area, closures are often the result of rainfall events within a 24-hour period. During extremely heavy rainfall events or unusual storm events, however, a public health emergency may be declared and the growing areas may be temporarily closed in accordance with 15A NCAC 18A .0913. DMF can re-open the growing area once the condition causing the closure "no longer exists and shellfish have had sufficient time to purify naturally from possible contamination" (15A NCAC 18A .0913). Polluted area proclamations are issued when growing areas are closed, re-opened, or permanently closed based on the findings of the sanitary survey. Polluted area proclamations can be found online, via an automated recording, and on an interactive map.

Figure 5--3 Conditionally Approved–Open Shellfish Growing Areas (2018) and Potential Pollution Sources (High to Low) in the White Oak River Basin



5.2.3 Water Quality and Shellfish Harvesting

Several divisions within DEQ have jurisdiction over marine fisheries, water quality and coastal management. Representatives from these divisions, along with several other state agencies , develop and implement the Coastal Habitat Protection Plan (CHPP). The CHPP is a source document that addresses habitat and water quality efforts needed to protect, enhance, and restore fish habitat along North Carolina's coasts. It supports the Albemarle-Pamlico National Estuary Program's (APNEP) Comprehensive Conservation and Management Plan (CCMP). The CCMP focuses on ecosystem-based management (EBM). EBM includes consideration of human and natural systems, an adaptive management framework, and meaningful engagement with citizens in the region to find environmental management and policy solutions (APNEP, n.d.).

Several recommendations to enhance, restore, and protect water quality are included in the 2016 CHPP. Many of these recommendations are applicable to the shellfish growing areas and nutrient sensitive waters (NSW) found throughout the White Oak River basin. Targeting these recommendations in watersheds with conditionally approved shellfish growing areas could reduce the amount of time growing areas are closed. They could also reduce the number of swimming advisories and closures due to high bacteria levels. Recommendations include:

- Conduct targeted water quality restoration activities to prevent shellfish closures and swimming advisories.
- Maintain effective regulatory strategies (i.e., stormwater controls, vegetated buffers, permit limits, etc.) to reduce nonpoint source pollution and minimize cumulative impacts to water quality and loss of habitat.
- Prohibit new or expanded stormwater outfalls to coastal beaches and shellfish growing areas except during times of emergency when public safety and health may be threatened. Continue to phase out existing outfalls by implementing alternative stormwater management strategies.
- Continue to improve strategies to reduce NPS pollution and minimize cumulative losses. This can be done through voluntary programs, actions, and assistance as well as incentives and include:
  - Improve methods for reducing runoff from land-disturbing activities including agriculture, urban development, and forestry.
  - Increase on-site stormwater infiltration.
  - Encourage and provide incentives for low-impact development, green stormwater infrastructure or nature-based solutions.
  - Increase the use of reclaimed water and address proper reuse of treated wastewater effluent.
  - Promote the use of best available technology to reduce wastewater loading to rivers, estuaries, and sounds.
  - Increase voluntary use and incentives for maintaining or establishing vegetated buffers on agriculture, timber-harvesting, and lands under development or slated for development.
  - Increase funding for land acquisition, conservation, preservation, and restoration.
  - Increase inspections of on-site wastewater treatment facilities (septic systems) and provide financial assistance to cover the cost of repairs.
- Enhance coordination with and provide financial and technical support to local governments to effectively manage and improve stormwater and wastewater infrastructure (DEQ, 2016).

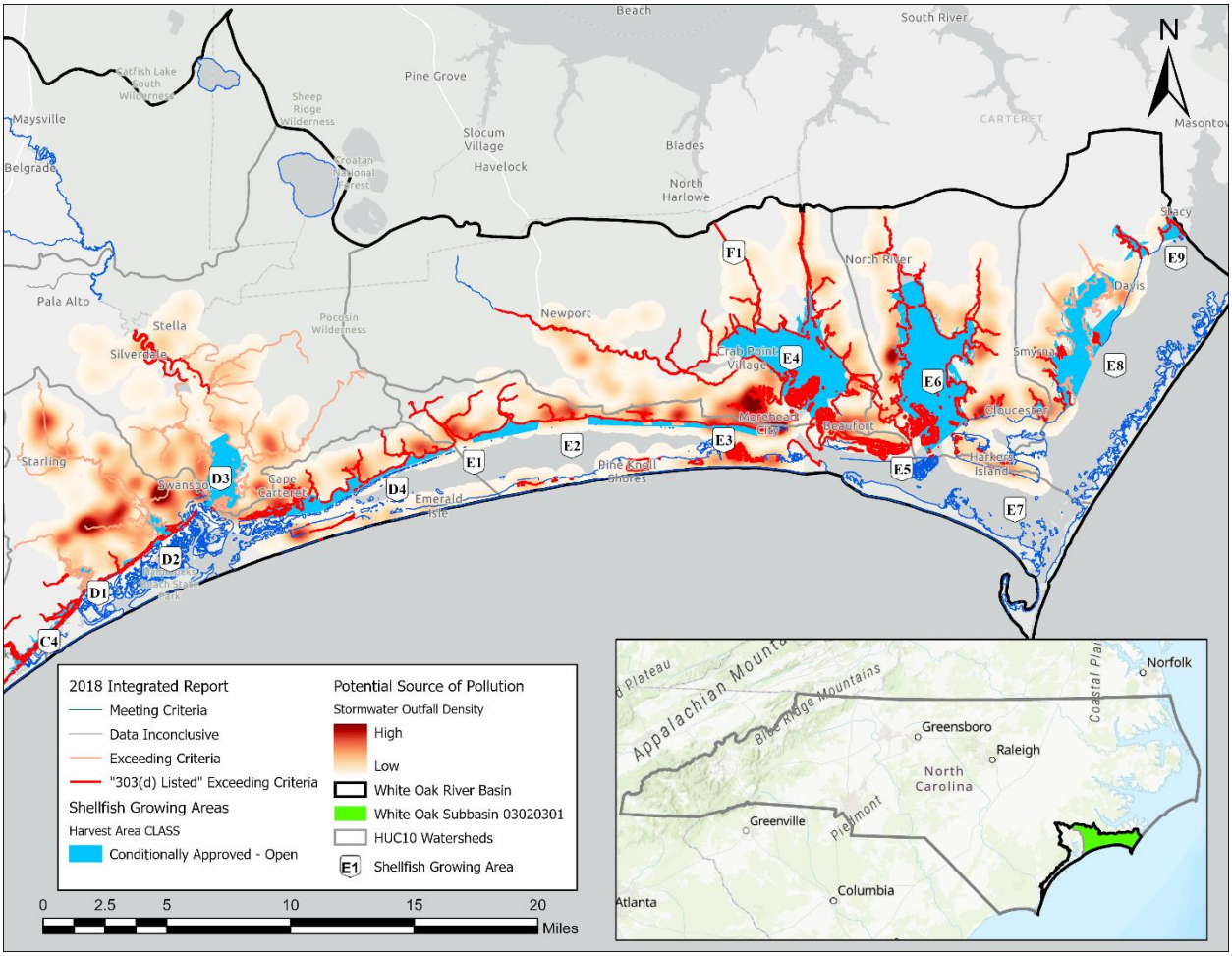
An amendment to the CHPP is scheduled to be approved by the three regulatory commissions (Marine Fisheries, Coastal Management, and Environmental Management) in 2021. It will include additional recommended actions for five priority habitat issues: (1) submerged aquatic vegetation protection and restoration through water quality improvements; (2) wetland protection and restoration through nature-based solutions; (3) environmental rule compliance to protect coastal habitats; (4) wastewater infrastructure solutions for water quality improvements; and (5) coastal habitat mapping and monitoring to assess status and trends. It is anticipated that no changes will be made to CHPP's source document. More information about CHPP and the implementation plans can be found on CHPP's website.

5.3 Shellfish Harvesting in the White Oak Subbasin (HUC 03020301)

The White Oak River subbasin drains 484,693 acres (757 mi^2). Land use consists of 36% wetlands, 18% forest, 11% agriculture, and 8% developed with 21% classified as open water (NLCD, 2016). The subbasin is in EPA Level IV ecoregion which includes Nonriverine Swamps and Wetlands, Carolina Flatwoods, and Carolina Barrier Islands and Coastal Marshes. Major tributaries include the White Oak River, Starky's Creek, Hunters Creek, Pettiford Creek, Queen Creek, Bear Creek, Newport River, Calico River, North River, Oyster Creek – Jarrett Bay, and Bogue Banks – Shackleford Banks. Significant natural heritage areas include the Croatan National Forest and Pocosin Wilderness.

The White Oak River subbasin contains seven HUC10 watersheds. More information about each of the HUC10 watersheds can be found in Chapter 3. Figure 5.4 includes the shellfish growing areas and potential pollution source densities for the entire White Oak subbasin. On-site wastewater management is a potential pollution source identified throughout the subbasin. All the sanitary surveys conducted in the subbasin reported that the county health departments were notified prior to the surveys being conducted. Each county health department agreed to provide corrective action and follow-up for any malfunctioning septic systems or illegal on-site wastewater discharges discovered during the survey. Copies of the sanitary survey are available in the NC Digital Collections Library. Current, or more recent, surveys are available upon request from DMF.

Figure 5-4 Shellfish Growing Areas (SGA) and Stormwater Outfall Densities (High to Low) in the White Oak Subbasin (HUC 03020301)



5.3.1 White Oak River Area (D-3) – Outlet White Oak River (HUC 0302030102) & Bogue Banks-Bogue Sound (HUC 0302030103)

Shellfish growing area D-3 includes the waters of White Oak River and its tributaries in Onslow and Carteret Counties as well as a series of channels and bays leading out to Bogue Inlet. Overall, the area includes just over 9,950 water acres. The towns of Swansboro and Cape Carteret, as well as a series of small, unincorporated towns, line the shores of the surveyed portion of the growing area. In 2014, shellfish production throughout D-3 was considered good and both oysters and clams can be harvested. DMF

noted in the 2014 sanitary survey that the removal of the Swansboro Wastewater Treatment Plant discharge from Fosters Creek, in conjunction with satisfactory sampling results throughout the area, allowed for the reclassification of approximately 200 acres of shellfish waters from Prohibited to Conditionally Approved (Sanitary Survey July 2009 – October 2014).

Closures were expanded following the 2015 and 2016 annual evaluations. DMF noted that the closures adequately encompassed portions of the area that exceeded the standards for Approved status (Sanitary Survey May 2012 – August 2017). An analysis of the impacts of rainfall and the associated runoff in D-3 revealed that a portion of the conditionally managed area south of the Intercoastal Waterway near Swansboro is not as susceptible to the impacts of stormwater runoff as several of the surrounding areas. A small portion of the growing area was reclassified from Conditionally Approved-Open to Approved.

A comprehensive shoreline survey was completed in December 2018. Annual updates were completed in December 2019 and April 2020. Review of the bacteriological and shoreline survey data collected indicated the area continues to grow (population and impervious surface area) and that bacteriological water quality continue to decline. Recent adjustments to growing area closure lines appear to have been effective at ensuring that areas available for harvest meet safe shellfish harvest standards when in the open status. No changes to classifications or sampling station locations were identified.

5.3.2 Bear Creek Area (D-1) – Bogue Banks-Bogue Sound (HUC 0302030103)

Shellfish growing area D-1 includes the waters of Bear Creek, Saunders Creek, a portion of the Intercoastal Waterway, and a series of channels, bays, and marshland leading to Bear Inlet. Overall, the area includes a total of approximately 2,405 water acres. Residential development is isolated to the eastern shore of the creek, while the entire western shore is taken up by the Camp LeJeune Marine Corps Base.

A comprehensive shoreline survey of area D-1 was completed in February 2018. Review of the bacteriological and shoreline survey data collected indicates little widespread change in bacteriological water quality or pollution source impacts in the growing area. All stations within the D-1 growing area continue to meet NSSP standards for Approved status. The Conditionally Approved-Closed portion of D-1 will be reclassified as Conditionally Approved-Open. The rainfall based Conditional Management Plan has been revised to reflect this reclassification. A few modifications to the sampling regime will be made to monitor the area more efficiently. A Conditional Area Management Plan for the waters surrounding the Brown Sound Community Dockage was also included in the sanitary survey report. The introduction of this management plan serves to formalize what has been the existing management practice for the waters surrounding this marina and does not represent a new management strategy. The previous sanitary survey report (November 2010 – August 2015) can be found online in the NC Digital Collections Library.

5.3.3 Queens Creek Area (D-2) – Bogue Banks-Bogue Sound (HUC 0302030103)

Shellfish growing area D-2 includes all waters in Queens Creek, Halls Creek, Parrot Swamp, and several smaller creeks and tributaries, as well as a portion of the Intercoastal Waterway and a series of channels, bays, and marshland between Bear Inlet and Bogue Inlet. Overall, the area includes a total of approximately 4,900 water acres. Portions of Swansboro and Hubert, as well as the uninhabited Bear Island, line the shores of the growing area.

Review of the most recent bacteriological and shoreline survey data indicates there has been continued growth throughout the watershed but little change in bacteriological water quality. The Conditional Management Plan for this area was updated in 2017. The update lowered the rainfall thresholds necessary

to bring about temporary closures in portions of the growing area. The was effective at ensuring that areas available for harvest met safe shellfish harvest standards when in the open status. No changes to classifications or sampling station locations were made. The previous sanitary survey report (June 2012 – July 2017) can be found in the NC Digital Collections Library.

5.3.4 Deer Creek Area (D-4) - Bogue Banks-Bogue Sound (HUC 0302030103)

Shellfish growing area D-4 consists of all waters in Bogue Sound bounded in the east by a line beginning at a point on the mainland near the end of Salty Shores Road in Newport, running southerly to a point on Bogue Banks near the end of 23rd Street in Emerald Isle and bounded in the west by a line beginning at a point on the mainland near the end of Bell Street in Cedar Point, running southerly through Intracoastal Waterway Beacon "45" and following the Coast Guard Channel to a point on Bogue Banks near the end of Channel Drive in Emerald Isle. Portions of Cedar Point, Cape Carteret, Newport, and Emerald Isle line the shores of the growing area. Overall, the area includes a total of approximately 7,669 water acres.

Review of the most recent bacteriological and shoreline survey data indicates little overall change in bacteriological water quality or pollution source impacts in the growing area and that all sampling stations now meet the standards for Approved status. Expanded closures were made around the Bogue Sound Drive Canal and the Blue Heron Bay Marina basin following the 2018 annual growing area evaluation, but no further changes in classification will be made as a result of the most recent survey data. A few adjustments to the sampling regime will be made to monitor the area more effectively. The Conditional Area Management Plan will be updated to reflect some recent changes to the written description of the conditionally managed areas. The previous sanitary survey report (April 2011 – March 2016) can be found in the NC Digital Collections Library.

5.3.5 Broad Creek Area (E-1) – Bogue Banks-Shackleford Banks (HUC 0302030107)

Shellfish growing area E-1 includes all waters in Broad and Gales Creeks, as well as a portion of Bogue Sound bordered in the west by line running southerly from a point on the mainland just west of Salty Shores Marina through Wood Island to point on Emerald Isle between 20th and 23rd Streets and bordered in the east by a line running southerly from a point on the mainland at the mouth of Gales Creek through Flashing Beacon "21" to a point on Indian Beach near The Ocean Club. Portions of Newport, Indian Beach, and Emerald Isle line the shores of the growing area. Overall, the area includes a total of approximately 4,809 water acres.

Review of the most recent bacteriological and shoreline survey data (September 2019) and annual update (September 2020) indicates little change in pollution source impacts or bacteriological water quality in the growing area. No changes in sampling station locations or classifications will be made, and the Conditional Area Management Plan will be updated to reflect some changes made during a recent project aimed at improving the written descriptions and sampling stations associated with the plan. The previous sanitary survey report (May 2010 – September 2014) can be found in the NC Digital Collections Library.

5.3.6 Bogue Sound Area (E-2) - Bogue Banks-Shackleford Banks (HUC 0302030107)

Shellfish growing area (E-2) includes all waters in Bogue Sound bounded in the east by a line beginning at a point on the mainland near the end of Harbor Drive in Morehead City, running southerly to a point on Bogue Banks near the end of Holly Road in Pine Knoll Shores, and bounded in the west by a line beginning at a point on the mainland at the mouth of Gales Creek, running southerly through Intracoastal Waterway Beacon "21" to a point on Bogue Banks near The Ocean Club in Indian Beach. Portions of Morehead City,

Newport, Pine Knoll Shores, Indian Beach, and Salter Path line the shores of the growing area. Overall, the area includes a total of approximately 7,496 water acres.

A comprehensive shoreline survey of area E-2 was completed in December 2016. Annual surveys were completed in September 2017 and February 2018. Review of the bacteriological and shoreline survey data indicates widespread improvements in bacteriological water quality throughout the area, and all sampling stations now meet the standards for Approved status. Detailed studies looking at the impacts of stormwater runoff on the area around the Pine Knoll Shores Canals and along the Conditionally Approved-Closed portion of Bogue Sound will be conducted in the coming year. Results from those studies will be evaluated, and potential reclassifications or revisions to the Conditional Area Management Plan for E-2 will be made where appropriate. No classification changes or changes to the Conditional Area Management Plan will be made at this time, however. The previous sanitary survey report (July 2010 – January 2015) can be found in the NC Digital Collections Library.

5.3.7 Morehead City Area (E-3) - Bogue Banks-Shackleford Banks (HUC 0302030107)

Shellfish growing area E-3 includes all waters in eastern Bogue Sound, including Tar Landing Bay, Hoop Pole Creek, Peletier Creek, and Spooners Creek. Portions of Morehead City, Atlantic Beach, and Pine Knoll Shores line the shores of the growing area. Overall, the area includes a total of approximately 5,811 water acres.

A comprehensive shoreline survey of area E-3 was completed in December 2019. Review of the bacteriological and shoreline survey data indicates little change in pollution source impacts or bacteriological water quality in growing area. Recent special sampling results targeting the mainland side of the growing area following rainfall events of varying intensity has indicated that a 2-inch rainfall threshold may be more appropriate for closure. The Conditional Area Management Plan will be updated to reflect the new threshold. Otherwise, no changes in sampling station locations or classifications will be made. An additional Conditional Area Management Plan for the waters surrounding The Bluffs Marina was added as part of the 2018 Annual Growing Area Evaluation. That plan is included in the most recent sanitary survey report. The previous sanitary survey report (October 2012 – July 2017) can be found in the NC Digital Collections Library.

5.3.8 Beaufort Area (E-5) - Bogue Banks-Shackleford Banks (HUC 0302030107)

Shellfish growing area E-5 includes the waters of Taylor Creek and Morgan Creek, as well as a portion of Gallants Channel, North River, and Back Sound. Portions of Beaufort line the northern shore of the growing area and much of the remainder of the watershed consists of uninhabited islands. Overall, the area includes a total of approximately 6,321 water acres.

A comprehensive shoreline survey was completed in October 2019 and an annual update was completed in August 2020. Review of the bacteriological and shoreline survey data indicates little change in bacteriological water quality or pollution source impacts on the area despite continued residential growth in Beaufort. No changes in classifications or sampling station locations will be made, and the current practice of closing the area on an emergency basis after extreme rainfall events will continue. That plan is included in the most recent sanitary survey report. The previous sanitary survey report (April 2012 – February 2017) can be found in the NC Digital Collections Library.

5.3.9 Harkers Island Area (E-7) - Bogue Banks-Shackleford Banks (HUC 0302030107)

Shellfish growing area E-7 includes the waters of Back Sound bounded to the north by Harkers Island, to the east by Core Banks, to the west by a line running from Harkers Point to near Bottle Run Point, and to the south by Shackleford Banks. Harkers Island is the only inhabited portion of the watershed. Overall, the area includes a total of approximately 10,169 water acres.

A comprehensive shoreline survey was completed in May 2019 and an annual update was completed in January 2020. Review of the bacteriological and shoreline survey data collected during the time period indicates little change in bacteriological water quality or pollution source impacts on the area and that Harkers Island is continuing to redesign their wastewater infrastructure. No changes in classifications or sampling station locations will be made, and the current practice of closing the area on an emergency basis after extreme rainfall events will continue. The previous sanitary survey report (May 2012 – April 2017) can be found in the NC Digital Collections Library.

5.3.10 Newport River Area (E-4) – Newport River (HUC 0302030104)

Shellfish growing area E-4 consists of all waters in the Newport River and its tributaries, as well as a portion of Core Creek. Portions of Newport, Morehead City, and Beaufort line the shores of the growing area. Overall, the area includes a total of approximately 11,382 water acres.

A comprehensive shoreline survey was completed in July 2019, and an annual update was completed in May 2020. Review of the bacteriological and shoreline survey data collected during the time period indicates that despite continued growth in the areas surrounding the growing area there were some improvements in bacteriological water quality. Recent adjustments to growing area closure lines as well as continued strict management measures appear to have been effective at ensuring that areas available for harvest meet safe shellfish harvest standards when in the open status. Notable water quality improvements in Core Creek will allow for a small reopening in the southern portion of the creek. The Conditional Area Management Plan will be updated to reflect these changes, as well as some recent changes to the written descriptions of the conditionally managed areas. An additional Conditional Area Management Plan for the waters surrounding the Haystacks Marina will also be added. The previous sanitary survey report (May 2012 –March 2017) can be found in the NC Digital Collections Library.

5.3.11 North River Area (E-6) – North River (HUC 0302030105)

Shellfish growing area E-6 includes the waters of North River, Ward Creek, The Straits, Whitehurst Creek, Sleepy Creek, Westmouth Bay, Eastmouth Bay, and a series of smaller creeks and tributaries. Portions of Beaufort, Otway, Bettie, North River, Gloucester, Marshallberg, and Harkers Island line the shores of the growing area. Overall, the area includes a total of approximately 14,976 water acres.

A comprehensive shoreline survey of area E-6 was completed in December 2017. Review of the bacteriological and shoreline survey data collected during the time period reveals little change since the last survey was completed in 2015. Crabbing Creek, Lynch Creek, and three small unnamed creeks in The Straits were all found to be impacted by multiple potential pollution sources but were also found to be difficult to access for sampling purpose. For these reasons, these areas will be closed as a result of the shoreline survey. Otherwise, no additional classification changes or changes to the sampling regime are recommended. The existing conditional area management plan has proven effective and will continue to be used. The previous sanitary survey report (March 2011 – December 2015) can be found in the NC Digital Collections Library.

5.3.12 Core Sound-Jarrett Bay Area (E-8) and Core Sound-Atlantic Area (E-9) – Oyster Creek-Jarrett Bay (HUC 0302030106)

Shellfish growing area in E-8 is located in the White Oak subbasin in the Oyster Creek-Jarrett Bay watershed (HUC 0302030106). A small portion of the shellfish growing area E-9 near Brett Bay is located in the Oyster Creek-Jarrett Bay watershed, but the majority lies within the Tar-Pamlico River basin in the Cape Lookout Shoals-Core Banks watershed (HUC 0302010504). Growing areas in E-8 and E-9 include the waters of Jarrett Bay, Oyster Creek, Brett Bay, Nelson Bay, Core Sound, and a series of smaller creeks and tributaries. Portions of Marshallberg, Smyrna, Williston, Davis, Stacy, Sea Level, and the Atlantic Ocean line the shores of the growing area. Overall, the area includes a total of approximately 44,638 water acres.

A comprehensive shoreline survey was completed in August 2017 and an annual update was completed in November 2018. Review of the bacteriological and shoreline survey data indicates declines in bacteriological water quality in two tributaries within Jarrett Bay. Both Ditch Cove and Great Creek will be closed as a result of this report and two new sampling stations will be added at the closure lines to ensure they are properly placed. A sampling station will be added in upper Brett Bay in order to more effectively monitor the waters surrounding a proposed shellfish aquaculture operation. The E-8 and E-9 growing area maps will be updated in order to clarify the distinction between Prohibited and Restricted waters. The previous sanitary survey report (March 2011 – November 2015) can be found in the NC Digital Collections Library.

5.4 Shellfish Harvesting in the New River Subbasin (HUC 03020302)

The New River subbasin is on the western end of the White Oak River basin. Most of the subbasin lies within Onslow County but portions of Pender and New Hanover counties are also located in the subbasin. Portions of the subbasin that lies within Pender and New Hanover counties were previously located in the Cape Fear River basin. In 2009, the Division of Water Resources (DWR) moved away from the previous subbasin boundaries and adopted the national Watershed Boundary Dataset (WBD). This also changed the delineation of a handful of watersheds including those previously located in the Cape Fear River as well as the Chowan and Pasquotank river basins (USGS, 2020). Where applicable, historical information about streams located in this portion of the New River subbasin can be found in previous Cape Fear River basin plans. Municipalities include Jacksonville, Richlands, Sneads Ferry, Surf City, Topsail, and portions of Wrightsville and Carolina Beach. Camp Lejeune Marine Corps Base is also located in the subbasin, and rural residential properties and communities are scattered throughout the subbasin as well.

The New River subbasin is located in EPA Level IV ecoregion which includes Nonriverine Swamps and Wetlands, Carolina Flatwoods, and Carolina Barrier Islands and Coastal Marshes. More than half of the watershed is estuarine and estuarine waters in the mainstem of the New River reach as far upstream as Jacksonville. The New River subbasin drains approximately 399,480 acres (624 mi^2). Major tributaries to the New River include Harris Creek, Brinson Creek, and Northeast Creek. Hewletts Creek and Pages Creek are located further west and drain to the Intracoastal Waterway. Land use consists of 28% wetlands, 26% forest, 19% developed, and 10% agriculture with 10% identified as open water (NLCD, 2016).

The New River subbasin contains five HUC10 watersheds. More information about each of the HUC10 watersheds can be found in Chapter 4. Figures 5.5 and 5.6 include the shellfish growing areas and potential pollution source densities for the New River subbasin. Stormwater, wastewater treatment plants, marinas, subdivisions, golf courses, and animals were identified as potential pollution sources in several of the shellfish growing areas. On-site wastewater management is also a potential pollution source

identified throughout the subbasin. All the sanitary surveys conducted in the subbasin reported that the county health departments were notified prior to the surveys being conducted. Each county health department agreed to provide corrective action and follow-up for any malfunctioning septic systems or illegal on-site wastewater discharges discovered during the survey. Copies of the sanitary survey are available in the NC Digital Collections Library. Current, or more recent, surveys are available upon request from DMF.

Figure 5-5 Shellfish Growing Areas (SGA) and Stormwater Outfall Densities (High to Low) in the New River Subbasin (East) (HUC 03020302)

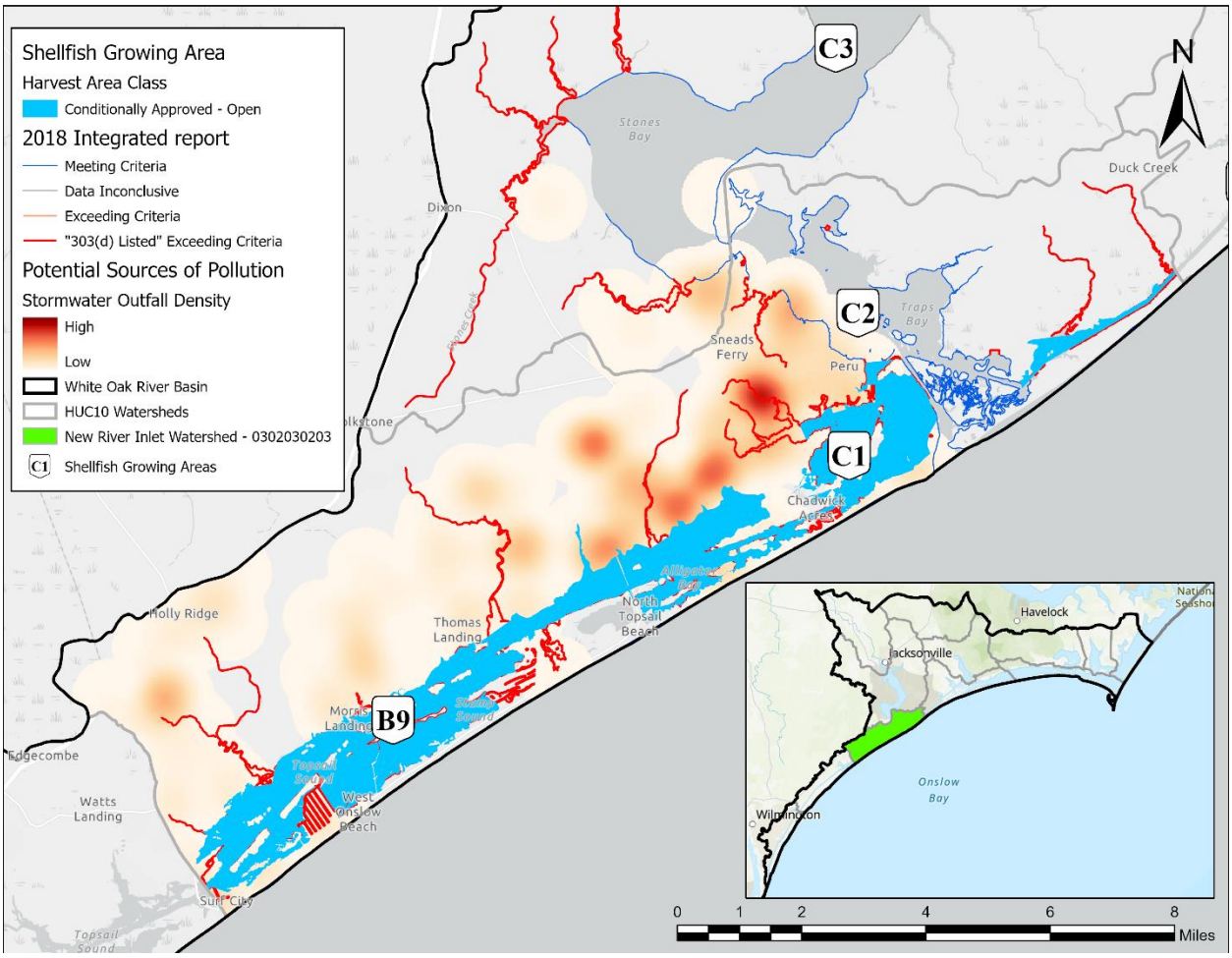
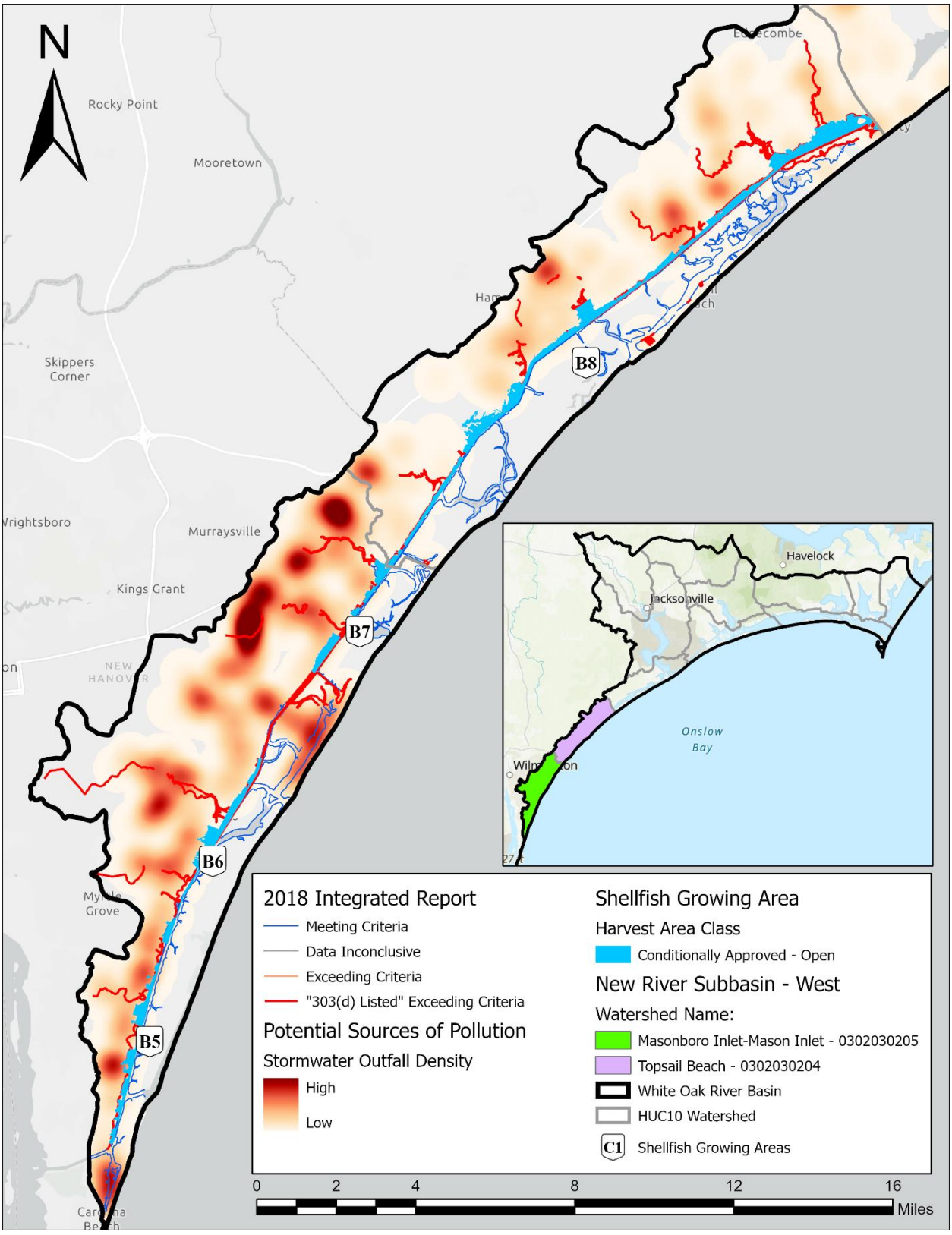


Figure 5-6 Shellfish Growing Areas (SGA) and Stormwater Outfall Densities (High to Low) in the New River Subbasin (West) (HUC 03020302)



5.4.1 New River Area (C-3) – Headwaters New River (HUC 0302030201) & New River (HUC 0302030202)

Shellfish growing area C-3 includes portions of the New River and its tributaries north of the Highway 172 Bridge. United States Marine Corps Base Camp LeJeune, New River Air Station, and other military installations make up the majority of the watershed, along with portions of Jacksonville and Sneads Ferry. Overall, the area includes a total of approximately 18,350 water acres.

A comprehensive shoreline survey for area C-3 was completed in December 2017. Review of the bacteriological and shoreline survey data indicates little change in bacteriological water quality or pollution sources in the growing area. All sampling stations located within Approved waters continue to meet the standards for safe shellfish harvest. Therefore, existing classifications will not be changed. It should be noted, however, that two closures along the western shore of Stones Bay were made in 2017 due to lack of access for sampling, as well as safety hazards posed by the presence of a nearby rifle range. The previous sanitary survey report (February 2011 – November 2015) can be found in the NC Digital Collections Library.

5.4.2 Sneads Ferry Area (C-2) – New River Inlet (HUC 0302030203)

Shellfish growing area C-2 includes all waters in New River between the Highway 172 Bridge and New River Inlet, as well as Fannie Creek, Wheeler Creek, Courthouse Bay, Traps Bay, Mile Hammock Bay, and several smaller creeks and bays. Most of the shoreline is owned by The United States Marine Corps Base Camp LeJeune with Sneads Ferry along a small portion of the eastern shorelines. Overall, the area includes a total of approximately 4,630 water acres.

A comprehensive shoreline survey for area C-2 was completed in December 2019. Review of the bacteriological and shoreline survey data indicates little change in bacteriological water quality or pollution sources. A closure will be made surrounding a small marina that receives stormwater drainage from a relatively large area, but otherwise, no changes in classification will be made. A few new sampling stations will be added to the sampling regime to monitor the area more effectively. The previous sanitary survey report (June 2011 – May 2016) can be found in the NC Digital Collections Library.

5.4.3 Hurst Beach Area (C-4) – New River Inlet (HUC 0302030203) & Bogue Banks-Bogue Sound (HUC 0302030103)

Shellfish growing area C-4 includes all waters along the Camp LeJeune Marine Corps Base between the Intercoastal Waterway Flashing Beacons “59” and “65A” as well as Browns Creek, Freeman Creek, Gillets Creek, Holover Creek, Salliers Bay, a portion of the Intracoastal Waterway, and a series of channels, bays, and marshland leading to Browns Inlet. A portion of growing area C-4 is located in the New River subbasin (HUC 03020302) in the New River Inlet watershed (HUC 0302030203) and a portion is located in the western most edge of the White River subbasin (HUC 03020301) in the Bogue Banks-Bouge Sound watershed (HUC 0302030103). The entirety of the growing area is located within the boundaries of the Marine Corps Base. There are no permanent residents within the growing area and much of the area is forested. The only human impacts are seen along roads and fields used for military training, as well as a small portion of Onslow Beach that is developed as a recreational and camping area for base personnel. Overall, the area includes a total of approximately 3,102 water acres.

A comprehensive shoreline survey for area C-4 was completed in September 2017. Camp Lejeune environmental personnel provided information and base access, allowing staff from the NC Shellfish

Sanitation Program to evaluate the area for potential sources of pollution entering shellfish growing waters. Review of the bacteriological and shoreline survey data indicates little change since the last survey was completed in 2015. All sampling stations currently meet the standards for approved status, and no changes in classifications or station locations will be recommended. The existing conditional area management plan has proven effective and will continue to be used. The previous sanitary survey report (May 2010 – October 2014) can be found in the NC Digital Collections Library.

5.4.4 Mill Creek Area (C-1) – New River Inlet (HUC 0302030203)

The shellfish growing area C-1 consists of all waters in Onslow County between Intracoastal Waterway Maker "76" near Hatch Point and the North Topsail High Rise Bridge, including Chadwick Bay, Fullard Creek, Charles Creek, Hell Gate Creek, Alligator Bay, Mill Creek, and a portion of the Intracoastal Waterway. The towns of Sneads Ferry and North Topsail Beach line the shores of the growing area. Overall, the area includes a total of approximately 3,954 water acres.

A comprehensive shoreline survey of Area C-1 was completed in April 2018. Review of the bacteriological and shoreline survey data revealed little widespread change since the last survey was completed in 2015. Water quality declined around Fullard Creek, but an expanded closure put in place in 2016 appears adequate to encompass the potential pollution sources impacting the growing area, and no changes in classification will be made. The NC Shellfish Sanitation Program will make a few changes to the sampling regime to monitor the growing area more effectively, and the growing area maps will be updated to clarify the distinction between Prohibited and Restricted waters. The Conditional Area Management Plan will be updated to reflect some recent changes to the written description of the conditionally managed area. No other changes were made to the plan. The previous sanitary survey report (January 2011 – October 2015) can be found in the NC Digital Collections Library.

5.4.5 Stump Sound Area (B-9) – New River Inlet (HUC 0302030203)

Shellfish growing area B-9 consists of all waters in Stump Sound and its tributaries bordered in the northeast by the North Topsail High Rise Bridge and the Intracoastal Waterway Beacon "71" near the new Surf City High Rise Bridge to the southwest. Portions of Holly Ridge, North Topsail Beach, and Surf City line the shores of the growing area. Overall, the area includes a total of approximately 5,771 water acres.

A comprehensive shoreline survey of area B-9 was completed in October 2018, and an annual update was completed in August 2019. Population continues to grow along the shorelines and in the watershed surrounding area B-9, but a review of the bacteriological and shoreline survey data indicates there has not been any notable change to the bacteriological water quality over the last several years. As a result, a few small canals and impoundments, as well as the upper portions of Turkey and Batts Mill creeks, will be reclassified as Prohibited in order to more efficiently manage the portions of the area that support harvestable resource. A few adjustments to the sampling regime will also be made to monitor the area more effectively, and the Conditional Area Management Plan will be updated to reflect some recent changes to the written description of the conditionally managed areas. The previous sanitary survey report (December 2011 – November 2016) can be found in the NC Digital Collections Library.

5.4.6 Topsail Sound Area (B-8) – Topsail Beach (HUC 0302030204)

Shellfish growing area B-8 consists of all waters in Topsail Sound between the Intracoastal Waterway Beacon "71" to the north and Intracoastal Waterway Beacon "118" in the south. It also includes Futch Creek, Mill Creek, Old Topsail Creek, Nixon Creek, Virginia Creek, and Beckys Creek. Portions of Hampstead, Topsail Beach, and Surf City line the shores of the growing area. Overall, the area includes a total of 12,307 water acres.

A comprehensive shoreline survey of Area B-8 was completed in December 2017, and annual updates were completed in December 2018 and September 2019. Review of the bacteriological and shoreline survey data indicates declines in bacteriological water quality, particularly within the mainland creeks of the growing area. This is likely the result of continued growth in the surrounding watershed. Although no new closures were identified, several areas that have been traditionally managed as Restricted or Conditionally Approved Closed will be transitioned to Prohibited so that management efforts can be better focused on areas that can be productive shellfish producers. A few adjustments to the sampling regime will also be made to monitor the area more effectively, and the rainfall-based Conditional Area Management Plan will be updated to reflect some recent changes to the written description of the conditionally managed areas. The previous sanitary survey report (May 2011 – July 2016) can be found in the NC Digital Collections Library.

5.4.7 Wrightsville Beach Area (B-7) – Masonboro Inlet-Mason Inlet (HUC 0302030205)

Shellfish growing area B-7 includes portions of Greenville Sound and Middle Sound, as well as Bradley Creek, Howe Creek, Pages Creek, and the Masonboro and Mason Inlet areas. The surrounding watershed is one of the most densely populated along the North Carolina coast, and includes portions of Wilmington, Wrightsville Beach, Ogden, and Figure Eight Island. Overall, the growing area includes a total of approximately 5,912 water acres.

A comprehensive shoreline survey of area B-7 was completed in December 2019. Review of the bacteriological and shoreline survey data showed some improvements in bacteriological water quality despite the continued growth within the surrounding watershed. No changes in sampling station locations or classifications will be made, and the Conditional Area Management Plan will be updated to reflect recent changes made as part of a project aimed at improving the written descriptions and sampling stations associated with the plan. An additional Conditional Area Management Plan for the waters surrounding several marinas in the area was added as part of the 2018 Annual Growing Area Evaluation. That plan was evaluated and updated in the most current sanitation survey report. The previous sanitary survey report (February 2010 – October 2014) can be found in the NC Digital Collections Library.

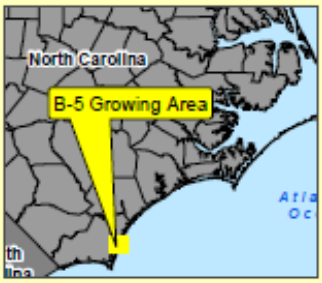
5.4.8 Masonboro Sound (B-6) – Masonboro Inlet-Mason Inlet (HUC 0302030205)

Shellfish growing area B-6 includes all waters in Masonboro Sound between Masonboro Inlet and Intracoastal Waterway Marker "140", as well as Whiskey Creek and Hewletts Creek. Portions of Wilmington, as well as the uninhabited Masonboro Island, line the shores of the growing area. Overall, the area includes a total of approximately 3,046 water acres.

A comprehensive shoreline survey of area B-6 was completed in July 2017, and an annual update was completed in April 2018. Review of the bacteriological and shoreline survey data revealed little widespread change since the last survey was completed in 2015. A Conditional Area Management Plan was introduced for the growing area following the 2015 Sanitary Survey Report, and it seems to have been

effective at ensuring that B-6 waters routinely meet the standards for safe shellfish harvest when the area is in the open status. No changes in classification or sampling regime will be recommended, although the B-6 growing area maps will be updated to clarify the distinction between Prohibited and Restricted waters. The Conditional Area Management Plan will be updated to reflect some recent changes to the written description of the conditionally managed area, but otherwise there will be no changes made to the plan. The previous sanitary survey report (January 2011 – September 2015) can be found in the NC Digital Collections Library.

5.4.9 Myrtle Grove Sound (B-5) – Masonboro Inlet-Mason Inlet (HUC 0302030205)



Shellfish growing area B-5 consists of all waters between the Cape Fear River and the Intracoastal Waterway Marker "141" near Peden Point, including Snows Cut, Myrtle Grove Sound, Carolina Beach Inlet, and Everett Creek. Portions of Carolina Beach, Myrtle Grove, and the uninhabited Masonboro Island line the shores of the growing area. Overall, the area includes a total of approximately 3,053 water acres.

A comprehensive shoreline survey of area B-5 was completed in April 2019. Review of the bacteriological and shoreline survey data shows that there have not been any consistent changes in bacteriological water quality over the last several years. Station 16, near the mouth of Everett Creek, however, has shown some declines in recent years and will be monitored closely in the coming months to ensure no further decline. Everett Creek itself will be reclassified from Restricted to Prohibited to free resources to focus on areas that are available for harvest and add two new monitoring stations. The waters in and around Dicks Bay have shown notable improvements since 2016, and this area will be reclassified from Restricted to Approved. The Conditional Area Management Plan will be updated to reflect some recent changes to the written description of the conditionally managed areas. The previous sanitary survey report (September 2011 – October 2016) can be found in the NC Digital Collections Library.

5.5 Conclusions

The growth of the shellfish industry will depend on regulatory, societal, and economic forces. To this end, in 2016 and 2017, the North Carolina General Assembly passed various legislation in support of assessing and growing the shellfish industry (S.L 2016-94, S.L. 2017-57 and S.L. 2017-197). This legislation was the catalyst for the formation of the Shellfish Mariculture Advisory Committee (SMAC). The SMAC was organized by the North Carolina Policy Collaboratory to fulfill the requirements of the 2016 and 2017 legislation. The SMAC is comprised of over 100 members from the areas of academia, law, business, industry, regulatory agencies, and non-government organizations (NGOs). The members were tasked with developing a Shellfish Mariculture Plan for the General Assembly. The final plan was presented to the North Carolina General Assembly and North Carolina Policy Collaboratory on January 2019. It represents the findings and recommendations to grow North Carolina's shellfish industry over the next ten years (2020-2030), with a goal of developing a $100 million industry. More information about the shellfish growing industry and how to protect it can be found in the following documents and websites:

- North Carolina Strategic Plan for Shellfish Mariculture: A Vision To 2030
- Economic Analysis of the Costs and Benefits of Restoration and Enhancement of Shellfish Habitat and Oyster Propagation in North Carolina (April 2016)
- North Carolina Oyster Blueprint: An Action Plan for Restoration and Protection

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