STATE OF THE OYSTER: Progress Report

on the OYSTER RESTORATION AND PROTECTION PLAN FOR NORTH CAROLINA

Prepared by the North Carolina Coastal Federation
Published September 2019

"North Carolina is the best place to grow oysters!
I'm trying to do my part by farming sustainable seafood,
giving back to the environment, and building a new coastal economy."

Ryan Bethea, Owner and Operator of Oysters Carolina
Harkers Island, North Carolina

STATE OF THE OYSTER: 2018 PROGRESS REPORT

PUBLISHED BY
North Carolina Coastal Federation

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Executive Summary

Oysters took center stage in many communities along our coast and in the halls of state government in Raleigh during 2018. All this public and political attention resulted in huge progress to both fuel economic growth and expand the acres of oysters that provide essential fish habitats and clean water for our coast.

The following progress was made in 2018 to advance the Blueprint's goals and objectives:

- The state became the sixth to join the National Shellfish Initiative. This program means that North Carolina will get more federal assistance in managing and promoting oyster farming and habitat restoration.
- More than 100 stakeholders completed and delivered a strategic shellfish mariculture plan to the state legislature. This plan will grow the shellfish farming industry into a $100 million industry by 2030.
- Shellfish farm production accounted for more than 50% of the oysters landed in the state for the second year in a row.
- State lawmakers funded North Carolina State University to hire a state shellfish pathologist who will monitor the health of oysters.
- Lawmakers also funded a Division of Marine Fisheries' water quality lab in Dare County to reopen shellfish waters for harvest.
- In order to protect and restore water quality, two local governments along the coast developed new watershed restoration plans.
- Nearly 8,000 acres of wetlands are being restored by Natural Resources Conservation Service and the North Carolina Coastal Federation to improve water quality in years to come.
- Oyster restoration efforts advanced with more than 15 acres of new oyster reefs created. The sanctuary reefs built over the past decade in Pamlico Sound were inventoried by researchers and found to produce 10 times more oysters per area than natural reefs.

While 2018 was filled with positive advancements regarding active stakeholders and political engagement, nature was not so cooperative. Hurricane Florence dealt a harsh blow to both natural and farmed oysters. Heavy rains and winds caused major problems with water quality and destroyed a number of shellfish farms. The hurricane revealed weaknesses in our existing management strategies, the need for crop insurance for shellfish farmers and just how vulnerable oysters are to poor water quality—including bacteria and significant salinity variations. State lawmakers allocated resources to help with the recovery after the storm and work is now in progress to rebuild lost farms and reefs.

In the coming year, the stakeholders involved with developing and using this Blueprint will update and revise the plan. A new plan should be developed and ready for use by the end of 2020. Anyone interested in helping with these efforts is invited to participate since it will take all hands on deck for this plan to succeed.

"The collective contributions from the members of the North Carolina Oyster Steering Committee are the driving force behind the successes in the world of North Carolina oyster work."

Todd Miller, executive director, the North Carolina Coastal Federation

Background and Purpose

The *2018 State of the Oyster Progress Report* is prepared by the North Carolina Coastal Federation and aims to track the work carried out by all stakeholders involved in implementing the *Oyster Restoration and Protection Plan: A Blueprint for Action 2015-2020*. The work reported does not always reflect the Coastal Federation's goals and mission, but it is the intention of this report to summarize all work and changes happening in the state around oysters. The actions reported build on the work of many since the 1995 Blue Ribbon Advisory Council on Oysters, 1997 Fisheries Reform Act and the first edition of the *Blueprint*, originally drafted in 2003 and now in its third edition.

The *Blueprint* aims to achieve the following goals by 2020:

1. Link restoration of oysters and water quality with an economic development strategy for North Carolina.
2. Establish at least 500 acres of new oyster sanctuaries.
3. Plant cultch to provide for ample sustainable wild oyster harvest.
4. Sustainably build the oyster mariculture industry to meet or exceed wild harvest.
5. Sustainably manage oyster harvest on public bottom.
6. Protect and improve water quality in priority shellfish growing areas.
7. Document oyster population status and trends resulting from the successful implementation of the *Blueprint*.

IMPORTANCE OF OYSTERS

Oysters are vital to North Carolina's coastal ecology and economy. They filter water, provide food for humans and create reefs that build homes for fish. These environmental functions, in turn, support jobs and provide economic opportunities for coastal communities.

OYSTERS IN TROUBLE

Worldwide, oyster populations are a record lows. Despite some recovery in recent years in North Carolina, it is estimated that oysters are at about 15-20% of historic harvest levels. Oyster harvest is currently considered the best measure of the oyster population.

Oysters in Decline

Oysters are listed as a "species of concern" by the North Carolina Division of Marine Fisheries. The *Blueprint* identifies the primary reasons for the decline in oyster populations and harvest levels as:

- Overharvest without returning enough substrate to the water
- Habitat loss
- Natural disasters
- Low recruitment
- Shellfish diseases and predators
- Water quality degradation

GOAL 1: Link restoration of oysters and water quality to an economic development strategy for North Carolina.

The *Blueprint* includes a five-year strategy for incorporating coastal restoration as part of a formal state economic development plan. The following progress was made in 2018 to link the restoration of oysters and water quality to an economic development strategy.

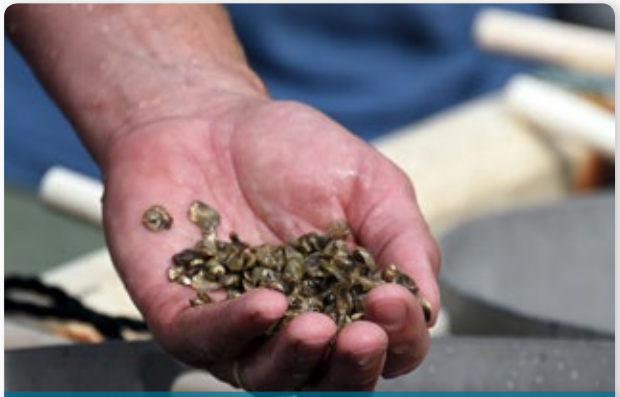
2018 LEGISLATIVE ACTION

Mariculture Plan Submitted

In 2017, the North Carolina General Assembly charged the North Carolina Policy Collaboratory with developing a strategic shellfish mariculture plan for North Carolina. After 18 months and a comprehensive stakeholder engagement process, the plan was submitted to the General Assembly in December of 2018. North Carolina has great potential to be a national leader in oyster mariculture. The plan revealed that with dedicated efforts, the industry could grow to $100 million ($33 million in gate value) and create 1,000 jobs for coastal North Carolina by 2030.

Permitting for Restoration Streamlined

The North Carolina Division of Coastal Management and the Wilmington District of the U.S. Army Corps of Engineers worked with a stakeholder group to devise new state and federal general permits for living shoreline projects. Recommendations from the stakeholder group were used to amend the existing state general permit for marsh sills and develop a new federal regional permit. In many locations, marsh sills are constructed within the intertidal to form oyster reefs.



The mariculture industry could grow to **$100 million** ($33 million in gate value) and create **1,000 jobs** for coastal North Carolina by 2030.[1]

For the increasing number of living shorelines being constructed around the state, the new permits increase the efficiency in permitting marsh sill projects which may include significant opportunities for oyster restoration. [2]

Advantages to the new general permit include:

- Allowing the use of oysters in living shorelines.
- Following a set of pre-approved design standards.
- Streamlining the coordination and approval process between agencies.

For more information on marsh sills and living shorelines, see page 8. [3]

OTHER ACTIONS

Oyster Restoration Continues to be an Economic Builder

In 2018, phase two of the Swan Island Oyster Sanctuary was completed. A total of 30 acres of sanctuary have now been built at this site. All materials, contractors and employees for this project are North Carolina based, including the 50,000 tons of granite and marl used in the construction. Each year roughly 56 people are employed during the construction of the project.

The National Oceanic and Atmospheric Administration's Community-based Restoration Program awarded approximately $8 million in total funding for 16 multi-year habitat restoration projects across the country. Of the total funding awarded, the Restoration Center provided a grant of $950,000 to the Coastal Federation, which was matched by $850,000 in state funds. With the funding in place, the Coastal Federation, the North Carolina Division of Marine Fisheries and private contractors plan to expand the 30-acre project to an almost 40-acre project in 2019. Work will continue to be carried out by local contractors, suppliers and workers.[4][5]

THROUGH SWAN ISLAND SANCTUARY PROJECT

$1.8 million	56 people	10 acres
INVESTED	EMPLOYED	OF REEF CREATED

1 Information received from https://tinyurl.com/UNCLegislativeStudies. The full plan can be found at https://tinyurl.com/MariculturePlan.

2 Information received from https://tinyurl.com/MarshSillsGeneralPermit, reference provided by NOAA

3 Information received by email from Dr. Brandon Puckett, Research Coordinator, North Carolina Coastal Reserve and National Estuarine Research.

4 Information received from https://tinyurl.com/SwanIsland

5 Information received by email from Bridget Callahan Lussier, Marine Habitat Restoration Specialist, NOAA Restoration Center/ERT contract

Making North Carolina the Napa Valley of Oysters: the North Carolina Shellfish Initiative

In 2018, North Carolina became the sixth of eight states to join the National Shellfish Initiative. The National Oceanic and Atmospheric Administration (NOAA) established the National Shellfish Initiative in 2011 with the goal to increase populations of bivalve shellfish in our nation's coastal waters—including oysters, clams, and mussels—through both sustainable commercial production and restoration activities. By joining the Initiative, the state recognizes the value and importance of shellfish to its economy, cultural heritage and environmental health. In launching a state initiative, North Carolina galvanizes the support of local, state and federal leadership in promoting sustainable seafood, shellfish restoration and clean water. The Initiative will advance the following four goals, which parallel the *Blueprint*:

Create Jobs

The Initiative will help create new jobs in North Carolina's coastal communities while protecting and restoring its environment.

Protect Water Quality

The Initiative will protect and restore water quality to allow natural reefs to thrive and mariculture to grow.

Protect Shellfish Health

The Initiative supports the establishment of a shellfish pathology program to ensure healthy wild and farmed shellfish populations and to support the existing state shellfish research hatchery.

Ensure Sustainable Management

The Initiative will safeguard industry growth and ensure siting is guided by a thorough regulatory framework to maximize environmental and economic returns while protecting public trust rights.

By launching the North Carolina Shellfish Initiative, the state's shellfish partners confirm their commitment to realizing the goals outlined above.[1]

1 Information received from https://tinyurl.com/ShellfishInitiative

GOAL 2: Establish at least 500 acres of new oyster sanctuaries.

The North Carolina Division of Marine Fisheries (NCDMF) strategically constructs oyster sanctuaries in estuarine waters to ensure there are sufficient natural juvenile oysters (spat) to populate nearby harvestable oyster reefs. The *Blueprint* outlines a goal to select suitable oyster sanctuaries sites to create a self-sustaining network of reefs and to minimize user conflicts in coastal waters.

2018 LEGISLATIVE ACTION

The general assembly continues to support oyster sanctuary construction through state appropriations. In 2018, $850,000 of recurring funds were allocated to the sanctuary program.[1]

Phase Two of Swan Island Oyster Sanctuary Project Complete, Phase Three Funded

Ten acres of oyster sanctuary were built in a partnership between NCDMF, the Coastal Federation and a private contractor in 2018. The site now covers 30 acres total. Funding from the state and the National Oceanic and Atmospheric Administration (NOAA) will allow the partners to build an additional 10 acres in 2019. The first phase of the project constructed oyster reefs out of limestone marl, the second phase was constructed from granite and the third will be built out of limestone marl. NCDMF will closely monitor the site to compare the materials and see if there is any cost efficiency or improved biological success between the two.

Oyster Sanctuaries Work

A recently completed, unpublished study by researchers at North Carolina State University indicates that subtidal oyster sanctuaries in Pamlico Sound account for over 30% of the oyster population in the Sound. The sanctuary reef locations studied support nearly 10 times more oysters per area than the other reefs monitored.[2]

NCDMF staff monitor the 15 sanctuaries every year between August-December. NCDMF surveyed the Swan Island

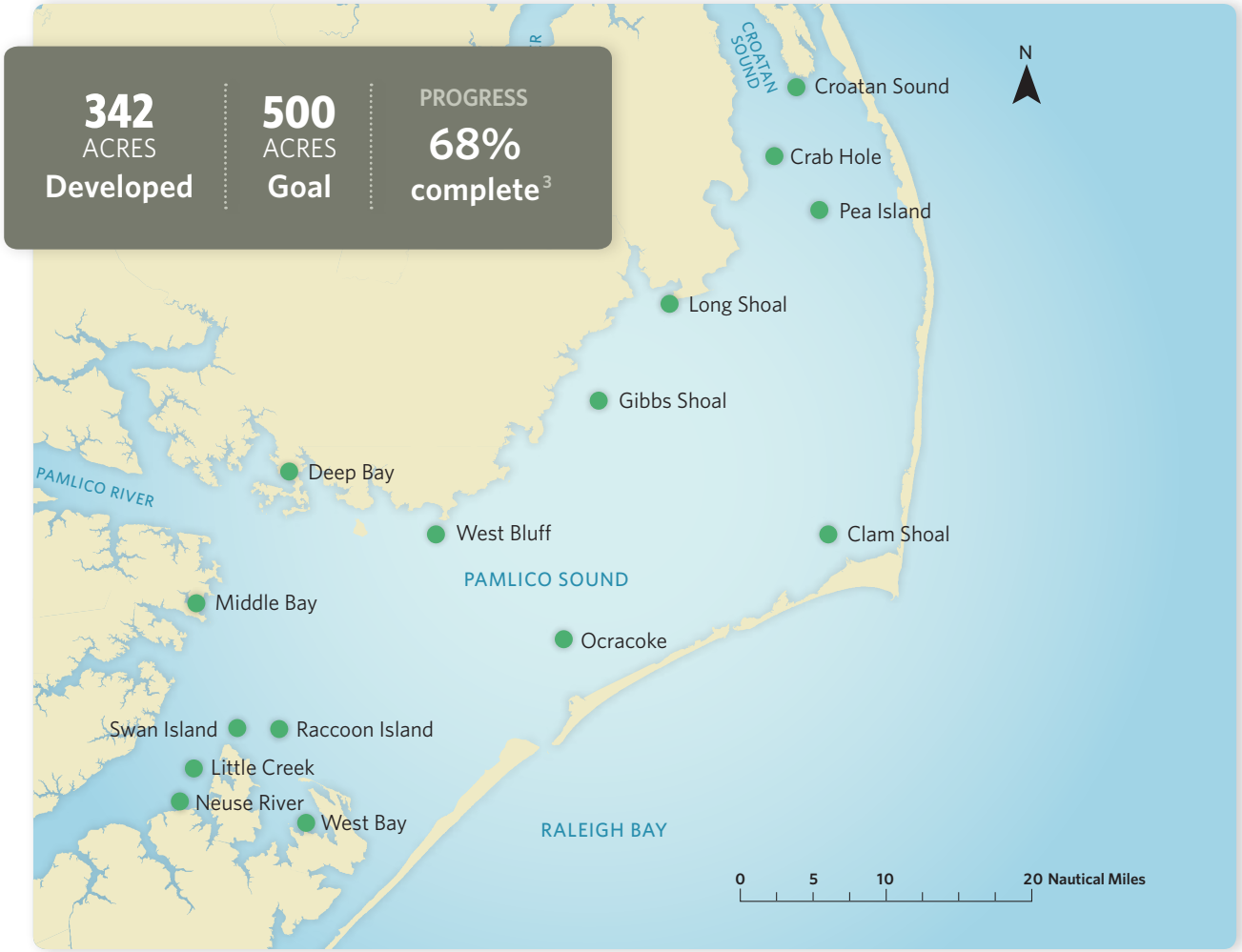


Figure 1: *North Carolina's oyster sanctuary network.* *Map courtesy North Carolina Division of Marine Fisheries.*

Sanctuaries contribute to the oyster population in Pamlico Sound disproportionately to their areal footprint. Sanctuaries take up **6% of the oyster reef footprint** in the Sound, but **provide over 30% of the oyster population**.

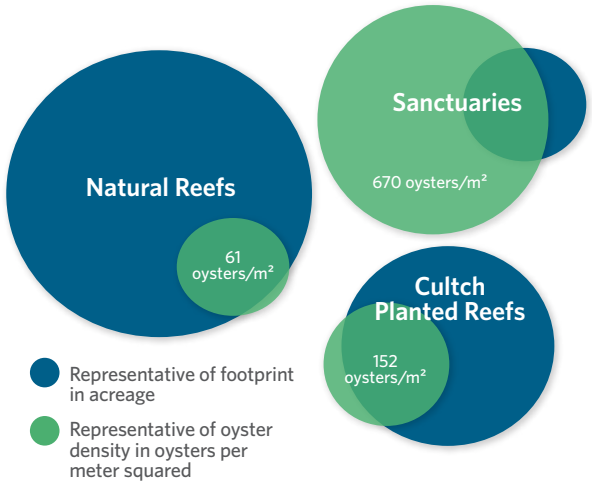


Figure 2: *North Carolina State University reports natural and cultch planted subtidal reefs in Pamlico Sound exhibit average densities of 61-152 per meter squared and sanctuaries, on average, have a density of 670 oysters per meter squared.*[4]

Sanctuary in August 2018 to observe oyster recruitment. Their monitoring showed 458 oysters per meter squared.[5]

NCDMF uses published research and past experiences to inform future reef building activities.

For access to an interactive map of oyster sanctuaries and artificial reefs in North Carolina, visit **tinyurl.com/ArtificialReefMap**.

IN PROGRESS

50 Million Oyster Initiative

Between 2017-2020, the Coastal Federation and its partners plan to create 50 new acres of oyster reef throughout North Carolina. With each acre of reef hosting well over one million oysters, there will be 50 million oysters supporting many different species of fish and wildlife. And with each oyster capable of filtering 50 gallons of water per day, those 50 million oysters will filter 2.5 billion gallons of water—every single day.

In 2018, the 50 Million Oyster Initiative was supported by NOAA grant funding, appropriations from the North Carolina General Assembly and support from Grady-White Boats and the Coastal Federation's members. In the second year of this initiative, the Coastal Federation and partners restored 14.43 acres of reef throughout the state. This includes 10 acres at the Swan Island Oyster Sanctuary and at least 4.43 acres of patch reef at various sites, including Carolina Beach State Park, the Wanchese Marine Industrial Park and several private living shorelines that incorporated oyster reef materials.

OTHER ACTIONS

Siting Tool Refined

Researchers from North Carolina State University's Center for Marine Science and Technology in collaboration with NCDMF, Division of Coastal Management, the Nature Conservancy, and NOAA refined the Geographic Information System-based tool used to locate potential subtidal oyster reefs for restoration. The updated tool now takes into consideration the water quality benefits that can be realized from siting new reefs in specific locations. The researchers developed three versions of their model that:

- Identify areas where oyster restoration yielded maximum water filtration benefits.
- Identify areas that would best sustain the overall oyster population.
- Identify areas with a balance between water filtration and population enhancement.

In some cases, all versions of the tool can be used. In others, one version may provide more advantages than another.[6]

Developing the New River "Highway of Oysters"

In 2018, a collaboration between the Coastal Conservation Association of North Carolina, the City of Jacksonville, the North Carolina Wildlife Habitat Foundation and the University of North Carolina's Institute of Marine Sciences took significant steps forward in an attempt to improve water quality and create oyster habitat in the New River Estuary (NRE). The partners began implementing the New River 'Highway of Oysters.'

The Highway of Oysters will create oyster habitat stepping stones in the central portion of the estuary. These stepping stones will host oyster broodstock populations that will supply larvae to habitats within the central and upper portions of the NRE. Six stepping stone sites were proposed. The NRE is an area covering approximately 34 square miles and is classified as Nutrient Sensitive Waters by the Division of Water Resources.

In 2018:

- Corners of the six reef locations were posted and signs installed.
- Four oyster castle reefs and four oyster catcher reefs were built on all six locations.
- Sites were monitored monthly.
- Half a million adult oysters were placed on 25 existing mounds at AR-398, a nearby artificial reef built by NCDMF in 2011.[7]

1 Data received from Joint Conference Committee Reports found https://tinyurl.com/JointCommitteeReports

2 Theuerkauf et. al in prep – Information received through email from Dr. Brandon Puckett, Research Coordinator, North Carolina Coastal Reserve and National Estuarine Research.

3 Information and data received via email with Jason Peters, NCDMF, March 2019.

4 Theuerkauf et. al in prep – Information received through email from Dr. Brandon Puckett, Research Coordinator, North Carolina Coastal Reserve and National Estuarine Research.

5 Data received through email with Jason Peters, Enhancement Program Supervisor, North Carolina Division of Marine Fisheries, Fall 2018

6 Information received through email with Dr. Brian Boutin, Program Director, The Nature Conservancy Albemarle Pamlico Sounds and https://tinyurl.com/SitingTool

7 Information and data received through email with David Sneed, Executive Director, Coastal Conservation Association North Carolina

Living shorelines are a creative and effective approach to shoreline stabilization while maintaining, restoring or enhancing the shore's natural habitats.

Oyster Patch Reefs and Living Shorelines

Additional oyster habitat restoration in the form of patch reefs and living shorelines are smaller scale restoration efforts carried out by nonprofits, universities, municipalities and waterfront property owners. In 2018, 4.43 acres of these reefs were built through these types of efforts.

Hurricane Florence demonstrated the utility of living shorelines as a shoreline stabilization technique that have the added benefit of creating coastal habitats like marsh and oyster reefs. A survey of shorelines after the storm revealed that soil behind some bulkheads was scoured out and many of these hard structures failed. Living shorelines on the other hand weathered the storm, outperforming bulkheads. Living shorelines demonstrate many advantages over hardened structures, like bulkheads.

Living Shorelines:

- Include planted salt marsh grasses and low profile sills or marsh toe revetments.
- Reduce erosion and maintain the natural slope of the land which helps absorb wave energy as it rolls up the shoreline.
- Often use recycled oyster shells which can potentially attract oyster larvae.
- The oysters and plants used in these projects filter and improve water quality, provide habitat for fish and wildlife and buffer the shore from changing water levels.

With the recently adopted state and federal general permits for living shorelines, it should become much easier to implement these types of projects in the future.

GOAL 3: Plant cultch to provide for ample wild harvest.

To create reefs, the North Carolina Division of Marine Fisheries (NCDMF) annually deposits tens of thousands of bushels of oyster shell, marine limestone and/or clam shell—collectively called "cultch"—in shellfish waters from the Shallotte River to the Pamlico Sound. NCDMF enhances oyster habitat in harvest areas by spreading cultch, which is colonized by oyster larvae, or "spat", that attach to the cultch and grow to three-inch harvest size in 24 to 36 months. These cultch planting sites are open to public harvest once oysters reach legal harvest size (3 inches). The Blueprint calls for continuing cultch planting efforts, implementing adaptive management when needed and building reefs with state and private partnerships whenever possible. These efforts contribute to the reconstruction of reefs that have been compromised by consistent harvesting, as well as aid in keeping up with future demands.

2018 LEGISLATIVE ACTION

In 2018, the legislature reduced the state's cultch planting program budget from $1.1 million to $402,000. The savings were used to fund the reopening of a northern water quality testing lab, a shellfish pathologist position at North Carolina State University and other water quality and oyster related programs.[1]

OTHER ACTIONS

In 2018, NCDMF planted 206,460 bushels of shell and marl at 12 locations for a grand total of 47.63 acres. Cultch planting in the southern coastal areas was limited. Material transport logistics were difficult because the NCDMF's flagship Research Vessel West Bay was decommissioned.[2]

An interactive map of NCDMF's cultch planting sites is available at **tinyurl.com/CultchPlantingMap**.

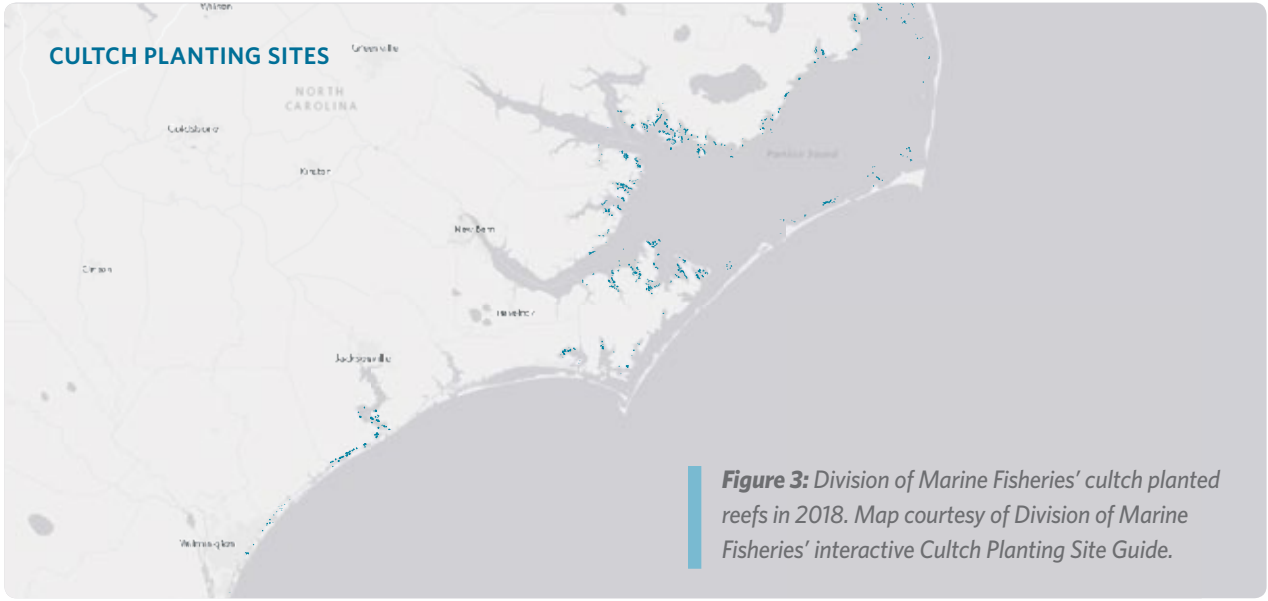


Figure 3: *Division of Marine Fisheries' cultch planted reefs in 2018. Map courtesy of Division of Marine Fisheries' interactive Cultch Planting Site Guide.*

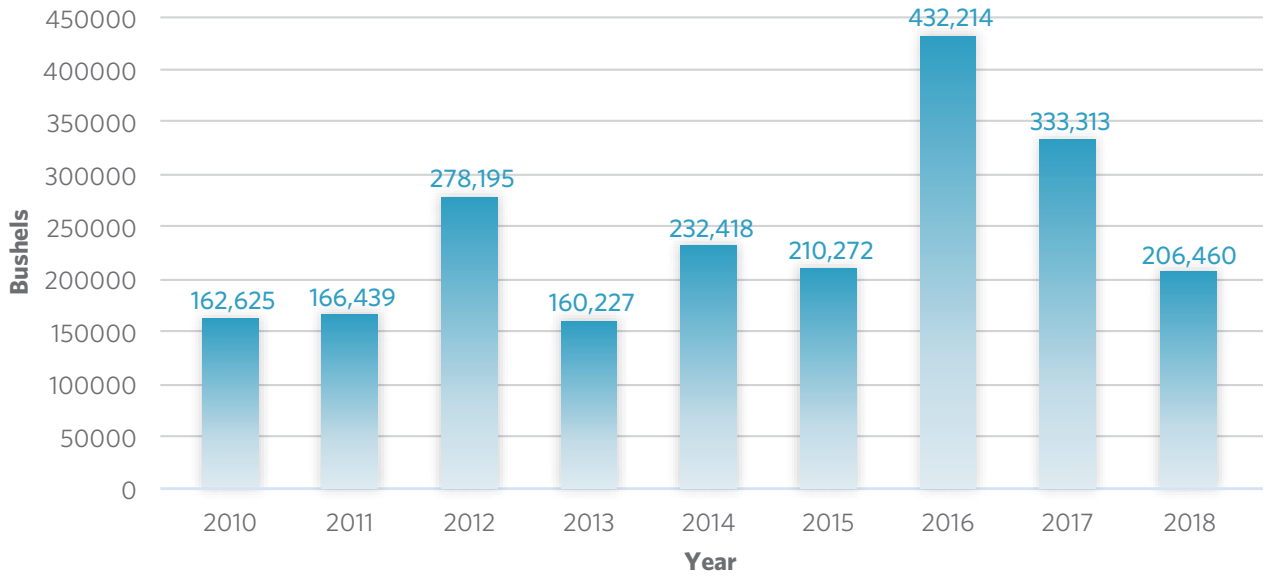


Figure 4: *The Division of Marine Fisheries deploys cultch material annually in designated cultch planting sites. In 2018 and with FY 17/18 funding, the Division planted 206,460 bushels of cultch.*[5]

Since 2003, NCDMF ran a statewide shell recycling program, collecting shell from restaurants and public drop off locations to use the material in cultch planting and restoration activities. At its peak, the program provided 15%of the state's needed material for cultch planting. State appropriations were cut in 2013 and NCDMF continued the program with grants and existing staff and equipment. In 2018, they formally dissolved the program as grant funding was lost. Several regional nonprofit organizations have worked to provide a stop-gap recycling effort while a formal plan for recycling efforts is devised.

IN PROGRESS

Research is ongoing by North Carolina State University Center for Marine Science and Technology to investigate habitat quality of cultch planting sites. Researchers are analyzing oyster settlement and fish use on the restored reefs. The habitat suitability of different cultch planting materials is also being monitored and compared.[3]

In order to implement the most cost-effective cultch planting strategy, NCDMF focused their planting efforts on historically successful areas and planted the material earlier in the year. Managers weigh the potential biological impact with material type options and construction logistics to maximize the return on investment.[2]

1 Data received from Joint Conference Committee Reports found https://tinyurl.com/JointCommitteeReports

2 Data received through email with Jason Peters, Enhancement Program Supervisor, North Carolina Division of Marine Fisheries

3 Information received through email from Dr. Brandon Puckett, Research Coordinator, North Carolina Coastal Reserve and National Estuarine Research.

4 Data received through email from Dr. David Eggleston, Director, Center for Marine Sciences and Technology, North Carolina State University, Spring 2018.

GOAL 4: Build the oyster mariculture industry to meet or exceed demands placed on wild harvest.

This goal was achieved in 2017. The value of farm-raised oysters now exceeds wild harvest levels in the state. A new goal was devised in 2018 to sustainably grow the industry to $33 million in landings by 2030. This will make shellfishing farming worth approximately $100 million to the coastal economy of North Carolina.

2018 LEGISLATIVE ACTION

Mariculture Plan Submitted

In December 2018, the North Carolina Policy Collaboratory submitted a Strategic Mariculture Plan to the North Carolina General Assembly. Guided by the Shellfish Mariculture Advisory Committee (SMAC), an over 100-person multi-stakeholder group, the plan proposes 20 priority recommendations for the legislature to consider in advancing the shellfish mariculture industry in North Carolina. These recommendations deliver a vision for the industry that will:

- Reduce grower barriers to entry.
- Address marketing and promotional needs.
- Implement an efficient regulatory structure.
- Address research needs.
- Improve water quality to sustain the industry.

North Carolina has great potential to lead the way in shellfish mariculture because of its clean water and the dedicated scientists, fishers and policymakers who support the development of this industry. The implementation of the strategic plan will allow the industry to garner support to develop new markets and expand market share within and outside of North Carolina. If approved, it will grow to provide $100 million dollars in total economic activity ($33 million farm-gate sales) by 2030 and create 1,000 jobs in coastal and rural North Carolina. Development of this plan is a key step in implementing the *Blueprint*.[1]

To read the full plan visit **tinyurl.com/MariculturePlan**.

State Shellfish Pathologist Funded

In 2018, the General Assembly appropriated funds to hire a state shellfish pathologist. This person will monitor and diagnose shellfish diseases in the state, ensuring healthy oyster populations. In addition, the person will help to certify that oyster "seed" (baby oysters) brought into the state from neighboring states are safe for use in the oyster mariculture industry. Currently, North Carolina relies on other states to provide this certification.

Shellfish Research Hatchery at the University of North Carolina Wilmington

University of North Carolina Wilmington's Shellfish Research Hatchery (SRH) continues to work on the development of superior performing oysters. With support from the General Assembly, the SRH breeding program continues to grow.

YEAR	# OF SPAWNS
2016	11
2017	15
2018	17

The SRH boasted 17 successful spawns in 2018, resulting in an increase in seed production of over 185% from 2016. Selected lines continue to improve, each generation generally showing an increase in size at 18 months of 5-10%.

Nearly 125,000 seed and 8.2 million larvae were sold or provided to growers and researchers in 2018. Broodstock was also given to Carteret Community College's hatchery. Hatchery lines were deployed in a variety of gear types on several farms across the state, and the results of their performance will soon be announced. The University of North Carolina Wilmington has expanded its demonstration site and continues to increase production, which will allow for increasing selectivity which in turn will accelerate the rate of improvement.[2]

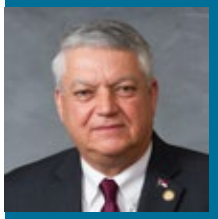
The SRH hatchery did sustain damages from Hurricane Florence. Refer to page 18 for more details.

OTHER ACTIONS

North Carolina Shellfish Initiative Launched

The Shellfish Initiative is a national initiative, led by the National Oceanic and Atmospheric Administration (NOAA),

"The North Carolina Oyster industry is important enough to do whatever it takes. It is great environmentally and economically as well as for commercial and recreational fishermen alike."



Senator Norm Sanderson
District 2 - Carteret, Craven, and Pamlico Counties

which recognizes the importance of shellfish to our coastal economies and habitats. The Initiative places value and importance on both shellfish restoration and farming efforts. North Carolina announced its participation in the initiative in 2018, making it the sixth state in the nation and first in the southeast to join this effort. The Shellfish Initiative will enhance the state's current efforts and provide the framework and guidance for creation of jobs, protection of water quality and shellfish health and ensuring sustainable management. For more information on this topic, refer to page 5.

Oyster Mariculture and Climate Change

The Nature Conservancy established a national Shellfish Growers Climate Coalition in partnership with growers on the East and West Coasts. The goal of the Coalition is to elevate the understanding that climate change has direct impacts on the shellfish mariculture industry. An additional goal of the Coalition is to communicate that concrete action on climate change is needed to secure the viability of shellfish mariculture and other food production into the future.[3]

For more information on the Coalition, visit **tinyurl.com/ClimateCoalition**.

Best Management Practices on Shellfish Farms to Prevent Marine Debris

The shellfish mariculture industry heavily relies on placing man-made gear in the marine environment. Producers are aware of the negative impact that gear can have if it escapes the farm and want to be proactive in preventing that from happening. While most growers are good stewards of the environment they rely on, storms and other natural disasters can cause gear to break loose. The Coastal Federation, NOAA, North Carolina Sea Grant (NCSG) and commercial shellfish operators partnered to develop best management practices for the prevention of marine debris from the shellfish farms. These management practices provide a guide for new growers and lease applicants to minimize loss of gear during normal operations as well as in preparation for a storm.[5]

View the full best management practices at **tinyurl.com/ShellfishBMPs**.

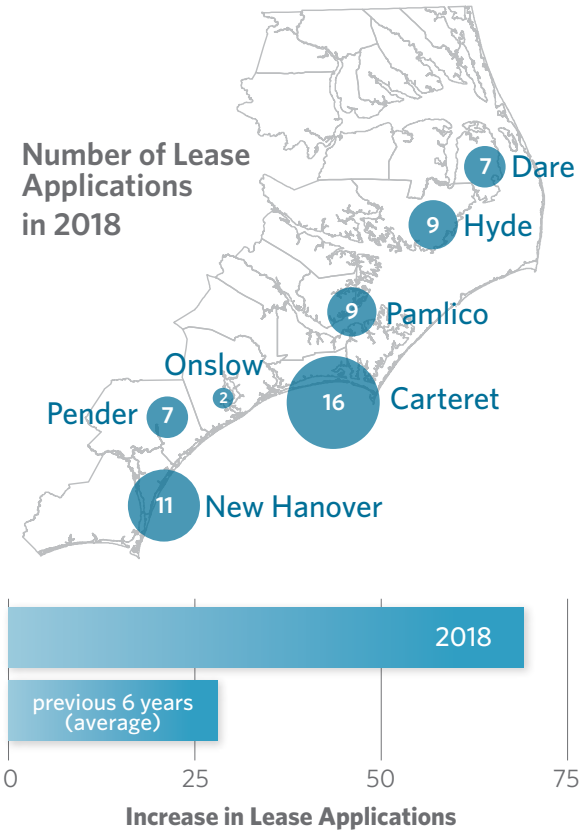


Figure 5: *Number of lease applications in 2018 by county.*[4]

IN PROGRESS

In efforts to ease prospective shellfish growers into the business, NCSG maintained outreach and industry support efforts, including development of a high school curricula aimed at workforce development. NCSG partnered with North Carolina Department of Agriculture to offer a shellfish mariculture session at the annual North Carolina Aquaculture Development Conference. Carteret Community College continued marine aquaculture education and training program.

NCSG began conducting trials to evaluate if new shellfish species could be successfully and commercially grown in the state. This would increase crop diversity for shellfish farmers. They are currently trialing grow out with bay scallops and sunray venus clams.[6]

Oyster Mariculture Interest Continues to Grow

In 2018, 69 lease applications were submitted with 39 leases granted. An average of 28 lease applications was submitted per year in the previous six years, showing a measurable increase in interest in the industry.[7]

YEAR	# OF LEASE APPLICATIONS	# OF LEASES GRANTED
2015	11	
2016	46	33
2017	72	52
2018	69	39

1 Information received from https://tinyurl.com/UNCLegislativeStudies.

2 Information and data received through email with Ami Wilbur, Director, University of North Carolina Shellfish Hatchery, Spring 2019

3 Information and data received through email with Ami Wilbur, Director, University of North Carolina Shellfish Hatchery, Spring 2019

4,7 Data received through email from Michael Graven, Lease Program Coordinator, North Carolina Division of Marine Fisheries, Spring 2019

5 Information received from https://tinyurl.com/ShellfishBMPs.

6 Information and data received through email with Dr. Chuck Weirich, Marine Aquaculture Specialist, North Carolina Sea Grant, Spring 2019

Updated goal:
to grow the oyster mariculture industry to $33M and generate 1,000 jobs by 2030

GOAL 5: Sustainably manage oyster harvest on public bottom.

Wild harvest of oysters is vital to our coastal economy and heritage. Efforts to refine strategies through the state's Fisheries Management Plan process and secure adequate resources will help to ensure that wild harvest can continue in a sustainable manner.

2018 LEGISLATIVE ACTION

Continued recurring funding to the North Carolina Division of Marine Fisheries (NCDMF) to staff and implement its fisheries management program.

The wild harvest and farming of oysters is guided by a state Oyster Fisheries Management Plan (FMP). Every three to five years NCDMF staff reviews its FMP with an Advisory Committee and makes recommendations to the Marine Fisheries Commission for any necessary changes. If changes to the management plan are approved, they are added to the FMP as an amendment. Amendment Four of the NCDMF's FMP was adopted in 2017, with rule changes coming into effect in the 2017/2018 oyster harvest season.[1]

One of the major changes to the FMP in 2018 is that you must hold a Standard or Retired Commercial Fishing License with a shellfish endorsement to harvest oysters from public bottom. For more information, contact Tina Moore with NCDMF at tina.moore@ncdenr.gov.

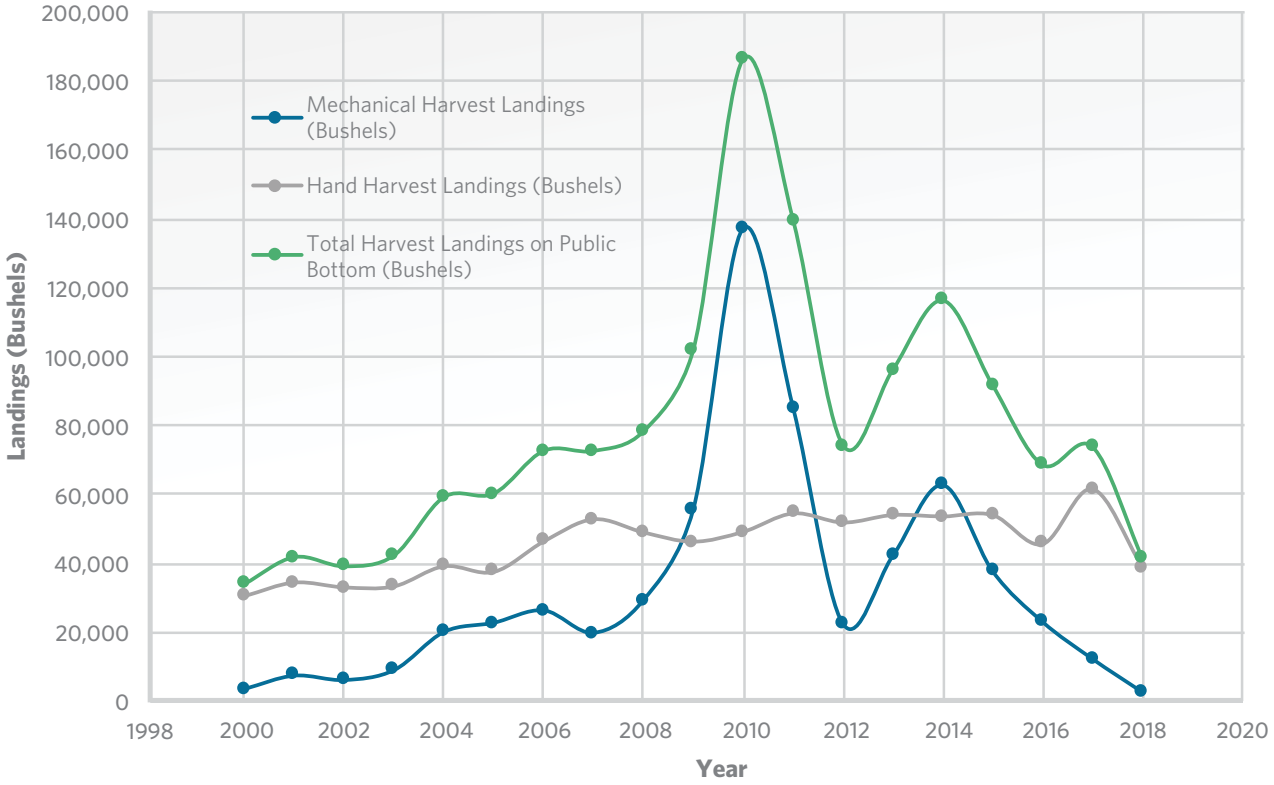


Figure 6: *Comparison of oyster landings off of public bottom areas by harvest method since 2000. Bushels calculated using the standard conversion rate of lbs. meat/ 5.29 = bushels.*[3]

IN PROGRESS

The Nature Conservancy, North Carolina State University Center for Marine Science and Technology, NCDMF and commercial oystermen completed the first year of research to develop a fishery-independent survey. This survey aims to provide the information necessary to assess the status of North Carolina's oyster stock. Though Hurricane Florence significantly impacted the region, enough useful information was acquired that will allow for the quantification of gear efficiency–a necessary first step for the survey.[2]

"Our coast is a very special place. It belongs to each and every one of us."

Michael Regan, Secretary, North Carolina Department of Environmental Quality

1 Information received through email with Tina Moore, Biologist Supervisor for North Carolina Division of Marine Fisheries

2 Information received via email from Dr. David Eggleston, Director, Center for Marine Sciences and Technology, North Carolina State University, Spring 2019

3 Data received through email from Alan Bianchi, Environmental Program Supervisor, North Carolina Divison of Marine Fisheries, Spring 2019

GOAL 6: Protect and improve water quality in priority shellfish growing areas.

Coastal waters must be clean enough to allow oysters to be safely harvested and eaten. Land drainage carries stormwater runoff and transports high levels of bacteria and other pollutants into coastal waters, threatening public health. Shellfish beds are often closed to fishing after moderate to severe rains.

Preparing watershed restoration plans to identify the most cost-effective measures to protect and improve water quality, restoring wetlands located in the headwaters of growing areas, retrofitting existing land uses with stormwater reduction measures and using low-impact development (LID) practices in new developments are tools that help restore and protect water quality management efforts.

2018 LEGISLATIVE ACTION

Funds Appropriated for Dare County Water Quality Lab

The legislature appropriated $176,946 in recurring funds and $95,898 in nonrecurring funds to the North Carolina Division of Marine Fisheries (NCDMF) to reopen a water quality testing lab in Dare County. NCDMF was granted those funds, allowing for the potential reopening of up to 54,000 acres of shellfish waters that have been administratively closed for almost four years. The funding will rehire two full time employees at the lab. The lab has not yet been secured due to limited space availability.[1]

Appropriations to Protect Water Quality

The North Carolina General Assembly increased nonrecurring appropriations to the Clean Water Management Trust Fund (CWMTF) by $4 million to support grants that address water pollution issues. The revised net appropriation for CWMFT grants was $18.3 million for fiscal year 18/19.

The General Assembly continued funding to the North Carolina Department of Environmental Quality for water quality monitoring, assessment and regulation.

Water Quality Included in State Mariculture Plan

Three recommendations in the State Mariculture Plan specifically address water quality due to its importance in successful shellfish mariculture. The recommendations are as follows:

- Appropriate funding for staff positions at the North Carolina Department of Environmental Quality to promote proper operation and maintenance of permitted stormwater systems and thereby increase water quality protection.
- Revise scoring criteria for state-administered grant funding programs to elevate projects that protect growing waters and provide additional funding for habitat restoration in high priority shellfish growing areas.
- Adopt a state policy that requires the use of LID practices for any state-funded construction project where use of such practices is feasible and practical. Model this policy after the existing federal policies that require use of LID for federal construction projects.[2]

"When you live at the coast, you need to know that clean water is one of the most important things. It has been eye opening to me to learn how much oysters do for the environment."

Rep. Pat McElraft
District 13 - Carteret and Jones Counties

"The time is now to reverse this trend of pollution."

Steve Weeks, owner of Crab Point Seafood in the Newport River

OTHER ACTIONS

Watershed Restoration Plans in Coastal Counties

Watershed restoration plans are put in place by municipalities or other interested groups to restore, improve and protect water quality using land-based management strategies. Once a watershed restoration plan is written, actions identified in the plan can be submitted to the U.S. Environmental Protection Agency or other grant agencies for implementation. In 2018, two restoration plans were developed. The Coastal Federation, the University of North Carolina Wilmington's Environmental Science Department, East Carolina Council and the town of Pine Knoll Shores drafted a plan for Pine Knoll Shores. Hyde County, the North Carolina Wildlife Resources Commission and the U.S. Fish and Wildlife Service partnered with the Coastal Federation

to develop a watershed restoration plan to help reverse the trend of water quality degradation for Lake Mattamuskeet.[3]

Closure Information Made Easily Accessible

NCDMF's Shellfish Sanitation Program now publish online maps that allow users to more easily see temporary shellfish closures in North Carolina. The maps are updated frequently and can be accessed at the following sites:

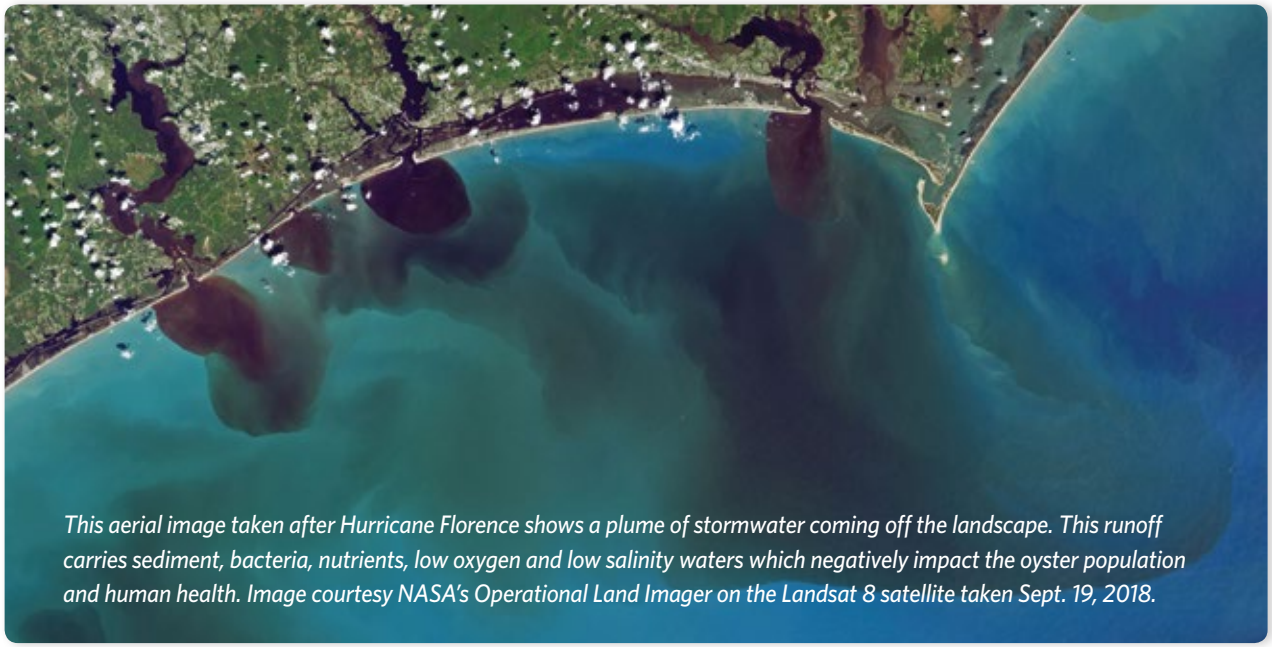
tinyurl.com/NCShellfishClosures

Maps like these can be useful to see water quality trends.

In 2018, new coastal river miles were classified as impaired in North Carolina, according to the state's draft impaired waters list. This includes additional miles in the White Oak, Neuse and Cape Fear River basins.[4] These waterbodies face significant water quality problems and action must be taken to halt these problems.

From 2017 to 2018, the acres of waters considered closed to shellfish harvest increased slightly. A total of 760,551 acres are considered closed to harvest in 2018 compared to 760,209 in 2017. This shows 34% of North Carolina coastal waters do not meet water quality standards for shellfish harvest. Closed waters include any coastal water that is rated by Shellfish Sanitation as conditionally approved closed, prohibited or restricted.

Hurricane Florence drove home the point that water quality impacts can be severe and need to be addressed moving forward. Many shellfish growers saw catastrophic losses to their crops due to prolonged low oxygen and low salinity in the wake of the storm.



This aerial image taken after Hurricane Florence shows a plume of stormwater coming off the landscape. This runoff carries sediment, bacteria, nutrients, low oxygen and low salinity waters which negatively impact the oyster population and human health. Image courtesy NASA's Operational Land Imager on the Landsat 8 satellite taken Sept. 19, 2018.

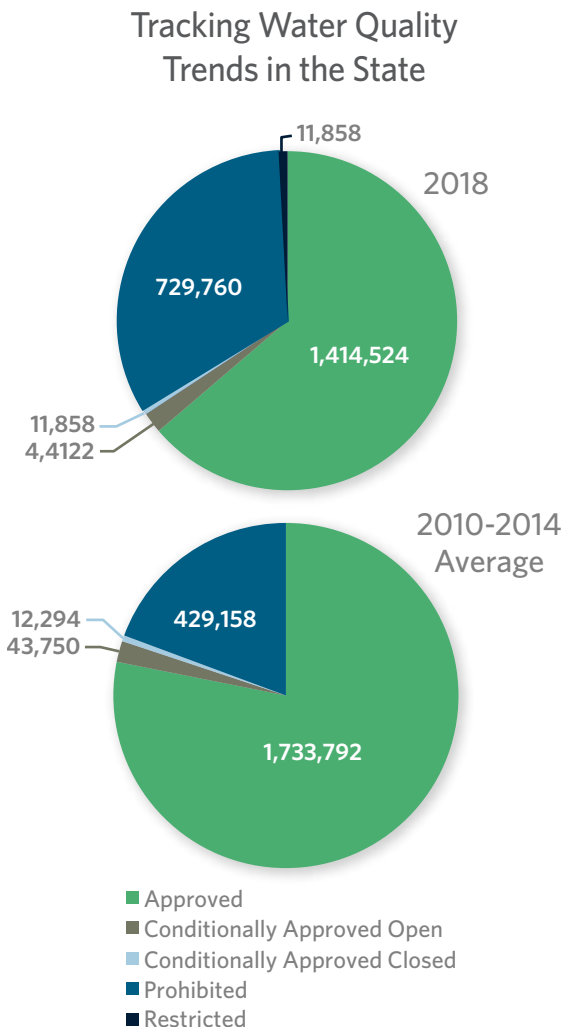


Figure 7: *The Shellfish Sanitation and Recreational Water Quality Section of the Division of Marine Fisheries monitors the health of the state's waters for public safety. In 2015, the northern water quality testing lab was administratively closed, effectively closing 314,710 acres of Albemarle Sound, of which 54,503 acres are viable shellfishing waters.*[3]

1 Information received from https://tinyurl.com/WaterQualityTesting

2 Information received from https://tinyurl.com/MariculturePlan

3 Information received through email from Dr. Lexia Weaver, Coastal Scientist and Central Regional Manager, The North Carolina Coastal Federation, Spring 2019

4 Information received from https://tinyurl.com/303dList

Hurricane Florence Impacts Oysters Across the State

The 2018 hurricane season had severe and catastrophic impacts on North Carolina's oysters. The storms touched all sectors including the oyster mariculture industry, wild populations of oysters and oyster sanctuaries. Hurricane Florence brought particular devastation to a large portion of the coast from Hyde County south when it made landfall on Sept. 14, 2018, near Wrightsville Beach. It was a slow-moving storm that lingered over the state for nearly three days, bringing up to 35 inches of rain in some areas and an estimated $17 billion in statewide damages.

Sustained high winds and large volumes of freshwater brought particular damage to oysters. Heavy rainfall caused flooding, dramatic decreases in salinity as well as sustained low dissolved oxygen levels. The decrease in salinity and dissolved oxygen levels were long lasting and difficult for oysters to tolerate. Damage assessments are ongoing.[1]

WILD AND REHABILITATED OYSTER POPULATIONS

The North Carolina Division of Marine Fisheries (NCDMF) and researchers at North Carolina State University assessed the wild and rehabilitated oyster populations after the storm.

The following areas were particularly hard hit:

- Outside of the bays in Pamlico Sound, in deeper waters, they observed large areas of completely dead or low density and small (less than 3-inch shell length) living oysters.
- Dive surveys on Middle Grounds in Pamlico Sound, found only four live oysters out of approximately 20 samples collected and numerous recently dead individuals, mostly new recruits.
- The Newport River, Stump Sound and the Cape Fear River saw high oyster mortality.
- Total mortality at a new artificial reef and shoreline restoration project at Carolina Beach State Park was observed.

County	Shellfish Operations	Farm Acreage	Property Damage	Product Loss
Beaufort, Dare, & Hyde	5	24	$4,000	$119,300
Pamlico	4	39	$1,800,000	$2,060,000
Carteret	19	89	$459,100	$4,097,300
Onslow	9	71	$11,000	$594,300
Pender	5	19	$16,500	$219,000
New Hanover	4	13	$21,800	$516,750
Total	**47**	**257**	**$2,319,900**	**$7,641,650**

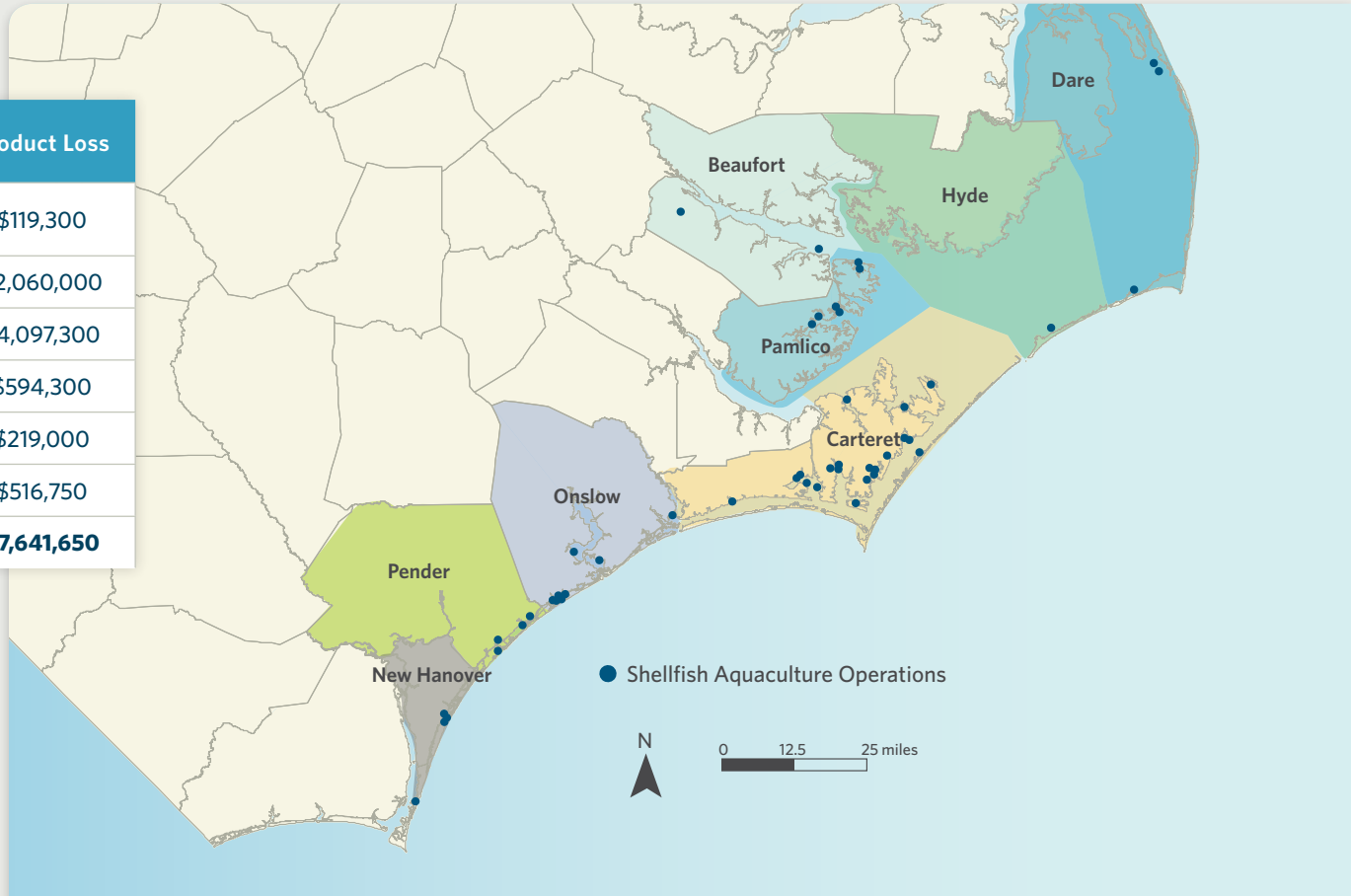


Figure 8: Shellfish aquaculture operations and loss due to Hurricane Florence. Map courtesy of North Carolina Sea Grant in conjunction with North Carolina Division of Marine Fisheries and NOAA. January, 2019

HURRICANE FLORENCE AQUACULTURE LOSS[4]

Estimated as of Spring 2018

$2.3 MILLION	$7.6 MILLION	$10 MILLION
Property and gear loss	Product loss	TOTAL LOSS

The storm highlighted the importance of:

Stable salinity patterns.

Clean water.

Managing land uses to protect and restore water quality.

Mortality in these cases is largely attributed to sustained low salinity and oxygen levels (hypoxic and anoxic conditions) and other water quality impacts which came from the storm's floodwaters.

Good news is that agency and university researchers observed that shallow subtidal reefs in Pamlico Sound and its tributaries were not as severely impacted as deep-water reefs.

Particular care was given to monitoring some of the oyster sanctuaries that were recently constructed. Swan Island Oyster Sanctuary showed some mortality in sublegal oysters, but still maintained high overall oyster densities. There was also evidence of a strong recent spat recruitment to the site after the storm.[2]

Due, in part, to the high mortality in the deeper waters of Pamlico Sound, mechanical harvest for the 2018-2019 oyster season in Pamlico Sound was closed on Dec. 13 when monitoring indicated that there were not sufficient live, legal sized oysters to keep the fishery open. This was the earliest closure to mechanical harvest since NCDMF has implemented this particular monitoring and management tool.[3]

MARICULTURE IMPACTS

Hurricane Florence and Tropical Storm Michael brought combined damages of nearly $10 million to North Carolina's shellfish aquaculture industry. Damages to property and gear totaled $2.3 million. Product loss totaled $7.6 million. A damage assessment survey was initiated by North Carolina Sea Grant (NCSG) with the assistance of North Carolina Department of Agriculture (NCDA), National Oceanic and Atmospheric Administration (NOAA) and the Division of Marine Fisheries.[4]

NCSG worked with 47 growers to gather damage estimates and NOAA mapped the reported losses. Their assessment shows that a large storm like Florence can have devastating impacts to shellfish farms in coastal waters across the state.

For example, Carteret County had 19 shellfish aquaculture businesses reporting losses, the highest count for any county.

Pamlico County had the highest dollar losses, with $1.8 million in property damage and $2.06 million in lost product. Carteret County reported the most acreage lost, totaling at 89 acres of farm.

"One of the biggest challenges for new growers is mass mortality events. This year was particularly bad with Hurricane Florence,"

Chris Matteo, owner and operator of Chadwick Creek Oysters and president of the N.C. Shellfish Grower's Association.

Business recovery efforts are ongoing and estimates are revised as new data becomes available.[4]

At the University of North Carolina's Shellfish Research Hatchery, nearly 80% of the reproducing adult oysters were lost due to poor water quality. This will have an impact on the hatchery's ability to provide oyster larvae as they regrow their stock over the next 2-3 spawning seasons.[5]

1 Information received from https://tinyurl.com/SeaGrantFlorence

2 Information and data received through email with Jason Peters, Enhancement Program Supervisor, North Carolina Division of Marine Fisheries, Spring 2019

3 Information received through email with Tina Moore, Biologist Supervisor for North Carolina Division of Marine Fisheries, Spring, 2019

4 Information and data received through email with Dr. Chuck Weirich, Marine Aquaculture Specialist, North Carolina Sea Grant, Spring 2019

5 Information and data received through email with Ami Wilbur, Director, University of North Carolina Shellfish Hatchery, Spring 2019

GOAL 7: Document oyster population status and trends resulting from successful implementation of the *Blueprint*.

The *Blueprint* includes seven overarching goals for successful oyster restoration and protection in North Carolina. *The State of the Oyster: 2018 Progress Report* is aimed at providing a way to track progress made in carrying out the *Blueprint*. For more immediate news and updates, go to ncoysters.org and sign up to receive the "On the Half Shell" quarterly email newsletter.

2018 LEGISLATIVE ACTIONS

No new actions.

OTHER ACTIONS

In 2018, researchers in North Carolina were busy focusing on oysters. Research conducted in 2018 by *Blueprint* partner agencies includes:

- Exploring restored reefs as habitat.
- Better understanding impacts of mariculture.
- Developing a rapid assessment diagnostic kit to determine if bacteria are present in oysters, protecting public health.
- Investigating different substrates for use in oyster restoration.
- Developing siting tools to determine the best location for sanctuaries.
- Incorporating ecosystem services in site suitability research.
- Better quantifying the native oyster populations.
- Working to understand the dynamics of boring sponge on oyster reefs.
- Surveying shellfish growers for industry statistics.
- Tracking the occurrence and distribution of *Vibrio spp*.
- Understanding the environmental and epigenetic effects on *Vibrio spp*.
- Investigating the ecological role of oyster cultch reefs.

IN PROGRESS

The Oyster Steering Committee continues to track the progress toward implementing the *Blueprint* and refining recommendations and guidance for its successful implementation.

KEY NEXT STEPS

A solid investment in oyster mariculture and restoration of natural oyster reefs safeguarded by enhanced restoration measures to protect water quality and habitat provide the potential for tremendous economic, social and environmental returns for coastal communities in North Carolina. The North Carolina coast is poised with all the assets and public interest to become the "Napa Valley" of oysters.

OVER THE NEXT TWO YEARS, THE FOLLOWING ARE KEY PRIORITIES:

- Invest in water quality and habitat restoration.
- Develop public-private partnerships whenever possible to build out oyster reefs and expand the state's capacity to restore oysters.
- Keep our waters clean and productive for the growing oyster industry by promoting effective stormwater management and low-impact development.
- Provide adequate funding to implement watershed restoration plans and the monitoring of shellfish waters.
- Implement the newly adopted strategic plan for the North Carolina shellfish mariculture industry.
- Develop North Carolina specific broodstock through university research and foster the development of private hatcheries to provide a suitable amount of seed for a growing mariculture industry.
- Develop enforceable measures to safeguard both public and private reefs from illegal poaching.
- Continue to produce sound science from the state's universities and community colleges in collaboration with stakeholders from all aspects of the industry to refine and expand oyster restoration and mariculture.
- Develop capacity within the state to ensure shellfish health is adequately researched and understood.
- Properly site shellfish mariculture and restoration activities so that they minimize user conflicts, maintain the public trust uses of the sound, restore important habitats and grow the shellfish mariculture industries.
- Educate and develop a highly skilled workforce, through practical education and training, that will support competitive and sustainable commercial shellfish production.
- Plan for and update the fourth edition of the *Oyster Restoration and Protection Plan for North Carolina: A Blueprint for Action.*

It is an exciting time for oysters in North Carolina. Over the next year, a solid investment in this industry and measures to safeguard water quality will advance the goals of the *Blueprint*.

RECOGNITON AND CONTRIBUTIONS

2018 Steering Committee Members

Troy Alphin, University of North Carolina Wilmington

Will Best, North Carolina Department of Commerce

Dave Cerino, Carteret Community College

Bill Crowell, Albemarle-Pamlico National Estuary Partnership

Braxton Davis, North Carolina Division of Coastal Management

Anne Deaton, North Carolina Division of Marine Fisheries

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Todd Miller, North Carolina Coastal Federation

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Ken Riley, National Oceanic and Atmospheric Administration

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Ami Wilbur, University of North Carolina Wilmington

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