Oyster Blueprint 2021-2025
Sanctuary Strategy
Draft Recommendations April 2020

Overarching Goal:

Build 100 acres of Oyster Sanctuary by 2025.

Workgroup Members:
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Background:
North Carolina has a long history of oyster and shellfish restoration. Beginning in 1915, oyster shell and marl were regularly returned to oyster growing waters to help replenish substrate to build or maintain harvest opportunities. Despite these efforts, by the late 1900's oyster harvest was at an all-time low. In 1994, the N.C. General Assembly enabled the Blue Ribbon Advisory Council on Oysters. This Council was charged with researching and reporting the best methods for restoring oysters on public beds, developing oyster aquaculture, managing oyster reefs for maximum production, zoning, marketing, managing harvest and other efforts related to the development and restoration of an oyster industry in North Carolina. Among their findings, was a recommendation to develop a system of oyster sanctuaries.

Beginning in 1996, the Division created the first oyster sanctuary. Building on the successes and lessons learned, the recommendation to build oyster sanctuaries holds true 25 years later.

Oyster Sanctuaries contain reefs that are built to function as broodstock, providing larvae to oyster reefs located throughout Pamlico Sound. They are envisioned to serve as an insurance policy for the oyster population in Pamlico Sound and supply viable larvae to wild populations and reefs that are available for harvest. In an oyster sanctuary, oysters cannot be harvested, but hook and line fishing is allowed.

By limiting harvest of oysters from sanctuaries, the reefs support a high density of sexually mature oysters relative to other reef types in North Carolina, which increases the reproductive output from sanctuaries (Peters et al. 2017). To harness the reproductive output of larvae from sanctuaries, the sanctuaries are being located in areas of the sound so that larvae from the sanctuaries can supplement and support the wild population, as well as other sanctuaries.

Oyster sanctuaries help to improve the demographics of oyster populations in Pamlico Sound. Compared to other reef types, oyster sanctuaries boast significantly higher densities of oysters, up to 10 times more oysters per area, than natural or cultch planted reefs (Puckett and

Eggleston 2012, Peters et al. 2017, Theuerkauf et al. 2017 (Figure 1)). This monitoring showed that natural subtidal reefs support, on average, 61 oysters per meter squared, compared to subtidal cultch planted reefs which support, on average, 152 oysters per meter squared and intertidal reefs which support 121 oysters per meter squared. In general, oyster sanctuaries supported 670 oysters per meter squared (10 times more than natural reefs and 4.4 times more than cultch planted reefs).

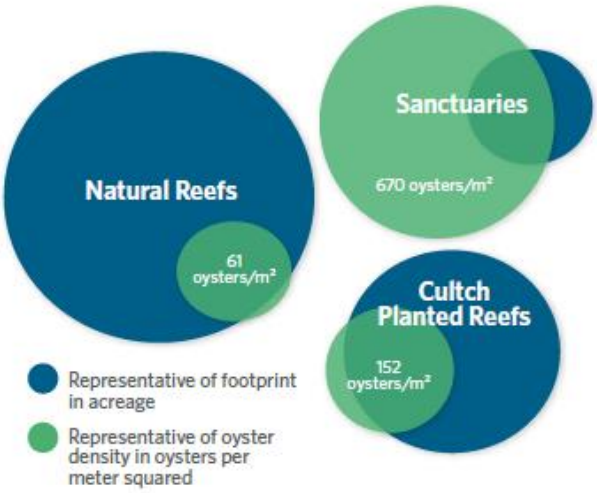

Figure 1. Average oyster densities (oysters/m2) at three different reef types relative to their aerial extent in Pamlico Sound. Adopted from Puckett et al. 2012, Peters et al. 2017, and Theuerkauf et al. 2017.

In addition to higher densities, oyster sanctuaries generally have a better distribution of size classes with higher densities of juveniles, sub-legal oysters and legal size (greater reproductive output) oysters compared to natural and cultch planted reefs (Figure 2). So not only do sanctuaries have more oysters in general, they have more, larger oysters than other reef types.

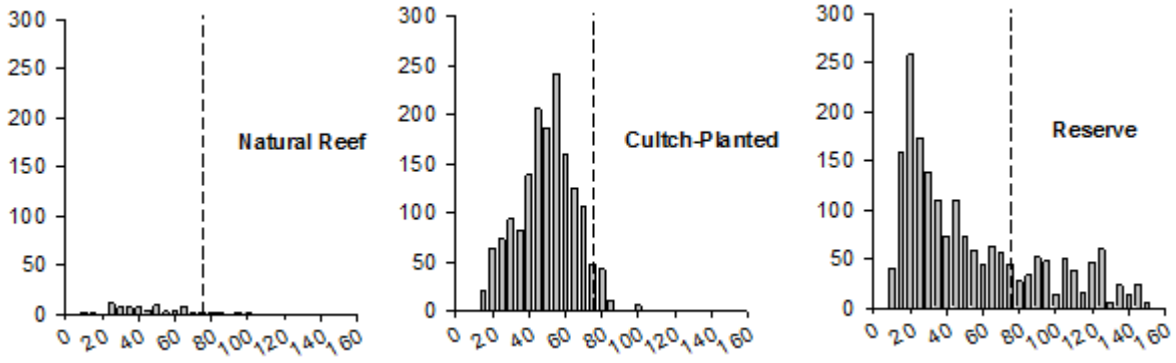

Figure 2. Comparison of oyster densities (per meter squared, on the y-axis) and size class (length of left valve in mm, on the x-axis) on three different reef types. Dotted line indicates 75 mm, the legal size for oyster harvest in North Carolina. Courtesy Peters et al 2017.

High oyster densities in oyster sanctuaries persist for well over a decade and in some cases, for nearly two decades (Puckett et al 2018; Figure 3). Two notable exceptions occurred at the Ocracoke and Clam Shoal sanctuaries (blue and red lines in Figure 3)- after initial oyster recruitment success, these two sanctuaries saw complete loss of oysters within 5 years of construction, potentially due to oyster pests such as boring sponge and drills.

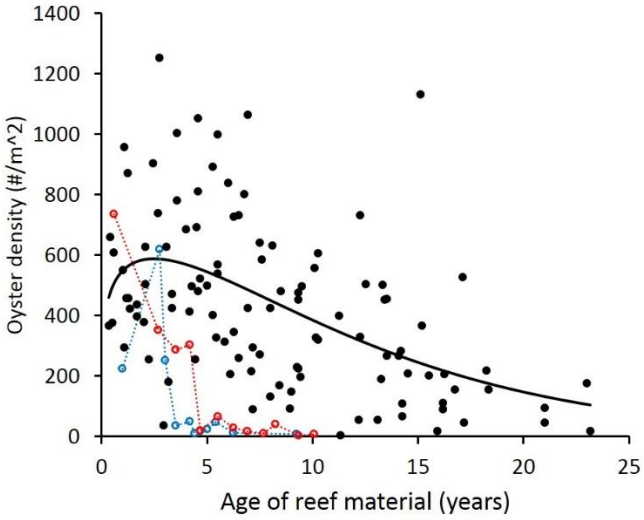

Figure 3. Mean oyster density in sanctuaries over time. The solid curve depicts best fitting trend and closed black circles are actual observations. Open circle lines represent two sanctuaries (Ocracoke = blue and Clam Shoal = red) where oyster densities collapsed within 5 years. Courtesy Puckett et al. 2018. Updated with data provided by N.C. Division of Marine Fisheries.

For their relative footprint, oyster sanctuaries contribute disproportionately to larval output in the sound. They cover only about 6% of the oyster reef footprint in the sound, but account for over 30% of the oyster population and provide nearly 75% of the larval output (Puckett and Eggleston 2016, Peters et al. 2017, Theuerkauf et al. (in prep)).

The division continues to refine the sanctuary program based on scientific literature, guidance from researchers and advisory groups and monitoring of sanctuary reefs. The material used in construction of the sanctuaries and locations selected for new sanctuary construction are an evolving, adaptive process.

For example, the division carefully considers the materials used and locations for sanctuary construction due to the loss of oysters and oyster habitat at Clam Shoal and Ocracoke oyster sanctuaries. These two sites initially showed high oyster recruitment, but after the initial success of the reefs, the populations declined to nearly zero within three to five years. To date, there is no conclusive published research explaining the loss. Some researchers have expressed concern about using limestone marl in high salinity, subtidal environments for sanctuary construction. Since these concerns were brought to light, the Division examined their construction methods and sanctuary siting guidelines.

They still use limestone in construction of some reefs but consider salinity, cost and availability of material before proceeding. Sanctuary sites with moderate to low salinity can be suitable for limestone marl reef construction. There is substantial cost-savings when using marl over alternate materials such as granite. For example, in constructing the first two phases of a recent sanctuary (Swan Island) the division estimated that building 10 acres of reef would cost $1,325,000 if constructed with granite, versus $855,000 when constructed with marl, a cost increase of nearly 50%.

A habitat suitability model developed by researchers at NC State University Center for Marine Research and Technology and the N.C. Coastal Estuarine Research Reserves helps to guide locations of sanctuaries. This model continues to be updated and refined. Most recently, the researchers have started to consider long-term persistence of the reefs (Puckett et al. 2018) and water filtration capacity (Theuerkauf et al. 2019) in addition to the larval connectivity and other environmental parameters that make for good oyster restoration.

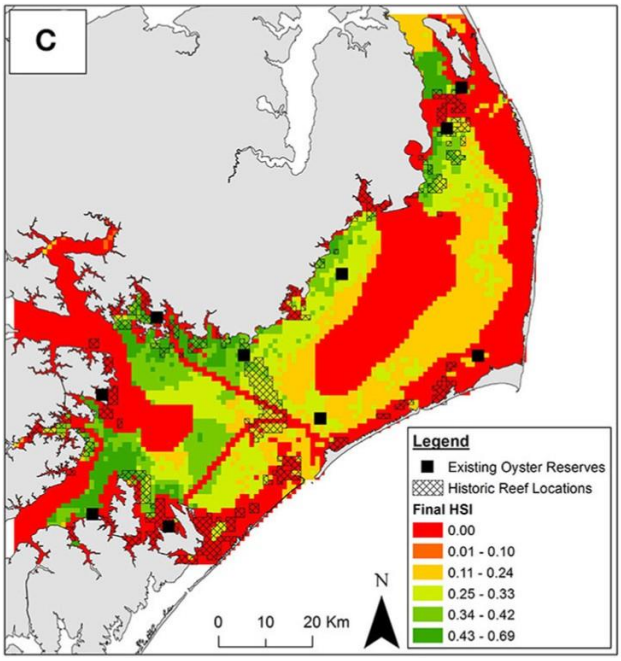

Figure 4. Habitat suitability index for siting sanctuaries in locations to maximize oyster persistence. Suitability increases from low (red) to high (green). Oyster sanctuaries depicted by black squares (not to scale) and location of historic (c. 1890) oyster reefs depicted by black crosshatch. Puckett et al. 2018.

In general, the oyster sanctuary program is thought to be very successful in restoring oysters to the sounds. Recent research and monitoring bears this out. A brief summary of recent monitoring and research results is available at the end of the draft recommendations.

Accomplishments thus far:

The first sanctuary was built in 1996, starting with Croatan Sound. Today, in 2020, there are 15 sanctuaries strategically located in Pamlico Sound (Figure 5). The division has permitted 395.44 acres and, with partners such as the Coastal Federation, developed 357.76 acres.

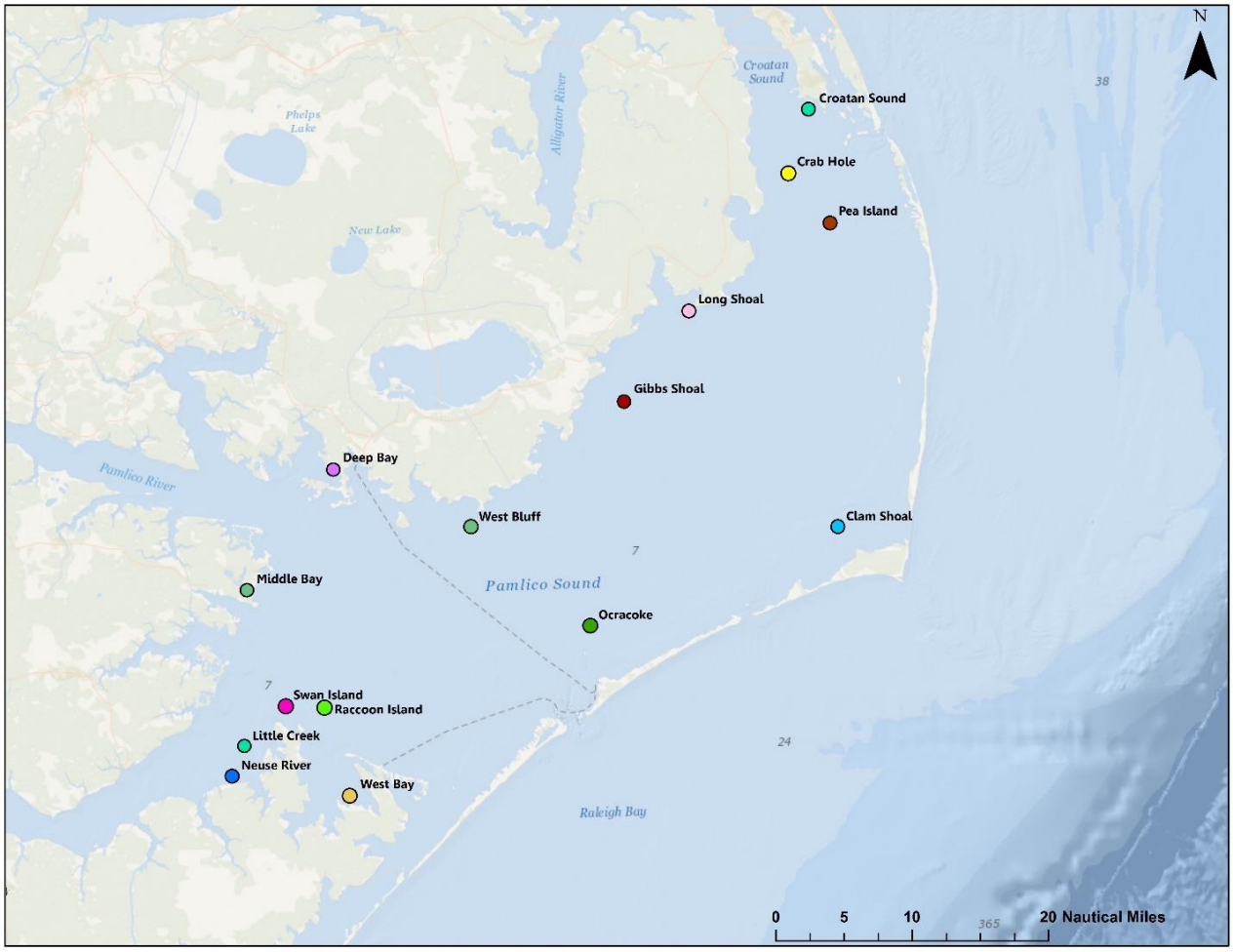

Figure 5. The current Senator Jean Preston Oyster Sanctuary Network, 2020. The network consists of fifteen sanctuaries and 357.76 developed acres of reef throughout Pamlico Sound.

In 2008 and 2015, the NC Oyster Steering Committee released the second and third editions of the Oyster Blueprint. The Blueprint outlined a goal of building 500 acres of oyster sanctuary. This goal was set based on the potential construction capabilities of the division working at full potential and with consistent, full funding. This goal was reiterated in 2016 when the Division provided a report to the General Assembly outlining their future needs in order to build the Senator Jean Preston Oyster Sanctuary Network by 2026. The plan called for an investment of $30 million to the sanctuary program (made up of state appropriations and federal grants) which would result in the completion of 500 acres of sanctuary reef in Pamlico Sound by 2026. In the past five years (2015-2020), nearly $8 million has been invested in the sanctuary program, building 40 acres of new oyster sanctuary habitat.

Building off of the goals stated in the previous Blueprints and the Senator Jean Preston Oyster Sanctuary Network recommends the following actions for consideration.

Draft Recommended Actions:

Action: Build additional 100 acres of Oyster Sanctuary in Pamlico Sound by 2025.

1) Build 100 acres of Oyster Sanctuary in Pamlico Sound.
    a. Secure funding and staff to build 100 acres of sanctuary reef.
        i. Maintain current state appropriations of $850,000 to build 3 to 5 acres of sanctuary reef annually.
        ii. Match with federal grants whenever possible so that 6 to 10 acres can be constructed each year.
        iii. Target a total of $3.5 million in state and federal grants annually to construct oyster sanctuaries at a rate of 20 acres per year.
    b. Determine best method to allow the Division to contract over multiple fiscal years.

2) Monitor and use the best science available to inform restoration activities. Including:
    a. Location of sanctuaries
        i. make sure they are well distributed.
        ii. understand sediment transport dynamics to avoid areas that will be buried during nor-easters/hurricanes.
    b. Selection of appropriate substrate material (not all materials are suitable in all locations).
    c. Appropriate design including size, architecture and amount of relief of reefs.
    d. Determine the metrics of success that would allow sanctuaries to sustain a positive return on investment. Consider:
        i. How much water filtration and nitrogen removal (convert to wastewater treatment value) should oyster sanctuaries contribute to Pamlico Sound?
        ii. How many oyster larvae should oyster sanctuaries contribute to commercial harvest?
        iii. How much fish production should be attributed to oyster sanctuaries?
        iv. How many recreational fishing opportunities should oyster sanctuaries provide?
        v. How many people should be employed in the construction of oyster sanctuaries?
    e. Monitor reefs for success metrics identified in 2.d. and practice adaptive management of sanctuaries as needed.

3) Make restoration of oyster habitat a state mandated activity, building off the State Shellfish Initiative.

4) Plan for future work: permit sanctuaries in 3-5 year batches for ease of construction and fund raising.
    a. Maximize use of existing permitted sanctuaries, where appropriate.
    b. Prioritize new sanctuary locations to maximize larval output and long-term persistence.

5) Report out and publicize the results of the sanctuary program in the annual State of the Oyster report. Include:
    a. acres created
    b. the success of the program, understanding that the success of the reefs (how many oysters and the size of the oysters) changes over time
    c. estimated fish production
    d. estimated water filtration improvements
    e. economic impact (number of people employed in the reef construction)

Action: Continue to refine and improve the oyster sanctuary acreage goal through the next five-year Blueprint period.

1) Determine the highest priority ecosystem service that more oyster reefs would achieve.

2) Based on the priority ecosystem services of the sanctuary network, determine how many sanctuaries are needed to achieve this goal.

For example, five hundred acres was set as an interim goal in the Senator Jean Preston Oyster Sanctuary Network recommendations and previous Blueprints. Researchers now estimate 700-1000 acres of sanctuary may be needed to maximize larval subsidies to harvested reefs and sanctuaries, as well as provide essential ecosystem services such as water filtration, based on the best science and models now available. This is still an evolving body of knowledge and additional research in the next five years could help to better define the ultimate reef needs.

3) Communicate sanctuary accomplishments, additional needs and goals through a coordinated outreach strategy.

4) Develop recommendations for sampling methods and survey design for a statewide oyster stock assessment of subtidal and intertidal populations.

Action: Determine the Feasibility of an Oyster Sanctuary and/or Shellfish Management Area Designation in Southern Waters.

Long have closed areas in southern waters been considered *de facto* sanctuaries. However, research from UNCW is showing that these closed waters may exhibit a shell budget deficit, skewed sex ratios and possibly low larval output- and may not in fact be serving in a sanctuary capacity. Therefore, it is recommended that this issue be considered under the Fisheries Management Plan framework and through the next edition of the Blueprint. A new management action may be adopted:

1) Define the need and intent of this management action (ecosystem service based v. larval connectivity v. coastal resiliency).
2) Determine the best- most appropriate designation of protected or created reef.
3) Enact rule change and/or legislation to allow new designation as needed.
4) Conduct research and modeling to inform the location, material, and architecture of reefs based on intent.
5) Use existing science to inform success of proposed reefs.
6) Establish a plan for future reefs.