



STATE OF THE OYSTER: 2015 Progress Report

on the OYSTER RESTORATION AND PROTECTION PLAN FOR NORTH CAROLINA

Prepared by the North Carolina Coastal Federation



“NORTH CAROLINA IS POISED TO BE THE NAPA VALLEY OF OYSTERS.”

—Rowan Jacobsen, author of *A Geography of Oysters*

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EXECUTIVE SUMMARY

The *Oyster Restoration and Protection Plan for North Carolina, A Blueprint for Action 2015-2020* (Blueprint) lays out seven overarching goals and dozens of action steps to advance efforts in reversing the decline and restoring oysters in North Carolina to their previous ecological and economic glory. In order to measure and track the progress of this plan, this annual *State of the Oyster Report* was developed.

The individuals leading efforts within the *Blueprint* and the *State of the Oyster Report* includes lawmakers, oyster growers, harvesters, researchers, managers, restoration practitioners and other stakeholders.

This diverse group continued to make statewide advances in 2015 to promote the restoration, aquaculture, and protection of oysters in North Carolina. The main accomplishments include:

Released at the March 2015 Oyster Summit:

- A new report by RTI International concluding that **oyster restoration is not just good for the environment; it's good for the economy too.**¹
- The updated **Oyster Restoration and Protection Plan for North Carolina: A Blueprint for Action 2015-2010.**

Eight legislative reports were requested to explore ways the state can promote oyster restoration, aquaculture and protection efforts. Including:

- Two reports from the North Carolina Division of Marine Fisheries, who with input from the Oyster Steering Committee, developed plans and recommendations for:
 - The Senator Jean Preston Oyster Sanctuary Network – a ten-year plan for a network of oyster sanctuaries.²
 - A Shellfish Aquaculture Report- outlines recommendations for advancing oyster aquaculture in the state.³

Legislative appropriations increased for the North Carolina Division of Marine Fisheries by:

- \$300,000, bolstering the division's cultch planting program
- \$450,000, to develop North Carolina specific broodstock oysters for the oyster aquaculture industry with the University of North Carolina Wilmington.

The North Carolina Division of Marine Fisheries also:

- Considered a number of issues and amendments to the *Oyster Fisheries Management Plan* in 2015.
- Began updating the Department of Environmental Quality's *Coastal Habitat Protection Plan* with the expansion of oyster restoration as a top priority.

Other 2015 accomplishments include:

- North Carolina Sea Grant and the North Carolina Coastal Federation secured funding to develop an economic development strategy recommendations for the state based on habitat restoration activities.
- The Albemarle-Pamlico National Estuary Partnership contracted with RTI International on a cost-benefit analysis of the state's shellfish restoration and habitat enhancement programs.
- North Carolina Sea Grant in partnership with Carteret Community College, University of North Carolina Wilmington and industry stakeholders received a \$450,000 grant through the National Oceanic and



Atmospheric Administration to develop shellfish aquaculture demonstration sites for training, improved culture practices and crop diversification.

- Findings from several of the state's universities (University of North Carolina Wilmington, North Carolina State University Center for Marine Sciences and Technology, University of North Carolina Charlotte, University of North Carolina Chapel Hill Institute of Marine Sciences, East Carolina University) and community colleges (Carteret Community College, Brunswick Community College) improved oyster restoration techniques, hatchery methods and oyster growing practices.

¹ Lawrence S., et al. (2015). *Coastal Restoration and Community Economic Development in North Carolina Final Report*. RTI International. Prepared for North Carolina Coastal Federation.

² State of North Carolina, Division of Environmental Quality, Department of Marine Fisheries. (2015). *Recommendations for Implementation of the Senator Jean Preston Oyster Sanctuary 10-Year Plan, as required by S.L. 2015-241 Section 14.9*. Legislative Report.

³ State of North Carolina, Division of Environmental Quality, Department of Marine Fisheries. (2015). *Division of Marine Fisheries Recommendations for Shellfish Aquaculture*. Legislative Report.

Background and Purpose

The State of the Oyster: 2015 Progress Report tracks progress during 2015 towards the common goals presented in the *Oyster Restoration and Protection Plan: A Blueprint for Action 2015-2020*. This progress builds on the efforts of many stakeholders working towards oyster restoration since the 1995 Blue Ribbon Advisory Council on Oysters, 1997 Fisheries Reform Act and the 2003 inception of the *Blueprint*.

The *Blueprint* outlines the following goals to be achieved in the next five years:

- 1 Link restoration of oysters and water quality to 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 Build the oyster aquaculture industry to meet or exceed wild harvest.
- 5 Sustainably manage oyster harvest on public bottoms.
- 6 Protect and improve water quality in priority shellfish growing areas.
- 7 Document oyster population status and trends resulting from successful implementation of the *Blueprint*.

HARVEST TRENDS

Oysters are important to North Carolina's coastal economic and ecological future. However, disease, habitat loss, overharvesting and poor water quality have caused a severe decline in their numbers since peak harvest over a century ago.

Oyster harvest within the state has declined to about 15-20% of historic 1889 harvest levels.

Harvest Over the Years (in bushels)

- 1889.....800,000
- 1960.....200,000
- 1994.....35,000
- 2004.....70,000
- 2014.....137,000⁴
- 2015.....119,000⁵

CAUSE OF THE DECLINE

Despite some recovery, oysters remain listed as a "species of concern" by the North Carolina Division of Marine Fisheries. The actions and efforts within the *Blueprint* and this report address these primary reasons for the oyster's population decline:

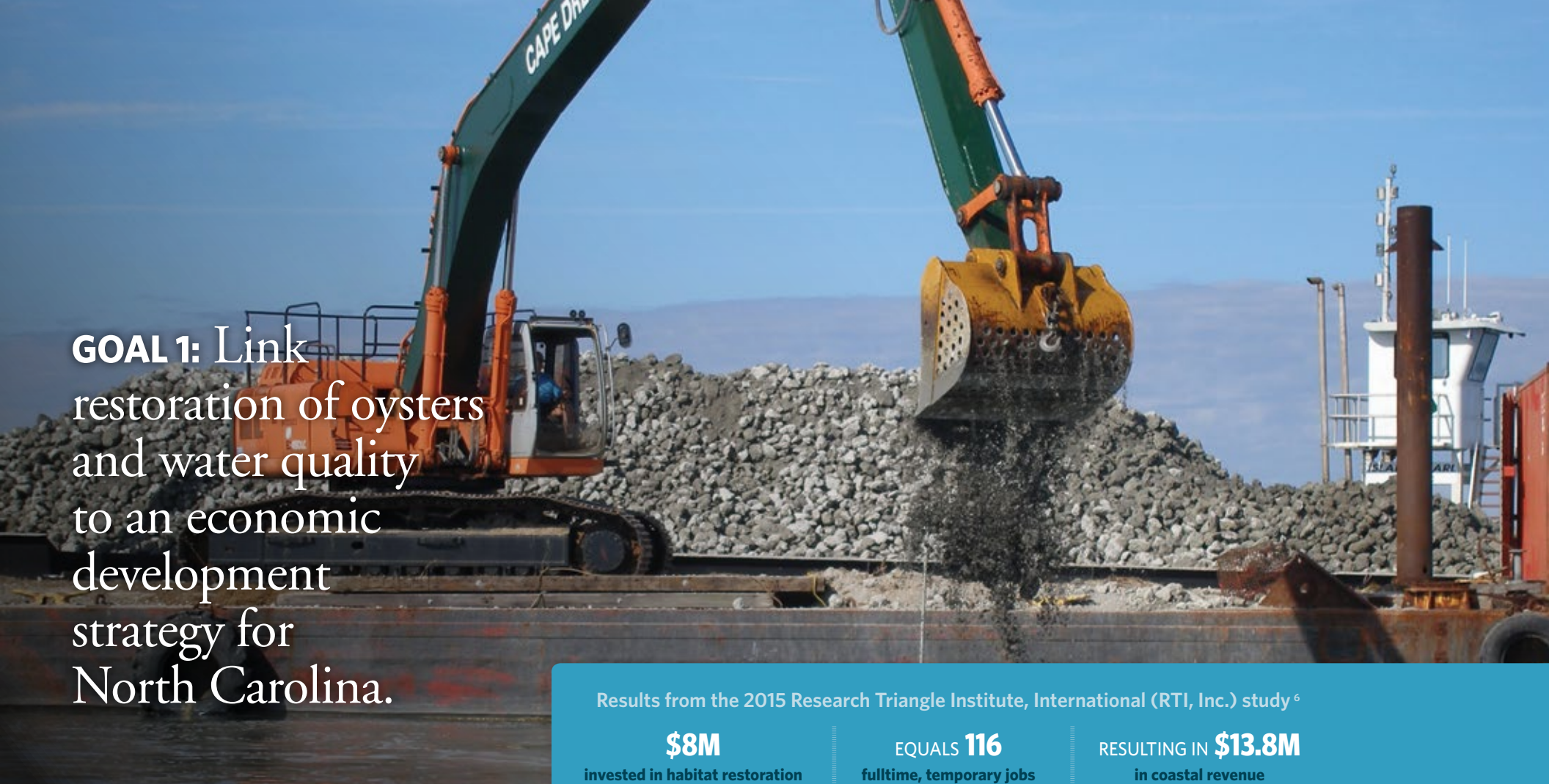
- Overharvest- taking too many oysters and too much shell substrate from the water
- Habitat Loss
- Natural Disasters
- Shellfish Disease
- Unsuitable Water Quality and Increased Sedimentation

⁴ North Carolina Department of Environmental Quality, Division of Marine Fisheries. (2015). North Carolina License and Statistics Section 2015 Annual Report.
⁵ Preliminary 2015 data was received through email from Grace Kemp, Marine Biologist, NCDEQ, March 2016.



OYSTERS: MULTITASKERS OF THE ESTUARY

- Provide habitat for commercially and recreationally important fish and wildlife.
- Filter and improve water quality
- Buffer shorelines from erosion
- Provide jobs and food for our coastal communities



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

Results from the 2015 Research Triangle Institute, International (RTI, Inc.) study ⁶

\$8M invested in habitat restoration
EQUALS **116** fulltime, temporary jobs
RESULTING IN **\$13.8M** in coastal revenue

The *Blueprint* includes a five-year strategy for incorporating coastal restoration as part of a formal state economic development plan.

2015 LEGISLATIVE ACTION

No legislative actions in 2015

OTHER ACTIONS

Recent research by RTI has demonstrated the potential of oyster restoration as an economic development strategy for the state.

IN PROGRESS

Another RTI study, commissioned by the Albemarle-Pamlico National Estuary Partnership, is exploring a cost-benefit analysis of the state's three habitat enhancement programs: 1) Shellfish Rehabilitation Program 2) Oyster Sanctuary Program, and 3) Artificial Reefs.

A 2015-2016 study by University of North Carolina Chapel Hill

is exploring the economic benefits of implementing watershed restoration plans in Hyde County.

The North Carolina Coastal Federation and North Carolina Sea Grant are spearheading a project to promote the use of restoration as an economic development tool for the coast.

⁶ Lawrence S., et al. (2015). *Coastal Restoration and Community Economic Development in North Carolina Final Report*. RTI International. Prepared for North Carolina Coastal Federation.

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



Oyster sanctuaries are planned to ensure there are sufficient natural juvenile oysters (spat) to populate existing oyster reefs.

2015 LEGISLATIVE ACTION

- Amended the 2014 legislation requesting a report and plan for expanding oyster sanctuaries in the state. The

newly named, Senator Jean Preston Oyster Sanctuary Network will extend through parts of the Pamlico Sounds and will be implemented over ten years, capitalizing on public-private partnerships whenever possible.

- Proposed exploration of a new simplified permitting process designed specifically for oyster restoration projects.

- Passed legislation allowing nonprofits whose primary mission is the conservation of natural resources, to apply for and secure North Carolina Division of Marine Fisheries scientific or educational activity permits that were previously only granted to scientific and educational institutions.⁷

OTHER ACTIONS

Oyster Sanctuaries

Large-scale oyster sanctuaries are being strategically located and designed to improve the wild stock of oysters by supplying larval oysters to commercially harvested reefs. These are constructed in sounds and rivers where the environmental conditions for oyster growth are favorable and serve as marine protected areas that are closed to oyster harvest, but open to hook-and-line fishing.

2015 PROGRESS

31.7
ACRES
Permitted

12.4
ACRES
Restored

STATE TOTALS (to date)

329.2 **187.4**
ACRES ACRES
Permitted Restored

37.5% of sanctuary goal is complete

State Allocations for Oyster Resource Enhancement

Funding for these large-scale oyster restoration projects is carried out through the North Carolina Division of Marine Fisheries. Funding levels have varied since the initial program was established in 1994. Beginning in 2015, \$150,000 was allocated in recurring revenue for sanctuary design and construction.⁸ Additional state and federal grants were also secured.

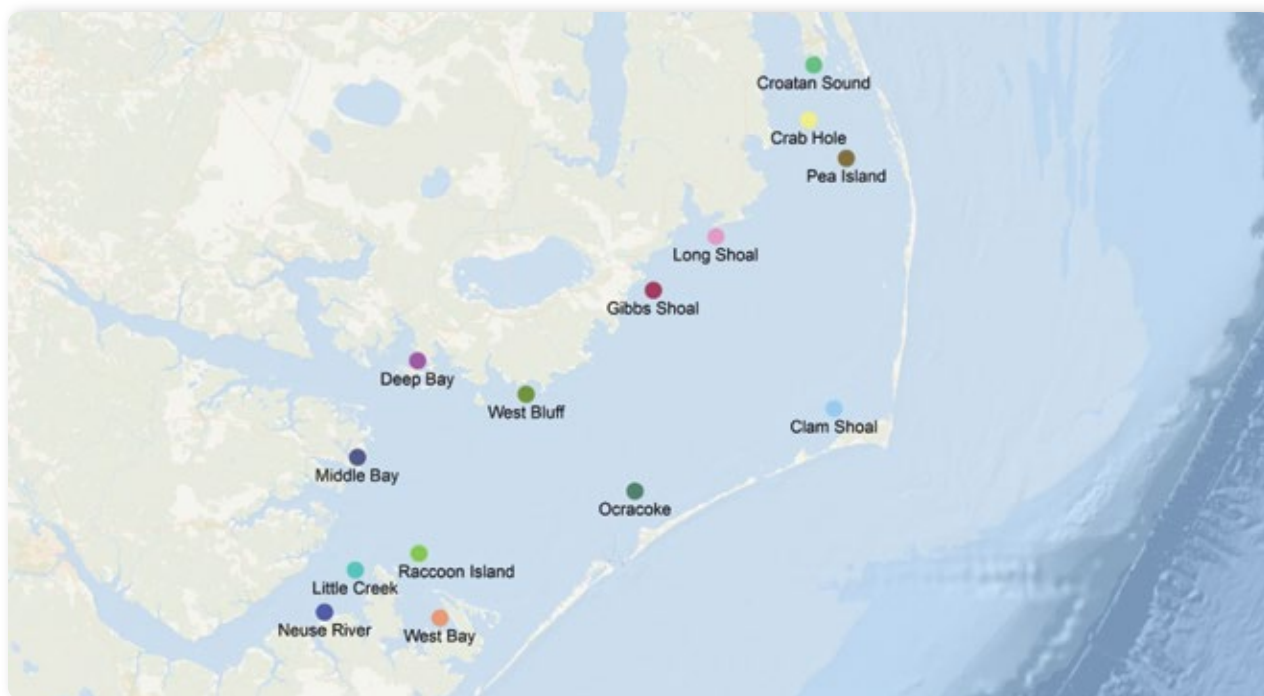


Figure 1: This map shows the architecture of the sanctuary network as it exists in 2015. The Senator Jean Preston Sanctuary Network proposes to expand this network over ten years. In 2015, the Pea Island sanctuary was permitted and construction of restored reefs began.⁹ Map courtesy North Carolina Division of Marine Fisheries.

IN PROGRESS

Identify New Sanctuary Locations, Size & Materials

Researchers at North Carolina State University and the North Carolina National Estuarine Research Reserve have developed a GIS-based tool that integrates environmental, biological and socioeconomic factors to identify appropriate locations for oyster sanctuary restoration in Pamlico and Core sounds.

University of North Carolina Wilmington has assisted in

developing a GIS-based, North Carolina aquaculture siting tool (uncw.edu/benthic/sitingtool/index.html). This tool is currently being modified to help site restoration projects in the southern and central part of the state.

Funding associated with the Senator Jean Preston Sanctuary Report request will be used to support continued development of the tool in collaboration with North Carolina Division of Marine Fisheries, The Nature Conservancy and the North Carolina Coastal Federation.

⁷ 2015 Appropriations Act. H97-PCCS30420-Rxf-6. Sections 14.6- 14.10 (2015).

⁸ Data received through email from NCDEQ data request performed by Jennifer Hoffman, North Carolina Fiscal Resource Division, February and March 2016.

⁹ State of North Carolina, Division of Environmental Quality, Department of Marine Fisheries. (2015). *Division of Marine Fisheries Recommendations for Shellfish Aquaculture*. Legislative Report.



OYSTER PATCH AND FRINGING REEFS

Additional oyster habitat restoration in the form of patch and fringing reefs and living shorelines are typically smaller scale restoration efforts carried out by nongovernmental conservation organizations, universities and engaged community members. They typically range in size from a tenth of an acre to two acres. In 2015, 0.47 acres of these reefs were built.



CULTCH PLANTING PROGRAM

The division annually deposits an average of 230,000 bushels of shell and marl- collectively called "cultch"- in shellfish waters from the Shallotte River to Pamlico Sound. Cultch is then colonized by oyster larvae (spat) which attach and grow to harvest size (three inches) in 18-24 months. These cultch planting sites are open to public harvest once oysters reach legal harvest size.

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

The North Carolina Division of Marine Fisheries has worked since 1915 to regulate oyster harvest and enhance reef habitat. Cultch planting throughout the state's shellfish waters creates public reefs. Increased cultch planting is necessary to rebuild reefs after being knocked down from decades of harvest pressure and to keep pace with current harvest levels. The *Blueprint* calls for renewing the cultch planting efforts through adaptive management and using results from the 2015-2016 RTI program assessment to determine the strategy for future support and operation of this program.

2015 LEGISLATIVE ACTION

- Passed legislation prohibiting the use of oyster shells in commercial landscaping. Ideally oyster shells are placed back in the water to provide habitat in support of future oyster populations instead of using them for mulch or other landscaping.
- Increased recurring funds for the cultch planting program to \$600,000 in FY15/16.¹⁰ This increase allows the division to plant more than twice as much cultch in 2016 than 2015.

OTHER ACTIONS

In 2015 the division planted 210,272 bushels of cultch material on 41 acres.¹¹

IN PROGRESS

The division is exploring a new rotational management cultch planting strategy that will be implemented in 2016 and beyond which is designed to maximize the effectiveness of the cultch planting program.

The division continues to solicit public input on the placement of future cultch planted reefs.

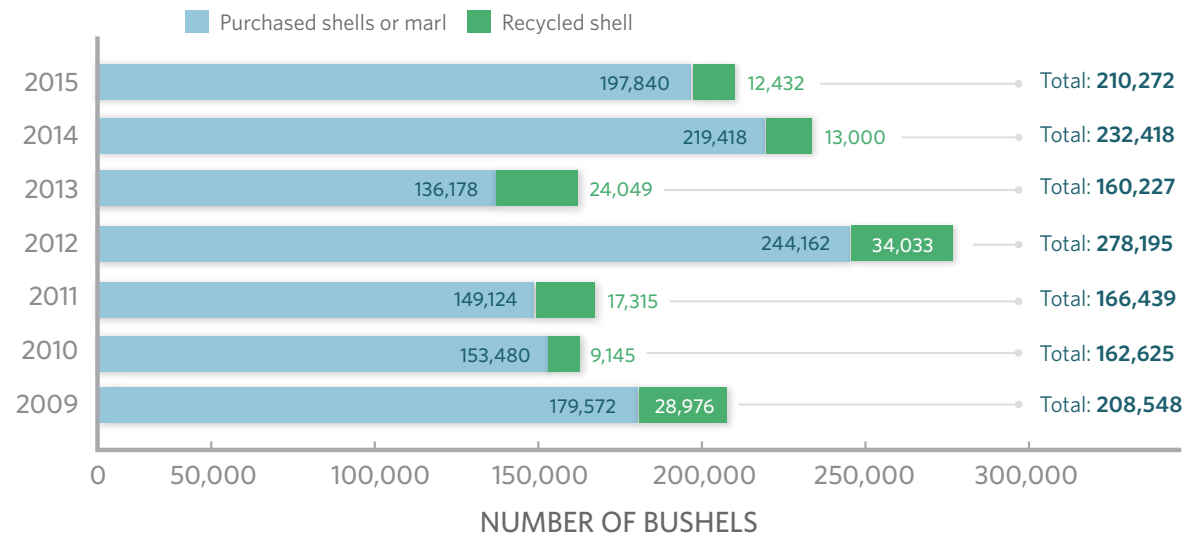


Figure 2: The North Carolina Division of Marine Fisheries deploys cultch material annually in designated cultch planting sites. From 2003-2013, a state funded oyster shell recycling program provided 6-15% of the annual material needed^{12,13}

OYSTER SHELL RECYCLING PROGRAM

For ten years the state maintained an active shell recycling program that provided 6-15% of their shell budget for cultch planting efforts.

This program kept shell, a scarce resource, in the state to create new oyster habitats and out of landfills where it has no habitat value. From 2005-2013 (when the program was active and funded), the state recycled, on average 24,859 bushels of shell valued at approximately \$50,000 annually. To date for 2014-2015, the program, operating with residual grant funds and existing equipment, has recycled 12,246 bushels (6% of materials needed). As the cultch planting program increases its efforts in the coming years, finding a local source of shell may become increasingly difficult.



¹⁰ 2015 Appropriations Act. H97-PCCS30420-Rxfi-6. Sections 14.6- 14.10 (2015).

^{11,12} 2015 data received through email from Greg Allen, Marine Biologist I, NCDEQ, North Carolina Division of Marine Fisheries, March 2016.

¹³ North Carolina Department of Environmental Quality, Division of Marine Fisheries. (2010-2014) *Division of Marine Fisheries Shellfish Rehabilitation Program 2010-2014 Annual Legislative Reports.*

GOAL 4: Build the oyster aquaculture industry to meet or exceed wild harvest levels.

The private growing of oysters, through the state's Shellfish Leasing Program, has the potential to provide significant economic benefits and potentially reduce harvest pressure on wild oysters while increasing production.

2015 LEGISLATIVE ACTION

- Requested a report to provide an assessment of barriers to oyster aquaculture and recommendations for promoting the industry in the state.
- Reformed regulations specific to shellfish leasing including:
 - Allowing growers to mark the perimeter of their leases with GPS devices and provide information that conforms to standards prescribed by the secretary concerning accuracy.
 - Extending lease contracts from five to ten years before a renewal application is necessary
 - Allowing bottom lease-holders to also place gear up to 18 inches off bottom without requiring a water column lease.
 - Allowing shellfish lease holders, who engage in mechanical harvest operations, to employ people without a commercial fishing license. Instead the license is held by the shellfish grower and the employees work under that license.
- Requested a study to explore opening shellfish cultivation and leasing opportunities in currently prohibited areas of Core Sound.¹⁴

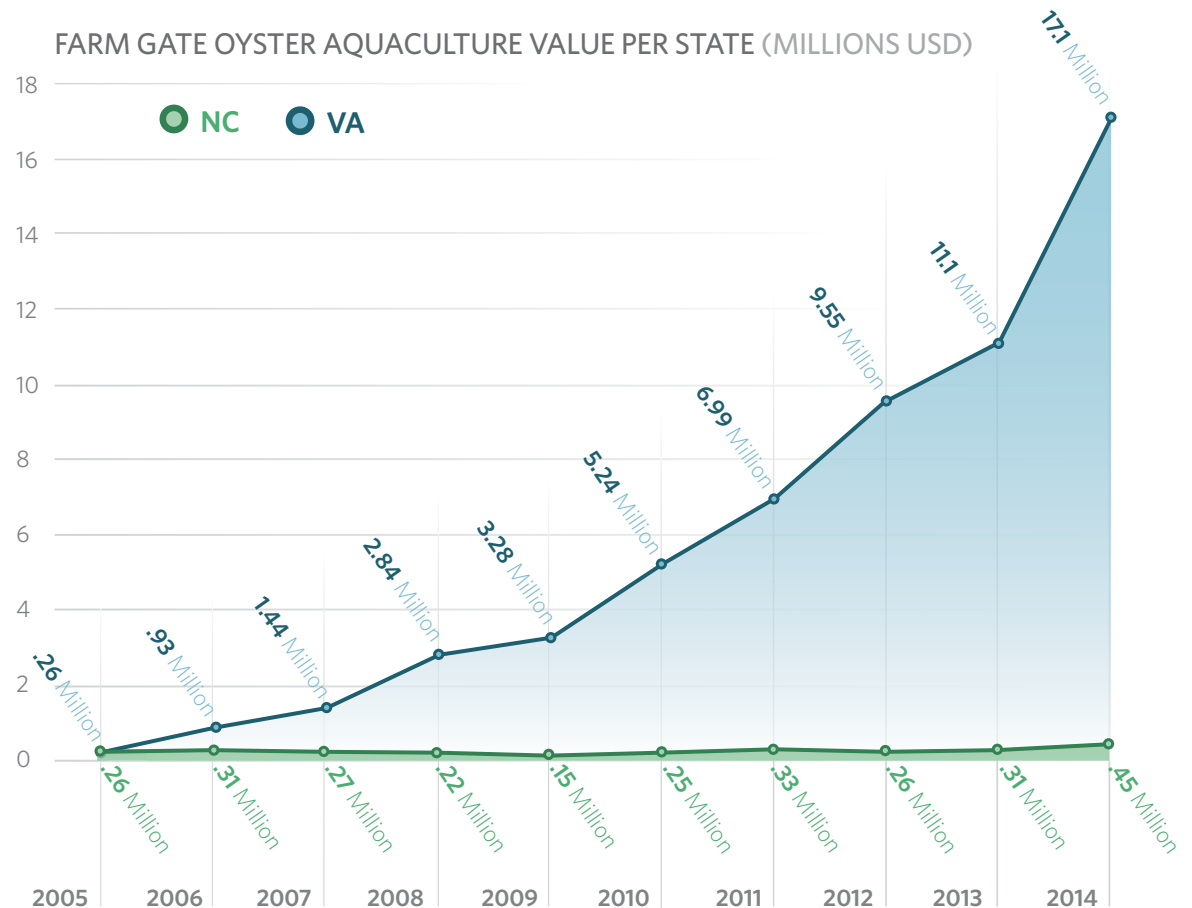


Figure 3: A comparison of the farm gate value of the oyster aquaculture industry in North Carolina and Virginia. While North Carolina has seen an increase in the value of shellfish, it is overshadowed by the exponential growth in Virginia. In 2015, 23% of all commercial landings came from private leases in North Carolina.

Figure courtesy Chuck Weirich, North Carolina Sea Grant.

As of September 2015, 292 bottom leases existed in North Carolina covering 1,931 acres (approximately 0.13% of all waters that meet shellfish water quality standards).¹⁵



OTHER ACTIONS

Increased Funding for Oyster Aquaculture in 2015

AMOUNT AWARDED	PURPOSE	AGENCIES INVOLVED
\$450,000 state appropriation-recurring revenue ¹⁶	To develop specific North Carolina broodstock oysters which will eventually supply nurseries and growers who currently purchase out of state stock for the majority of their oyster growing.	The North Carolina Division of Marine Fisheries, University of North Carolina Wilmington
\$450,000 grant from NOAA Aquaculture Extension and Technology Transfer Program ¹⁷	To develop shellfish aquaculture demonstration sites for training, improved culture practices and crop diversification.	North Carolina Sea Grant, Carteret Community College, University of North Carolina Wilmington and industry stakeholders

IN PROGRESS

University of North Carolina Wilmington has assisted with the siting of shellfish aquaculture operations since 2015 with the creation of the GIS-based, North Carolina Shellfish Siting Tool (uncw.edu/benthic/sitingtool/index.html). This tool is currently being modified to help site restoration projects as well. During 2015, this program fielded more than 50 inquires related to shellfish aquaculture and thousands of online visits.

¹⁴ 2015 Appropriations Act. H97-PCCS30420-Rxfr-6. Sections 14.6- 14.10 (2015).

¹⁵ State of North Carolina, Division of Environmental Quality, Department of Marine Fisheries. (2015). Division of Marine Fisheries Recommendations for Shellfish Aquaculture. Legislative Report.

¹⁶ Data received through email from NCDEQ data request performed by Jennifer Hoffman, North Carolina Fiscal Resource Division, February and March 2016.

¹⁷ Data received through personal communication with Chuck Weirich, Marine Aquaculture Specialist, North Carolina Sea Grant, March 2016.

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 safe and sustainable manner.

2015 LEGISLATIVE ACTION

No legislative actions in 2015

WILD HARVEST OF OYSTERS

2015
119,186
BUSHELS¹⁸

approximately
15%
OF

1889
800,000
BUSHELS¹⁹

IN PROGRESS

Oyster Fisheries Management Plan

Since 1997, the North Carolina Division of Marine Fisheries has prepared Fisheries Management Plans (FMPs) for all commercially and recreationally significant species.

In early December 2015, the division released an outline of amendments to the Oyster FMP. Four public meetings were held in December to solicit comments on the draft plan. Issues and amendment considerations include:

- Reopening the shallow bays (less than 6 feet deep) of Pamlico Sound to mechanical harvest.
- Continuing the trigger of 26% legal-sized live oysters to determine when to close mechanical harvest.
- Making hand harvest limits the same statewide.
- Strategies to mitigate harvest effort impacts on oyster resources in the Southern Region.

- Protecting shellfish lease and franchise rights while still protecting public trust rights.
- Defining adverse impacts to submerged aquatic vegetation from shellfish leases and franchises.
- Discussing the Brunswick County shellfish lease moratorium.
- Modifying shellfish lease provisions.
- Considering the elimination of the shellfish license and require all shellfish harvesters to have a Standard/Retired Commercial Fishing License.
- Developing requirements for shading molluscan shellfish when it is being transported from lease to market.

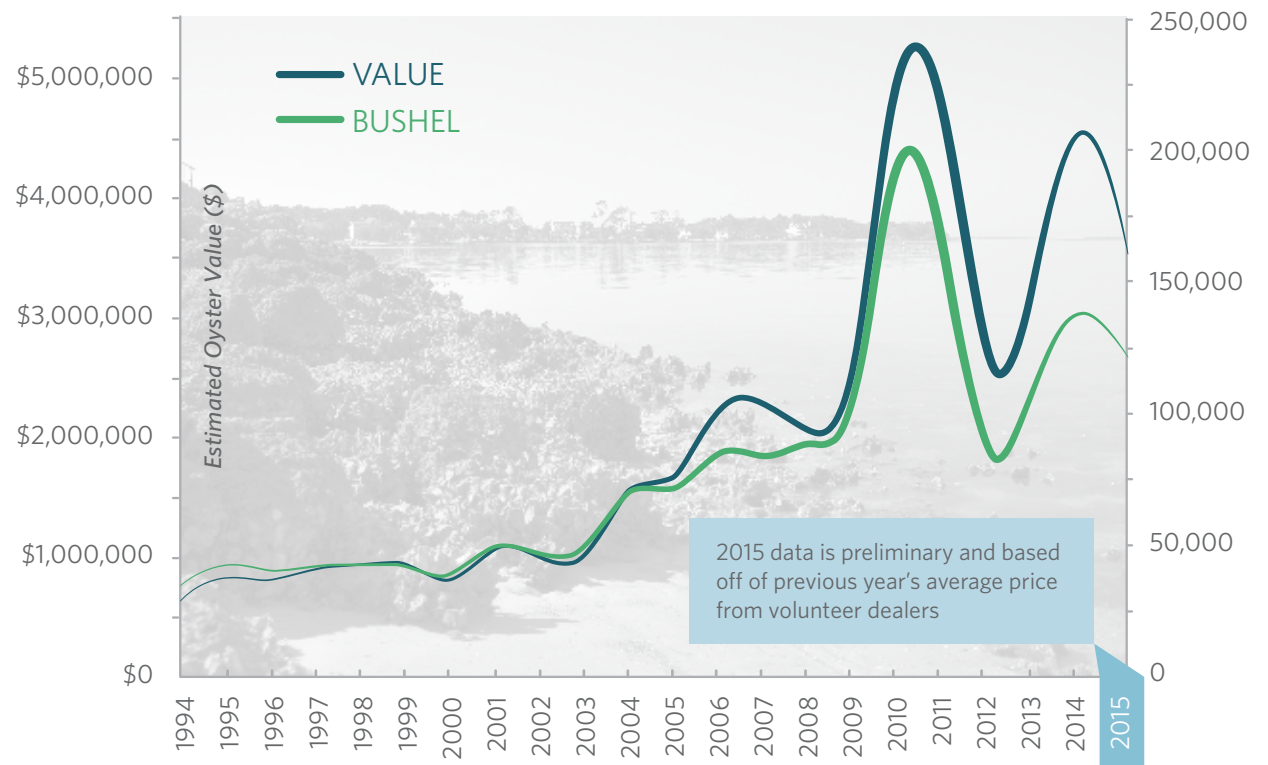


Figure 4: Since 2005, when the state declared it the year of the oyster, oyster harvest has improved.^{20,21}

¹⁸ Preliminary data received through email from Grace Kemp, Marine Biologist, NCDEQ, North Carolina Division of Marine Fisheries, March 2016.

²¹ Preliminary 2015 data received through email from Grace Kemp, Marine Biologist, NCDEQ, North Carolina Division of Marine Fisheries, March 2016.

^{19, 20} North Carolina Department of Environmental Quality. Division of Marine Fisheries. (2015). *North Carolina License and Statistics Section 2015 Annual Report*.

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

Coastal waters must be clean and free from bacteria to allow oysters to be harvested and eaten. Land drainage carries increased volumes of runoff and transports bacteria into coastal waters. This bacteria is a threat to public health. Shellfish beds are closed to fishing after moderate rains. For example, the rich oyster beds in Stump Sound in Onslow County were polluted for half of 2015 due to runoff.

Strategically restoring wetlands, retrofitting existing land uses with stormwater reduction measures and low impact development practices are tools that help restore and protect water quality. Watershed restoration plans strategically guide cost-effective water quality management efforts.

2015 LEGISLATIVE ACTION

No legislative actions in 2015

OTHER ACTIONS

148 acres of shellfish waters near Swansboro were **re-opened due to improved water quality**.

314,710 acres of Albemarle Sound were **administratively closed** due to lack of funding to continue monitoring efforts in this area.²²

Watershed Restoration Plan

Since 2010, five oyster-growing areas have been featured in watershed restoration plans that include stormwater volume reduction goals to protect shellfish waters.

- Lockwood Folly River
- Hewletts Creek
- Bradley Creek
- Lower White Oak River
- Mattamuskeet Drainage Association (Pamlico Sound)²³

In 2015 funding from the Environmental Protection Agency was secured to implement a project identified in the Mattamuskeet Drainage Association watershed restoration plan.

IN PROGRESS

In 2015, the Governor's South Atlantic Alliance committed to hosting a series of sessions to train local governments, planners, watershed managers and other water quality professionals on how to develop watershed restoration plans that focus on a volume reduction approach to stormwater management.

Stormwater Rules

The state stormwater management rules are currently under review.

^{22,24,25} Data received through email from Shannon Jenkins, Shellfish Sanitation and Water Quality Section Chief, NCDEQ, North Carolina Division of Marine Fisheries, March 2016.

²³ Data received through email from Heather Jenkins, Grant Administrator, NCDEQ, Division of Water Resources-Planning Section, February 2016.

Tracking water quality trends in the state

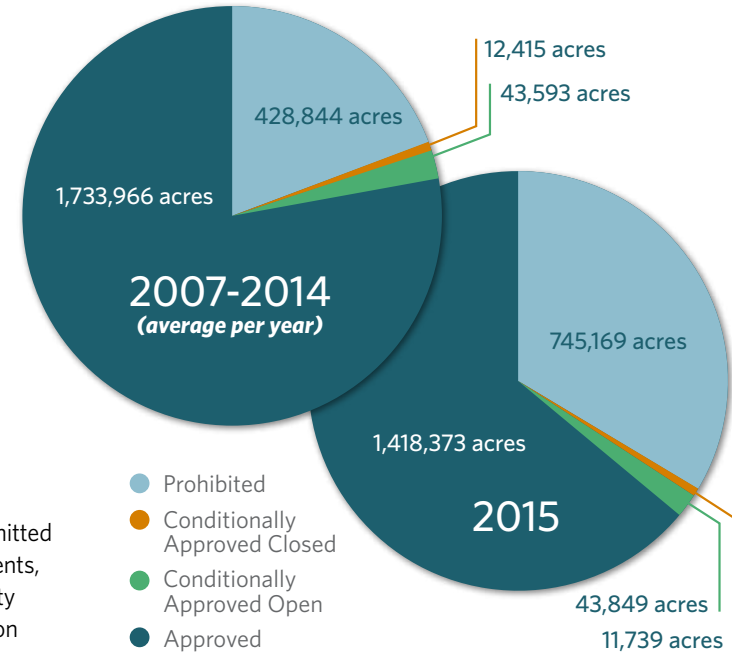


Figure 5: The Shellfish Sanitation and Recreational Water Quality Section of the North Carolina Division of Marine Fisheries monitors the health of the state's waters for public safety. They track whether waters were open, closed, prohibited or conditionally approved open or closed. The drastic increase in closures seen in 2015 is a result of administratively closing Albemarle Sound due to a lack of funding for continued monitoring in this area. ²⁴

In 2015, 34% of all shellfish waters in North Carolina were closed or prohibited for harvest due to marinas or other unsafe discharges to shellfishing waters.

Additional temporary closures are issued after heavy rainfall. For example portions of Stump Sound were closed for 50% of the year due to stormwater runoff. ²⁵



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

The *Blueprint* lays out seven overarching goals for successful oyster restoration and protection in the state. *The State of the Oyster: 2015 Progress Report* is aimed at providing a way of tracking progress towards the implementation of the *Blueprint*.

2015 LEGISLATIVE ACTION

No legislative actions in 2015

OTHER ACTIONS

The website www.ncoysters.org was developed to provide an online format for tracking the implementation of the *Blueprint*.

In 2015, at least 12 peer reviewed articles about North Carolina oysters were published. This research covered the topics of:

- Streamlining restoration success monitoring
- The effectiveness of restoration practices in protecting shorelines and creating habitat
- Ecosystem services of oyster reefs including nitrogen removal
- Complex ecosystem interactions and the survival of juvenile oysters
- The preference of oyster larvae settlement location
- Ideal growing conditions for oyster reefs

- The potential effects of sea level rise on oyster reef survival
- Shellfish related infections
- Design of sanctuaries and sanctuary networks

To find bibliographies and abstracts of 2015 North Carolina Oyster research, click on New Discoveries under the Resources heading at www.ncoysters.org.

IN PROGRESS

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

KEY NEXT STEPS

A solid investment in the oyster aquaculture industry and measures to safeguard water quality will yield tremendous returns. Developing a state economic strategy to encourage and promote this industry is key. North Carolina is poised to become the “Napa Valley” of oysters. With our acres of pristine waters and a large and growing interest in cultivated oysters, the potential for the industry in the state is huge. Neighboring Virginia has seen a marked increase in economic return from the oyster aquaculture industry; with farm-gate values growing from \$250,000 in 2005 to nearly \$17.1M in 2014.²⁶ Developing a North Carolina specific broodstock and production hatchery are important components of this industry’s expansion.

Invest in the division’s habitat enhancement and management efforts continues to be a critical component to the overall strategy of promoting healthy coastal waters and adequate oyster habitat.

Develop public-private partnerships whenever possible to build out oyster reefs and expand the state’s capacity to restore oysters.

Keep our shellfish waters clean and productive for the growing oyster industry and other oyster efforts.

Provide adequate funding to implement watershed restoration and monitor shellfish waters.

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 to refine and expand restoration and oyster aquaculture practices.

It’s an exciting time for oysters in North Carolina. Over the next four years, a solid investment in this industry and measures to safeguard water quality will yield tremendous returns.

²⁶ Hudson K., Murray J.M. (2015). *Virginia Shellfish Aquaculture Situation and Outlook Report, Results of the 2014 Virginia Shellfish Aquaculture Crop Reporting Survey*. Virginia Institute of Marine Science, Virginia Sea Grant Marine Extension Program.



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