NORTH CAROLINA STRATEGIC PLAN FOR SHELLFISH MARICULTURE: A VISION TO 2030

FINAL REPORT TO THE NORTH CAROLINA GENERAL ASSEMBLY

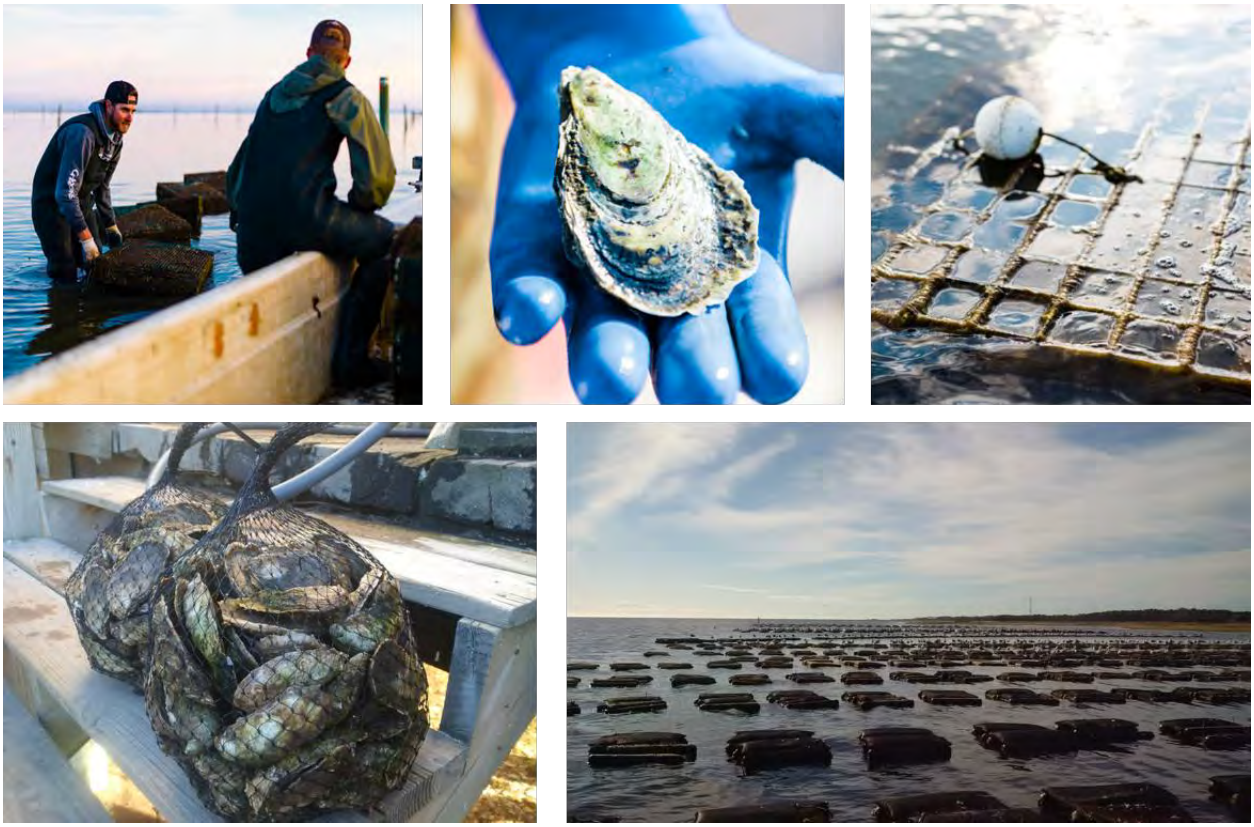

Photo credit clockwise from top left: Suspended oyster culture by Bax Miller; Single oyster by Bax Miller; Suspended oyster cage with buoy by Bax Miller; Floating bags on a water column lease by Chuck Weirich; Sacks of single oyster by Chuck Weirich.

Cover photos: Shucked raw oyster by Paul Manley

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FOREWORD

Commissioning the Shellfish Mariculture Advisory Committee

In 2016, the North Carolina General Assembly passed legislation (S.L. 2016-94 Section 14.11.(d)) directing the North Carolina Policy Collaboratory to convene stakeholder meetings aimed at advancing efforts to bolster North Carolina's shellfish industry. Senate Bill 257 (Section 13.13.(b)) amended this legislation, adding a mandate for the North Carolina Policy Collaboratory to prepare a Shellfish Mariculture Plan by December 31, 2018. Specifically, this report was required to address the following:

1. A summary of available and relevant information on shellfish mariculture.
2. An analysis of existing programs, policies, rules, and laws that govern or affect shellfish mariculture operations within the State, including an examination of workforce training and marketing programs that could facilitate the growth of shellfish mariculture within the State.
3. A summary of shellfish mariculture plans from other states and countries, including a comparison of how these entities (i) promote and manage shellfish mariculture, (ii) reduce barriers to entry for potential participants in shellfish mariculture, and (iii) offer incentives to encourage entry into shellfish mariculture.
4. Analysis of siting strategies that reduce potential user conflicts impeding the siting of shellfish mariculture operations and that protect riparian property owners and the public trust uses of estuarine waters for navigation, fishing, and recreation.
5. Evaluation and consideration of enforcement mechanisms necessary to protect shellfish mariculture operations from theft and degradation and to ensure that shellfish mariculture operations make productive and fair use of public trust coastal waters dedicated to these operations.
6. Opportunities for local traditional fishermen to effectively compete for shellfish mariculture sites in public waters and participate in enterprises in or near their own communities.
7. Examination of environmental policies that protect or enhance shellfish mariculture operations.
8. Consideration of the most appropriate substrate for cultch planting, with consideration of regional differences in bottom conditions within the State that may require different substrates to maximize shellfish sustainability.
9. Strategies to mitigate or eliminate shellfish pests such as MSX, Dermo, blister worms, and boring sponges.
10. Any other issues deemed relevant by the Collaboratory to grow and support shellfish mariculture.

Additionally, Section 13.13.(d) of Senate Bill 257 directed the North Carolina Policy Collaboratory to work in conjunction with the Economic Development Partnership of North Carolina, the North Carolina Department of Commerce, the North Carolina Department of Natural and Cultural Resources, and any other relevant stakeholder groups to provide conceptual plans and recommendations for the economic development and promotion of the State's shellfish industry. Plans and recommendations for creating a North Carolina Oyster Trail and a North Carolina Oyster Festival were specifically requested.

Shellfish Mariculture Advisory Committee Formation and Structure

To fulfill the mandates laid out in Senate Bill 257, the North Carolina Policy Collaboratory formed the Shellfish Mariculture Advisory Committee (SMAC) to generate a report of findings and recommendations to the General Assembly. The SMAC membership represents academia, regulatory agencies, non-governmental organizations, and industry stakeholders to develop recommendations that would promote the growth of a socially, ecologically, and economically responsible shellfish mariculture industry (Appendix A). The SMAC began meeting in early 2017 to discuss avenues to support the existing North Carolina shellfish industry, identify barriers to industry growth, and generate recommendations aimed at overcoming natural, business, and management challenges. Consulting other states' and countries' strategic plans for shellfish mariculture and, based on expert opinion of members within the group, the SMAC identified five major areas of concentration requiring legislative action around which they based working groups: 1. Key Business Metrics and Climate; 2. Industry Governance & Leadership/Promotion; 3. Siting Shellfish Mariculture; 4. Water Quality; and 5. Applied Research and Development. Work-group findings have been synthesized and integrated to generate a final pool of 21 major and 4 supplementary recommendations. SMAC's overarching goal has been to leverage a broad base of expertise to generate a comprehensive plan to grow the industry while balancing the needs of diverse North Carolina stakeholders to whom coastal public trust waters belong. The recommendations that were generated, which form the core of this report, are intended to inform the North Carolina General Assembly on legislative actions that can address many of the current constraints on the responsible growth of shellfish mariculture in the State. This report presents a strategic vision for a decade (to 2030) of sustainable growth of the shellfish mariculture industry that we hope will be embraced by the North Carolina General Assembly, industry participants, and North Carolina residents.

EXECUTIVE SUMMARY

North Carolina possesses over 1.4 million acres of coastal waters with biological and physical characteristics that make it uniquely well suited for shellfish mariculture. In addition to an abundance of prime growing waters, North Carolina has a long history of shellfishing, thereby provisioning the State with entire communities of citizens with the potential to run successful mariculture operations. North Carolina is also a leader in coastal research with many universities and technical colleges, non-governmental organizations, and management agencies actively engaged in interdisciplinary marine sciences and with the capacity to address research needs of a growing shellfish mariculture industry. A burgeoning local seafood movement occurring within North Carolina suggests new potential markets exist for the 278 shellfish mariculture leases currently in the State to serve. This growing industry is still identifying new distribution networks and ways to integrate with established commercial infrastructure, which currently supplies wild-caught seafood to profitable markets at State, regional, and national scales (Newsome 2014). Given additional support to develop new markets and expand market share within and outside of North Carolina, there is the potential to grow the industry well beyond its current farm-gate sales of $2.5 million, which generate approximately $7.5 million in economic activity based on a conservative 3x multiplier, to a valuation of $100 million dollars in total economic activity ($33 million farm-gate sales) by 2030.

The research hatchery at UNCW. Credit: Chuck Weirich, North Carolina Sea Grant.

Validating this potential, North Carolina's shellfish mariculture industry has grown appreciably in recent years. Between 2011 and 2017, the number of water column leases and acreage rose from 2 leases with a cumulative footprint of 6 acres to 46 leases with a cumulative footprint of 211 acres (North Carolina Division of Marine Fisheries). In that same period, the number of active bottom leases has remained relatively stable at ~230. While the increase in water column leases has had little impact on the production of hard clams, which are almost exclusively cultured on bottom, production and farm-gate value of mariculture-grown oysters has jumped from 11,330 to 32,515 bushels and ~$530,000 to ~$2,400,000, respectively, between 2011 and 2017. Indeed, there is rapidly growing interest in entering the shellfish mariculture industry in North Carolina, demonstrated by the nine-fold increase in bottom lease applications and 12-fold increase in water column leases applications between 2012 and 2017.

There is strong empirical evidence that North Carolina is positioned to dramatically increase its national market share of farmed shellfish and become a "Napa Valley of Oysters" given the recent growth of this industry locally, including the launching of a National Oceanic and Atmospheric Administration Shellfish Initiative in North Carolina, infrastructure investments that the State already has and continues to make, and diversity of growing environments and resultant oyster flavor merroirs across the State. Over the next decade, North Carolina shellfish

mariculture farm-gate sales could increase by nearly an order-of-magnitude, and attain overall economic impact on par with, or greater than, some of our State's 20 most valuable land-based crops.

Simultaneously, the growth of the shellfish mariculture industry can support the sustainable development of our coast, as oyster farming represents an addition of oysters to our sounds and estuaries that reduces harvest pressure on wild shellfish stocks, increases water filtration, mitigates nutrient loading, and supports enhanced biodiversity via the provision of structurally complex habitat (meaning both the oysters themselves, as well as, potentially, the bag/rack gear used to hold oysters). These are ecosystem services somewhat unique to shellfish farming among other plant and animal crops.

North Carolina Oyster Singles. Credit: Bax Miller

Despite these positive signs, North Carolina has not yet made the leaps evident in some other states relative to shellfish mariculture growth, resulting in significant opportunity costs accruing for our resident fishermen, businesses, and seafood connoisseurs. As such, North Carolina sits at a crossroad relative to operating under the status quo in supporting this nascent industry, or making bold decisions and, as necessary, adopting innovative strategies to realize the potential of shellfish mariculture to support traditional and entrepreneurial fishermen, coastal communities, tourism, and the estuarine environment unique to this State. We also recognize that North Carolina requires a model for growth that suits the unique attributes of our coastal waters and communities, and that we seek responsible growth and adaptive management to respect both the investments already made by current shellfish growers, as well as the complex issues associated with public trust waters. Most notably, the recommendations comprising this report advocate for a model of growth in which North Carolina shellfish growers are supported to strive for high unit-area production to meet the State's farm-gate sale targets. This stands in stark contrast to states characterized by low unit-area productivity across leases, necessitating large footprints across public trust bottoms to support the seafood industry in those states. North Carolina is also positioned to benefit from the growth of both oyster and hard clam production, given the diverse grow-out setting and techniques available to seafood farming operations.

Continuing and accelerating the forward momentum of the shellfish mariculture industry in North Carolina needed to attain goals related to job creation (e.g., 33 million in farm-gate sales would be expected to directly support 1000 on-the-water jobs) and economic impact is contingent on leveraging the significant expertise within the North Carolina Department of Agriculture and Consumer Services to promote mariculture products in local, national, and international markets; establishing an efficient and well-staffed regulatory framework; safeguarding our precious natural resources; and providing avenues to make North Carolina competitive in shellfish mariculture research and development.

There should be optimism that North Carolina is willing and eager to make investments to grow environmentally responsible jobs along the coast as proven by recent action: appropriations to establish and support a research shellfish hatchery at the University of North Carolina Wilmington (UNCW), refunding of the northern Shellfish Sanitation Laboratory, recurring appropriations for a shellfish pathologist position at North Carolina State University's Center for Marine Science and Technology (CMAST), and funding for a Carteret Community College's (CCC) Aquaculture Technology Program.

With all of these factors converging, the time is now for several important decisions at the State level to responsibly nurture shellfish mariculture as part of a strategic plan to 2030, such as:

- What economic programs should exist to support shellfish growers, analogous to land-based farmers (e.g. loans, crop insurance)?
- What regulatory and promotional frameworks are needed to account for the unique needs and opportunities of farming shellfish in North Carolina estuaries?
- What are the production and overall acreage needs of leases to reach the goal of $33 million in farm-gate sales by 2030?
- What statutory considerations are needed to cope with the potential for increasing conflicts related to lease siting and the diverse uses/users of public trust resources?
- What environmental concerns and solutions would enhance the ability of shellfish growers to generate a safe, reliable supply of shellfish product?
- How can research support be directed to address the most pressing shellfish mariculture industry needs related to seed security, grow-out techniques, disease and other stressor resistance, distribution, lease siting, socio-economics, etc.?

To address these challenges and identify potential solutions aimed at growing the shellfish mariculture industry, this report provides background information on the history of shellfish mariculture and its current status in North Carolina to contextualize our findings and recommendations. The recommendations are divided into two sections: Major Recommendations and Supplemental Recommendations. Major Recommendations are those which are most critical to responsible growth of the shellfish industry and around which we have been able to build substantial consensus. Supplementary Recommendations represent actions that may be valuable for responsible growth of the shellfish industry, but which due to the complexity of those topics and need for further consensus building, require further vetting. Importantly, beneficial outcomes from many of the recommended actions contained in this report are contingent on the implementation of other recommendations. Therefore, we intend for the legislature to view these recommendations as a holistic framework rather than a patchwork of selected actions.

SUMMARY OF MAJOR RECOMMENDATIONS

The following 21 Major Recommendations are organized within seven themes in response to priorities identified by the North Carolina General Assembly (S.L. 2016-94 section 14.11.(d)). Detailed rationale for each Major Recommendation follow in the body of this report.

Vision for Industry Development

Recommendation #1:

Achieve $100 million annual shellfish mariculture value ($33 million dockside sales) by 2030.

Supporting Shellfish Growers

Recommendation #2:

The North Carolina General Assembly should appropriate $30,000 to support the North Carolina Shellfish Growers Association's efforts to develop a pilot Federal Crop Insurance program for farmed shellfish.

Recommendation #3:

Establish a low-interest loan program to provide start-up and expansion capital to shellfish growers.

Recommendation #4:

Establish eligibility of shellfish growers in future disaster relief fund appropriations to the North Carolina Department of Agriculture and Consumer Services.

Marketing and Promotional Needs

Recommendation #5

Commission a market analysis specific to North Carolina's shellfish mariculture products.

Recommendation #6

Appropriate recurring funding to establish a Shellfish Mariculture Advisory Panel at the North Carolina Department of Agriculture and Consumer Services to facilitate the fulfillment of their mandate to promote shellfish mariculture (Article §106-759). Most critically, this

panel should develop an annual report regarding areas of success and disappointment across the industry to guide adaptive management.

Recommendation #7

Appropriate funding for the North Carolina Department of Agriculture and Consumer Services and the North Carolina Department of Commerce to develop a North Carolina Oyster Trail.

Efficient Regulatory Structure

Recommendation #8

Appropriate recurring funding to establish a Shellfish Mariculture Governance Advisory Committee to the North Carolina Marine Fisheries Commission.

Recommendation #9

Appropriate recurring funding to establish a new section, the Shellfish Leasing Section, at the North Carolina Division of Marine Fisheries.

Defraying costs of Shellfish Leasing Section: Increase non-refundable shellfish lease application filing fee to $500 dollars; establish a fee schedule for lease surveys payable to the Division of Marine Fisheries; shift financial responsibility for advertising for public scoping from agency to the applicant; and increase annual rent.

Statutory Changes

Recommendation #10

Amend North Carolina General Statute §113-202 to afford the Secretary of the Department of Environmental Quality substantial discretion in balancing public trust uses.

Recommendation #11

The North Carolina Division of Marine Fisheries should designate appropriate tracts as Shellfish Enterprise Areas (SEAs) containing multiple, connected parcels available for shellfish mariculture and managed by the Division of Marine Fisheries.

Recommendation #12

In Pamlico Sound, the Secretary of the North Carolina Department of Environmental Quality should be granted discretion to grant up to three (total) 50-acre (each contiguous) water column or bottom leases, each obtained by a single lease application. These lease tracts must be separated from each other, and from shore, by at least 250 yards. Otherwise, current lease size maximums, including overall acreage possession limits for any single entity, should be retained throughout the State, and no more than three large water column or bottom leases may be established in Pamlico Sound until 2025.

Recommendation #13

Increase utilization requirement and strictly monitor and enforce "use it or lose it" policy for shellfish leases. Specifically, water column leases should be required to produce a minimum of 100 bushels $acre^{-1}$ annually averaged over the previous three-year period beginning in year five of the lease. Alternatively, water column lease holders may provide evidence of purchasing 45,000 shellfish seed $acre^{-1}$, annually. Bottom lease holders should be required to produce a minimum of 40 bushels $acre^{-1}$ annually averaged over the previous three-year period beginning in year five of the lease. Alternatively, intensive culture bottom operations may provide evidence of purchasing 30,000 shellfish seed $acre^{-1}$, annually. Free-on-bottom operations may also fulfill their utilization requirement by planting a minimum of 250,000 remote-set spat $acre^{-1}$ $year^{-1}$.

Recommendation #14

Institute higher minimum fines and mandatory restitution for those convicted of stealing or damaging property on shellfish leases. Elevate charges for theft from any contained culture (e.g. cages, bags) or free-on-bottom operation (including clams under netting) to a felony with a minimum fine of $2,500 and mandatory restitution to the property owner. For those convicted who hold a commercial license, first offenses will result in a one-year loss of license, and second offenses will result in a permanent loss of license.

Recommendation #15

Amend North Carolina General Statute §113-203 to allow nursery of shellfish in waters classified as prohibited.

Maintaining and Improving Water Quality

Recommendation #16

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.

Recommendation #17

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.

Recommendation #18

Adopt a State policy that requires the use of Low Impact Development (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.

Addressing Research Needs

Recommendation #19

Establish a recurring appropriation to fund a Shellfish Mariculture Grant Program, administered by North Carolina Sea Grant, that funds research projects aimed at informing an economically, ecologically, and socially beneficial shellfish mariculture industry.

Recommendation #20

Establish a Mariculture Resource Grant program, administered by North Carolina Sea Grant with significant collaboration from the North Carolina Shellfish Growers Association, that funds grower-led projects aimed at increasing return on investment, broadening industry participation, increasing product safety, environmental quality, and facilitating crop diversification.

Recommendation #21

Appropriate funds to support an Aquaculture Business Agent at North Carolina Sea Grant to aid the existing Marine Aquaculture Extension Specialist in meeting the ever-growing needs of the shellfish mariculture industry.

BACKGROUND AND CURRENT STATUS OF THE NORTH CAROLINA SHELLFISH MARICULTURE INDUSTRY

Decline of North Carolina's Wild Shellfish Fisheries

For centuries, shellfishing has been both economically and culturally important to coastal communities across North Carolina. Following the introduction of sail dredging in 1889, eastern oyster (*Crassostrea virginica*) harvests in North Carolina peaked at 800,000 bushels in 1902 (Kirby 2004). Since that time, despite increased regulation in response to downward harvest trends, oyster populations and yields have declined. These declines are attributable to both anthropogenic stressors such as overharvesting, loss of suitable substrate for juvenile oyster settlement, and degraded water quality, as well as natural stressors such as disease (NOAA 2014). In 1994, a year in which only 37,400 bushels of wild oyster were harvested, concern over declining oyster stock led the North Carolina General Assembly to commission the Blue Ribbon Advisory Council on Oysters (BRACO). BRACO recommended that "the best hope for maintaining the oyster resource in the face of current disease challenges is through private culture" and endorsed that improvement of the shellfish lease program be given highest priority. In response, the Division of Marine Fisheries enacted a new Management Plan for Oysters in 2001 that included recommendations to augment shellfish mariculture, establish oyster sanctuaries, and expand the cultch planting program. Annual wild oyster harvest has since increased more than three-fold over the 1994 level but remains only ~15% of 1902 harvest. In contrast to oysters, intense harvesting pressure on hard clams *Mercenaria mercenaria* only began in the late 1970s, increasing five-fold (306,000 lbs to 1,542,000 lbs) from 1976-1980 (Peterson et al. 1983), although landings of hard clams are reported back to the 1880s (Chestnut 1951). Before the 1970s, hard clams were considered a banked resource that could be exploited by fishers during downturns in other fisheries, however, as prices for hard clams increased in the 1970s, so too did the use of clam kicking, a mechanized harvesting technique (Peterson 2002). With these advancements in capture gears, high harvest levels proved unsustainable and between 1983 and 2000, wild harvest of hard clams fell by over 50% (Guthrie and Lewis 1982, Peterson 2002). Annual wild harvest in 2017 was the lowest on record since 1974 and between 2011 and 2017 averaged just one-fourth of peak harvest in the 1980s (NCDMF, 2017).

A shellfish lease with floating bags containing oysters. Credit: Chuck Weirich, North Carolina Sea Grant.

Given these trends, and broad experiences across the United States (U.S.) and internationally, there is growing consensus that the key to a sustainable seafood supply is further expansion of mariculture, with shellfish mariculture playing a particularly important role (Kobayashi et al. 2015, Knapp and Rubino 2016).

Shellfish Mariculture Practices

Oysters

Historically, the principle method of culturing oysters was for growers to place cultch, either empty oyster shell, other bivalve shell, or marl, on lease bottom as a substrate for wild, free-swimming oyster larvae to settle. The settled larvae, or spat, would grow in clusters on cultch and those that survived were harvested by hand, tong, or dredge. In the late 1960s, the advent of remote setting, in which hatchery reared oyster spat are attached to cultch prior to planting, allowed for the grow-out of oysters in areas with poor natural spatfall (Congrove et al. 2009). Around the same time, researchers developed a method for settling spat on micro-cultch, so that each oyster settles on its own grain-sized piece of substrate (Hudson 2012). These single oysters are grown in upwellers to a size at which they can be placed in bottom cages or floating cages for grow-out to market size, at which time they are generally sold to the raw, half-shell market (Paynter and Dimichele 1990, Walton et al. 2013). Intensively grown oysters, such as those cultured in cages, incur significantly less predation, often grow more quickly, and are of a more desirable shape than oysters grown free-on-bottom or harvested from natural, consolidated oyster reefs; however, intensive culture requires an appreciably larger initial investment and is more labor intensive throughout the grow-out process (Walton et al. 2013).

Another major breakthrough in oyster mariculture was the development of the triploid oyster. Like most animals, wild oysters are diploid, possessing two sets of chromosomes, one from each parent (Allen Jr and Bushek 1992). Triploid oysters, either produced chemically or by selective breeding, possess three sets of chromosomes rendering them largely sterile. The original method of treating newly fertilized eggs with chemicals, heat, and pressure to promote retention of two sets of chromosomes by eggs rather than casting off a pair prior to joining the chromosomes from oyster sperm. This method has largely been replaced by selective breeding, a more effective approach to producing triploids, in which tetraploid broodstock are crossed with diploid to yield triploid oysters without the use of chemical induction. The suppression of gamete production in triploid oysters frees up a considerable amount of energy and resources resulting in appreciably faster growth than in wild diploid oysters, as well as higher

Single oysters that will be sold for raw consumption. Credit: Ryan Belter, Cape Hatteras Oyster Company.

condition index and improved meat quality during summer – the primary season in which diploid oysters invest in reproduction (Nell 2002).

A clam farmer scattering clams underneath pulled back predator exclusion netting. Credit: Chuck Weirich, North Carolina Sea Grant.

Hard Clams

Hard clams produced in hatcheries are generally grown out in nurseries until they reach between 9-15 mm, at which time they are transferred to shallow lease bottom for grow-out (Castagna 2001). At these sizes, juvenile clams remain highly vulnerable to predation and require protection from predators. Grow-out operations can use hard structures, such as pens or trays, or soft structures, such as bags or net covers, to effectively reduce predation on shellfish product (Grabowski et al. 2000b, Castagna 2001). Once a large proportion of clams have reached the desired market size, pens and net-covered areas are uncovered and then clams are harvested using rakes or dredges, while clams in trays and bags are harvested by hand (Webster 2002).

Shellfish Relay

In the early 1900s, researchers discovered that fecal coliform bacteria levels in contaminated shellfish could be reduced to undetectable levels by moving them from contaminated to clean waters to depurate (Phelps 1911). Shellfish relay can be achieved by hand collecting, raking, tonging, or mechanical dredging of shellfish from polluted waters and then transporting those individuals to leases in conditionally open waters (Godwin 1981, Easley Jr 1982). In North Carolina, relayed shellfish must depurate for at least 21 days, generally considered to be ample time to clear fecal coliform; however, their ability to fully purse viral and heavy metal loads in this timeframe is less certain (Cunningham and Tripp 1975, McLeod et al. 2017). While shellfish relay, which transfers wild shellfish from public to private bottom, is not understood to confer the environmental benefits of mariculture operations that add new hatchery-reared shellfish or settlement substrate to the ecosystem (Easley Jr 1982), the practice

Hard clams produced on a bottom lease. Credit: Morris Family Shellfish Farms

increases the diversity of tools/options available to leaseholders to meet production and market demands. In addition to removing the expense of purchasing seed from hatchery/nursery operations, relayed shellfish are often near market size and therefore do not require much if any grow-out, only the time specified by Shellfish Sanitation to depurate. Relay may also provide the public greater access to seafood that otherwise represents an inaccessible public-trust resource due to water-quality and human-health concerns.

History of Shellfish Mariculture in North Carolina

North Carolina has allowed private use of public trust coastal waters for shellfish production through leases to residents since 1858. The first laws permitting shellfish leases prohibited any one person from leasing more than two acres. Lease size restrictions were amended in 1873 to allow 10 acres per person and by the late 1880s there were 250 such leases in the State (Winslow 1889). In 1887, the General assembly adopted new laws (Chapters 90 and 119 of the General Statutes), expanding the acreage allowances, allowing state residence to be granted no more than 640 acres in any five-year period. Non-residents of North Carolina were also allowed leases in Pamlico Sound, but were required to be two miles or farther from the shoreline.

Statutory authority to issue leases for cultivation of shellfish was adopted in 1909, incorporating many of the concepts that are still used to manage shellfish mariculture today, including lease renewal terms, performance requirements, and a public comment period on potential leases (Chestnut 1951). For the first half of the 20th century, there were approximately 260 leases covering 3,200 acres of bottom (Chestnut 1951). In 1976, production requirements, which had been 5 bushels of clams or oysters per acre, were increased to 25 bushels of shellfish per acre. Between 1982 and 1986, 71% of active shellfish lease holders failed to meet this requirement, but efforts to revoke 100 of the 285 leases were blocked by legislative action, allowing leaseholders a two-year extension to meet production requirements (NCDMF 2008). Although many leases remained underutilized, the Division of Marine Fisheries faced several administrative and logistic challenges during the early 1990s that precluded termination of leases still in violation. Presently, there is considerable evidence that shellfish production from some leases remains below production requirements and far below what could be produced based upon the performance of other leases from within the same or similar waterbodies.

Bottom leases with water column amendments (henceforth referred to as water-column leases, meaning that grow-out structures can extend beyond 18 inches above the seafloor) were first allowed in North Carolina in 1989, but applicants were likely deterred by the high annual rental fee of $500 per acre. The first water column lease was issued 1991. In 2005, the annual fee for water column leases was lowered to $100 per acre.

North Carolina currently has 51 franchises, which are private culture areas occurring on privately owned submerged lands. Franchises were conveyed to private citizens through either King's grants, the 1889 North Carolina Session Laws Chapter 298, or NC Board of Education deed for lands given to countries to generate education funds through their sale. Franchises are recognized under North Carolina General Statutes 113-205 and 113-206. Claimed lands recognized by the State were still required to undergo field surveys to ensure compliance with environmental standards and to provide farm management plans.

Shellfish Mariculture: Current Status

Although there has been little recent change in the number and acreage of bottom leases in North Carolina, the number and acreage of water-column leases have increased dramatically since 2011 (Figs. 1 & 2). As of 2017, there were 46 water-column leases encompassing 211 acres and 232 bottom leases encompassing 1626 acres (Figs. 1 & 2).

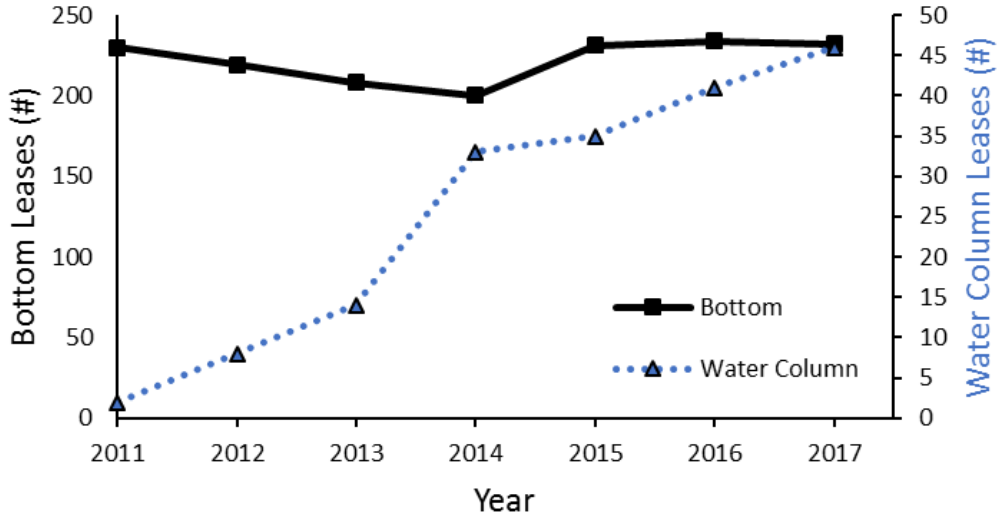

Figure 1. Number of bottom and water-column leases in North Carolina. Source: Chuck Weirich, North Carolina Sea Grant.

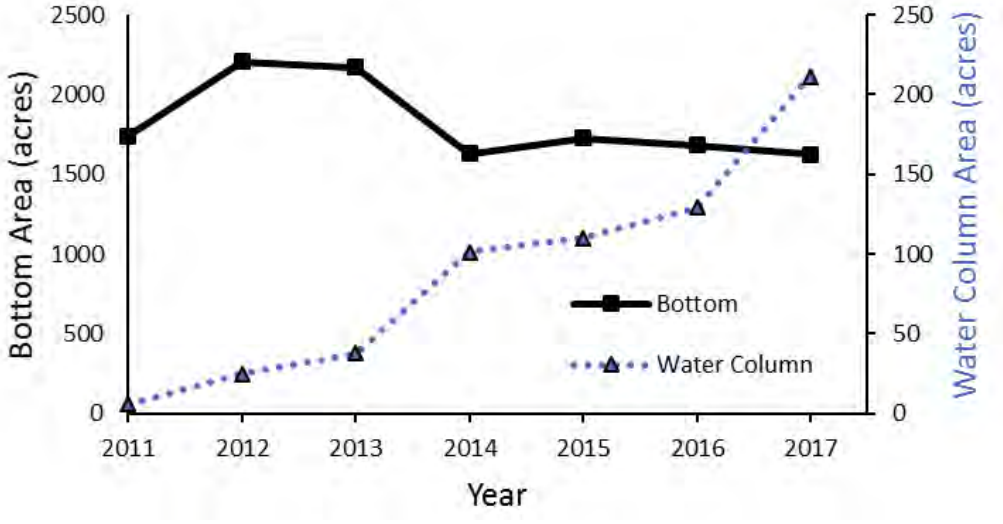

Figure 2. Acreage of bottom and water-column leases in North Carolina. Source: Chuck Weirich, North Carolina Sea Grant.

The current average size of shellfish leases and franchises in North Carolina is approximately six acres. Approximately 60% of bottom leases in the state are five acres or smaller and only about 12% are larger than 10 acres (Fig. 3). Nearly half (47.5%) of all water-column leases are two acres or less (Fig. 3). Although the largest franchise is 201 acres, approximately 65% and 85% of franchises are smaller than five or ten acres, respectively (Fig. 3).

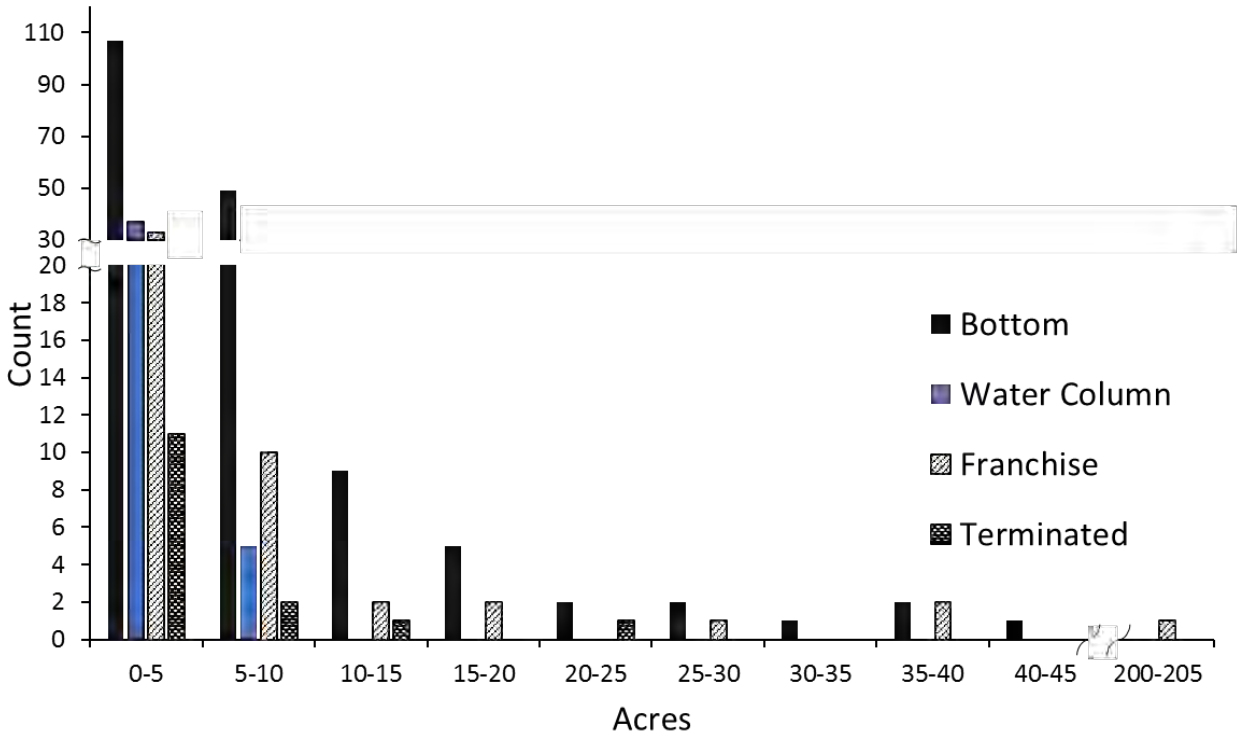

Figure 3. Histogram of lease acreage by lease type. Terminated leases are those terminated since 2005. Data extracted from North Carolina OneMap GeoPortal.

Current shellfish leases and franchises are located within eight coastal counties in North Carolina: Beaufort, Carteret, Date, Hyde, New Hanover, Onslow, Pamlico, and Pender Counties (Fig. 4). Carteret County has the greatest number (91) of active shellfish leases, while Onslow County has the greatest number of acres under lease or franchise (560).

Shellfish produced in the water column are grown inside floating gear (mesh bags, cages, tubes) and generally have higher survivorship (reduced predation and fouling) and growth rates (greater food availability) (Leonhardt 2013, Walton et al. 2013). Similarly, oysters may be grown in bottom enclosure gear, such as cages or racks that do not extend more than 18 inches above the seafloor. Although some oyster clusters are produced in floating or bottom enclosure gear, the vast majority of oysters produced using these methods are individual oyster ("singles") to be sold in the half-shell market. These single oysters command a greater price than clustered oysters that are generally sold into the bushel market, but singles are often appreciably more labor intensive to produce. Oysters may also be produced on bottom as spat-on-shell. While they require considerably less financial investment and maintenance, spat-on-shell oysters incur higher mortality from predators, fouling, and sedimentation. Hard clams and scallops are largely grown on bottom. To protect juvenile clams and scallops from predators, they are grown in mesh bags, cages, or under predator-exclusion netting. The composition of shellfish culture methods varies considerably among states. For instance, spat-on-shell accounts for only 10% of farm-gate value of farmed oysters in Virginia. Conversely, in Maryland, a state with environmental conditions and regulations that direct growers toward extensive bottom culture methods, spat-on-shell accounts for approximately 80% of mariculture produced oysters.

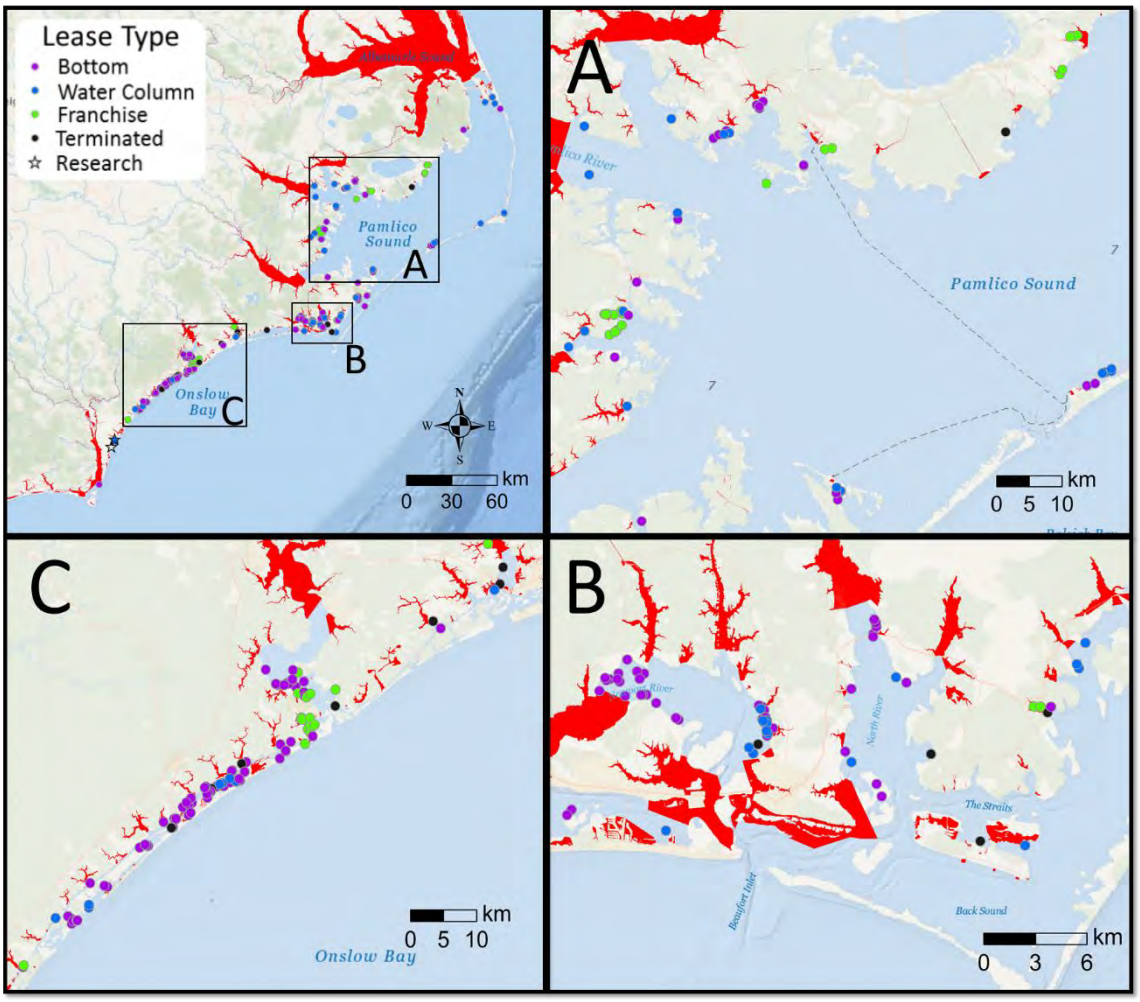

Figure 4. Map of shellfish leases and franchises statewide. Inset: (A) Pamlico Sound region; (B) Newport River, North River, Bogue Sound, and southern Core Sound region; and (C) Stump Sound to Rich's Inlet region. Waters permanently or conditionally closed to shellfishing are shaded red. Data Source: Department of Commerce Grant Analysis Map, ArcGis.

Mariculture production of oysters has grown substantially in North Carolina as the number of water-column leases has increased, with production increasing more than three-fold and farm-gate value growing more than five-fold between 2011 and 2017 (Fig. 5). In contrast, mariculture production of hard clams, which occurs almost exclusive on bottom, has declined appreciably since peak production of approximately 25,000 bushels in 1993 (NCDMF 2008). Among other factors, the rapid expansion of hard clam production in Florida, increasing from 100,000 lbs in 1987 to 4.5 million lbs in 1999. During the 1990s-2000s, this significantly depressed clam prices, reducing the profitability of clam leases in North Carolina (Northern Economics INC 2015). Clam production has remained relatively stable in recent years, with an average of 3,598 bushels between 2011 and 2017 (Fig. 6).

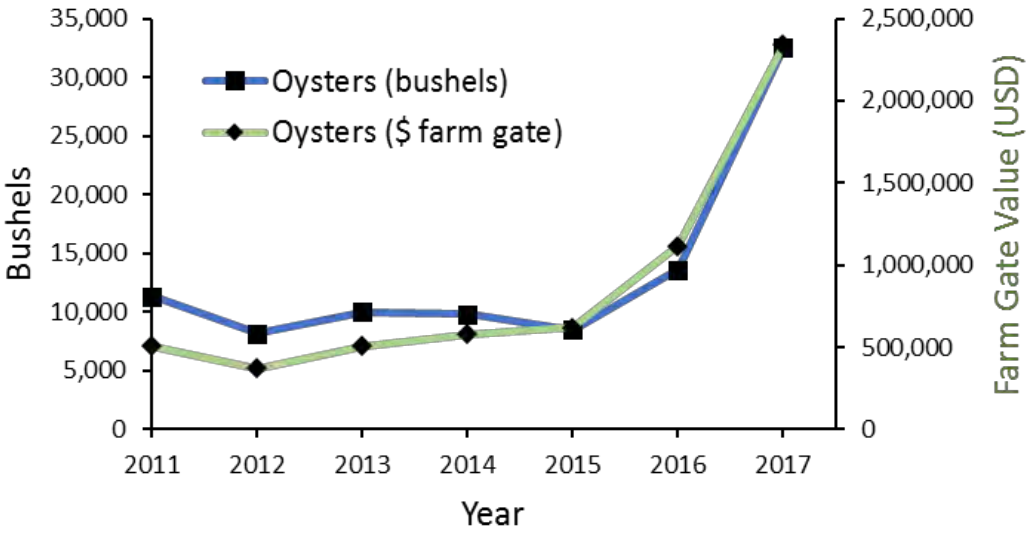

Figure 5. Production and farm-gate value of mariculture produced oysters in North Carolina between 2011 and 2017. Source: Production data from the North Carolina Division of Marine Fisheries. Farm-gate value calculated by multiplying individually sold oysters by $0.41 and bushels of oysters sold to the bushel market by $44.

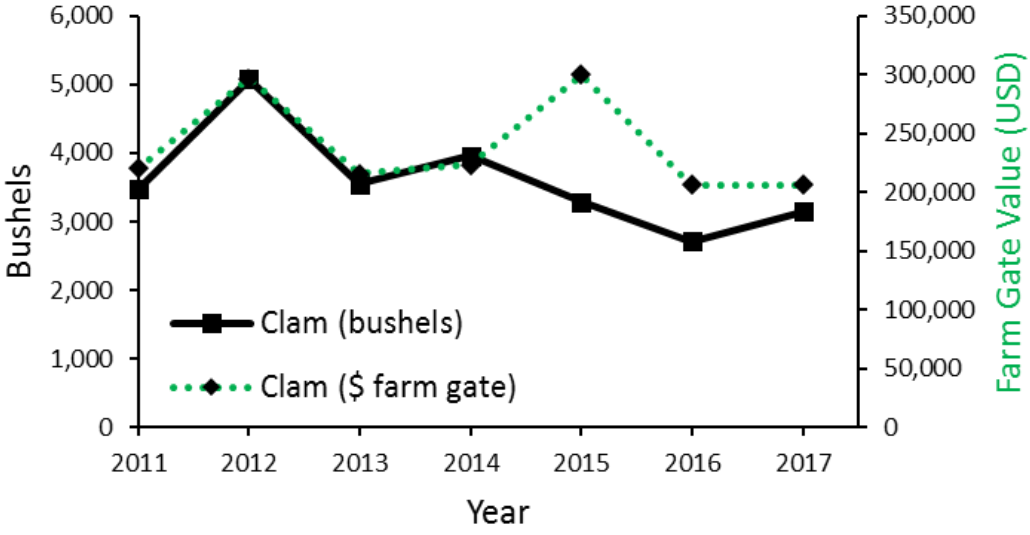

Figure 6. Production and farm-gate value of mariculture produced hard clams in North Carolina between 2011 and 2017. Source: Production data from the North Carolina Division of Marine Fisheries. Farm-gate value calculated by multiplying the average annual per-clam price paid to farmers by 400 to yield the average bushel price and then multiplying that number by the number of bushels produced.

Although production and farm-gate value of mariculture-produced oysters has grown dramatically in the last decade in North Carolina, the farm-gate value of North Carolina's mariculture-grown oysters in 2017 was only 15% of Virginia's value (Fig. 7). Even more striking

is the fact that the farm-gate value of North Carolina hard clam mariculture industry is substantially less than 1% of Virginia's (Fig. 7). Importantly, Virginia began taking substantive steps to grow their mariculture industry much earlier than North Carolina, allowing riparian owners to lease bottom adjacent to their property and permitting considerably larger lease acreage than allowed under North Carolina law. As such, there are currently over 5,500 leases occupying more than 120,000 acres in Virginia, roughly 20-fold and 67-fold more leases and acres, respectively, than in North Carolina. Although Virginia's shellfish farming industry is often referenced as a model for North Carolina, their lenient leasing policies that allow riparian owners to acquire leases on adjacent bottom without meeting utilization requirements has resulted in those 120,000 acres producing, on average, approximately one bushel of oysters and four bushels of clams per leased acre (Hudson 2017). Occurring on public trust bottom, unproductive leases represent an impediment to other public trust uses without delivering the economic and ecological benefits used to justify their conveyance for private uses. Furthermore, Virginia's policies appear to have established a culture in which riparian owners obtain leases primarily to prohibit others from doing so, contributing to the current backlog of approximately 400 pending applications dating back to 2011, that the Virginia Marine Resources Commission is tasked with permitting.

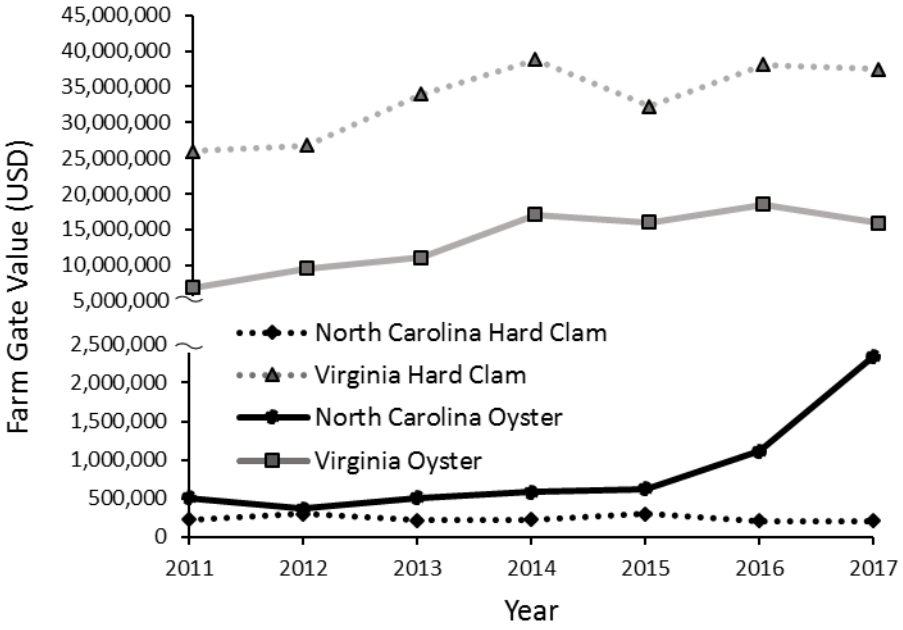

Figure 7. Production and farm-gate value of mariculture oysters and clams in North Carolina and Virginia between 2011 and 2017. Source: North Carolina data was provided by the North Carolina Division of Marine Fisheries. Virginia data was obtained from Murry and Hudson, Virginia Shellfish Aquaculture Situation and Outlook Report: 2011-2017.

North Carolina has begun to invest more heavily in managing shellfish mariculture, with an increasing proportion of Department of Environmental Quality appropriations for shellfish and mariculture being devoted to mariculture specific programs. Specifically, between 2010 and

2018, funding devoted to shellfish mariculture increased from $3,235, all of which was allocated to the Division of Marine Fisheries to administer shellfish leases, to $855,683, divided among funding the University of North Carolina Wilmington shellfish hatchery ($500,000), the Division of Marine Fisheries ($155,683), a shellfish pathologist position at North Carolina State University ($125,000), and the Carteret Community College Aquaculture Technology Program ($75,000) (Fig. 8). These investments are important commitments to the development of a thriving shellfish industry and are cornerstones for further industry development in combination with the Major Recommendations of this report.

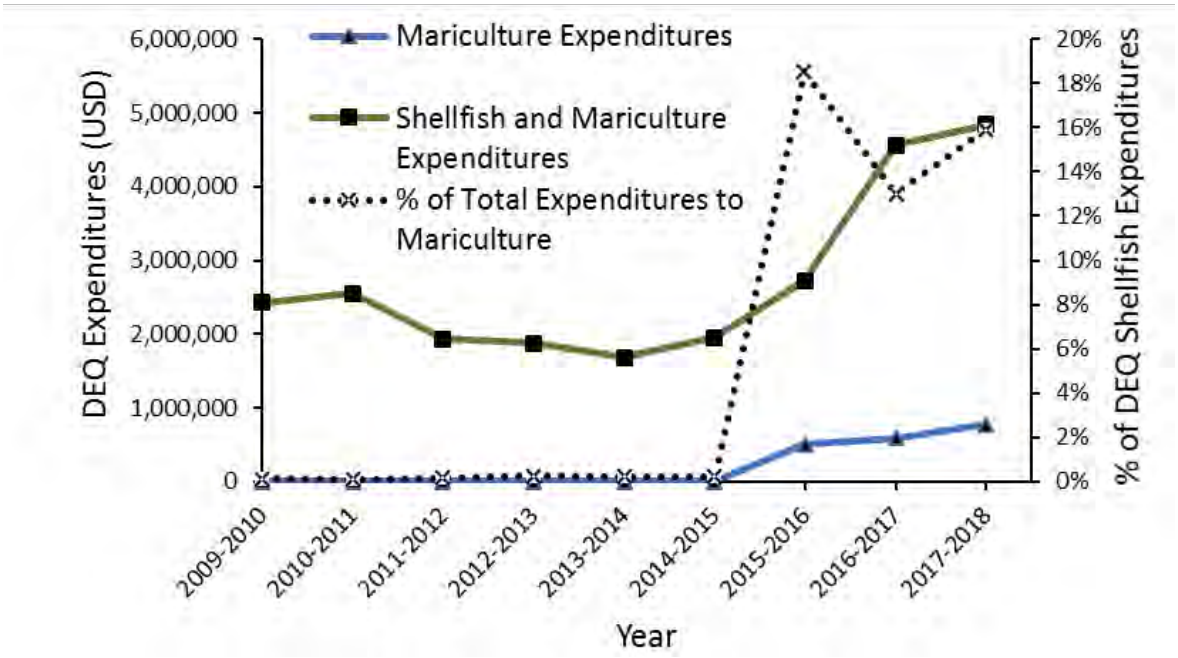

Figure 8. North Carolina Division of Environmental Quality funding for Shellfish, Oysters, and Aquaculture Fiscal Year 2009-2010 through 2017-2018: Total expenditures, mariculture specific expenditures, and percent of total allocated to mariculture. Source: North Carolina Policy Collaboratory.

Historical Barriers to Shellfish Mariculture

Financing Availability

Start-up costs of an intensive shellfish mariculture farm are typically $20,000-60,000 per acre and operations often take multiple years to become profitable (Hudson 2012). This represents a considerable barrier to entry to the shellfish industry, as highlighted by a 2011 survey of North Carolina shellfish growers in which 40% of respondents indicated availability of startup funding as a factor impeding growth of the industry (Turano et al. 2011). While financing for aquaculture is available at the federal level through programs administered by the Small Business Administration and the United Stated Department of Agriculture, these loan guarantee programs require considerable collateral and the participation of commercial creditors that are often unwilling to take the actuarial risk for any unsecured portion of a loan. As such, these programs may be of limited usefulness to those wishing to start or expand a shellfish farm. Other states

have addressed these shortcomings by creating their own shellfish mariculture specific loan programs (e.g. Maryland); however, there are currently no equivalent programs in North Carolina.

Limited Crop Insurance

Although crop insurance is an important mechanism for managing production, price, and quality of agricultural products, insurance options for aquaculture operations have historically been limited compared to traditional agricultural crops. Both the Federal Crop Insurance Corporation and private insurers have been hesitant to insure aquaculture operations because of inherent, yet difficult to quantify, risks associated with in-water operations. Further, monitoring aquaculture inventory to verify losses following claims is, or is perceived to be, more difficult compared to land-based crops and livestock (Shaik et al. 2003).

Even when best management practices are followed, shellfish growers remain vulnerable to losses from factors outside of their control, such as storms (e.g. Hurricane Florence in 2018) and disease. Although North Carolina shellfish growers are eligible for Noninsured Crop Disaster Assistant Program (NAP) insurance, this program provides appreciably less security than insurance provided to crops covered under Farm Bill insurance. For example, Federal Crop Insurance which has no cap on covered losses and has options to insure crops at levels up to 85% of approved yield at 100% of market price, while NAP covered losses are capped at $125,000 and buy-up coverage limited to 65% of approved yield (Hueth and Furtan 2012, Hungerford et al. 2017). An amendment to the recently passed 2018 Farm Bill has the potential to dramatically improve the crop insurance options that are available to shellfish growers. The amendment directs the United States Department of Agriculture's Risk Management Agency to conduct listening sessions with aquaculturists to develop workable methods to insure aquaculture products under the Whole Farm Revenue Protection (WFRP) program. Furthermore, the amendment directs the Risk Management Agency to insure each life stage as a separate crop in recognition of their differential mortality rates. Provided this amendment leads to Whole Farm Revenue Protection Coverage for shellfish operations, it will provide growers with access to higher levels of buy-up coverage (75% for monoculture operations and 85% for operations with three different commodities) and dramatically increase ($11,333,333 and $10,000,000, respectively) covered losses. However, until these insurance options materialize, the current lack of adequate insurance puts many shellfish growers at significant financial risk and is therefore an important deterrent for many potential industry participants.

Inefficient Regulatory Frameworks

Formulating the rules that regulate shellfish mariculture in North Carolina, other than those written in statute, falls to the North Carolina Marine Fisheries Commission (MFC). To aid the MFC, and Division of Marine Fisheries convenes several regional and topic-specific advisory committees, as guided by the 1997 Fisheries Reform Act. Notably, however, the MFC and advisory committees are most familiar with matters related to wild-capture finfish and shellfish/crustacean fisheries. At present, there is no advisory committee to provide expertise on matters related specifically to shellfish mariculture. Given the unique management considerations and needs of shellfish mariculture, other coastal U.S. states (e.g. FL, MA, MD, NJ, OR, VA), and the federal government (NOAA) have recognized the value of having advisory committees dedicated to shellfish mariculture/aquaculture.

Lack of Promotion and Marketing

Despite the growth of mariculture as an engine for coastal economies, there remains a lack of awareness by the general public about its value, methods, and products. This, in part, is attributable to campaigns that present mariculture products as a unified seafood sector (even combined with wild harvests in some instances), rather than discrete products with different environmental impacts and benefits that manifest among different species/approaches within the umbrella of farming in the sea (MARE 2014). Specifically, marketing campaigns for mariculture products often fail to highlight the environmental benefits of shellfish mariculture (e.g. improving water quality) for fear of highlighting, by juxtaposition, the more negative effects of finfish mariculture operations. Exacerbating this problem, state and Federal agriculture or commerce agencies are generally assigned the lead role in marketing and promotion of aquaculture products. These agencies, however, whose expertise have historically focused their promotional efforts around land-based agriculture and live-stock products, often lack the research funding needed to develop marketing and promotion strategies tailored to the unique needs of shellfish mariculture (CAQ 2015).

Public Trust Conflicts

Coastal tidal and navigable waters to which the state of North Carolina holds property rights are subject to public trust protection under the State's Constitution. These public trust rights stipulate that the lands and waters held in trust by the State cannot be conveyed in a manner that adversely affects public trust uses, including, but not limited to, navigation, swimming, hunting, fishing, and all other approved recreational activities. In addition to being protected under the North Carolina Constitution, these activities generate significant economic activity within the State. Specifically, commercial fisheries, of which some of the most lucrative are primarily conducted within estuarine waters (e.g. blue crab, shrimp, flounder), have averaged $86.9 million in dockside sales over the past five years (NCDMF 2018) and in 2016 contributed $188 million to North Carolina's Gross Domestic Product (Harrison et al. 2017). Recreational saltwater fishing, an appreciable portion of which also occurs within estuarine waters, is estimated to provide $1.6 billion in total economic impact annually and support 16,150 jobs (Harrison et al. 2017). In addition to recreational fishing, other forms of recreation and tourism (e.g. sightseeing, watersports, waterfowl hunting, nature parks) that draw visitors to the North Carolina coast were estimated to contribute $1.1 billion to annual Gross Domestic Product in 2016 and to support 38,138 jobs in the State (Harrison et al. 2017).

Shellfish mariculture farms operating within submerged lands and waters held in public trust will generally, by their very existence, affect some local change vis-à-vis other public trust uses. The State of North Carolina has decided that, due to the economic and ecological benefits of shellfish mariculture, properly sited shellfish leases may indeed be in the public interest (Eichenberg and Vestal 1992). To protect public trust uses of coastal waters, the legislation permitting the private cultivation of shellfish in North Carolina requires that "the cultivation of shellfish in leased areas will be compatible with lawful utilization by the public of other marine and estuarine resource. Other public uses which may be considered include, but are not limited to, navigation, fishing, and recreation" (N.C. Gen. Stat. §113-202). In stipulating that leases must be *compatible*, defined as able to exist or occur together without conflict, with other public trust uses, the statue has left shellfish lease decisions open to challenge on almost unlimited grounds. In most other states which permit shellfish mariculture, it is required that shellfish mariculture not

unreasonably interfere with other public trust uses, allowing considerably more discretion to the permitting agency and courts.

Declining Water Quality

Mariculture operations in coastal waters are subject to increasing coastal water pollution from both federally regulated point source pollution as well as land-based nonpoint source pollution. North Carolina prohibits "the discharge of wastes into Shellfishing Area (SA) waters and unnamed tributaries of SA waters, which could adversely affect the taking of shellfish for market purposes", and has declared protecting shellfish waters from pollution a top priority (Craig 2002). Despite these protections, in 2017 alone, 433,896 acres (19% of shellfish growing areas) were classified as prohibited due to poor water quality and an additional 314,710 acres (14% of available waters) were closed due to lack of funding to monitor water quality (Fig. 9). Between 2007 and 2018, the number of acres classified as prohibited and conditionally closed due to non-administrative reasons (i.e. degraded water quality) increased by 3,574 and 404 acres, respectively. Growers and other coastal stakeholders are deeply concerned about and burdened by the continued downstream progression of permanent "closure lines" and increasing periods of the year during which temporary water-quality closures are in effect (during which leases are off limits for harvest).

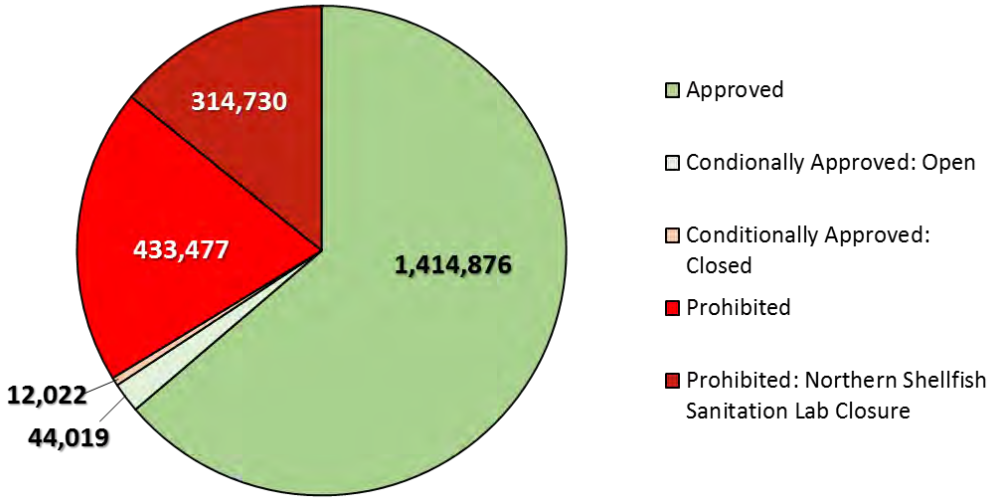

Figure 9. Coastal water shellfish classification acreages for 2017. Source: Shellfish Sanitation, North Carolina Division of Environmental Quality.

Shellfish disease exacerbates issues associated with declining water quality. Although North Carolina's shellfish industry has experienced relatively few large-scale mortality events associated with shellfish pathogens over the last 20 years, historical precedent from other Atlantic coast states and provinces highlight the need for preparedness. For example, outbreaks of MSX (Multi-Nucleated Sphere Unknown), a disease caused by *Haplosporidium nelsoni,* in Delaware Bay in 1957 and Chesapeake Bay in 1959, resulted in more than 90% oyster mortality among wild stocks (Andrews 1988, Andrews 1996). *Perkinsus marinus,* a parasite that thrives in warm, high-salinity waters and causes Dermo disease in eastern oysters, can reduce abundances of wild oysters to <20% of before-disease numbers (Powell et al. 2011, Bushek et al. 2012).

Furthermore, QPX (Quohog Parasite Unknown) has resulted in significant mortalities in hard clams along Canada, Massachusetts, New Jersey, and Virginia (Calvo et al. 1998, Ragone Calvo and Burreson 2002). Historically, these disease impacts have been isolated to wild stocks. However, the expansion of marine aquaculture has increased the potential for the transmission between the wild stocks that support these infectious diseases and aquaculture stocks through the surrounding water (Murray and Peeler 2005, Kurath and Winton 2011). Indeed, farmed stocks may be more vulnerable to infection and the negative impacts of infectious diseases may be greater than observed in wild hosts due to a lack of coevolution between farmed oysters and pathogens. Further, high stocking densities of farmed oysters may enhance the abilities of pathogens to spread and persist (Colorni et al. 2002, Krkošek 2010).

Scientific Uncertainties

A farmer measures an oyster. Credit: Bax Miller.

Although shellfish mariculture has a longer history than many other forms of aquaculture in the U.S., intensive shellfish mariculture practices have only been widely used since the late 20th century (Carriker 2004). As such, our understanding of the ecological and societal implications of shellfish mariculture are incomplete, hindering the ability of government agencies to determine where shellfish mariculture is suitable. For example, our limited understanding of how submerged aquatic vegetation is impacted by shellfish mariculture necessitates a highly conservative, but scientifically uncertain, approach to siting shellfish leases. We still lack comprehensive, regionally specific information on social carrying capacity of shellfish leases and the geospatial tools to minimize user conflict. As such, developing mechanisms to address research needs is critical for efficient environmentally and socially conscious shellfish mariculture management. Furthermore, the shellfish industry would benefit considerably from increased research efforts focused on disease prevention and mitigation (for both the diseases that elevate oyster mortality, as well as the pathogens carried by shellfish that can impact human health), development of broodstock, marketing, and crop diversification.

MAJOR RECOMMENDATIONS

Vision for Industry Development

Recommendation #1
Achieve $100 million annual shellfish mariculture value ($33 million dockside sales) by 2030.

Rationale

As of 2013, the most recent year for which comprehensive poverty rate data for North Carolina exists, poverty rates in 14 of North Carolina's 20 coastal counties exceeded the State average (by 4.2 percentage points; Table 1). In the first quarter of 2018, unemployment rates in 16 of 20 coastal counties exceeded the State average (by 2.3 percentage points; Table 1). Although several factors influence poverty and unemployment in coastal North Carolina, the lack of industry likely plays a significant role. Specifically, the top employers in nearly all coastal North Carolina counties are within the education, public health, and public administration sectors (Table 1). The dearth of large, private employers is structural for coastal North Carolina and has not exhibited signs of transformation in recent decades. Expanding the shellfish industry in North Carolina represents a viable means of bring much needed jobs to coastal communities, and in particular, those families defined by a history of working on the water. In addition to farm owners and workers, the shellfish mariculture industry can also support hundreds and potentially thousands of jobs indirectly related to shellfish leases (e.g. restaurateurs; Table 2).

The value of setting realistic shellfish production goals has been demonstrated by numerous other states and provinces with successful mariculture plans (e.g. Alaska, Maine, New Brunswick). These benchmarks can inform the success or failure of policies and programs and create accountability for agencies responsible for marketing and promotion (Nash 2004). The proposed goal of building a $100 million shellfish industry ($33 million farm-gate sales with an economic impact multiplier of 3) in North Carolina by 2030 was not derived arbitrarily. Achieving farm-gate sales of $33 million annually within ten years would place shellfish mariculture within or close to the top-20 most valuable agricultural products in the State (Table 3). Furthermore, should North Carolina follow trends documented in other states (see Table 2), a shellfish mariculture industry worth $33 million in annual farm-gate sales could support nearly 1000 coastal jobs (Fig. 10). It is precisely this gain in jobs, and associated socioeconomic benefits which would accrue, that justify tax-payer funded investment allocated toward administration, promotion, and grower support for this emerging coastal industry. The non-recurring and recurring appropriations to embrace all of the recommendations within this report would cost $13,440,000 over ten years ($2,060,000 non-recurring, $1,138,000 annual appropriation; Appendix B). Presuming these actions result in approximately 1,000 direct employment jobs in the shellfish mariculture industry (Fig. 10), this would amount to $13,440 of State investment per job. This compares very favorably to estimates from the President's Council of Economic Advisors report "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009", which predicted that approximately $92,000 of government spending is required to create one job-year (Executive Office of the President Council of Economic Advisers 2009). Furthermore, retrospective analysis on job creation resulting from the American Recovery and Reinvestment Act found their estimates to be low, with the actual

spending required to generate a single job falling closer to $125,000 (Wilson 2012). Similarly, a 1956-1992 study on job creation resulting from government spending found that it took between $145,000 and $237,000 (adjusted to 2018 dollars) to creating one local job-year (Davis et al. 1997). Given this context, $13,440 in appropriations spread across ten years resulting in one local job seems an economical approach to bolster employment in coastal counties.

Beyond job creation and direct economic activity, it is also important to acknowledge the value of ecosystem services provided by shellfish mariculture, a value not universally derived from other forms of terrestrial or marine farming. For example, the value of 40 million maricultured oysters in Long Island Sound during 2017 in removing biologically available nitrogen ranged between $8.5 and $230 million yr^{-1} depending on the man-made nitrogen-removal alternatives that could have mitigated similar amounts of excess nutrients (Bricker et al. 2017). Furthermore, studies have shown that, through habitat provision, off-bottom shell aquaculture in the Gulf of Mexico provides an estimated marginal economic value per acre per year of $1,564 and $2,286 in terms of recreational and commercial fisheries enhancement, respectively (Wellman et al. 2014).

Table 1. Top employers, employment rates, and unemployment rates in coastal counties, as well as Statewide poverty and unemployment rates. Data Source: North Carolina Division of Employment Security.

	Top Employers by County (2017)				
County	**Employer**	**Sector**	**Employees**	**Poverty Rate (2013)**	**Unemployment Rate (Jan 2018)**
Beaufort	Beaufort County Schools	Education & Health Services	1000+	20.5	5.4
Bertie	Perdue Products Inc.	Manufacturing	1000+	26.6	6.3
Brunswick	Brunswick County B.O.E.	Education & Health Services	1000+	16.1	6.9
	Progress Energy Service Co	Trade, Transportation, & Utilities	1000+		
	County Of Brunswick	Public Administration	1000+		
Camden	Camden County BOE	Education & Health Services	250-499	9.5	4.5
Carteret	Carteret County B.O.E.	Education & Health Services	1000+	15.2	5.1
	Carteret County General	Education & Health Services	1000+		
Chowan	Edenton-Chowan Schools	Education & Health Services	250-499	22.2	5.7
	Vidant Medical Center	Education & Health Services	250-499		
	Meherrin Ag & Chem Co	Trade, Transportation, & Utilities	250-499		
Craven	Army Navy & Air Force	Public Administration	1000+	16.6	4.8
	Carolina East Medical Center	Education & Health Services	1000+		
	Craven County B.O.E.	Education & Health Services	1000+		
	BSH Home Appliances Corp	Manufacturing	1000+		
Currituck	Currituck County B.O.E.	Education & Health Services	500-999	11.7	5.2
Dare	Dare County Schools	Education & Health Services	500-999	11.1	10.5
	County Of Dare	Public Administration	500-999		
Gates	Gates County B.O.E.	Education & Health Services	250-499	18.2	4.5
Hertford	Hertford County B.O.E.	Education & Health Services	100-249	24.9	6
	Vidant Medical Center	Public Administration	100-249		
Hyde	Hyde County B.O.E.	Education & Health Services	500-999	22.9	14.6
	Nc Dept Of Public Safety	Education & Health Services	500-999		
New Hanover	New Hanover Reg Med Center	Education & Health Services	1000+	18.9	4.5
	New Hanover Schools	Education & Health Services	1000+		
	UNC Wilmington	Education & Health Services	1000+		
	PPD Development Llc	Professional & Business Services	1000+		
	County Of New Hanover	Public Administration	1000+		
	Cape Fear Community College	Education & Health Services	1000+		
	Cellco Partnership	Information	1000+		
	City Of Wilmington	Public Administration	1000+		
Onslow	Onslow County B.O.E.	Education & Health Services	1000+	16.9	5.3
	Department Of Defense	Public Administration	1000+		
	Marine Corps Community Services	Trade, Transportation, & Utilities	1000+		
	Wal-Mart Associates Inc	Trade, Transportation, & Utilities	1000+		
	County Of Onslow	Public Administration	1000+		
	Onslow Memorial Hospital	Education & Health Services	1000+		
Pamlico	Pamlico County Schools	Education & Health Services	250-499	19	5.1
Pasquotank	Elizabeth City County Board	Education & Health Services	500-999	21.8	6.1
	Sentara Internal Med. Physicians	Education & Health Services	500-999		
	U.S. Dept. Homeland Security	Public Administration	500-999		
Pender	Pender County Schools	Education & Health Services	1000+	18.3	5
Perquimans	Perquimans County Schools	Education & Health Services	250-499	20.9	5.8
Tyrrell	Tyrrell County B.O.E.	Education & Health Services	100-249	27.2	10.6
	Nc Dept Of Public Safety	Public Administration	100-249		
Washington	Domtar Paper Company Llc	Manufacturing	250-499	25.5	7.6
	Washington County B.O.E.	Education & Health Services	250-499		
NORTH CAROLINA				17.9	4.5

Table 2. For each coastal state in the United States, the number and acreage shellfish leases by type, total and per-acre production of oysters and clams, number of direct and indirect jobs generated by each state's shellfish mariculture industry, and the number of state employees whose funding was appropriated to administer the shellfish industry. Source: Industry statistics reports produced by states or personal communication with state administrators.

	Leases						Production								Shellfish Aquaculture Jobs			State Staffing for Mariculture Governance
	Water Column		Bottom		Cumulative		Oysters			Clams		Oysters	Clams	Data Year	Direct	Indirect	Year	
State	# Leases	Acreage	# Leases	Acreage	# Leases	Acreage	Bushels	Pieces	Value	Pieces	Value	Bu/acre	Bu/acre					
ME	--	--	--	--	110	557	N/A	8,804,391	$5,964,214	--	--	53	--	2014	500	500	2016	6.5**
NH	1.0	2.3	24.0	68.4	25	71	N/A	329,156	$246,441	--	--	16	--	2017	24	--	2015	1
MA	--	--	--	--	360	1,259	N/A	38,251,358	$21,711,683	5,554,641	$132,806	101	11	2016	769	140	2013	2
RI	--	--	--	--	73	296	N/A	8,434,541	$5,752,886	71,000	$18,460	95	1	2017	194	--	2016	1
CT	326.0	30,669.0	674.0	22,422.0	1000	53,091	73,367	22,010,000	$8,010,682	106,323,500	$17,405,028	1	5	2010	350	--	2018	--
NY	--	--	--	--	859+	4,621	--	--	--	--	--	--	--	--	--	--	--	0[$]
NJ	--	--	--	--	1742	<3876	N/A	2,029,500	$1,370,060	--	--	2	--	2016	319+	--	2016	6
DE	--	--	--	--	21	21	Leasing began 2017, no production reported							2017	84+	--	2011	1.5
MD	57.0	222.0	309.0	3,960.0	334	4,182	21,362	3,838,037	$2,769,867	--	--	8	--	2014	498	--	2014	8
VA	--	--	--	--	5500	120,000	27,000	38,900,000	$15,900,000	176,000,000	$37,500,000	1	4	2017	965	--	2016	--
NC	46.0	211.0	232.0	1,626.0	278	1,837	20,983	3,459,740	$2,400,000	1,260,000	$206,500	18	2	2017	228+	--	2011	2***
SC	--	112.4	--	946.0	23	1,058	2,520.0	--	$375,117	2,969,865.0	$407,333	2.4	7.0	2018	--	--	--	--
GA	--	--	--	--	17	29,186	1,328.0	--	$119,876	9,488,160	$1,611,613	0	0.8	2017	--	--	--	--
FL	60.0	156.0	549.0	1,259.0	609	1,415	--	--	--	126,600,000	$11,900,000	--	224	2012	400	--	2016	7
AL	14.0	28.0	0.0	0.0	14	28		2,698,755	$1,956,766	--	--	321	--	2016	30	--	2016	--
MS	0.0	0.0	7	623.2	7	623	--	299,900	--	--	--	2	--	2010	--	--	--	6
LA	--	--	--	--	8020	403,461	--	227,737,226	$40,500,000	--	--	2	--	2013	--	4800	--	--
TX	--	--	--	--	43	2,270	--	28,571,428	$3,700,000	--	--	42	--	2014	--	--	--	0[$]
CA	--	--	--	--	17	878	--	16,121,835	$16,096,460	257,640	$42,940	61	1	2016	200	80	2010	5
OR	--	--	--	--	77	3,837	88,631	--	$3,102,098	--	--	23	--	2017	--	--	--	0[$]
WA	--	--	--	--	121	2,058	175,863	--	$34,853,940	0	$0	85	0	2013	1900	810	2010	--
AK	39.0	177.0	17.0	87.0	56	264	--	1,161,518	$796,945	0	$0	15	0	2016	166	--	2016	5**

(--) Data Unavailable

**Administer all forms of mariculture (e.g. shellfish, seaweed, urchins)

*** 5 Additional staff assist, but budgetted from Benthic Mapping and Habitat Enhancement Sections

[$] Administered by employees under non-shellfish mariculture budgets

Table 3. Farm-gate sales of the 20 most valuable agricultural commodities in North Carolina during 2016, compared with farm-grown oysters and clams. Data Source: North Carolina Department of Agriculture and Consumer Services.

Farm Income		
NC Rank	**Commodities**	**2016**
		x 1000 Dollars
1	Broilers	3,091,561
2	Hogs	2,103,444
3	Turkeys	993,389
4	Tobacco	668,596
5	Soybeans	543,241
6	Chicken eggs	444,403
7	Corn	429,589
8	Sweat potatoes	342,000
9	Cattle and calves	255,295
10	Dairy products, milk	164,160
11	Cotton	159,601
12	Cotton lint	131,619
13	Wheat	76,426
14	Peanuts	68,283
15	Blueberries	66,924
16	Hay	60,078
17	Tomatoes	51,894
18	Watermelon	29,198
19	Cottonseed	27,982
20	Strawberries	26,928
--	Mariculture Oysters	1,100
--	Mariculture Clams	207

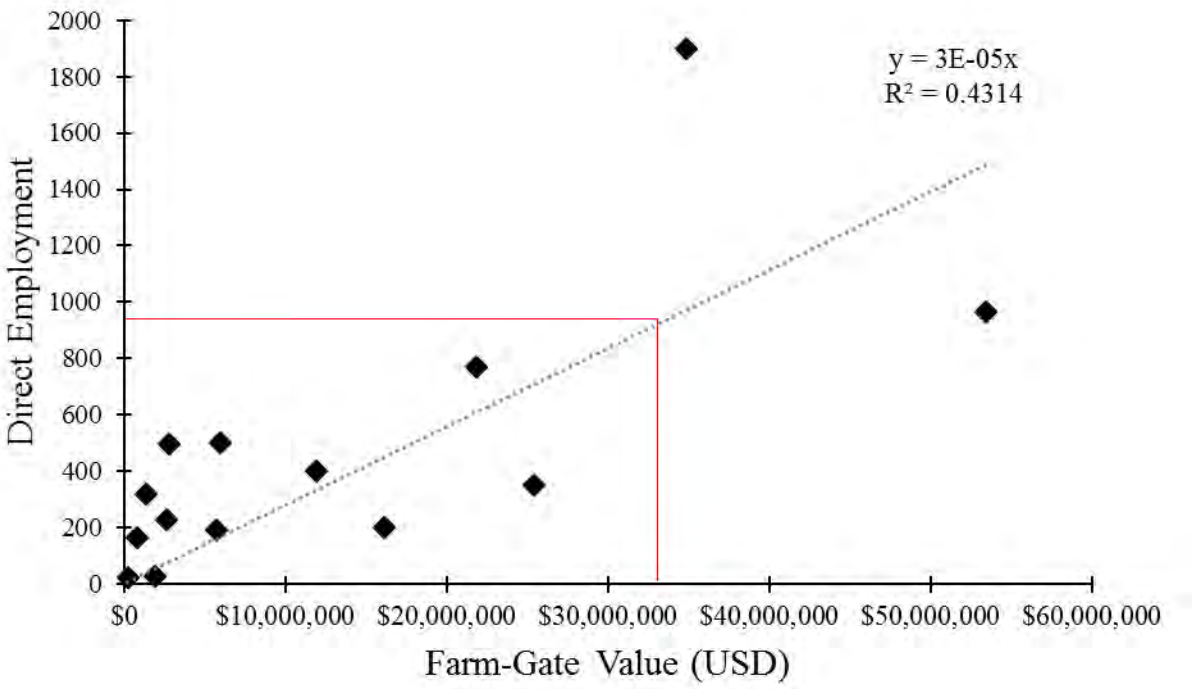

Figure 10. Direct employment as a function of shellfish industry farm-gate value from states in the U.S. with available data. The best-fit linear relationship is indicated by the dotted blue line. The intersection of the two red lines indicates the predicted direct employment resulting from an industry with $33 million in farm-gate sales. Industry statistics reports produced by states or personal communication with state administrators.

Supporting Shellfish Growers

Recommendation #2
The North Carolina General Assembly should appropriate $30,000 to support the North Carolina Shellfish Growers Association's efforts to develop a pilot Federal Crop Insurance program for farmed shellfish.

Rationale – developing a pilot Federal Crop Insurance program for farmed shellfish

The availability of mariculture insurance has historically been limited in comparison to those available to traditional agricultural crops and livestock operations (Shaik et al. 2003). Despite insurance serving as an important and cost-effective mechanism of managing risk – and therefore price, yield, and quality of agricultural products – real and perceived difficulties in verifying product losses in aquaculture, as well as a limited understanding of the complex threats to aquaculture operations, have impeded the development of private or governmental aquaculture insurance programs in the U.S. (Shaik et al. 2003, Beach and Viator 2008). Even if private insurers for shellfish mariculture operations were to emerge, the premiums for private risk-sharing programs would likely be prohibitive to many operation, particularly small farms like those that dominate North Carolina's industry (Secretan 2007). As such, providing adequate insurance options to shellfish mariculture operations requires government intervention.

In North Carolina, insurance for shellfish growers is available through the Noninsured Crop Disaster Assistance Program (NAP). This program, which covers crops that are not insurable under Federal Crop Insurance, covers the amount of loss greater than 50% of the approved yield at 55% of market price. While this is the same as the most basic 50/55 catastrophic coverage (CAT) under Federal Crop Insurance, Federal Crop Insurance Coverage allows buy-up coverage of 50% yield at 100% market price (50/100), 75/100, and even 85/100 in certain areas (Shields 2015). In contrast, buy-up policies for NAP insurance cover a maximum of 65% of yield at 100% market price (Hueth and Furtan 2012, Hungerford et al. 2017). Importantly, NAP insurance is event specific, requiring at least a 50% (for 50/55 coverage) loss during a given event for claim eligibility. Particularly given the potential for multiple hurricane events to affect mariculture operations in North Carolina within a given crop year, the fact that NAP does not cover repetitive losses (e.g. multiple loss events that in aggregate exceed the loss threshold) is a serious shortcoming of the program. Further differentiating NAP from Federal Crop Insurance is the presence of a $125,000 per crop year limit on claims, whereas there is no cap for losses covered under Federal Crop Insurance. Increased availability of more comprehensive insurance could provide a level of security that should limit exposure risk and encourage growth of existing operations or new entry into the industry (Du et al. 2016).

A recent development has the potential to dramatically improve the insurance options available to shellfish growers. Efforts spearheaded by Senators from Maryland (Ben Cardin), New York (Kirsten Gillibrand), Connecticut (Chris Murphy), and Rhode Island (Sheldon Whitehouse) led to the inclusion of an amendment of Section 11122 (Research and Development Authority) of the Agriculture Improvement Act of 2018 (Farm Bill). The amendment directs the United States Department of Agriculture's Risk Management

Agency (RMA) to conduct listening sessions with farmers of aquaculture products to develop workable methods to insure their products under the Whole Farm Revenue Protection (WFRP) program. Additionally, the amendment directs the RMA to treat each life stage as a separate crop in recognition of their differential mortality rates. The need to consider each life stage separately was underscored by an mariculture grown clam insurance pilot study that began in 2000 (Beach and Viator 2008). The program offered insurance to hard clam growers in 13 counties spread across Massachusetts, Virginia, South Carolina, and Florida. Plagued by a large number of payouts in the first few years of the program, program administrators identified the major source of losses as occurring during the nursery phase, a time in which wild clams also incur high natural mortality, and discontinued insuring nursery phase clams. As a result, the program experience significant improvement in actuarial performance, highlighting the potential viability of mariculture insurance provided that policies incorporate a basic understanding of the species being insured (Beach & Viator 2008). If the listening sessions the RMA is directed to hold lead to Whole Farm Revenue Protection Coverage for shellfish operations, it will provide growers with access to higher levels of buy-up coverage (75% for monoculture operations and 85% for operations with three different commodities) and dramatically increase ($11,333,333 and $10,000,000, respectively) covered losses.

Although Whole Farm Revenue Protection would provide appreciably greater security to North Carolina shellfish farmers, its highest buy-up coverage of 75% of maximum approved yield for operations with less than three commodities remains inferior to the 85% of approved yield buy-up coverage for single commodity operations available through Federal Crop Insurance plans. To provide North Carolina shellfish growers with a viable path towards Federal Crop Insurance coverage, the General Assembly should appropriate $30,000 in seed funding for the development of a pilot Crop Insurance Concept Proposal, an important first step in the development of a Shellfish Crop Insurance Program under Section 508(h) of the Federal Crop Insurance Act (FCIC 2012). Section 508(h) allows individuals or entities to submit insurance plan proposals to the Federal Crop Insurance Corporation (FCIC) for consideration by its Board of Directors. Prior to submitting a full plan, individuals and entities may submit a Concept Proposal detailing the viability and marketability of the commodity, the need for FCIC backing, the risks the proposed policy will cover and how they are insurable by the FCIC Act, the availability of sufficient and creditable data to use in rating/pricing, and actuarial rating and pricing methodologies appropriate for the risks covered (FCIC 2012, 2017).

The $30,000 appropriation would be used to finance a collaboration between the North Carolina Shellfish Growers Association and private partners to develop the aforementioned Concept Proposal for shellfish mariculture. If the Board of Directors approves the Concept Proposal, 50% of the submitter's expected research and development costs may be advanced by the FCIC per Section 522(b) of the FCIC Act. If the full plan that is submitted to the Board of Directors is approved, the remaining research and development costs are paid in full by the FCIC/Risk Management Agency. The plan is then implemented as a four-year pilot program that gives the submitter, in this case the North Carolina Shellfish Growers Association, the ability to make suggested modifications. As such, a relatively small appropriation could result in the FCIC paying the research and development costs (which a private entity with knowledge of the process estimated could range from $300,000-$500,000) of a national Shellfish Crop Insurance

Program over which North Carolina growers will have considerable influence. It is keenly important that North Carolina takes a leadership role in the early development stages of this insurance plan to ensure that the risks unique to our State are included in the coverages adopted by the Federal Government. For instance, were Washington or Massachusetts – two other leading shellfish growing states (Table 2) – to approach the FCIC with a plan first, hurricane coverage could be excluded to keep costs down for growers in those states while effectively precluding participation of North Carolina growers in a Shellfish Crop Insurance Program under Section 508(h) of the Federal Crop Insurance Act. Conversely, if North Carolina develops the Crop Insurance Concept Proposal and includes coverage for hurricane-related losses, the cost of that coverage could be spread among participating shellfish growers across the East, West, and Gulf coasts. Therefore, this investment of seed funding is a crucial and cost-effective approach for supporting North Carolina shellfish growers by mitigating exposure risk, which is central in expanding the industry.

Rationale - Supplemental approaches to provide grower's with adequate coverage (buy-up subsidies)

The process of developing a Concept Proposal and completing the necessary research and development to submit a full product insurance plan for shellfish will likely take multiple years. It will also likely be a few years before mandates from the 2018 Farm Bill result in the Risk Management Agency creating a Whole Farm Revenue Protection produce suitable for shellfish mariculture products. In the interim, the General Assembly may also wish to consider providing greater stability to growers by improving access to buy-up NAP coverage (65% of yield/100% market price) with subsidies. Buy-up coverage premiums are calculated as the lesser of either 5.25% of the payment limit or 5.25% of the guarantee. In other words, those whose approved yield (65% of crop value) meets or exceeds the payout cap of $125,000, their buy-up premium would be 5.25% of $125,000, or $6,562. Farms with less than $125,000 approved yield would pay 5.25% of the guarantee. Importantly, the Farm Service Agency will waive service fees and reduce buy-up premiums by 50% for any farmer that has been in business for less than 10 years, has limited resources, or is considered socially disadvantaged. As a majority of growers would qualify for the 50% fee waiver, subsidies to the highest level of buyup coverage would amount to approximately $3,250 per grower and many have yields considerably lower than $125,000. If the average grower required a $4,500 subsidy to purchase 65/100 buy-up insurance, it would require annual subsidies of $225,000-$450,000 to cover 50-100 growers.

While subsidizing 65/100 buy-up insurance would require a non-trivial annual appropriation, the General Assembly should consider whether this may be cost saving should it avert or mitigate the need for future disaster assistance funds. Furthermore, this appropriation should only be necessary for the few years it takes the North Carolina Shellfish Growers Association and private partners to develop a Shellfish Insurance Plan and have it approved by the FCIC.

Recommendation #3

Establish a low-interest loan program to provide start-up and expansion capital to shellfish growers.

Rationale

Approximately 40% of surveyed shellfish lease holders in North Carolina during 2011 responded that lack of available capital (i.e. loans) was a major factor limiting the growth of the industry (Turano et al. 2011). The capital required to establish a shellfish farms is considerable, with estimates ranging from $20,000-60,000 per acre for water-column leases (Hudson et al. 2012, Hilton 2017). Once established, shellfish farms routinely take multiple years to become profitable during which time they still incur operational expenses (Hudson 2012). There are two avenues to provide shellfish growers with the capital needed to start new operations or expand existing farms: grants or loans. Grant programs, however, have considerable shortcomings: namely, the lack of "skin in the game" that allows recipients to walk away from farms when problems arise, leaving the State to clean up abandoned farms.

At the Federal level, there are multiple programs that offer financial assistance and loans to aquaculture businesses; however, attributes of these programs present continued barriers for shellfish growers. For example, the Small Business Administration Section 7(a) loan and USDA Business Industry Loan Guarantee programs both require considerable collateral and depend on finding commercial creditors willing to take the actuarial risks associated with the marine environment, such as weather, disease, and degraded water quality, since only a percentage of the loan amount is guaranteed (Le Bihan et al. 2013). To address barriers to shellfish aquaculture financing, other states have developed their own loan programs dedicated to aquaculture and, more specifically, shellfish mariculture (e.g. Alaska, Maryland).

A highly successful example of a state-run loan program for shellfish mariculture is Maryland's Agricultural & Resource-Based Industry Development Corporation (MARBIDCO) Shellfish Aquaculture Loan Fund and Remote Setting Aquaculture Loan Fund. Since its inception, MARBIDCO has played a major role in growing Maryland's mariculture industry. The Shellfish Aquaculture Loan Fund provides $5,000-$100,000 grants for a term of five years with interest-only payments for the first three years (3% APR). Provided the grower has paid interest in full throughout the first three years of the loan, 40% of the principal is forgiven and, in years four and five, the remaining balance is amortized over those two years at 5% APR. The Remote Setting Aquaculture Loan Fund is similar but provides loans from $5,000-$30,000. The fund was started in 2010 with $2 million allocated to Maryland from the National Oceanic and Atmospheric Administration (NOAA) Blue Crab Disaster Funds. It has continued to be supported by federal (NOAA), and state capital (Maryland Department of Natural Resources and Maryland Port Administration).

Since its inception, MARBIDCO has funded 69 shellfish projects totaling over $3 million. Despite these loans being unsecured, repayment performance has been high, with only a few instances of non-repayment. During the first five years of the program (2010-2015), Maryland increased the area under shellfish lease by more than 2,000 acres, representing 100 additional lease holders (Parker 2015). In 2017, the MARBIDCO program lent more than $9 million dollars across all agriculture business, levering more

than $38.3 million in commercial lending funds, a four-to-one leverage ratio (MARBIDCO 2017). Although MARBIDCO is required by law to be self-sustaining after 2020, because of the principal forgiveness component specific to the shellfish aquaculture loan programs, these programs will be self-liquidating unless they are periodically replenished (personal communication with Steve McHenry, Executive Director, MARBIDCO).

Should the General Assembly embrace the goal of building the State's shellfish mariculture industry to a $100 million valuation ($33 million dollars in dockside sales, Major Recommendation #1), they should appropriate funds to establish a low-interest loan program similar to the MARBIDCO Shellfish Aquaculture Loan Fund. The program should be established with a one-time appropriation of $2 million. Based on the success of the MARBIDCO program, similar loan caps, terms, and APR should be implemented. The program should be administered by the North Carolina Rural Center, an agency with experience administering small business loans and that is heavily involved in the rural communities in which a majority of shellfish growers reside. To cover administrative costs, the North Carolina should capture 3% of the initial $2,000,000 and receive a recurring appropriation of $60,000 annually to cover administrative costs. In the absence of principal forgiveness, the MARBIDCO model demonstrates that targeted loan programs should be self-sustaining. Were the General Assembly to embrace a plan that included principal forgiveness, the loan program would be self-liquidating unless top-ups were budgeted from the general fund, or unless the General Assembly embraced an alternative funding approach (e.g. Supplemental Recommendation #3).

Recommendation #4

Establish eligibility of shellfish growers in future disaster relief fund appropriations to the North Carolina Department of Agriculture and Consumer Services.

Rationale

In response to the devastating impacts of Hurricane Florence in September of 2018, the North Carolina General Assembly passed Session Law 2018-138 Senate Bill 823: *An Act to Provide Additional Disaster Relief in Response to Hurricane Florence*. Of the $299,800,000 appropriated by the bill, $240,000,000 was allocated to the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) to provide disaster assistance to farmers (Section 1.3(3)) and $10,000,000 was allocated to the North Carolina Division of Marine Fisheries (NCDMF) to assist commercial fishers (Section 1.3(5)).

While shellfish mariculture is for all intents and purposes equivalent to other forms of terrestrial agriculture and freshwater aquaculture, the language describing aquaculture species eligible for relief funds allocated to the NCDA&CS by Session Law 2018-136 Senate Bill 3 was equivocal regarding shellfish mariculture. Specific to aquaculture, the Bill directed the NCDA&CS to provide relief to growers of "aquacultural species propagated or reared in a controlled or selected environment." While shellfish mariculture products are raised in a controlled or selected environment (e.g. bags on racks, floating cages, underneath predator exclusion netting), the NCDA&CS originally interpreted aquacultural products as defined by S.L. 2018-136 to encompass only "inland aquaculture (catfish, crawfish ponds, etc.)" (Stewart 2018). Thus, by default, shellfish growers were originally instructed to request relief funds from the much smaller appropriation to the Division of Marine Fisheries.

The directives for allocating funds through DMF specified in Section 2.7.(a) S.L. 2018-138 S.B. 238 ("Commercial Fishing Assistance") to shellfish growers further underscore the issues associated with failing to distinguish shellfish farming from wild capture shellfish/finfish fishers. The North Carolina General Assembly specified that allocation of relief funds should be calculated based on "reductions in landings [September 1, 2018-November 30, 2018] demonstrated from trip data ticket or other verified landing compared with average landings over a prior comparable period determined by the Division of Marine Fisheries." (NCGA Session Law 2018-138 Senate Bill 823 2018). With this, the Division of Marine Fisheries had well-defined bounds on how to calculate an individual's losses, with flexibility only to decide what "comparable period" to use - ultimately deciding on the previous three years. While this approach may adequately capture the losses sustained by wild-catch fishers, it is not well suited to capture losses sustained by the participants of a rapidly growing shellfish mariculture industry.

The use of a retrospective three years' worth trip tickets effectively excludes new shellfish farmers, who have invested heavily but were still awaiting their first harvest as Florence struck (one to three years from the time of planting), from being eligible for relief. Furthermore, while calculating losses based on trip tickets from September-November is practical for wild-catch fishers who can resume fishing once waters have reopened and their gear is operational, it does not account for the fact that much of the losses experienced by shellfish growers were of purchased and planted shellfish seed that

represent a large loss of investment and one to three years of future potential revenue, but fall outside of the specified three-month loss window. Further magnifying the impacts to shellfish growers is the fact that they are often unable to immediately re-plant even once they have repaired their farm due to seasonal availability of shellfish seed. As such, even a three-year retrospective analysis of annual trip ticket data, while more appropriate for established growers, wouldn't adequately serve the new, and potentially most vulnerable, growers. A final consideration is that shellfish nurseries do not fall under the trip tickets system of documenting their sales. Thus, they are excluded from financial support via the DMF appropriation, jeopardizing the viability of a critical component of North Carolina's growing shellfish mariculture industry.

Advocacy by representatives from the North Carolina Shellfish Growers Association (NCSGA) has recently resulted in a dialogue with the NCDA&CS that ultimately led the NCDA&CS to revise their interpretation of shellfish growers' eligibility to request relief from the Agricultural Disaster Program (Section 1.3(3)). This decision on the part of the NCDA&CS represents a major step in affirming inclusion of shellfish mariculture as a form of agriculture and securing shellfish growers' equal access to forms of assistance already available to terrestrial agriculture and pond aquaculture. To ensure that shellfish farmers continue to receive the same treatment as other recognized forms of agriculture in the unfortunate, but ultimately inevitable, event of future disasters, the North Carolina General Assembly should ensure that future relief bills specify that their Agriculture Relief Program mandate specify "aquaculture species, both inland and marine, cultured or propagated in a controlled or selected environment." In the wake of disasters, farmers as well as regulatory and promotional agencies (i.e. NCDMF, NCDA&CS) would benefit from this clarity in moving effectively and efficiently toward community assistance and recovery.

Marketing and Promotional Needs

Recommendation #5
Commission a market analysis specific to North Carolina's shellfish mariculture products.

Rationale

Relatively little is known about the existing and potential markets for North Carolina shellfish mariculture products. For example, the State does not have comprehensive estimates of the proportion of oysters consumed in North Carolina that were grown within our borders. To date, the most comprehensive analysis on national shellfish mariculture markets, *Maine Farmed Shellfish Market Analysis*, was conducted by the Hale Group and Gulf of Maine Research Institute (HaleGroup/GMRI 2016). This report provides a valuable, data-driven assessment of the U.S. markets for shellfish mariculture products; however, many of its findings and interpretations were specific to characteristics of the Maine and New England shellfish mariculture industry.

A major takeaway from the HaleGroup/GMRI (2016) report is that demand and willingness to pay for mariculture products is highly state specific. For example, their research demonstrated that New England consumers are willing to pay a premium for Maine and Rhode Island oysters compared to all other New England states (HaleGroup/GMRI 2016). Additionally, they found that Maine farmers experience a late-fall drop-off in demand for oysters, a drop-off not experienced in other New England states (HaleGroup/GMRI 2016). These state-specific difference in perceived quality and temporal demand highlight the need a more comprehensive understanding of local, regional, and national markets for North Carolina shellfish mariculture product. Limited, and partially anecdotal, data pertaining to North Carolina consumer's preference is indicative of the presence of untapped markets, a willingness to pay a premium for locally cultured shellfish, and a desire for year-round availability of these products (Center 2013). These data represent an intriguing snapshot into the growth potential of North Carolina's shellfish mariculture markets.

Notably, the HaleGroup/GMRI (2016) report also projected that the U.S. supply of oysters will meet demand in 2026. This further emphasizes how the North Carolina shellfish industry would benefit from an assessment of existing and potential markets, both nationally and international, for their products. State-specific projections would underpin rational decision making by perspective growers considering whether they should enter the industry and inform current industry participants on whether to grow and how best to diversify their existing businesses. Additionally, a market analyses is needed to confirm or allay concerns among existing North Carolina growers that increased lease acreage/production will not swamp available markets. Among skeptics regarding the accessibility of larger, untapped half-shell markets, the experience of North Carolina clam growers, who saw the price of clams decline by nearly half following the expansion of state-supported clam mariculture in Florida, looms particularly large. Finally, a comprehensive understanding of which current markets are most poised for growth and where new markets is high will inform and incentive the establishment of much needed distribution networks (HaleGroup/GMRI 2016).

Recommendation #6

Appropriate recurring funding to establish a Shellfish Mariculture Advisory Panel at the North Carolina Department of Agriculture and Consumer Services to facilitate the fulfillment of their mandate to promote shellfish mariculture (Article §106-759). Most critically, this panel should develop an annual report regarding areas of success and disappointment across the industry to guide adaptive management.

Rationale

The North Carolina Department of Agriculture and Consumer Services is the lead agency responsible for the promotion of aquaculture in our State. Article §106-759 states that "For the purposes of this article, aquaculture is considered to be a form of agriculture and thus the Department of Agriculture and Consumer Services is designated as the lead State agency in matters pertaining to aquaculture. The Department shall have the following powers and duties: (1) to provide aquaculturists with information and assistance in obtaining permits related to aquacultural activities; (2) to promote investment in aquaculture facilities in order to expand production and processing capacity; and (3) to work with appropriate State and federal agencies to review, develop and implement policies and procedures to facilitate aquacultural development. (1989, c. 752, s. 147; 1997-261, s. 109.)"

The NCDA&CS has taken numerous steps towards promoting shellfish mariculture. Specifically, NCDA&CS organizes the North Carolina Aquaculture Development Conference in which shellfish mariculture related presentations have been featured prominently in recent years. Additionally, NCDA&CS has sponsored booths for shellfish growers at the North American Seafood Expo through their *got to be NC SEAFOOD* and *got to be NC AQUACULTURE* initiatives. However, approaches used successfully in other states and countries could be incorporated and more aggressively employed to facilitate building a brand and new markets for North Carolina mariculture products.

States with well-developed shellfish mariculture industries provide valuable models for effective promotion of North Carolina's farm-raised shellfish sector. For example, Florida's aquaculture plan identified 11 marketing-specific recommendations, including: 1) Create publications and social media campaigns describing culture methods and environmental impacts/benefits of aquaculture products compared to wild-capture fisheries; 2) Test aquaculture product branding using social media to quantify value-added benefit; 3) Complete a market analysis of value, volume, demand and product specifications for Florida oyster culture (see Major Recommendation #5); and 4) Develop an aquaculture-based model for agricultural tourism (see Major Recommendation #7), and evaluate potential economic, educational, and/or market impacts (FARC 2017). Additionally, the North Carolina Department of Agriculture should leverage data from large-scale analyses examining the efficacy of promotional campaigns on aquaculture (e.g. Communication Campaign on Aquaculture in the European Union: Analysis of International Campaigns on Aquaculture). This study, commissioned by the European Union Directorate-General for Maritime Affairs and Fisheries, highlights the importance of dispelling negative perceptions about aquaculture and highlighting the positive attributes of aquaculture products (i.e. local, year round availability, sustainable, traceable, environmentally-friendly, low carbon footprint) (MARE 2014).

A Shellfish Mariculture Advisory Panel (SMAP), responsible for informing industry promotion, reporting on industry trends, and generating reports on promotional outcomes, should be created and modelled after the NCDA&CS Sustainable Local Foods Advisory Council (SLFAC). The SLFAC, established by Senate Bill 1067, was formed to "Contribute to the building of a local food economy, thereby benefitting North Carolina by creating jobs and stimulating statewide economic development." The SMAP would serve a direct advisory role within the NCDA&CS, and also perform important consulting roles with industry (North Carolina Shellfish Growers Association) and pertinent regulatory agencies (North Carolina Division of Marine Fisheries; Figures 11 and 12).

The Shellfish Mariculture Advisory Panel should consist of representatives from the following entities that would serve staggered, three-year terms (# of representatives):

- Department of Agriculture and Consumer Services (1; Chair)
- Department of Commerce (1)
- North Carolina Sea Grant (NCSG) Marine Aquaculture Extension Agent (1)
- North Carolina Shellfish Growers Association (3; Representatives from northern, central, and southern regions)
- Academia (2; e.g. University of North Carolina at Chapel Hill, North Carolina State University, University of North Carolina Wilmington, East Carolina University, or Carteret/Brunswick/Cape Fear Community Colleges)
- Restaurant Association/Seafood Distributor (1)

To ensure accountability across agencies in the responsible development and growth of North Carolina's shellfish mariculture industry, the Chair of the Shellfish Mariculture Advisory Panel should be responsible for generating an annual accountability report that will be submitted to the NCDA&CS Commissioner, Governor, and General Assembly. The report should include industry trends (e.g. lease number and acreage, farm-gate value), major promotional achievements of the past year (e.g. new markets established, North Carolina product representation at trade shows, advertising campaign launches), and strategic goals and plans for the present year and beyond. Additionally, the report should identify major strategic challenges limiting the growth, profitability, or sustainability of the industry (e.g. litigation, staffing shortages, promotional or regulatory inefficiencies) and, where possible, propose actions or approaches to mitigate or eliminate identified challenges. Without this accountability measure and mechanism for adaptive management, enacting the Major Recommendations of this report in a manner that is responsive to the needs of our State will be extremely challenging.

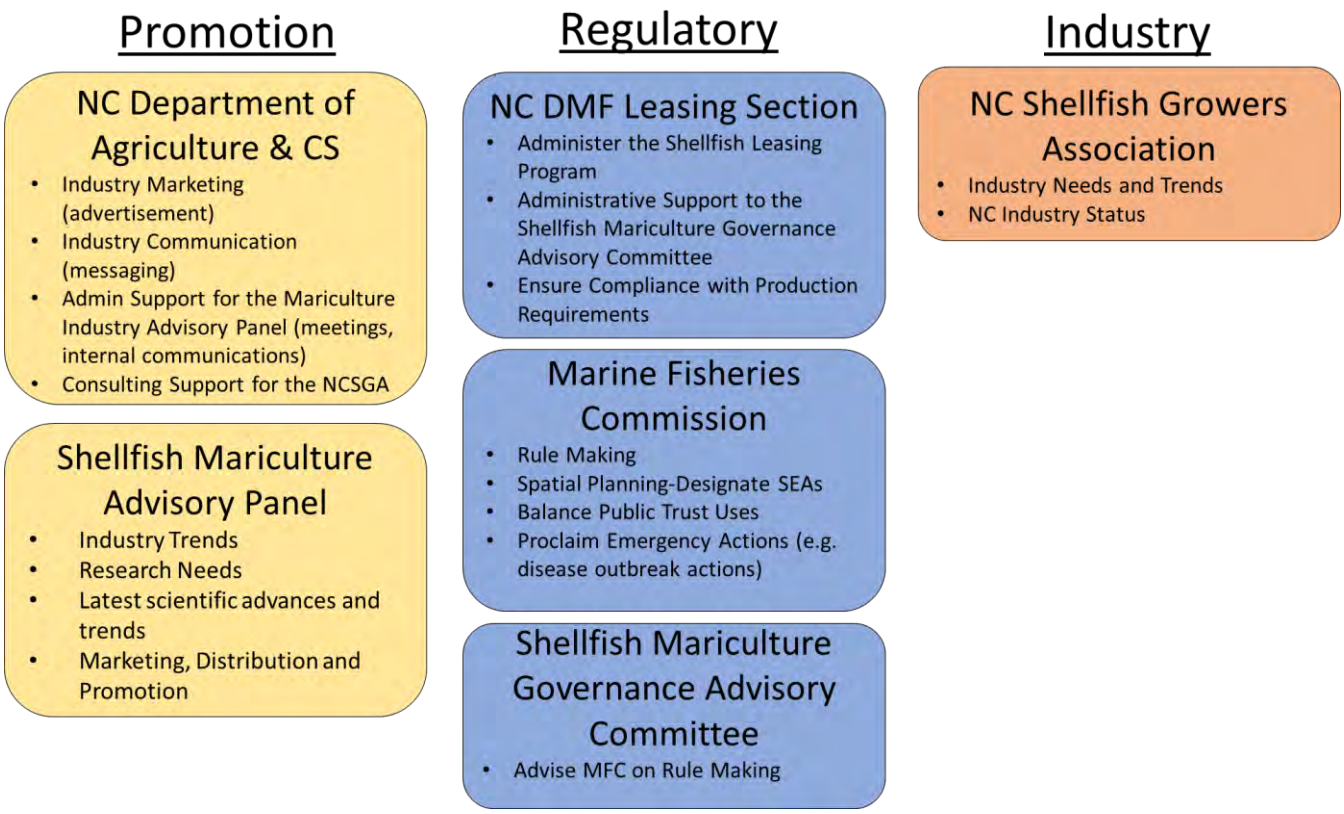

Figure 11. North Carolina shellfish mariculture industry promotion, governance, and leadership: Entities and roles.

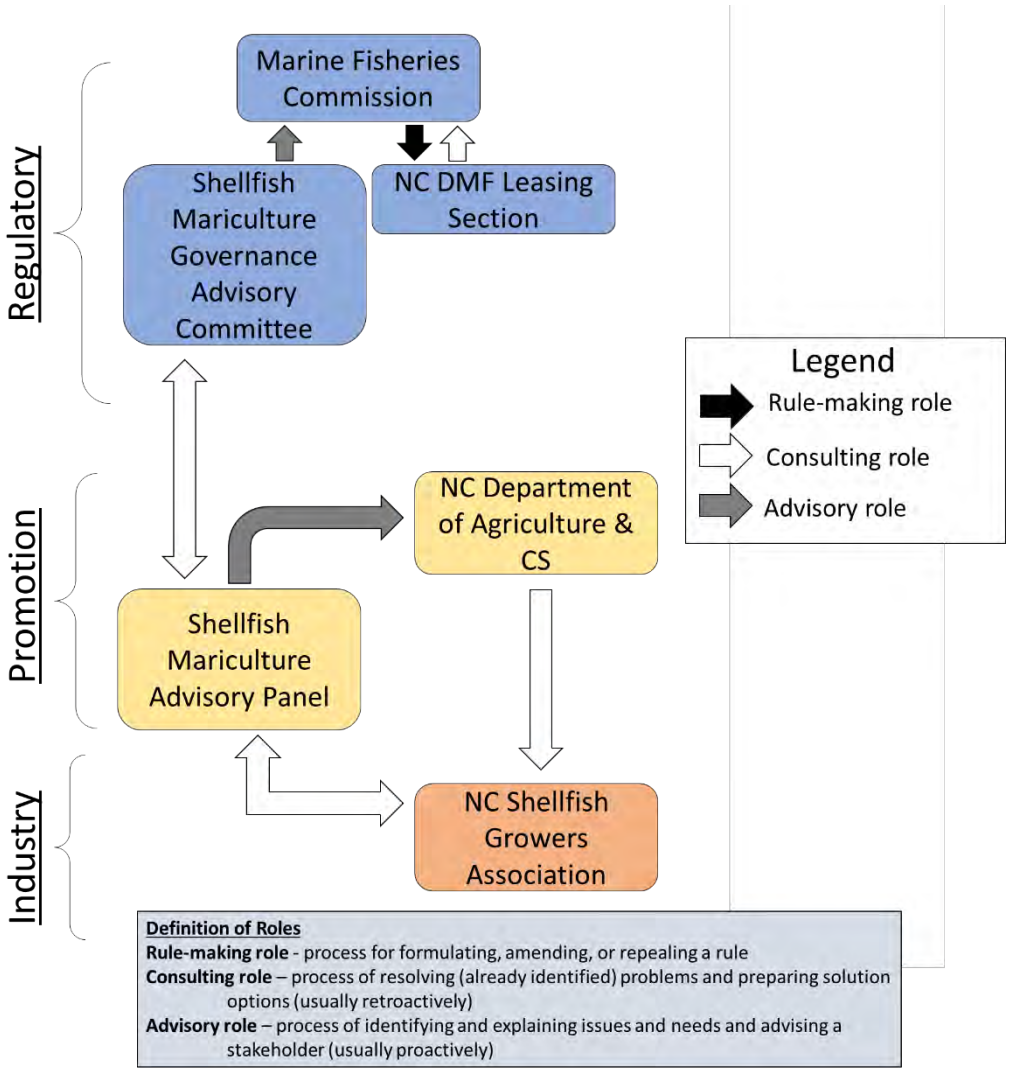

Figure 12. Integration of shellfish industry mariculture governance, leadership, and promotion.

Recommendation #7

Appropriate funding for the North Carolina Department of Agriculture and Consumer Services and the North Carolina Department of Commerce to develop a North Carolina Oyster Trail.

Rationale

Between 2006 and 2013, the percentage of surveyed U.S. leisure travelers who travelled to learn about and partake in unique dining experiences jumped from 40% to 51% (Mandala 2013). In 2012, it was estimated that tourism expenditures on food services reached >$200 billion, representing 25% of all travel expenses (Liu et al. 2013). Undoubtedly, people are increasingly drawn to destinations where they can consume local foods, making culinary tourism a major growth sector on which industries can capitalize. As a result, local specialty foods and beverages can become a major regional attraction that enhances destination competitiveness (Rand et al. 2003). The promotion of local seafood as a premium product that draws tourists to coastal regions has become an increasingly common practice to bolster economic development (Jodice et al. 2018). Culinary trails highlighting specialty foods can enhance visitors' destination experience (e.g. craft wines and beers), aid in the retention of regional identities, and showcase the sustainability of an industry, all while providing social and economic benefits for local food producers, processors, and retailors (Boyne et al. 2003, Anderson and Law 2012).

The economic benefits of an oyster trail could be considerable. In 2016, North Carolina hosted 48.6 million person-trips, making it the 6th-most visited state in the U.S. (VisitNorthCarolina 2016). Analysis of the potential economic impact of culinary tourism by Tourism Nova Scotia indicated that if only 3% of the two million annual visitors spend an extra day in that province to take part in a culinary experience, it would increase tourism revenue by $11 million (ICON 2015). Extrapolating these projections to North Carolina visits suggests a potential $250 million impact for our tourism-based economy. Similarly, Ontario has approximately 40 million visitors annually and estimated that the

15% of all travelers characterized as deliberate culinary travelers generated $816 million in total trip-related expenditures and the 18% of travelers characterized as opportunistic and accidental culinary tourists generated an additional $955 million in expenses (OntarioMinistryofTourism 2011). Analysis by the New England Agricultural Statistic Service estimated that between 2002 and 2007, average farm income in that region increased by nearly $5,000 via agritourism (Duffy 2014).

Leveraging increasing public interest in consuming seafood in areas steeped in maritime history and heritage, combined with seafood-based culinary trails, facilitates the building of brands around mariculture-related businesses. States such as Virginia (participants: 29 farms/wineries/breweries, 52 restaurants, 23 hotels, and 60 additional business featuring seafood related art and culture), Maine (participants: 30 farms and 50 restaurants), and Rhode Island (participants: 24 farms and 9 restaurants) have all embraced the economic and social development benefits of oyster trails. Successful culinary trails require leadership, funding, product, and sufficient membership (Anderson and Law 2012). North Carolina already has a number of culinary trails (e.g. The North Carolina Barbecue Society's Historic Barbecue Trail, the Raleigh Beer Trail, the Asheville Ale Trail, and the North Carolina Cheese Trail) and the North Carolina Department of Agriculture and Consumer Services and Department of Commerce are well suited to facilitate the development of a North Carolina Oyster Trail.

Specific recommendations to guide the development of a North Carolina Oyster Trail were generated by a collaboration between the University of North Carolina Kenan-Flagler Business School and the North Carolina Policy Collaboratory. Their findings and detailed recommendations are presented in Appendix C.

Efficient Regulatory Structure

Recommendation #8

Appropriate recurring funding to establish a Shellfish Mariculture Governance Advisory Committee to the North Carolina Marine Fisheries Commission.

Rationale

In the U.S., the NOAA's interpretation of the Magnuson-Stevens Act includes aquaculture as a form of fishing, giving regional fishery councils jurisdiction to regulate aquaculture activities in Federal waters (Mamoser 2011). Similarly, the federal government of Canada assigned the Department of Fisheries and Oceans as the lead agency regulating aquaculture in 1984 (Noakes 2018). As such, the federal government of both countries have placed the management of aquaculture with councils primarily designed for the management of wild-capture fisheries (Montañez 2014). Wild-capture fisheries are generally managed using tools such as quotas, size restrictions, gear restrictions, and closed areas or seasons to allow maximum harvest without depleting stocks of the target species (Botsford et al. 1997). With the exception of shellfish relay, in which wild-stock are captured and transferred to mariculture operations for growout on leased public-trust bottom, wild-capture management practices are not readily transferable to mariculture. It is often argued that mariculture should instead be managed like other forms of agriculture (DeVoe 1997). Unlike terrestrial agriculture, however, mariculture generally relies on access to and use of public trust resources (e.g. submerged lands and coastal waters). This factor necessitates the involvement of agencies that protect these public trust resources (DeVoe 1997).

In North Carolina, the shellfish mariculture industry is regulated by the Marine Fisheries Commission, the rule making entity for wild-capture fisheries in the State. To inform the Fisheries Management Council on best management practices for fisheries sectors and the coastal resource upon which managed fisheries are reliant, North Carolina is served by several standing advisory committees (e.g. Finfish, Shellfish/Crustacean, Habitat & Water Quality). These advisory committees are comprised of topical experts from academia, industry, and other stakeholder groups that collectively provide guidance to the Marine Fisheries Commission. Both Canada, the European Union, and numerous U.S. states (e.g. Florida, Maine, Maryland, New Jersey, Virginia) have established aquaculture advisory councils or committees to provide regulators with expert guidance and insight from the industry. Membership of these committees range from 4 members (Maine) to 17 members (Maryland). There is regional precedent for task force recommendations leading to legislative creation of an aquaculture advisory council. In 2005, the Maryland legislature created the Aquaculture Coordinating Council (ACC) based off of a recommendation made by a Task Force on Seafood and Aquaculture. The ACC generates annual reports for Maryland's Governor, as well as both the House of Representatives and Senate Environmental Committees, regarding the status of the state's shellfish mariculture industry. For North Carolina, the proposed Shellfish Mariculture Advisory Panel would generate a similar report (see Major Recommendation #6), and this is advantageous given the focus on avenues of/for promotion and the proposed role(s) for NCAG&CS.

Still, the Shellfish Mariculture Advisory Panel is not well-suited to provide scientific and practical advice on issues related to the regulation of the shellfish mariculture industry such as siting, production requirements, etc. Therefore, to provide advice and detailed analyses on mariculture-related issues to the Marine Fisheries Commission similar to other standing committees, as well as consult with the NCAG&CS via the SMAP, the General Assembly should support the creation of a Shellfish Mariculture Governance Advisory Committee within the North Carolina Division of Marine Fisheries.

The Shellfish Mariculture Governance Advisory Committee should consist of representatives from the following entities that would serve staggered, three-year terms (# of representatives):

- North Carolina Shellfish Growers (3; representatives from northern, central, and southern regions)
- At-large members representing diverse public trust uses (3; e.g. recreational fishers, hunters, boaters, coastal developers)
- North Carolina Commercial Fishermen representing wild-harvest fishing (1)
- Academia (2; e.g. University of North Carolina at Chapel Hill, North Carolina State University, University of North Carolina Wilmington, East Carolina University, or Carteret/Brunswick/Cape Fear Community Colleges)

Recommendation #9

Appropriate recurring funding to establish a new section, the Shellfish Leasing Section, at the North Carolina Division of Marine Fisheries.

Defraying costs of Shellfish Leasing Section: Increase non-refundable shellfish lease application filing fee to $500 dollars; establish a fee schedule for lease surveys payable to the Division of Marine Fisheries; shift financial responsibility for advertising for public scoping from agency to the applicant; and increase annual rent.

Rationale - Staffing and budgetary increases

Despite 775% and 1,100% increases in the number of bottom and water-column shellfish lease applications, respectively, between 2012 and 2017 (Fig. 11), the North Carolina Division of Marine Fisheries has only 2 positions specifically funded to administer shellfish mariculture (Table 2). To fulfill administrative duties associated with shellfish mariculture, five additional staff from the Division's Habitat Enhancement and Benthic Mapping sections have assumed major roles in administering shellfish leasing. Creating a dedicated and adequately staffed Shellfish Leasing Section at the DMF would represent a major step towards ensuring the well-managed growth of the shellfish industry in North Carolina. Maine, by comparison, which has substantially fewer shellfish leases and acreage has 6.5 full time positions dedicated to administering marine aquaculture (Table 2). Maryland, a state with a growth trajectory comparable to North Carolina toward a $100 million industry valuation ($33 million farm-gate sales; see Major Recommendation #1) has 8 positions dedicated to administering shellfish mariculture (Table 2).

North Carolina should appropriate recurring funding for three additional full-time equivalent positions within the Shellfish Leasing Section, including one licensed surveyor position ($55,000 salary, plus $17,000 fringe), one survey technician ($35,000 salary, plus $12,000 fringe), and one marine fisheries technician II position ($30,000 salary, plus $11,000 fringe), to conduct the field work needed to permit shellfish leases. Additionally, recurring appropriations to the Division of Marine Fisheries for the purposes of administering shellfish leasing should be increased from $155,683 to $200,000. This funding would support administrative positions within a dedicated Shellfish Leasing Section at the DMF. These positions will provide much needed assistance with field operations (e.g. mapping, sampling, and marking leases), a need that will increase as the industry grows and as DMF manages Shellfish Enterprise Areas (see Major Recommendation #11).

Rationale - Defraying costs to the Shellfish Leasing Section

Permitting a single shellfish lease, which includes field surveys, purchasing public-comment notices, holding public hearings, and administrative expenses, costs the North Carolina Division of Marine Fisheries approximately $3,000 (NCDMF 2016). Costs can be considerably higher for large leases. The current non-refundable filing fee of $200 dollars for bottom leases and $100 for a water column amendment fall well short of covering these expenses. Increasing this fee to $500 dollars, commensurate to states such as California and Mississippi, would help cover administrative costs, yet remain considerably lower than filing fees in Maine ($1,500), New Hampshire ($1,000), and

New Jersey ($1,000). Despite the legislative removal of lease survey requirements, the Division of Marine Fisheries believes that, as real property under law, surveys with legally defensible accuracy are still a requisite for granting shellfish leases (NCDMF 2016). Many other states charge for survey work conducted by their state agencies. For example, Virginia charges $675 per survey, Massachusetts and Louisiana charges dependent on the scope of the lease, and Connecticut and New Jersey charge $35 and $30 per corner respectively (O'Connell 2018). Other states, including Florida, Mississippi, Texas, and Oregon require applicants to acquire surveys from competent private surveyors (O'Connell 2018). Additionally, North Carolina is in the minority of U.S. states that do not require lease applicants to pay for scoping meetings, public hearings, or both (O'Connell 2018). Shifting the financial burden of paying for field surveys and advertising scoping and public hearing meetings from the agency to the applicant would appreciably reduce the costs incurred by the Division of Marine Fisheries to permit shellfish leases. Additionally, higher application costs could help deter lease "speculators", but not be cost prohibitive for those truly invested in operating a productive lease (for earnest applicants, increased application fees would remain a small portion of their total startup costs). The utilization of a public trust resource for private use is a privilege, not an entitlement, according to public trust doctrine. As such, North Carolina taxpayers have a reasonable expectation that they will not shoulder the vast majority of costs associated with granting this privilege.

Annual rental fees in North Carolina are current $10 acre^{-1} for bottom leases and $100 acre^{-1}. The discrepancy in rent acre^{-1} is appropriate given that water column leases are generally more restrictive of other public trust uses and more profitable than bottom leases. These rates are, however, well below the national average for states with fixed per acre rental rates. Among the 15 states with fixed per acre rent, annual rental for bottom lease average $87.70 acre^{-1} (range: $2.00-$2722.50 acre^{-1}) and annual rental for water column leases averages $326.32 acre^{-1} (range: $2.00-$450.00 acre^{-1}) (O'Connell 2018). Those not included in this comparison are states with competitive bidding, density-dependent rates, or negotiable rent (e.g. NY, MS, CA, WA). To put North Carolina in line with national averages and increase the funds available to the Division of Marine Fisheries to administer shellfish leasing, North Carolina should increase rental fees for bottom leases to $50 acre^{-1} year^{-1} and rental fees for water column leases to $250 acre^{-1} year^{-1}. This change would increase annual fees paid to the Division of Marine Fisheries by $65,040 for the 1626 acres of bottom leases and $31,650 for 211 acres of water-column leases currently held in North Carolina.

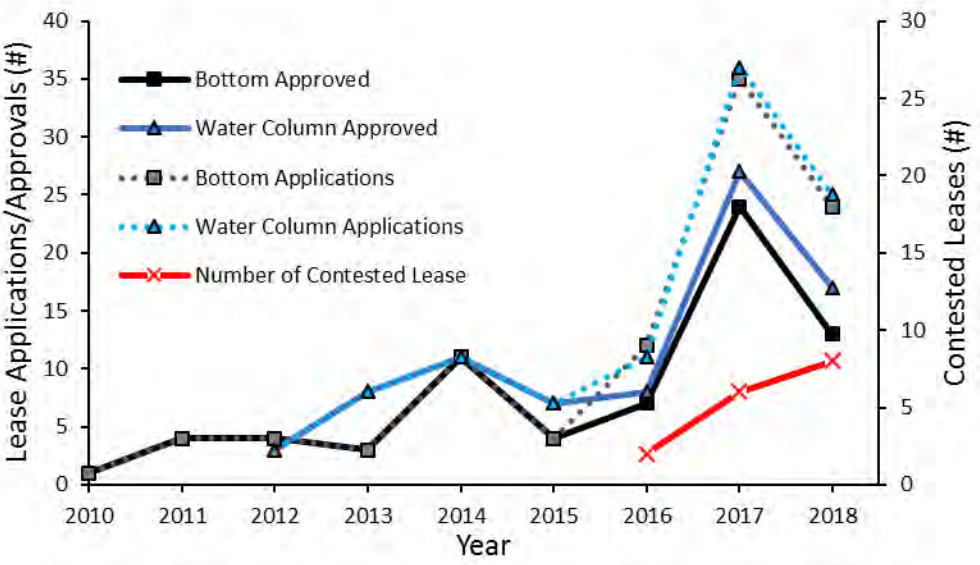

Figure 11. Number of applications and approvals for bottom and water-column leases in North Carolina since 2010, and number of lease decisions contested by applicant or aggrieved third party since 2016. Data for 2018 represent mid-year totals. Source: North Carolina Division of Marine Fisheries.

Statutory Changes

Recommendation #10
Amend North Carolina General Statute §113-202 to afford the Secretary of the Department of Environmental Quality substantial discretion in balancing public trust uses.

Rationale

North Carolina has approximately 2,200,000 acres of coastal waters and submerged lands that are held by the state in public trust (Spalding 1989). The North Carolina Constitution's Public Trust Doctrine and common law stipulate that public trust waters and the underlying lands be protected and conserved by the State for the benefit of the citizens and shall not be conveyed for private use to the detriment of public trust uses. Alienation of public trust rights to the State's navigable waters and submerged lands must occur through the legislature's clear and specific wording stating otherwise (342NC287 1995). In accordance with protection of public trust rights, the current statute permitting the private cultivation of shellfish in North Carolina state waters requires that "the cultivation of shellfish in leased areas will be compatible with lawful utilization by the public of other marine and estuarine resource. Other public uses which may be considered include, but are not limited to, navigation, fishing, and recreation" (N.C. Gen. Stat. §113-202).

In stipulating that shellfish leases must be *compatible*, defined as able to exist or occur together without conflict, with other public trust uses, this statute has left shellfish lease decisions open to being contested on almost unlimited grounds. For example, under the current statute, if a shellfish lease is sited where a third-party fishes, anchors, birdwatches, etc., even very intermittently, this third party would have standing to argue a shellfish lease was incompatible with their public trust use. The effects of holding shellfish mariculture to the standard of being compatible with all other public trust uses is evident in the dramatic increase in contested cases in recent years (Fig. 14). These cases must be argued in court by the Director of the Division of Marine Fisheries and legal counsel at considerable time and financial cost. Furthermore, in cases where the court rules in the aggrieved party's favor, the Division of Marine Fisheries must pay that parties legal expenses. As a result, there is disturbing potential for the DMF's annual budget for administering shellfish mariculture of $150,000 being exhausted to cover third party legal expenses.

High courts of other states have ruled that public trust lands may be conveyed for limited private use when said private use encourages the development of new industries and economic activity, while not *unreasonably interfering* with the public's use of the leased areas for purposes protected under public trust doctrine (e.g. Supreme Court of California: State ex rel. Ellis v. Gerbing, 56 Fla. 603, 47 So. 353 (1908); Supreme Court of Oregon: Brusco Towboat Co. v. State, etc., 284 Or. 627, 589 P.2d 712 (1978); Supreme Judicial Court of Maine: Harding v. Commissioner of Marine Resources, 510 A.2d 544 (1986)). These states successfully argued that, provided aquaculture leases did not unreasonably interfere with other public trust uses, aquaculture serves the public interests of its citizens.

Statutory language specifying that shellfish leasing must not unreasonably interfere with public trust uses provides greater discretion to the state appointed agent administering shellfish leases to determine where the public benefit a shellfish lease represents a reasonable interference on other uses. Although affording substantial discretion to a single decision-making entity could lead to future abuse of authority, current administrative process, through the Office of Administrative Hearings, fulfils the necessary checks and balances on this added discretion. Specifically, parties aggrieved by lease decisions will still be afforded the same opportunity to have their case heard. However, the presiding Office of Administrative Hearings judge will consider whether lease decisions violate the new standard of *unreasonable interference*, taking into account the lease context (e.g. availability of similar resources in the area proximate to the lease, frequency of use) in determining whether a shellfish lease violated public trust doctrine.

See Appendices D & E for comprehensive revisions to 15A NCAC 03O Section .0200 and N.C. Gen. Stat. §113 Article 16, respectively.

Recommendation #11

The North Carolina Division of Marine Fisheries should designate appropriate tracts as Shellfish Enterprise Areas (SEAs) containing multiple, connected parcels available for shellfish mariculture and managed by the Division of Marine Fisheries.

Rationale - Shellfish Enterprise Areas

The permitting process for a shellfish lease can be complicated and lengthy, and likely represents a considerable barrier to entry for some potential applicants. To streamline the process and reduce the cost of permitting, states such as Maryland, Florida, Delaware, Massachusetts, New Jersey, New York, and California have established designated areas in which state agencies have already verified site environmental and public trust suitability, as well as acquired necessary Federal permits. Thus, those states must only verify the suitability of an applicant and issue a permit to operate within those approved, specified areas. The streamlining effect of implementing Shellfish Enterprise Areas (SEAs) has been credited for its role in growing the number of leases in New Jersey from 163 in 2005, the year prior to their approval, to 851 leases in 2016 (Hilton et al. 2016). Additionally, as the lease holder of SEAs, those individual states have greater authority to regulate the activities conducted by individuals subleasing parcels.

Although this approach puts the onus of identifying sites and acquiring all relevant federal permits on the state, site inspection and permitting of large blocks of acreage is appreciably more cost and labor efficient than conducting individual site inspections of applicant-proposed areas (Hilton et al. 2016). Even with the increased level of rigor with which these sites are vetted for potential user conflict and shellfish-growing potential, the efficiencies associated with block permitting should provide cost savings for North Carolina government. These pre-permitted zones should also limit the Division of Marine Fisheries' exposure to legal action, which consume great time and financial resources. Additionally, if legal challenges do arise contesting siting of shellfish enterprise areas, the DMF, as the lease holder, would be representing itself, rather than representing a private lease holder, an arguably more appropriate use of State funds.

In addition to removing the need for applicants to select appropriate sites for their shellfish leases and navigate the complex Federal and State permitting process, the aggregation of leases within concentrated areas would likely have additional benefits to lessees. First, the aggregation of shellfish growers encourages cooperation amongst a group with a vested interested in preventing theft, which was the top concern reported by North Carolina shellfish growers in a 2011 survey, ranking above hurricanes, water quality, user conflict, predation, leasing procedure, marketing, and climate issues (Turano et al. 2011). Furthermore, aggregation of shellfish leases would allow law enforcement personnel to more effectively target efforts to protect against theft. Second, de facto cooperatives of shellfish growers could split the investment in necessary shore side facilities (storage, dockage, processing areas) that geographically isolated leases must shoulder independently. Finally, aggregations of leases would likely attract supporting businesses (processing, transport, marketing) to the areas, creating a mutually beneficial relationship with growers and enhancing economic development (Walton 2007). Ideally,

SEAs would become innovation incubators, and hubs of technology and growth within the shellfish farming industry.

Although these pre-permitted SEAs have numerous designations among different states (i.e. Aquaculture Enterprise Areas, Shellfish Aquaculture Development Areas, Aquaculture Use Zone), they serve the same purpose: streamlining permitting, encouraging industry development, easing the state's permitting burden, and mitigating user conflict. In North Carolina, the Division of Marine Fisheries has the expertise to conduct the field surveys, public hearings, and permitting that will be required to establish Shellfish Enterprise Areas. Furthermore, the DMF has the expertise and incentive to use each SEA in a manner that ensures access to multiple prospective or existing growers as local conditions dictate.

Rationale – Gear Identification

In SEAs, where multiple growers' gear will be situated in close proximity, the need and utility of properly labelling of gear is highlighted. In the wake of a storm, growers' gears, which currently require no distinguishing markings, could be displaced from their SEA tract. Given that growers purchase their gear from a limited number of manufacturers and there are currently no tagging requirements, this could result in disputes over ownership of gear which could hinder insurance claim appraisals and provides no means to hold growers accountable for cleaning up derelict equipment. Therefore, gear (i.e. each floating bag, or rack bag on bottom cage) within SEAs should be required to have durable tags affixed identifying their owner.

More broadly, these durable tags are relatively inexpensive (<$1.00 per unit), and could benefit all growers who lose gear during inclement weather or by accident. These tags would enable growers and the State to find gear that is displaced from a lease to public trust bottom or private riparian property. For these reasons, as well as the need to treat SEA- and non-SEA-associated growers uniformly, the requirement to tag each floating bag and bottom rack-on-cage container should be applied universally. The information required on each tag should follow the model currently used in the crab pot fishery.

Note: This recommendation is contingent on providing adequate staffing and funding for DMF to administer a growing shellfish mariculture industry (see Major Recommendation #9)

Recommendation #12

In Pamlico Sound, the Secretary of the North Carolina Department of Environmental Quality should be granted discretion to grant up to three (total) 50-acre (each contiguous) water column or bottom leases, each obtained by a single lease application. These lease tracts must be separated from each other, and from shore, by at least 250 yards. Otherwise, current lease size maximums, including overall acreage possession limits for any single entity, should be retained throughout the State, and no more than three large water column or bottom leases may be established in Pamlico Sound until 2025.

Rationale

The current laws governing the size of shellfish leases in North Carolina date back to a report from 2001 in which caps on the size of individual leases and cumulative ownership were among the suggested approaches to minimize user-group conflicts. Based on recommendations within the report, the Marine Fisheries Commission unanimously approved a provision to restrict ownership to a maximum of 50 acres, with individual lease parcels not exceeding five acres in areas where mechanical harvesting is prohibited and not exceeding 10 acres where mechanical harvesting is allowed.

There are no statutes or rules stipulating that adjoining leases may not be contiguous and that an individual cannot submit multiple lease applications at one time. As such, individuals wishing to obtain a contiguous 50-acre lease are not prohibited from doing so; however, they must submit, and the Division of Marine Fisheries must process, either five or 10 separate applications for areas that allow or prohibit mechanical harvest, respectively. It is uncertain what this approach accomplishes other than increasing regulatory burden and creating an additional hurdle for shellfish lease applicants. Allowing an individual to apply for a 50-acre lease through a single application has the potential to reduce these burdens while retaining the exact same approval procedure safeguards as any other proposed shellfish lease (i.e. public hearings to assess user conflict, field surveys to verify their compliance with regulations protecting important marine habitats). To investigate whether this approach would indeed reduce regulatory burden and streamline the application process, North Carolina could permit a capped number of leases in excess of 10 but less than 50 acres in Pamlico Sound requiring a single application through 2025 at which time the Marine Fisheries Commission should decide on whether allow additional single-application leases of up to 50 acres.

Ultimately, there are likely very few water bodies that a contiguous 50-acre lease could be sited without resulting in user conflict. The obviously exception, due to the size of the water body and presence of expanses of undeveloped shoreline, is the Pamlico Sound, which, at approximately 80 miles long and 20 miles wide, conservatively encompasses ~750,000 acres. If permitted, the three 50-acre (or part thereof) water column or bottom leases would comprise, in total, a maximum of 0.02% of the available acreage in the Pamlico Sound. Given the potential for contiguous leases of this size to have a greater impact on navigation than smaller leases, they should be separated from each other by a minimum of 250 yards to provide unobstructed travel corridors for other recreational and commercial activities. Recognizing that proximity to shore increases potential conflict, in 1889, laws were enacted stipulating that only state residents could have leases less than

10 acres within two miles of the Pamlico Sound shore. All leases larger than 10 acres, as well as all leases issued to non-residents, were required to be sited two miles or more from the nearest shoreline (NCDMF 2008). Today's shellfish mariculture industry is very different from that of the late 1800's and the cost and complexity of operating a lease increases with distance from shore and the associated support facilities. As such, a 250-yard buffer from shore represents and reasonable balance of not placing undue burden on shellfish growers while mitigating some of the potential conflict with riparian owners and the recreational fishers and duck hunters whose activities are often concentrated along the shoreline.

At the end of 2025, the Shellfish Mariculture Governance Advisory Committee should seek feedback from:1) the Division of Marine Fisheries on whether consolidated permitting of parcels greater than 10 acres was a net positive or negative; 2) shellfish growers regarding whether expanding the availability up to 50 acre leases with a single application would be beneficial to the industry; and 3) other public trust stakeholders as to whether these larger contiguous leases resulted in unreasonable interferences with other approved uses of public trust waters. Feedback should be compiled into a report by the Shellfish Mariculture Governance Advisory Committee and submitted to the Marine Fisheries Commission. Based on the findings, the Marine Fisheries Commission should determine whether to allow additional larger leases.

Recommendation #13

Increase utilization requirement and strictly monitor and enforce "use it or lose it" policy for shellfish leases. Specifically, water column leases should be required to produce a minimum of 100 bushels acre^{-1} annually averaged over the previous three-year period beginning in year five of the lease. Alternative water column lease holders may provide evidence of purchasing 45,000 shellfish seed acre^{-1}, annually. Bottom lease holders should be required to produce a minimum of 40 bushels acre^{-1} annually averaged over the previous three-year period beginning in year five of the lease. Intensive culture bottom operations may alternatively provide evidence of purchasing 30,000 shellfish seed acre^{-1}, annually. Extensive culture bottom operations may fulfill their utilization requirement by planting a minimum of 250,000 remote-set spat acre^{-1} year^{-1}.

Rationale – utilization requirements

There are multiple approaches to achieving the goal of $33 million in dockside sales. North Carolina could follow the model of states like Louisiana or Virginia, which have 400,000+ and 120,000+ acres under lease, respectively. However, these states produce, on average, only a few bushels per acre (Table 2). Alternatively, North Carolina could follow the model of states like Massachusetts (578 fewer acres under lease than North Carolina) or Washington (221 more acres under lease than North Carolina), that, due to high production per acre, currently have ~nine-fold and ~14.5-fold the dockside sales of North Carolina (Table 2). Given the nature and diverse uses of the State's estuaries, North Carolina seems best served by meeting market demands while occupying a relatively small footprint over public trust bottom, as opposed to diffuse, low-production leases meeting market demands across a relatively large total footprint. Among other benefits, this approach would reduce conflicts over use of public trust bottom for mariculture and promote participation by growers who are responsible stewards of coastal resources.

In their policy declaration pertaining to the permitting of shellfish leases (N.C. Gen. Stat. §113-201), the North Carolina General Assembly provides rationale for leasing public trust bottom by highlighting shellfish cultivation's long term economic and ecological benefits. In doing so, the State is justifying its conveyance of a public trust resource for private gain by stating that the issuance of these leases is to the benefit of the public by making productive use of unproductive bottom. To ensure that shellfish leases do indeed provide the economic and ecological benefits justifying their potential encroachment on some public trust uses, past (i.e. North Carolina Fisheries Regulations for Coastal Waters 1975. H-12 Cultivation of Oysters; North Carolina Regulations for Coastal Waters 1977, 15A NCAC 03C.0311) and current (i.e. N.C. Gen. Stat. §113-201) statutes require that all leases meet production requirements established by the Marine Fisheries Commission.

Historically, North Carolina has a poor track record of enforcing these active use requirements. Between 1982 and 1986, 71% of active North Carolina shellfish lease holders failed to meet production requirement (NCDMF 2008). Average production per acre on shellfish farms during this period was 10 bushels per acre, well short of the 25 bushel per acre requirement of the time (NCDMF 2008). Recognizing that "Acts of God" could lead to periods of low productivity, the State accepted active planting of 25 bushels seed or shell per acre as fulfillment of the active use requirements. Still, 100 of 285 leases

failed to meet requirement and the Division of Marine Fisheries began proceedings to terminate these leases in 1986. However, termination proceedings were blocked by legislation that provided a two-year extension for leaseholders to meet production requirements (NCDMF 2008). Although many leases continued to not meet production requirements following that extension, termination of those leases has been difficult due to a number of logistical and social factors.

Over time, the hesitancy of the General Assembly to strictly require production on leases has likely had lasting impact on the aggressiveness with which the Division of Marine Fisheries pursues the termination of leases for failure to provide benefit (i.e. production) in exchange for constrained use of public trust lands. Despite the continuation of leases failing to meet production requirements, only 8 leases were terminated between 1987 and 2008 (NCDMF 2008). The importance of a strictly enforced "use it or lose it" policy is perhaps best exemplified by the effects of Maryland's restructuring of their leasing policy in 2010. Contending with an industry in which the majority of >600 leases were not being actively farmed, Maryland instituted a strict "use it or lose it" policy. As a result, unproductive leases were returned, many of which were then leased by productive farmers (Green and Tracy 2013). By 2017, despite 100 fewer leases, Maryland's shellfish production had increased from less than 5,000 bushels $year^{-1}$ to ~75,000 bushels $year^{-1}$ and the industry had generated over 1,500 new shellfish mariculture jobs (Green and Tracy 2013, Jones 2017). An additional benefit of these surrendered leases is that, due to having already undergone a full permitting process, their re-allocation would be much more expeditious than the process for permitting new lease acreage.

Not only would strictly enforced "use it or lose it" policies fulfill our State's commitment to ensuring public benefit from the conveyance of a public trust resource, it may also have appreciable potential to bolster growth of the industry. To demonstrate that the State supports a strict "use it or lose it" policy and update the precedent set in the 1980s, the General Assembly should amend current legislation with specific language stipulating strict enforcement and provide the Division of Marine Fisheries with the personnel required to ensure compliance (see Recommendation # 9).

Fourteen of twenty-two states in the contiguous U.S. that allow shellfish mariculture have some form of utilization requirement. Nine states have subjective active use requirements for shellfish lease holders, allowing for lease termination if the permitting agency deems the lease not "actively used" (Table 4). North Carolina is one of five states that have quantitative active use requirements, which stipulate either minimum planting effort or production (Table 4). North Carolina shellfish lease holders are required to submit documentation of their investment, production, or both. Current production criteria in North Carolina (10 bushels per acre per year for bottom leases, 40 bushels per acre per year for water column leases); however, are underwhelming, and do not support the principle that North Carolina should attempt to meet market demand with the smallest footprint over public trust bottom as possible.

Trip ticket data and consultation with industry experts reinforce that new, higher production requirements are highly feasible production numbers to achieve. Based on non-confidential dealer trip ticket data aggregated by region, current there is a significant divergence between "high" and "low" production leases across the State. For instance, only within the last two years has state-wide average production from bottom leases

exceeded minimum production requirements (Figs. 12 & 14). Trip ticket data suggest that average production from bottom leases selling to dealers already exceeds the current requirement of 10 bushels acre^{-1} by 1.5 and 3-fold for clams and oysters, respectively (Fig. 12 & 14). These averages are inevitably dragged down by operations that are not committed growers, producing and selling a small quantity of shellfish, but less than the current production requirements.

Trip ticket data from water column leases provides support for the assertion that the current production requirement of 40 bushels acre^{-1} may also merit revision. Average per-acre production from leases selling to dealers exceeded 100 bushels acre^{-1} in both 2016 and 2017 (Fig. 12), demonstrating that the feasibility of 100 bushels acre-1 as a production requirement. Furthermore, shellfish leases in Alabama, a state that only permits water-column operations, produced an average of 321 bushels per acre in 2016 (Table 2). Given the fact that water-column leases are almost universally more of an impediment to other public trust uses, increasing active use requirements would help ensure that these leases are held by individuals committed to making fully exploiting the potential of the granted acreage.

Increasing production minimums to 100 and 40 bushels acre^{-1}, for water column and bottom leases, respectively would enable the industry to achieve the goal of $33 million in farm-gate sales ($100 million industry valuation) with a much more modest increase acreage than would be possible with current production minimums. With all leases averaging at least 100 bushels acre^{-1} for water column leases and 40 bushels acre^{-1} for bottom leases, $33 million in farm-gate sales could be achieved with an ~5-fold increase in acreage of both lease types, as opposed to the 10+-fold increase in acreage for both lease types that would be required under current production requirements (Figure 13). Even without the expansion of lease acreage, correcting production requirements to 100 bushels acre^{-1} for water column leases and 40 bushels acre^{-1} for bottom leases would immediately promote a ~$10 million farm-gate industry.

As under current law, growers should have the opportunity to meet utilization requirements through either production or investment. The inclusion of alternative planting minimums to fulfill utilization requirements would ensure that farmers are not unduly penalized for “Acts of God” while also making sure that leases are being held by committed and invested growers. Water column leases should be required to produce a minimum of 100 bushels (30,000 individuals) acre^{-1} annually averaged over the previous three-year period beginning in year five of the lease (Table 5, Appendix E). As production can be impacted by a number of “Acts of God”, water column lease holder may also submit proof of purchase of a minimum of 45,000 shellfish seed acre^{-1} year^{-1} (Table 5). These investment figures account for fairly conservative estimates of nursery phase and floating-cage growout mortality (Davidson 2001, Hudson 2012, Leonhardt 2013). For oysters, those with their own nursery operation who would be purchasing seed at sized of 2-4mm could expect to pay $8.50 or $10.75 per 1,000 2-4mm wild diploid or disease resistant diploid/triploid seed, respectively. This would amount to an investment of this amounts to $382.50 per acre for wild diploid seed or $483.75 per acre for disease resistant diploid/triploid seed, annually. For those without nursery facilities who would be purchasing juvenile shellfish (6-10mm) that would be moved directly to growout operations, these shellfish could range from $13.50 or $25.00 per 1000 depending on

size, ploidy, and disease resistance, equating to a cost range of \$607.50-\$1125 acre^{-1} year^{-1}. Overnight shipping would add approximately \$50-60 per shipment. Furthermore, shellfish seed purchased from out of state require pathology certification of 30-60 individuals from each batch within a 30-day period, which generally costs on the order of a few hundred dollars. As a result, expenses for pathology certification increase with the number of separate orders throughout the season.

Bottom leases should be required to produce a minimum of 40 bushels (12,000 individuals) acre^{-1} annually averaged over the previous three-year period beginning in year five of the lease (Table 5). The lower production requirement for bottom leases is justifiable as these leases generally are less restrictive to other public trust uses and incur greater mortality than water column leases. Alternatively, utilization requirements for bottom lease holder should be considered fulfilled with proof of purchasing a minimum of 30,000 shellfish seed acre^{-1} year^{-1} (Table 5). For oysters, those with nursery facilities who would be purchasing hatchery direct seed (2-4mm) at \$8.50 or \$10.75 per 1,000 wild diploid or disease resistant diploid/triploid seed, respectively, this amounts to \$255.00 per acre for diploid seed or \$322.50 per acre for disease resistant diploid/triploid seed. For those without nursery operations who would be purchasing growout ready juvenile oysters (6-10mm) ranging in price from \$13.50-\$25.00, this equates to a cost range of \$405-\$705 acre^{-1} year^{-1}. For clams, those with nursery operations purchasing seed at 2-4mm could expect to pay \$13.00 per 1,000, amounting to \$390 per acre. For those purchasing clam seed direct to growout, they could expect to pay \$22.50-\$30.00 per 1000, equating to an investment of \$675-\$900 acre^{-1} year^{-1}. Again, there would be additional costs for shipping and pathology certification as specified above.

Gear-less operations (excluding clam netting; i.e. extensive spat-on-shell culture or cage/bag-less clam culture) should be allowed to fulfill their utilization requirement by planting a minimum of 250,000 remote-set spat acre^{-1}.At a price of \$250-\$600 per million, depending on quality and ploidy, it would cost between \$625 and \$1,500 acre^{-1}, to purchase the 2.5 million eyed larvae required to achieved 250,000 spat on shell given a setting rate of 10%. In addition to the eyed larvae, the shell on which to set them, assuming between 50-150 bushels of shell at \$3.50 a bushel, would add an additional \$175-\$525. Disease certification and shipping would be an additional expense.

Importantly, *either* production or investment requirements should be met for lease continuation, rather than both production and investment requirements. This either-or approach allows operations able to rely on natural spatfall to bypass unnecessary investment costs. Alternatively, gear-intensive operations would not have to invoke the "Act of God" provision in years defined by lost production (as is likely the case for many growers following Florence) if they could, instead, demonstrate a reasonable investment in shellfish production on their lease.

Even with regulatory frameworks and support for growers in place to emphasize high unit-area shellfish production, the acreage of shellfish leases will likely need to increase to achieve the production goal of \$33 million dockside sales. Although average production acre^{-1} has increased in recent years (Fig. 12), without dramatic increases in average production acre^{-1} (i.e. >10-fold) the \$100 million goals is not achievable with current acreage. Moreover, a 10-fold increase in production is unrealistically high based on data from other states (Table 2) and expert analyses (Meritt and Webster 2012). To

explore avenues that would achieve $33 million in annual farm-gate sales, we modeled various scenarios exploring the effect of increasing acreage, increasing production requirements, and varying the percent of bottom leases used for extensive culture. These analyses showed that, at current production requirements, even a five-fold increase from current water column and bottom lease acreage would fall appreciably short of the $33 million goal. Instead, it would take approximately a 10-fold increase in acreage to meet this goal at current production standards. However, a 10-fold increase in cumulative leased acreage (i.e. 18,370 acres from the current 1,837 acres, an increase of 16,533 acres) appears unnecessary provided that production standards are increased to 100 bushels $acre^{-1}$ for water column leases and 40 bushels $acre^{-1}$ for bottom leases (readily achievable levels for committed growers).

If increased production requirements of 100 and 40 bushels $acre^{-1}$ for water-column and bottom leases, respectively, were introduced and all leases produce only the minimum amount required, the goal of $33 million could be achieved with much smaller increases in acreage than under current production requirements. Specifically, a $100 million industry valuation ($33 million farm-gate sales) could be achieved by: (1) increasing the amount of water column leases by 1,899 acres while retaining current bottom acreage; (2) increasing the amount of bottom acreage by 6,504 acres (assuming 50% spat on shell and 50% intensive bottom culture) while retaining current water column acreage; or as is most likely, (3) by a combination of increasing both water column and bottom acreage (Fig. 13). While market-driven increases in water column and bottom lease acreage will be contingent on demand and the rate at which new leases can pass administrative review, our analysis shows that $33 million in farm-gate sales can be achieved with only a ~2- to 5-fold increase in cumulative leased acreage provided per acre production is increased.

Rationale – relay

Shellfish relay, or the collection of oysters and clams from public bottom in closed areas and transfer to leases for depuration and then sale, is currently included in lease production. There is some concern, however, that shellfish relay does not provide the ecological benefits often used to justify shellfish mariculture's impingement on public trust land. Furthermore, relay involves a fiscal burden on the DMF, who must oversee relay activities. Many growers have expressed the belief that relay will not be preferred option for new growers given the physically demanding nature of this work, while conservationist worry about the impacts of expanding relay (in an expanding industry) on donor areas. Still, relay has distinct heritage value and offers a mechanism for providing the public with greater access to seafood. Additionally, evidence regarding the ecological benefits or costs of relay in North Carolina are lacking. Considering these multiple, and sometimes contradictory, factors, North Carolina should allow relay by those who have previously held shellfish relay permits or been actively engaged in relay activities within the last 10 years as evidenced by having held a relay permit issued by the Division of Marine Fisheries. Furthermore, shellfish relay should only be allowed to occur on leases current in operation as of December 31, 2018. This would allow those who have previously held relay permits to continue the practice on the leases they already have, while prohibiting the expansion of relay to new leases as the industry grows. This approach both values the heritage of those who have relied on relay to generate primary

or supplemental income and mitigates concerns by conservation groups that relay could expand dramatically with growth of the shellfish mariculture industry in North Carolina.

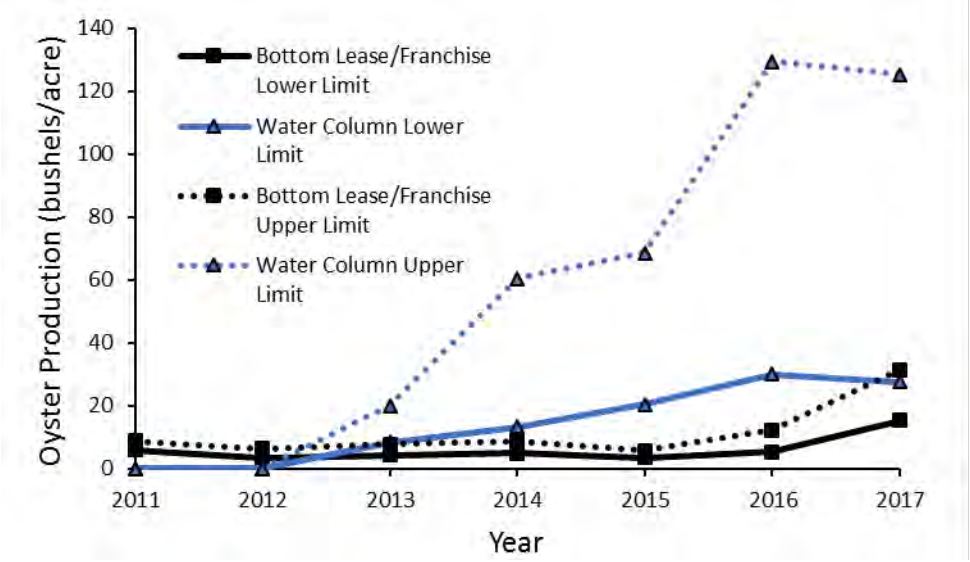

Figure 12. Trip ticket data on bushels of oysters produced per acre on water column and bottom/franchise leases. Source: North Carolina Division of Marine Fisheries

**Lower Limit assumes all leases with no trip ticket sales had no production (i.e. Total bushels sold to dealers divided by the total acreage under lease).*
**Upper Limit only considers acreage of lease holders who had trip tickets and does not consider production or acreage of those who did not have sales to dealers (i.e. Total bushels sold to dealers divided by acreage of those who sold to dealers).*

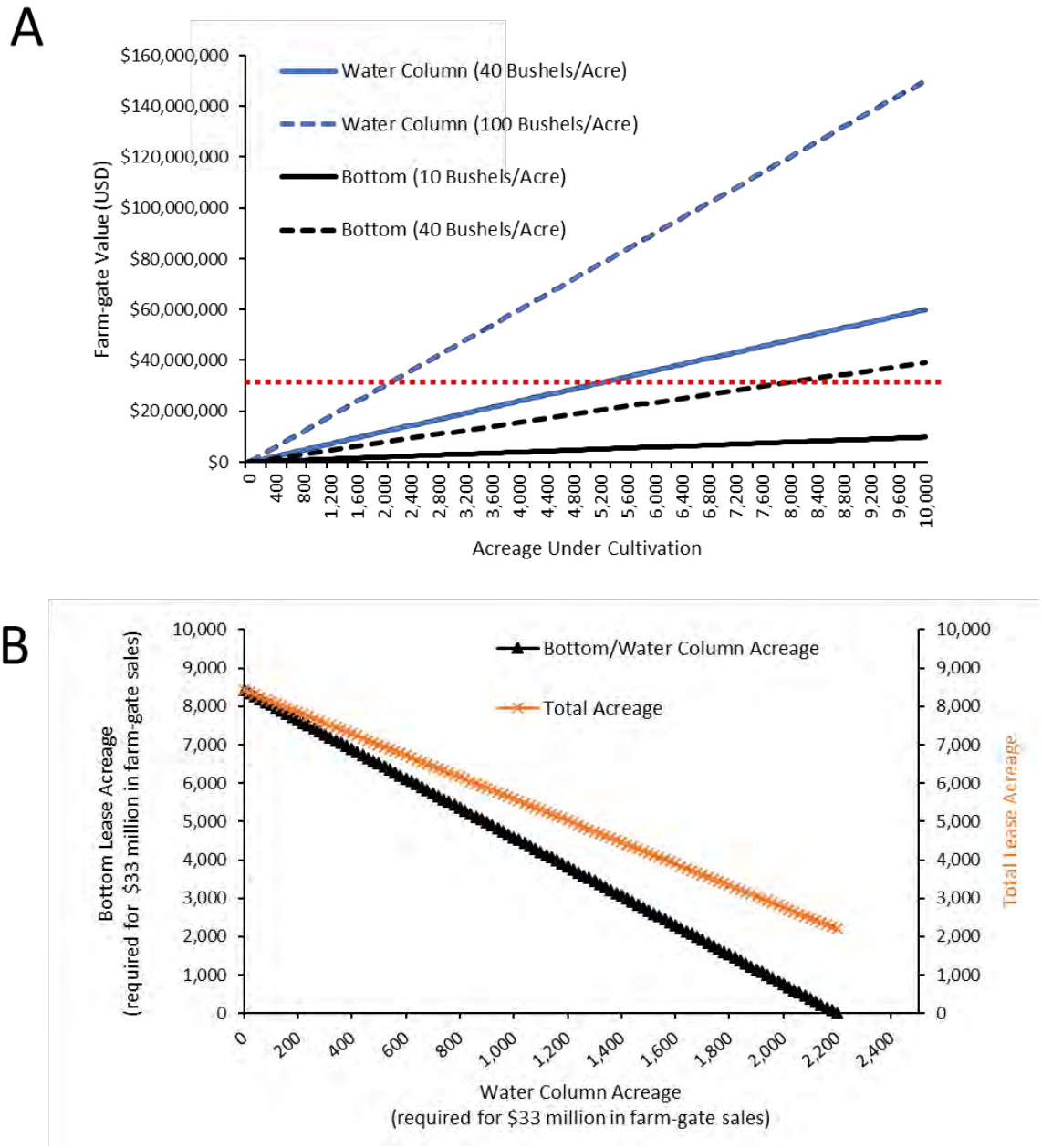

*Figure 13. Acres of water column (blue) **or** bottom (black) shellfish leases required to achieve $33 in farm-gate sales (red dashed line) under current (solid) or increased (dashed) production requirements (A). Acreage of bottom leases and total leased acreage required to achieve $33 million in farm-gates sales as a function of water column acreage. Analysis assumed production of 100 bushels acre^{-1} for water column leases and 40 bushels acre^{-1} for bottom leases (B). For all analyses, it is assumed that all water column produced shellfish and half of the shellfish produced on bottom leases are sold individually for $0.50 apiece. The other half of bottom produced shellfish are assumed to be sold at a price of $46 bushel^{-1}.*

Table 4. Utilization requirements for shellfish leases by state.

Shellfish Lease Utilization Requirements

State	Quantitative			Subjective	Percent of Permitted Acreage under Cultivation (Year Reported)	Notes
	Investment (annual)		Production (annual)			
	Planting	Financial				
ME	None	None	None	Requires "active use".	No Data	
NH	None	None	None	None	No Data	
MA	None	None	None	Municipalities given jurisdiction. State requires "substantial use".	<92% (2016)	
RI	None	None	None	Annual review of sales and seed. Revokation for lack of active use.	No Data	
CT	None	None	None	Required to be "actively, consistently and continually" worked for profitable sale of shellfish.	No Data	
NY	None	None	None	Requires "substantial shellfish aquaculture activity".	No Data	
NJ	None	None	None	Annual utilization form required	No Data	
DE	24 Months: 100,000 acre^{-1}	None	36 Months: 10 bu oysters or 5000 clams acre^{-1}	None	No Data	
MD	One-fourth of lease 1,000,000 acre^{-1}	None	None	None	No Data	
VA	No Data	No Data	No Data	No Data	No Data	
NC	Bottom: 25 bushels seed or 50 bushel cultch acre^{-1}; Water Column: 100 bushels seed or cultch acre^{-1}	None	Bottom: [and] 10 bushels acre^{-1}; Water Column: [or] 40 bushels acre^{-1}	None	No Data	
SC	50 bushels acre^{-1}	None	None	Planting requirement can be modified by SCDNR on a case-by-base basis.	No Data	
GA	None	None	None	None	No Data	
FL	100,000 clams or 70,000 oysters acre^{-1}	None	None	None	No Data	
AL	None	None	None	None	No Data	
MS	None	None	None	Leases must be active and engage in shellfish aquaculture activities throughout their term.	No Data	
LA	None	None	None	None.	44% (2006)	Dicontinued requirement of a cultivation certificate [affidavit] stating 10% of lease acreage actively leased.
TX	None	None	None	None	No Data	Proposed amendment to §58.30 to establish minimum activity of 25 cubic yards of cultch within first five years.
CA	None	None	None	Renewal of lease dependent on active engagement in aquaculture, as determined by commission	12% (2010)	
OR	None	None	None	Revokation if more than 50% of lands claimed are unproduction, as deemed by the director, after three years of plat being issued.	32% (2010)	
WA	None	None	None	None	No Data	
AK	None	None	$3,000 per acre or fraction thereof, or $15,000 per farm in annual sales	None	No Data	

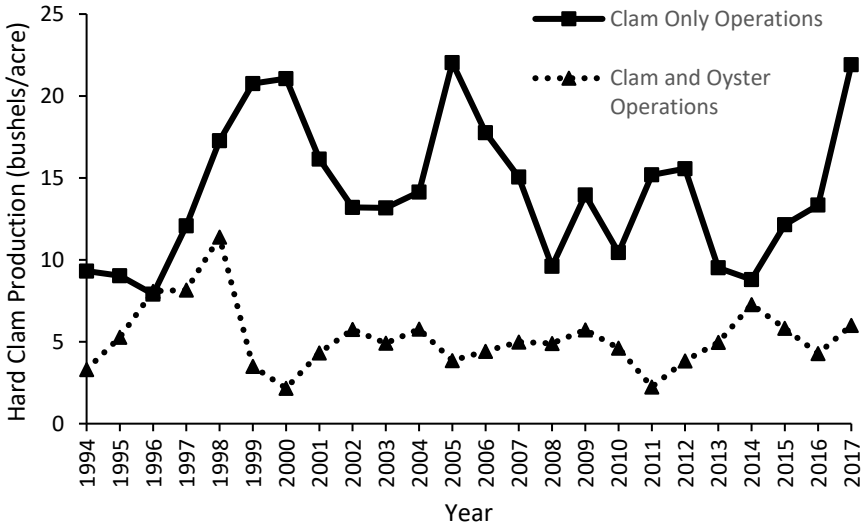

Figure 14. Trip ticket data on bushels of hard clams produced per acre on bottom and franchise leases. Clam only operations represents production per acre from the acreage of growers whose trip tickets were only for clam sales. Clam and Oyster Operations represents production per acre from acreage of growers who had sales of both clams and oysters. Source: NC Division of Marine Fisheries

Table 5. Suggested increased utilization requirements, either production or investment, based on culture method.

	Culture Method		
	Water Column	Intensive Bottom	Extensive Bottom
Production Requirement (Bushels Acre^{-1})	100	40	40
	OR		
Investment Requirement (# Acre^{-1})	45,000 shellfish seed	30,000 shellfish seed	250,000 remote-set spat

Recommendation #14

Institute higher minimum fines and mandatory restitution for those convicted of stealing or damaging property on shellfish leases. Elevate charges for theft from any contained culture (e.g. cages, bags) or free-on-bottom operation (including clams under netting) to a felony with a minimum fine of $2,500 and mandatory restitution to the property owner. For those convicted who hold a commercial license, first offenses will result in a one-year loss of license, and second offenses will result in a permanent loss of license.

Rationale

Cultured shellfish, particularly floating bag culture, are an easy and lucrative target for shellfish thieves. As shellfish leases are often located in isolated areas to minimize user conflict, theft from oyster leases, which usually occurs at night, is difficult for law enforcement to detect and prevent. Results from a 2011 survey of the North Carolina shellfish mariculture industry indicated that theft was the top concern among growers that responded, ranking ahead of hurricanes, water quality, user conflict, predation, leasing procedure, marketing and climate issues (Turano et al. 2011). Unfortunately, even when shellfish thieves have been caught by law enforcement, prosecutors and judges often fail to take these offenses seriously. Indeed, between 2006 and 2016, the average fine for those convicted of theft from North Carolina leases has been less than $25 (NCDMF 2016). Importantly, these meager fines were only issued to those caught and convicted, a major challenge given the difficulties associated with catching shellfish thieves and meeting the burden of proof required to convict them (personal communication, NC Marine Law Enforcement). Under current penalties, shellfish farmers can incur thousands of dollars in losses, with no source of restitution. Furthermore, while morally indefensible, the current laws make shellfish theft an attractive prospect to criminal who realize that if caught, they will receive much more lenient treatment in comparison to penalties for similar property crimes committed against other businesses. Instituting increased minimum fines and elevating the seriousness of theft from oyster leases would convey the seriousness of these crimes to the court and ensure that convictions resulted in meaningful penalties. Recognizing that minimal penalties make oyster theft an attractive prospect, other states have already classified shellfish theft as a felony (e.g. Texas) or have begun more aggressively charging oyster poachers with felonies using general grant larceny laws (e.g. Maryland).

While the approach used by Maryland of more actively pursuing shellfish poachers under felony larceny laws works if the legal system recognize that shellfish theft should be treated with the same seriousness as other property crimes, precedent from North Carolina and other states suggest that that mind-shift is slow to catch on, Thus, the SMAC is in favor of elevating penalties for those convicted of stealing from shellfish leases, a position supported by the high-ranking Marine Law Enforcement officer we consulted. As there is little potential to mistake oysters and clams grown within cages or bags for those that can be publicly harvested, we recommend elevating this to a felony charge with a minimum fine of $2,500 and required restitution to the farmer. We believe this penalty to be appropriate as shellfish poachers are not only committing a property crime, but, as poachers are almost certainly not handling the stolen product in accordance with practices to reduce the risk of disease (icing, refrigeration), shellfish poachers are also putting the public's health at risk if these shellfish enter the market. The SMAC has

been presented with a few instances in which these penalties may not be appropriate (e.g. youthful indiscretions, which, while reflecting incredibly poor judgement and requiring repercussions, may not merit a felony conviction on their record). We have, however, consistently heard that officer, prosecutor, and judge discretion would likely allow these cases to be plead to more minor offenses for first-time juvenile offenders.

Things become more complicated when it comes to prosecuting theft from spat-on-shell bottom leases. These leases are often marked with small PVC pipes that can be difficult to see and are susceptible to displacement during storm events. As such, there is increasing potential for some claims of inadvertent poaching to be sincere. This does not make these offenses any less injurious to the shellfish farmer, but we are hesitant to suggest major penalty increases for first-time offenses. Instead, the SMAC recommends retain current penalties with the additional condition of restitution for those without a previous illegal taking of shellfish convictions. We further recommend that the General Assembly revise statutes specify that illegal taking of shellfish from a shell farm by those with previous convictions for illegally taking either wild or farmed shellfish be classified as a felony charges with a minimum fine of $2,500 and mandated restitution to the farmer.

Recommendation #15

Amend North Carolina General Statute §113-203 to allow nursery of shellfish in waters classified as prohibited.

Rationale

Shellfish nurseries serve as critical support infrastructure for the shellfish industry (Claus 1982, Utting and Spencer 1991, Helm 2004). While it is generally more economical for oyster and clam growers to buy small seed (1-3mm) from shellfish hatcheries that to produce them on site due to the economy of scale of commercial hatcheries, raising shellfish from these sizes to grow-out ready individuals (10-25mm) is often feasible and cost-saving for private aquaculturists (Flimlin et al. 2010). Ideally, small seed from hatcheries are cultured in nurseries at a site near their grow-out location, allowing the juvenile shellfish to acclimate to local conditions. Nurseries can be either land-based or water-based. Land-based systems are predominantly either raceway systems, which pump water across shellfish seed horizontally, or weller (up- or down-) systems, which pump water across shellfish seed vertically. Water-based nurseries are largely comprised of floating up-weller systems (FLUPSYs) and, to a lesser extent, floating trays, both of which are best suited to calm, protected areas, such as marinas (Flimlin et al. 2010). In both land- and water-based nursery systems, seawater supplies the juvenile shellfish with the naturally occurring phytoplankton on which they feed. As they filter phytoplankton from the seawater, bivalve shellfish will also assimilate any pollutants in the water, including bacteria, viruses, heavy metals, and polyaromatic hydrocarbons (Richards 1988). As a result, consumption of shellfish directly from polluted waters can pose a serious threat to human health. However, even at the upper size range at which nursery culture is practical, they remain well below the threshold for marketability and must be relocated to grow-out operations in approved shellfish growing waters.

For over a century, scientists have recognized that bivalve shellfish can purge themselves of bacteria (>99%) once moved to clean waters in just a few days (Johnstone 1908, 1914). Even viral loads, which are purged at a slower rate than bacteria, can be effectively reduced to undetectable levels with depuration period on the scale of weeks, a practice used for shellfish relay that has considerably reduced the incidence of illnesses associated with cultured shellfish (Rippey 1994, Iwamoto et al. 2010, McLeod et al. 2017). Concerns over the accumulation of contaminants in shellfish grown in prohibited waters were likely a major consideration when the language addressing shellfish nurseries in General Statute §113-203 was crafted. Specifically, General Statute §113-203 Section 1.3.(a2) stipulates that it is unlawful to:

"Transplant oysters or clams from public grounds or permitted aquaculture operations utilizing waters in the restricted or conditionally approved classification to private beds except when the transplanting is done in accordance with the provisions of this section and implementing rules."

The Statutes then stipulate it is lawful to (G.S. §113-203 Section 1.3.(a3)):

"Transplant seed oysters or seed clams taken from permitted aquaculture operations that use waters in the restricted or conditionally approved classification to private beds pursuant to an Aquaculture Seed Transplant Permit issued by the Secretary that sets times

during which transplant is permissible and other reasonable restrictions imposed by the Secretary."

By omitting waters classified as prohibited with G.S. §113-203 Section 1.3.(a2 and a3), nursery culture in prohibited waters fall within the overarching prohibition on shellfish cultivation in areas recommended be closed by the State Health Director due to pollution. Available research indicates, however, that with appropriate precautions, shellfish nurseries in prohibited waters likely do not pose an elevated health risk and their prohibition is limiting industry growth via restricting access to seed shellfish supply. To ensure that shellfish raised in nurseries within potentially contaminated, but not prohibited, waters have adequate depuration periods, current language within G.S. §113-203 Section 1.3.(a3) stipulated that shellfish grown in nurseries in restricted or conditionally approved classification waters must be transplanted to permissible waters prior to reaching 12 mm for clams and 25 mm for oysters. Even under ideal growing conditions, clams and oysters would take a minimum of six months, and often considerably longer, to achieve market size (Paynter and Dimichele 1990, Adams and Van Blokland 1998, Grabowski et al. 2000a, Leonhardt 2013), dramatically exceeding the depuration period required by the National Shellfish Sanitation Program (NSSP).

Recognizing that transplanting shellfish from prohibited waters to clean waters at sizes that will ensure months of depuration prior to harvest, numerous states, such as Massachusetts, Maryland, New Jersey, and Florida, allow shellfish nurseries in prohibited waters with provisions requiring their transplanting at sizes similar or equal to those specified for restricted or conditionally approved waters in North Carolina G.S. §113-203 Section 1.3.(a3). Recently, the North Carolina Division of Marine Fisheries was consulted on the issue and expressed their support for allowing shellfish nurseries in prohibited waters, even drafting a rewrite of G.S. §113-203 Section 1.3.(a3) that was included in the ultimately unsuccessful Senate Bill 738 (2017 Session). The rewritten statutory language was as follows (with further clarification indicated by [text]):

"Unless the Secretary determines that the nursery of shellfish in an area will present a risk to public health, it is lawful to transplant seed oysters or seed clams taken from permitted aquaculture operations that [<u>occur within or draw water from</u> ~~use~~ waters ~~in the~~ <u>classified as prohibited],</u> restricted, or conditionally approved [by Shellfish Sanitation] to private beds pursuant to an Aquaculture Seed Transplant Permit issued by the Secretary that sets times during which transplant is permissible and other reasonable restrictions imposed by the Secretary under either of the following circumstances:

> (1) When transplanting seed clams less than 12 millimeters in their largest dimension.
> (2) When transplanting seed oysters less than 25 millimeters in their largest dimension."

This change was intended to expand nursery access to shellfish growers, thereby allowing a greater number of private aquaculturists to raise their own shellfish seed. This change has the potential to demonstrably reduce seed limitation and reliance on out-of-state nursery operations as well as lowering production costs for growers. Notably, this language still provides substantial discretion to the Secretary to determine whether proposed nurseries located in prohibited waters present any health risk or unreasonably

impair public trust uses. Furthermore, all water-based nursery systems would require an additional level of review by the Division of Coastal Management.

Embracing the statutory rewrite of G.S. §113-203 Section 1.3.(a) proposed in Senate Bill 738 (2017 Session) would be valuable to the development of North Carolina's shellfish mariculture industry. The modified statute would continue to provide discretion to the Secretary to determine whether proposed sites in prohibited waters present an unacceptable risk due to the likelihood of high levels of contamination from pollutants about which depuration rates are less well understood (e.g. PAHs, heavy metals) or are unreasonably obstructive of public trust uses. Furthermore, this change would align North Carolina with other states' policies, including Massachusetts, a state with which the European Union allows imports only with strict shellfish sanitation policies. Finally, this change should make North Carolina shellfish growers more competitive by reducing the unit cost of shellfish seed and increasing the availability of locally acclimated and potentially hardier seed supplies (Helm 2004).

Maintaining and Improving Water Quality

Recommendation #16
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.

Rationale

The Federal Clean Water Act established a structure for regulating pollution discharge into waters across the U.S. and criteria for surface waters. On top of Federal standards, North Carolina's Environmental Bill of Rights mandates the State take actions to mitigate pollution of its waters. Additional measures, such as North Carolina's Antidegradation Policy (15A NCAC 2B .0201) and statutory authority for nonpoint source management of pollution (Chapter 143-215.8B), have been enacted to further safeguard North Carolina's surface waters and wetland. Despite these measures, water quality in the coastal waters of North Carolina continues to be degraded. Between 2007 and 2018, an additional 4,507 acres of coastal waters were closed to shellfishing due to degraded water quality (NCDEQ Shellfish Sanitation). As of 2018, 433,477 acres of coastal water were classified as prohibited for shellfish harvest due to degraded water quality (Fig. 9).

Non-point source pollution (NPSP) accounts for approximately 70% of surface water degradation across the U.S. (Potter et al. 2004), making it the nation's largest remaining source of surface water impairments. Sources of NPSP, include agricultural runoff, urban runoff, pollution generated by modifying natural stream hydrology, abandoned mine drainage, and failing on-site disposal systems that result in elevated levels of heavy metals, sediment, nitrate, phosphate, PAHs, and fecal coliform in State waters (NCDENR 2005). In North Carolina, runoff from agriculture and livestock operations represent the largest source (>50%) of surface water impairment (Evans and Skaggs 2004), increasing nutrient, fecal coliform, and sediment inputs into State waters (NCDENR 2005). Furthermore, impervious surfaces can dramatically increase runoff during rainfall events compared to natural baselines (Stumpf et al. 2010). Runoff from agriculture and urban sources entering receiving coast water bodies and tidal creeks impacts not only environmental quality but represents a public health issue as many of these waters are used extensively for shellfish harvest, commercial and recreational fin-fishing, swimming, and a myriad of other recreational uses. To protect the public, the State has instituted rainfall threshold (i.e. 3.81 cm over a 24-hour period) that result in the closure of conditionally approved waters for shellfishing until Shellfish Sanitation has conducted monitoring demonstrating safe levels of fecal coliform bacteria. Despite declining water quality in North Carolina as population growth has led to increased deforestation and impervious cover (Coulliette and Noble 2008), the regulatory agencies responsible for monitoring and protecting the State's water quality continue to battle a growing problem with limited – and in some instances, declining – resources.

A 2014 report by the North Carolina Non-Point Source Program (NPS) identified significant staffing needs for the State's water quality monitoring program. The data collected by these staff are critical to enacting mitigation strategies and assessing the effectiveness of restoration strategies. The number of full-time equivalent positions the

DEQ's Sedimentation Control Program has declined from 65 in FY 2008-2009 to 36 in FY 2016-2017, nearly a 50% reduction despite a similar number of "open" sediment projects (NCDEQ 2017). In 2016-2017, the 36 employees reviewed 2,952 (1,948 new, 488 express, and 516 revised) erosion and sedimentation control plans, conducted 11,373 sedimentation site inspections, issued 194 notices of violation, and handled 22 enforcement case referrals (NCDEQ 2017). This amounts to 6.05 site inspections and 1.58 permit reviews work-week^{-1} employee^{-1}. In FY 2016-2017, the Stormwater Control Program at DEQ, which oversees 116 MS4 local governments permittees, 286 water supply watershed communities, and 4,000 industries with stormwater permits, had only 28.5 full time equivalent positions (NCDEQ 2017).

In addition to the need for increased staffing to address water quality enforcement issues, there is a need for budgetary increases to provide these staff with the most up-to-date tools and strategies to identify critical source areas (CSAs) for non-point source pollution. Identifying CSAs, defined as hydrologically sensitive areas that overlap with lands that have a high potential to generate polluted runoff, is an efficient and cost-effective approach to mitigating non-point source pollution and identifying major violators (Qiu 2009). Approaches such as the Soil and Water Assessment Tool (SWAT, the Soil Topographic Index (STI), travel time indices, and agricultural pollution potential indices have been demonstrated to be powerful tools for identifying and remediating non-point source pollution at fine spatial scales (Giri et al. 2016). With appropriate staffing and financial support, North Carolina water quality regulators could use these tools to identify the most vulnerable receiving water bodies, monitor those areas for impacts, and trace pollution back to major violators. Furthermore, with improved resources, the North Carolina Department of Environment Quality could conduct the research necessary to facilitate remediation for violators, providing an avenue through which agriculture development, valuable industries in North Carolina, need not be mutually exclusive with pristine surface waters. By tailoring models (e.g. Best Management Practices (BMP) Tool) to specific topographic and hydrological conditions, managers are able to identify specifications for readily implementable approaches (e.g. changing from a ~3 m width vegetated filter strip, which filters ~40% of nitrogen and phosphorous, to a ~20m vegetated filter strip can result in ~90% in reduction of nutrient runoff from livestock operations (Geng et al. 2015)) to achieve major reductions in non-point source pollution.

Importantly, addressing water quality issues would not only have a positive impact on shellfish mariculture, the topic of this report, but would also have positive impacts across numerous other sectors of economic importance. As demonstrated in other states (e.g. Massachusetts: A harmful algal bloom (HAB) leading to $21 million in losses to the shellfish industry (Jin et al. 2008); Maine: A HAB leading to a loss of $2.9 million in shellfish harvest (Jin et al. 2008); Alaska: Shellfish poisoning from a HAB leading to $1.3 million in losses in geoduck and crab harvest (Ralonde 1998)), as well as in North Carolina, where nutrient pollution driven hypoxia resulted in $1.7 million losses to the brown shrimp fishery in the Pamlico Sound alone (Huang et al. 2010), nutrient pollution can dramatically impact wild-caught fisheries. Outside of extractive practices, research has shown that modest improvements in the Chesapeake Bay's water quality can have significant positive impacts on waterfront and near-waterfront property values (Walsh et al. 2017). Furthermore, harmful algal blooms in degraded waters can have appreciable consequences for both human health and tourism as demonstrated by North Carolina's

massive 1987 dinoflagellate bloom which caused 48 cases of neurotoxic shellfish poisoning and conservatively resulted in $25 million ($54 million in 2017 dollars) in lost tourism revenue to coastal counties that year, not to mention any lost tourism in subsequent years due to negative publicity (Tester et al. 1988).

Inclusion of additional economic benefits derived from water quality enhancement serves to highlight the fact that, in considering appropriations to improve water quality monitoring and enhancement, the General Assembly could consider far more than the current and future value of shellfish mariculture in their cost-benefit analyses for any legislative action. Given the number of sectors that rely on water quality, appropriations for enhanced water quality monitoring and enforcement provide a high return on investment for both governments and citizens (Arrow and Kruz 2013). Therefore, an overall increase in staffing for the North Carolina Division of Environmental Quality's Water Resource Section is warranted. Specific to shellfish mariculture, funds should be appropriated for three additional positions (environmental specialists at $45,000 salary plus $16,000 fringe) in the Water Resource Section whose job descriptions are focused on addressing water quality issues in the shellfish growing waters of North Carolina, many of which also represent primary or secondary fish nursery habitat. At least 50% of the hours of these new hires should be dedicated to addressing water quality issues within areas covered by Phase II of the National Pollutant Discharge Elimination System (NPDES) Stormwater Runoff Management Program, specifically those small municipalities outside of the Wilmington area that impact North Carolina's prime shellfish growing waters. Additionally, these environmental specialists should work directly with Shellfish Sanitation to identify the growing areas most in need of increased stormwater compliance.

Recommendation #17

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.

Rationale

There are currently a number of grants administered by the North Carolina government aimed at protecting and enhancing water quality. Among them are grants administered by the Nonpoint Source Section 319 Grant Program, the Clean Water Management Trust Fund, the North Carolina Division of Mitigation Services, the Conservation Reserve Enhancement Program, and the Environmental Enhancement Grant Program. Given that projects that protect and restore high priority shellfish growing areas have multiple value added benefits (i.e. protecting and enhancing wild shellfish populations that provide numerous ecosystem services including water filtration, shoreline stabilization, and serving as important fish nursery habitat (Grabowski et al. 2012), as well as maintaining or expanding waters approved for shellfish farming and thereby increasing the number of shellfish filtering coastal waters), grant scoring criteria should be modified so that additional points are awarded to proposals that would benefit shellfish growing waters.

Additionally, the State should consider appropriating additional funds for restoration or replication of natural hydrology in high priority shellfish growing areas. Wetland vegetation, such as freshwater and salt marshes, provide substantial ecosystem services, including enhancement of water quality. Salt marshes can filter both waste (Brenner et al. 1991, Entry et al. 2000) and nutrients (Valiela and Bowen 2002, Valiela et al. 2002), reducing loading into adjacent water bodies (Joyce and Anderson, 2008). Indeed, stormwater treatment wetlands exhibit removal rates of nutrients (e.g. phosphorous, ammonia, nitrate) that correlate positively with the ratio of stormwater treatment wetland area to watershed area (Carleton et al. 2001). Oysters similarly augment water quality, with an individual oyster filtering as much as 50 gallons of water per day, removing nutrients from the system in the form of pseudofeces. This potential has resulted in extensive use of oyster restoration to improve water quality across the southeast and mid-Atlantic region of the U.S. (Coen et al. 2007, Grabowski and Peterson 2007). Restoring coastal wetlands, which play a critical role in nutrient cycling and water quality, has additional benefits such as increased resilience to storms and augmenting fisheries species - making restoring natural costal hydrology a cost-effective approach for improving water quality (Day Jr et al. 2003).

North Carolina has been the recipient of considerable funding for conservation programs authorized through the federal Farm Bill. Between 2009 and 2015, the U.S. Department of Agriculture invested more than $400 million to conserve water, land, and air resources in our State (USDA 2017b). Among these programs are the Environmental Quality Inventive Payments Program, the Conservation Stewardship Program, the Conservation Reserve Program, and the Wetlands Reserve Program (WRP). The WRP provides financial incentives to landowners for protecting and restoring wetlands on their property through the establishment of permanent or 30-year conservation easements on their property and is the most specifically tailored to have beneficial impacts on water quality. Since 2009, North Carolina has received ~$7.5 million annually from the WRP, leading to the conservation and/or restoration of over 50,000 acres of wetlands (USDA 2017a).

The Wetland Reserve Enhancement Partnership (WREP), a component of the USDA's Agricultural Conservation Easement Program, allows state and local government agencies as well as nongovernmental organizations (NGOs) and First Nations tribes to enter into partnerships with the Natural Resources Conservation Service (NRCS) to leverage WRP funds for either new land enrollment or implementation of restoration on existing WRP lands. However, partners must provide at least 25% of the funds for easements, management, or restoration. Revising scoring criteria of state funded grants to elevate projects that protect growing waters and restore natural hydrology would increase the availability of funds that could be used to leverage existing federal dollars more effectively.

Additional funding options to further embrace the protection and remediation of water quality in North Carolina: There is precedent for passing voter-approved legislation to fund these types of activities. Minnesota is among the best examples of using voter-approached amendments to benefit environmental enhancement. For example, in 1988, state voters approved an amendment to establish the Environmental and Natural Resources Trust Fund, using 40% of the Minnesota State Lottery proceeds as well as private donation to provide continued funds to protect the environment and natural resource. Since 1991, the Environmental and Natural Resource Trust Fund has provided approximately $500 million dollars to fund over 1,000 projects throughout that state (ENRTF 2018). More recently, in 2008, Minnesota voters passed the Clean Water, Land, and Legacy Amendment, increasing sales tax by three-eighths of one percent through 2034 and generating an estimated $171 million in annual revenue to fund conservation and environmental enhancement. Although only 33% of the funds from the Clean Water, Land, and Legacy Amendment are devoted to specifically to water quality, this has amounted to over $860 million since the fund's inception (Anderson et al. 2018). Work analyzing the potential return-on-investment (ROI) from land acquisitions purchased using these funds estimated that ROI from environmental benefits (i.e. water quality, carbon sequestration) and recreational opportunities could exceed five, depending on future land use change and service valuation (Kovacs et al. 2013). In 2010, Iowa voters approved an amendment a constitutionally protected Water and Land Legacy Natural Resources and Outdoor Recreation Trust Fund, which stipulates a three-eight of one-cent revenue from the next sales tax increase will be allocated to the fund in perpetuity. The bill was supported by over 90% of legislators and approved by 63% of those Iowa voters. While the sales tax has yet to be increased, triggering the implementation of this measure, when the next sales tax increase occurs it is estimated that it will generate up to $180 million annually for environmental protection and enhancement (NRORTF 2018).

Recommendation #18

Adopt a State policy that requires the use of Low-Impact Development (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.

Rationale

Low-impact development (LID) is the practice of using approaches and techniques to recreate the natural processes and landscapes that result in the infiltration (e.g. permeable pavements) and evapotranspiration (e.g. bioretention ponds, rain gardens) of stormwater or its use as a resource (e.g. vegetated rooftops), as opposed to a waste product. These practices can dramatically reduce stormwater runoff, the leading source of surface water degradation across the U.S. (Potter et al. 2004). A study conducted by North Carolina State University researchers evaluating the potential for bioretention cells to remove nutrients and pollutants from stormwater found that these cells were capable of reducing phosphorous loading by 22-65%, nitrogen loading by 40-70%, copper and zinc loading by 56-99%, and fecal coliform by over 90% at sites in Chapel Hill, Louisburg, and Charlotte (Hunt and Lord 2006). Even small modifications can dramatically reduce loading to receiving water bodies. For example, studies from around the U.S. (Booth and Leavitt 1999, Rushton 2001, Scholz and Grabowiecki 2007),including North Carolina (Zachary Bean et al. 2007), have found that replacing impervious surfaces with permeable pavers can dramatically reduce, and in some cases completely eliminate, runoff and associated pollution loading to adjacent water bodies.

In response to an increasing awareness of the detrimental impacts of stormwater runoff from urban and developing areas on surface waters throughout the U.S., in 2007, Congress enacted Section 438 of the Energy Independence and Security Act (EISA). Section 438 of EISA requires that "the sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow." Aimed at protecting both onsite and downstream water resources, in essence, this mandate stipulates that the percentage of annual rainfall running into streams post-development must be no greater than the percentage before development. In doing so, onsite and downstream water sources should receive water at a similar rate, temperature, and volume as conditions prior to development, as well as mitigate streambed erosion and loading of pollutants (EPA 2009).

Section 438 Technical Guidance provides two option through which developers can meet the mandate: 1) Prevent the off-site discharge of stormwater resulting from all rainfall events less than or equal to the 95th percentile rainfall events specific to the projects geographic location (i.e. only the 5% of rainfall events with the greatest 24-hour precipitation total over a given period, usually 30 years, would be exempt); or 2) Employ site-specific hydrological analyses to determine pre-development runoff conditions and maintain those runoff levels post-development (EPA 2009). To achieve this, approaches such as bio-retention areas, permeable pavements, green roofs, and cisterns/recycling are

suggested. Additional off-site options may also be employed such as the purchase of stormwater retention credits. Importantly, the mandate includes wording specifying that stormwater mitigation is required to the Maximum Extent Technically Feasible (METF), acknowledging that some projects will have specific constraints that allow for a dispensation. For example, if developers can provide evidence that stormwater retainment would adversely impact receiving waters, soil infiltration capacity of the site is limited, the site is too small to infiltrate the necessary volume of water, modifications to existing buildings are infeasible, or state or local requirements restrict LID/green infrastructure/water harvesting, projects may be given dispensation to proceed without meeting Section 438 Technical Guidance requirements (NAVFAC 2015).

Requiring that state funded construction utilize low impact design practices would be a major step towards protecting and improving our state's water quality. There is a perception that low impact design is often more costly than projects that use conventional design, however, a study from Pender County, NC found that for 11 out of 12 projects analyzed, LID was less expensive (Andrea 2011). For some projects, LID will certainly add to construction costs. For example, requiring all new highways to include bioretention pond would certainly cost more than if they were not required. However, given that the drainage ditches boarding these roads are major vectors for stormwater pollution of freshwater and coastal water bodies, the General Assembly should weight the one-time investment associated with new construction or retrofitting old construction against the economic benefits derived from enhanced water quality over the lifetime of the LID feature. There is also a perception that LID requires considerably more maintenance than conventional design, however, low impact design has been found to often require less maintenance than its conventional design alternatives (Houle et al. 2013).

Given the value of low impact development as a tool to mitigate and remediate degradation of surface waters in North Carolina, the General Assembly should embrace a similar approach to that implemented Federally through Section 438 of the Energy Independence and Security Act of 2007.

Addressing Research Needs

Recommendation #19
Establish a recurring appropriation to fund a Shellfish Mariculture Grant Program, administered by North Carolina Sea Grant, that funds research projects aimed at informing an economically, ecologically, and socially beneficial shellfish mariculture industry.

Rationale

There are two major categories of research needs for growing the shellfish mariculture industry in North Carolina: (1) large-scale projects that likely require the infrastructure of universities and expert oversight of academic researchers; and (2) small-scale research programs best suited to be developed and executed by industry participants with the assistance of partners from academia. Here we present a flexible mechanism to fund large-scale research projects. See Major Recommendation #19 for our proposed funding mechanism for a small-scale industry-academia partnership research grant program.

The dollars awarded to projects aimed at addressing pressing research questions surrounding shellfish mariculture will have the additional benefit of making North Carolina more competitive for Federal grant money, which often require matching funds. Historically, North Carolina has lagged well behind other States in Federal funding for shellfish mariculture research, receiving just $2.7 million between 1990 and 2015, compared to $11.8 million and $11.5 million by Washington and Virginia, respectively (Table 6). Even as recently as 2017, North Carolina researchers were absent from the 32 grants (totaling $9.3 million to researchers in Alabama, Alaska, California, Florida, Hawaii, Maine, Maryland, Massachusetts, Mississippi, New York, New Jersey, Oregon, South Carolina, Virginia, and Washington) awarded through two Sea Grant aquaculture funding opportunities: Integrated Projects to Increase Aquaculture Production and Addressing Impediments to Aquaculture Impediments. Indeed 33 U.S. Code § 1124 stipulated that, by law, non-Federal matching funds or cost share are required for most Sea Grant awards. Increased availability of State research funds may have increased the likelihood of North Carolina researchers claiming a portion of the $9.3 million awarded, which was estimated to have had a $90 million economic impact and created or sustained 1,800 and 900 aquaculture related jobs and businesses, respectively (NOAA 2018a). Again in 2018, North Carolina researchers were not among the 22 recipients (California, Florida, Hawaii, Louisiana, Maine, Massachusetts, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Washington, and Wisconsin) of National Sea Grant's Aquaculture Awards totaling $11 million that are generating an estimated economic impact of $78 million while supporting 792 business and 1,387 jobs (NOAA 2018b).

To provide a reliable source for shellfish mariculture research and increase competitiveness for Federal funds, the General Assembly should appropriate recurring funds ($250,000, annually) for a Shellfish Mariculture Grant Program, administered by North Carolina Sea Grant. Proposals should be reviewed under NCSG's already formalized and vetted proposal review process. The program should stipulate a 15%

administrative cap to provide NCSG with the resources necessary to administer the program.

Research priorities will be identified by expert review panels during each cycle. While likely to shift over time, foci are likely to include, although are not limited to: siting and spatial planning, human health, shell disease mitigation, hatchery performance (including further development of locally adapted diploid or triploid lines) socioeconomics, and environmental impact of shellfish mariculture (Appendix H).

Table 6. Cumulative Federal and matching shellfish mariculture research funding amount for U.S.' states and territories between 1990 and 2015. Funding amount (adjusted to 2015 USD) and the funding rank compared to other states and territories are reported for all shellfish mariculture funds, as well as oyster- and hard clam-specific projects. Source: United States Department of Agriculture's National Agricultural Library

State	**Cumulative federal and matching funding between 1990 and 2015 (Adjusted to 2015 USD; rank among U.S. states and Territories)***					
	All Shellfish		Oysters		Clams	
	$	Rank	$	Rank	$	Rank
ME	$7,956,605	5	$2,825,175	9	$785,041	4
NH	$2,560,805	17	$1,106,424	16	$252,663	6
MA	$3,136,555	14	$860,210	17	$136,735	11
RI	$4,924,554	10	$4,027,087	6	$0	12
CT	$2,644,633	16	$812,797	18	$0	12
NY	$963,795	19	$179,417	21	$231,195	8
NJ	$7,921,403	6	$4,714,939	4	$427,130	5
DE	$3,269,646	11	$3,269,646	8	$0	12
MD	$6,889,295	8	$5,092,110	3	$194,000	10
VA	$11,504,397	2	$7,461,672	2	$1,215,437	3
NC	$2,700,673	15	$1,991,753	12	$0	12
SC	$2,232,450	18	$1,504,245	15	$221,753	9
GA	$567,494	20	$567,494	19	$0	12
FL	$10,918,144	3	$1,664,759	14	$2,583,420	1
AL	$3,245,498	13	$2,530,535	11	$240,921	7
MS	$190,166	22	$0	22	$0	12
LA	$8,100,216	4	$7,783,068	1	$0	12
TX	$559,234	21	$312,941	20	$0	12
CA	$5,511,714	9	$2,602,236	10	$0	12
OR	$6,909,655	7	$3,560,067	7	$0	12
WA	$11,802,166	1	$4,527,992	5	$1,305,072	2
AK	$3,247,602	12	$1,729,447	13	$0	12

*Federal Grants from DOD, DOE, EPA, HHS, NASA, NOAA, NSF, USAID, USDA

Recommendation #20

Establish a Mariculture Resource Grant program, administered by North Carolina Sea Grant with significant collaboration from the North Carolina Shellfish Growers Association, that funds grower-led projects aimed at increasing return on investment, broadening industry participation, increasing product safety, and facilitating crop diversification.

Rationale

Between 1993 and 2013, the North Carolina's Fishery Resource Grant (FRG) Program funded collaborative research among commercial fishers, recreational anglers, seafood purveyors, and university researchers. This program recognized that industry participants "often have the best ideas for improving and protecting fisheries [mariculture] but may lack the financial resources or scientific background to conduct experiments, collect data, and analyze results." (Rebach 2009). Despite being discontinued by the General Assembly in 2013, results from FRG funded research continue to be used by fisheries managers to update numerous stock assessments and fisheries management regulations as well as by commercial fishers to inform their practices (Sea Grant 2015). Collaboration between industry participants and researchers generated findings relevant to both commercial and recreational fishing, such as new methods to reduce shrimp trawl bycatch, minimize juvenile sea turtle interaction with fishing gear, reuse derelict crab pots for oyster restoration (the genesis of the Sandbar Oyster Company), identify potential nursery habitat for commercially important fishes, and determine the impact of hook-and-line discard mortality on dolphinfish (mahi-mahi), just to name a few (Sea Grant 2015).

Mariculture was one of four FRG research priority areas. Funding was prioritized for research aimed at developing best management practices, improving return-on-investment, assessing impacts of regulations on the industry, and assessing environmental and economic impacts of mariculture. Funded projects provided insight into techniques to facilitate polyculture on mariculture farms (e.g. 2013-AM-02, 2013-MARI002), market development for farm-raised mariculture products (e.g. 2013-R/MG-1303), and approaches to expand and diversify North Carolina's shellfish aquaculture industry (e.g. 2008-F/AF-50, 2015-EXT-14, 2015-AQUA-01, 2015-EXT-12). As an unfortunate coincidence, the discontinuation of the FRG program occurred just as North Carolina's shellfish mariculture industry really began to ramp up production and value.

Other states with thriving shellfish mariculture industries, such as Virginia, demonstrate the importance of keeping funds available to facilitate industry-led research benefitting the North Carolina's industry participants. For example, a 2016 Virginia Fishery Resource Grant demonstrated the potential value of using radio-frequency identification (RFID) technology to reduce theft from shellfish leases (Kellum and Pollard Sr. 2016). As results from these research projects are generated, they can be disseminated to growers within the state by Sea Grant agents. While many states make results from FRG projects publicly available once reports are generated (usually 1 to 2 years after project completion), the early availability of this information to growers within the state provides a competitive advantage.

Given the successful track record of the North Carolina Fishery Resource Grant program in generating valuable insights to guide management and farm practices, a Mariculture Resource Grant program should be reinstituted following the FRG model. The program should be administered by North Carolina Sea Grant, with a 15% administrative cap to provide Sea Grant with the resources necessary to administer the program. Standard proposal review practices used by NCSG, which proved successful in their administration of the Fisheries Resource Grant Program, should be employed. The Mariculture Resource Grant program should receive an annual recurring appropriation of $150,000, a value in line with Virginia's 2017 appropriation of ~$160,000. Although these are intended to be small grants (i.e. less than $25,000), the review panel should have appropriate expertise to evaluate whether expensive, but particularly valuable projects are justifiable.

Recommendation #21

Appropriate funds to support an Aquaculture Business Agent at North Carolina Sea Grant to aid the existing Marine Aquaculture Extension Specialist in meeting the ever-growing needs of the shellfish mariculture industry.

Rationale

Currently, North Carolina Sea Grant has in place a Marine Aquaculture Specialist that serves the entire coast. This position, based centrally in Morehead City at North Carolina State University's Center for Marine Science and Technology (CMAST), is responsible for interfacing with academia, NGOs, and regulatory agencies to disseminate science-based information to industry participants throughout the state. In addition, the Specialist works with growers to identify pressing industry research needs, identifies and entities with the expertise and capabilities to engage in research to address these needs. The Specialist has also established a successful collaborative applied research program to address industry needs. With 278 leases spread across the coastline of North Carolina (Fig. 4) and North Carolina's dozens of universities and NGOs staffed by experts in marine ecology, policy, economics, and social sciences, the responsibilities of the Specialist are broad and encompassing.

Shellfish growers consistently affirm that the Marine Aquaculture Specialist plays a critical role in communicating best available science to growers, providing guidance on farm practices, facilitating collaborations with academics, and conducting applied research. As the industry grows, however, the demands on this position to alone serve growers will be severely tested. Additionally, many growers not only need technical assistance "in the water", but also in developing business models, understanding complicated insurance options (as evidenced following Florence when many growers purchased "top-ups" through NAP to 65/100 coverage, but did not understand how to complete forms to receive warranted benefits), and connect with effective distribution networks. Therefore, the State should allocate funding to support a Marine Aquaculture Business Agent at NCSG ($60,000 salary, plus $20,000 fringe). This position would provide business planning assistance to the growers and afford the current Marine Aquaculture Specialist additional assistance while maintaining existing grower-NCSG connectivity throughout the State that is so critical to facilitating collaboration within and among entities such as the North Carolina Shellfish Growers Association (NCSGA), academia, and regulatory/promotional agencies. Similar Sea Grant structures are used in Maryland and Mississippi/Alabama, who are supported by Aquaculture Extension Specialists, and assisted by Shellfish Aquaculture Business Agents.

Should the General Assembly embrace Major Recommendations 17 and 18, (establishing grant programs administered by North Carolina Sea Grant), the responsibilities of the Aquaculture Business Agent could also include an administrative role in those grant programs.

SUPPLEMENTARY RECOMMENDATIONS

Supplementary recommendations are those which the SMAC has been unable to build consensus around and require further vetting by the General Assembly. These recommendations may benefit the North Carolina shellfish mariculture industry, however, statutory changes and not yet recommended without further vetting and consideration.

Supplementary Recommendation #1
Investigate the need for and availability of bonds for leases other than spat-on-shell (expiring one year after lease term) to ensure cleanup in the case of abandonment.

Rationale

States with shellfish mariculture industries routinely require performance bonds (also called surety bonds) or payments held in escrow to cover the cost of cleaning up abandoned gear after major storm events, or from terminated or abandoned leases (i.e. Maine, Massachusetts, Rhode Island, Delaware, Florida, Louisiana, California, Washington, and Alaska). The amount of the required bond varies considerably by state, ranging from as little as $1,500 in Maine for leases smaller than 400 ft^2 ($5,000 for leases larger than 400 ft^2), and up to $250,000 for shellfish leases in certain municipalities (e.g. Westport) in Massachusetts, a state where leasing authority is given to towns. The potential need for bonding shellfish leases is perhaps best underscored by the clam fishery in Cedar Key, Florida, which was largely established by Federally-funded job-training programs for underemployed commercial fishers in the early 1990s and quickly became one of the nation's largest producers of hard clams. Having grown to over 200 farms by the early 2000s, the area was impacted by four major hurricanes during the 2004-2005 hurricane season (Hurricanes Charley, Francis, Ivan, Jeanne), resulting in over 20,000 abandoned clam bags that needed to be cleaned up using state appropriations (Frederick et al. 2015).

Currently, comprehensive gear- and scale-specific estimates of lease remediation costs are not available. One prominent example, the remediation of a 3.2-acre clam lease near Harkers Island, NC, at a cost of ~$130,000 (Rich 2017), suggests that performance bond pricing used by most other states would fall well short of the true costs to remediate abandoned leases. However, the Harkers Island remediation could also dramatically exceed normal costs due to the added complexities of remediating a highly derelict lease containing sediment covered, scattered gear due to weathering and storm events. Setting bonds unnecessarily high could present an additional barrier to entry due to financial or logistical difficulties associated with acquiring a bond or having the personal capital to place in escrow. If set too low, bonds would still represent and added financial hurdle, but one that may do little to offset the true costs of lease remediation. Thus, a more comprehensive study should be conducted to evaluate the per-acre cost of remediating bottom and water column leases, whether the bonds necessary to ensure remediation

would represent a major disincentive for to prospective shellfish, and how best to balance these interests.

Alternative:
Currently, there are no statutes or rules requiring that growers' gear possess identifying markings such as a durable tag listing the grower's name and contact information. Tags, such as those required for crab pots, are inexpensive (<$1.00 apiece) and would not only assist growers in reclaiming lost gear but would also provide a means of accountability in the wake of storm events or poor farm practices. Implementing statutory language requiring the tagging of mariculture gear and holding shellfish growers accountable for cleaning up gear displaced from their leases would be valuable safeguards against environmental degradation, particularly as the shellfish mariculture industry in North Carolina expands. For additional information, see the Gear Identification rationale in Major Recommendation #11.

Supplementary Recommendation #2
Investigate the impacts of enacting reciprocity laws that allow seed importation only from states that allow importation of North Carolina seed.

Rationale

Disease has been identified as a major factor constricting the expansion of aquaculture through 2050 (Stentiford et al. 2012). As such, biosecurity measures are critical to mitigating the potential for disease outbreaks, which come at considerable environmental and economic costs. In response, most U.S. states and foreign countries have laws regulating the importation of foreign broodstock for aquacultural purposes. While land-based aquaculture operations can institute physical barriers, water treatment, and quarantines to limit the spread of disease, shellfish mariculture farms operating in coastal waters can readily communicate introduced diseases to wild populations and adjacent shellfish farms (Pruder 2004).

To combat the spread of infectious disease and minimize the risk of epizootics in shellfish populations, numerous states have enacted laws requiring foreign sources shellfish broodstock, seed, or adults to be certified as disease-free by a state approved lab (Table 5). Whether because of some limitations in disease testing capabilities, (Carnegie et al. 2016), or because of concerns over introducing deleterious genetic characteristics into wild populations, states such as South Carolina, Florida, and Mississippi have banned the importation of shellfish broodstock and seed that do not originate from within their state or region's waters (Table 7).

Although not explicit, Virginia's added permitting burden to import seed from Florida and South Carolina (Chapter 4 VAC 20-754-30) may serve to penalize these states for their lack of reciprocity. It is unclear what quantity, if any, of seed used by North Carolina shellfish farmers is sourced from Florida, South Carolina, or Mississippi, and thus, what impact an importation ban would have on the growth of our shellfish industry. Particularly given issues of seed limitation reported by North Carolina farmers within recent years, further constraining seed availability should be done with great caution. Instead, we recommend that as additional shellfish hatchery become operational in North Carolina and our state's growers become less reliant on out-of-state sourced product, the General Assembly should consider placing restrictions on the importation of seed from states that do not reciprocate. Prior to such action, we recommend that the Division of Marine Fisheries and North Carolina Sea Grant engage these states to discuss the potential for reciprocity agreements under Best Management Practices.

Table 7. State regulations on the importation of out-of-state shellfish seed.

State	Region	Allows importation of NC Seed	General Restrictions
ME	Atlantic	Yes	Required Permit or Certification.
NH	Atlantic	Yes	Required Permit or Certification.
MA	Atlantic	Yes	Required Permit or Certification.
RI	Atlantic	Yes	Required Permit or Certification.
CT	Atlantic	Yes	Required Permit or Certification.
NY	Atlantic	Yes	Required Permit or Certification.
NJ	Atlantic	Yes	Required Permit or Certification.
DE	Atlantic	Yes	Required Permit or Certification.
MD	Atlantic	Yes	Required Permit or Certification.
VA	Atlantic	Yes	Requires Permit or Certification. Specific constraints on SC and FL.
SC	Atlantic	**No**	Ban on out of state seed importation. Only South Carolina seed allowed.
GA	Atlantic	**Clam Only**	Ban on out of state oyster seed importation.
FL	Atlantic/GOM	**No**	Ban on importation of seed from Atlantic coast states. Only broodstock which originated in Florida's Atlantic Coast or GOM.
AL	GOM	Yes	Required Permit or Certification.
MS	GOM	**No**	Imported shellfish seed must be first generation descendants of broodstock who originated in the Gulf of Mexico.
LA	GOM	Yes	Required Permit or Certification.
TX	GOM	Yes	Required Permit or Certification.
CA	Pacific	Yes	Required Permit or Certification.
OR	Pacific	Yes	Required Permit or Certification.
WA	Pacific	Yes	Required Permit or Certification.
AK	Pacific	Yes	Required Permit or Certification.

Supplementary Recommendation #3
Investigate the use of a sales tax on half-shell oysters sold in North Carolina to fund shellfish mariculture research and programs.

Rationale

There is appreciable precedent for levying taxes on shellfish and other seafood to fund resource management and programs that assist industry participants. Washington has the enhanced food fish tax, a tax levied on the first person who commercially possesses certain food fish, shellfish, and other seafood products in the state (Chapter 82.27). Alaska has number taxes on seafood, including the Seafood Marketing Assessment tax, which taxes all seafood at a rate of 0.5% of its value. The funds raised from the Seafood Marketing Assessment tax support the Alaska Seafood Marketing Institute, a public-private partnership between the state of Alaska and its seafood industry that conducted research and outreach aimed at economic development of Alaska's marine fisheries resources. The State of Maine has specific taxes on Quahogs, providing funds for their Department of Marine Resources' Quahog Monitoring Fund. In an effort to defray some of the costs associated with industry support programs featured in recommendations provided in the North Carolina Strategic Plan for Shellfish Mariculture, the General Assembly could consider a point-of-purchase sales tax on all half-shell oysters sold in North Carolina.

Generating an estimate of the funds that would be collected from such a tax is complicated by a lack of comprehensive data on oyster consumption in North Carolina (a data limitation that could be addressed by the comprehensive market analysis detailed in Major Recommendation #3). In 2017, roughly ~1,200,000 individual oysters were sold from water column leases in North Carolina. While a small percentage of water-column produced oysters may have been destined for shucking, these numbers were likely compensated for by bottom-lease produced oysters that were sold to the half-shell market. In consulting with shellfish dealers, 75% is a conservative estimate of the percentage of raw oysters consumed in North Carolina that are imported from other states. Given this assumption, that would place current raw oyster consumption in North Carolina in the ballpark of 5 million. A tax of $0.01 per oyster would therefore generate $50,000, annually, in revenue. Hopefully, with increase product availability, publicity, and education, the demand for mariculture produced oysters will grow in NC, increasing the revenue from this tax appreciably over the decadal time scale of the strategic plan presented within the body of this report.

The suggested point-of-sale tax would be charged directly to the consumer and would not affect restaurant list prices. The cost would appear as a separate tax on the consumer's bill and would represent a marginal enough increase (0.5%, which is $0.12 on a $24 bill, the average coast of a dozen half shell oyster sold in North Carolina) so as to not impact demand (Fig. 15). Importantly, the General Assembly would need to determine the cost to implement and administer such a program to ensure that administrative costs would not consume a majority of the revenue generated.

If the General Assembly decides to embrace this tax, proceeds should be used to fund a portion of the $150,000 annually appropriated for the Mariculture Resource Grant (Major

Recommendation #19). As the number of farmed shellfish sold in North Carolina grows and funds from the tax grow, the proceed could cover and increasing portion of the Mariculture Resource Grant and, if they eventually exceed $150,000, could be used to top up the fund for low-interest loans to shellfish mariculture operations (Major Recommendation #2. One additional use for these funds is to fund a shellfish recycling program aimed at providing substrate to spat-on-shell operations.

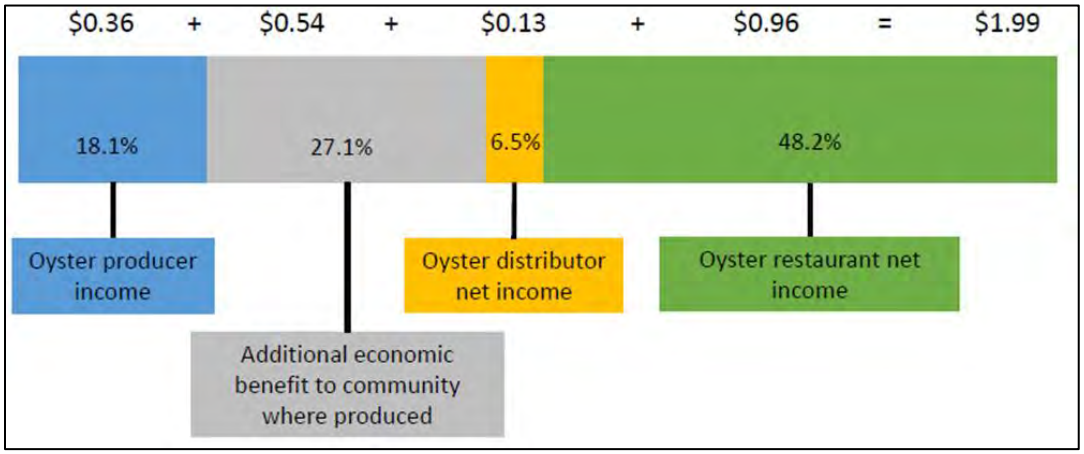

Figure 15. Value chain of North Carolina produced and sold single oysters. Values are averages for raw, half-shell oysters sold throughout the State. Source: University of North Carolina Kenan-Flagler Business School and the North Carolina Policy Collaboratory.

Supplementary Recommendation #4
Revisit recommendations within the Division of Marine Fisheries' 2016 Report on Core Sound Shellfish Aquaculture Leasing. Consider funding further study of the social, ecological, and economic attributes that influence the suitability or unsuitability of existing lease moratoriums within State waters for additional shellfish leases.

Rationale

In 1993, the proposal of a 7-acre lease in Core Sound brought forward the contentiousness of shellfish leasing's potential conflict with other public trust uses. Opposition resulted in the submission of a petition with 875 signatories to the Marine Fisheries Commission (NCDEQ 2016), resulting in a two-year moratorium on leases in Core Sound (NC House Bill 416, 1993 Session). Upon the expiration of NC House Bill 416 in 1995, the submission of eight lease applications in eastern Core Sound triggered over 400 protests, culminating in an indefinite moratorium on additional leases in eastern Core Sound and an additional two-year moratorium in western Core Sound (House Bill 1074). In addition, this legislation mandated a study of shellfish leasing practices in the state, generating a 2001 report in which three options for western Core Sound were identified: 1) keeping it closed; 2) opening 1-3 percent of western Core Sound; or 3) open western Core Sound under normal leasing practices. Continued protests resulted in the legislature placing an indefinite moratorium on leases in western Core Sound (Session Law 2003-63), which, in addition to the existing 1995 indefinite moratorium on eastern Core Sound, indefinitely halted any further shellfish leases in the entirety of Core Sound, 65,340 acres in total. Existing leases at the time of the final moratorium included 33 leases in western Core Sound covering 92.4 of its 36,460 acres (<0.3%) and a single lease in eastern Core Sound covering 7 of its 28,880 acres (~0.02%) (NCDEQ 2016). Largely clam leases at the time, most are now used for oyster growing and 8 leases covering 30 acres in western Core Sound have been terminated.

In 2015, Session Law 2015-241, Section 14.8 was passed based on renewed interest in re-opening portions of Core Sound to new shellfish leases. The law required that the North Carolina Division of Marine Fisheries consult with mariculture industry representatives, commercial fisheries representatives, and Federal regulatory agencies to formulate a proposed plan to re-open certain sections of Core Sound to shellfish leasing. In year one of the plan they proposed: making Core Sound leases available to only Carteret County residents, allowing 40 new acres of leases in western Core Sound with a maximum size of 5 acres, and allowing leasing of the footprint occupied by expired or terminated leases through exempting these sites from the 10-bushel per acre restriction on new leases (NCDEQ 2016). The effects of those actions would be investigated by a committee designed by and reporting to the Marine Fisheries Commission. Based on their findings, the Marine Fisheries Commission could, if appropriate, institute further acreage allowances in Core Sound.

The stipulation allowing only Carteret County residents to apply for leases in Core Sound was deemed illegal based on the fact that the public trust bottom in Core Sound belonged to all residents of North Carolina, not just those in Carteret County. Following this determination, the recommendations were abandoned due to lack of support. Importantly,

Core Sound is not the only waterbody in North Carolina with a moratorium on new shellfish leases.

Brunswick county has been under moratorium on new shellfish leases since the 1960s due to opposition from commercial fishers (Rice 1968). A similar moratorium in the area surrounding Masonboro Island expired in March 2017, but the moratorium was quickly renewed by Session 2017 House Bill 16: An Act to Establish a Moratorium on Shellfish Leasing in the New Hanover County Area, which enacted a moratorium on new shellfish leases through July 1, 2019.

The General Assembly should be aware of the issues surrounding existing lease moratoriums, and revisiting recommendations contained within the 2016 DMF report would be valuable (NCDEQ 2016). Further investigation of the social, economic, and ecological dynamics influencing the suitability or unsuitability of Core Sound for additional leases can informed compromises be made regarding the future of shellfish leasing in Core Sound. For example, spatial analysis may show that, due to the abundance of seagrass and prevalence of conflict with other public trust uses, there are few if any places where shellfish leases could be sited if the moratorium were lifted. With this information, stakeholder groups could discuss whether this small area was not worth the effort to lift the moratorium or, alternatively, that the moratorium could be lifted because these few areas that would qualify for leasing were not contentious. Furthermore, social science research may help identify the major sources of opposition to further shellfish leases and identify conflict resolution approaches to permit some level of compromise. Regardless of the outcome, further research of the complex dynamics leading to the existing moratoriums of shellfish leasing in North Carolina waters is merited.

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Appendix A. Shellfish Mariculture Advisory Committee Membership and Contributors

SMAC Working Groups

Key Business Metrics and Climate

Chair: Tom Looney, EDPNC & NCCF

Membership: Will Best, NC Dept. of Commerce; Dave Forcinito, Cheney Brothers Distributing; Jane Harrison, NCSG; Todd Miller, NCCF; Jay Styron, NCSGA; and Chuck Weirich, NCSG.

Goals:

1. Define specific 10-year goals and an on-going disciplined mechanism for measuring harvest, leasing, economic development impacts, tourism, water quality, community engagement
2. Create a conducive business climate by eliminating barriers to entry
3. Financing, marketing & distribution, workforce development, tourism, governance structure, community awareness

Industry Governance & Leadership/Promotion

Co-Chairs: Chuck Weirich, NCSG

Ana Zivanovic-Nenadovic, NCCF

Membership: Will Best, NC Dept. Commerce; Bill Cary, Brooks Pierce Law Firm & NCCF; Tom Looney, EDPNC & NCCF; Jay Styron, NCSGA; and Jeff Warren, NCPC.

Goals:

1. Develop a structure and define roles and responsibilities for industry leadership in NC by building upon existing framework from other states/industries
2. Garner support from state government & private enterprise
3. Devise plan for efficient state regulatory oversight

Siting Shellfish Mariculture

Chair: Bill Cary, Brooks Pierce Law Firm & NCCF

Membership: John Allen, Brunswick County economic development manager; Troy Alphin, UNCW; Jacob Boyd, NCDMF; Anne Deaton, NCDMF; Dave Eggleston, NCSU CMAST; Michael Graven, NCDMF; Jonathan Howell, NCDCM; Niels Lindquist, UNC-IMS; Todd Miller, NCCF; Pete Peterson, UNC-IMS; Martin Posey, UNCW; Brandon Puckett, NCNEERS; Ken Riley, NOAA; Jay Styron, NCSGA; Chris Voss, UNC-IMS; and Ana Zivanovic-Nenadovic, NCCF.

Goals:

1. Reaffirm that shellfish mariculture is in the public interest
2. Ensure protection of identified compatible water uses and other appropriate public trust activities
3. Update and increase discretion where possible in setting required annual production standards for leases
4. Establish Shellfish Enterprise Areas (SEAs)
5. Update and remove discretion where possible in siting standards for non-SEA leases
6. Clearly define agency roles and responsibilities
7. Simplify siting of support facilities

Water Quality

Chair: Ana Zivanovic-Nenadovic, NC Coastal Federation

Members: Tere Barret, NCDMF; Bill Cary, Brooks Pierce Law Firm & NCCF; Bree Charron, NCCF; Anne Deaton, NCDMF; Joey Daniels, NCSGA; Tim Ellis, APNEP; Erin Fleckenstein, NCCF; Brett Froelich, UNC-IMS; Phil Gagnon, UDOC grower; Jonathan Howell, NCDCM; Shannon Jenkins, NC DMF; Lauren Kolodij, NCCF; Annette Lucas, NCDEMLR; Jeff Manning, NCDWR; Ian McMillan, NCDWR; Todd Miller, NCCF; Rachel Noble, UNC-IMS; Pete Peterson, UNC-IMS; and Carter Witten, NC Marine Patrol.

Goals:

1. Devise strategies to support the growing shellfish industry while maintaining/improving coastal water quality
2. Identify areas that should have enhanced protection

3. Identify management authorities, tools and funds that will be needed to adequately protect or restore prime growing waters

Applied Research and Development

Co-Chairs: Pete Peterson, UNC-IMS
Christine Voss, UNC-IMS

Members: Troy Alphin, UNCW; Brett Froelich, UNC-IMS; Rachel Noble, UNC-IMS; Martin Posey, UNCW; Brandon Puckett, NCNERRS; Ami Wilbur, UNCW; and Chuck Weirich, NCSG.

Goals:

1. Identify the technical and technological processes and issues for which data could lead to relevant solutions and to successful shellfish mariculture
2. Establish a shellfish mariculture resource grant program
3. Establish a scientific shellfish mariculture research council

Special Contributors

SMAC Coordinator

Kasia Grzebyk, North Carolina Policy Collaboratory

Contributions:

- Organization of SMAC meetings
- Website development
- Liaison between SMAC and the North Carolina Policy Collaboratory

North Carolina Coastal Federation Interns

Members: Marygrace Rowe, Max Issokson

Contributions:

- Background research and analysis of mariculture policies and programs in other states

University of North Carolina Kenan-Flagler Business School

Members: Lynne Gerber, Faculty Advisor; Jeff Jorgensen, Project Lead; Ted Meyers; Brian Dienes; Alyson Levitz-Jones; Indy Stevens; Sophie Riegel.

Major Contributions:

- North Carolina Oyster Tourism and the North Carolina Oyster Brand

Out-of-State Industry Experts

Julie Davis; Living Marine Resource Specialist, South Carolina Sea Grant Consortium

Daniel Grosse, President, East Coast Shellfish Growers Association & TerrAqua Environmental Science and Policy, LLC

Karen Hudson, Shellfish Aquaculture Specialist, Virginia Institute of Marine Science

Dennis McIntosh, Research Professor and Aquaculture Extension Specialist, Delaware State University

Matt Parker, Aquaculture Business Specialist, Maryland Sea Grant

Robert Rheault, Executive Director, East Coast Shellfish Growers Association & Department of Fisheries, Aquaculture and Veterinary Science at The University of Rhode Island

Frank Roberts, Lady's Island Oyster, South Carolina

William Walton, Auburn University Shellfish Lab, Auburn University & Mississippi-Alabama Sea Grant Consortium

Donald Webster, College of Agriculture and Natural Resource & Regional Extension Specialist, University of Maryland

SMAC Meeting Attendees and Contributors:

Devri Adams, Ryan Bathea, Christian Bayer, Teresa Bayer, Ryan Belter, Dodie Blakely, Charlotte Brown, Scott Burrell, Tom Cannon, Dave Cerino, Michelle Clower, Leda Cunningham, Teri Dane, Diane Durance, Chris Elkins, Sarah Eure, Luke Fairbanks, Dean Foster, Ryan Gadon, James Hargrove, Craig Harms, Danielle Herman, Susan Hill, Tim Holbrook, Mark Hooper, Greg Huhn, Clark Hutchinson, Jimmy Johnson, Mary Penny Kelley, Lauren Kolodij, Mike Lam, Rob Lamme, Chris Matteo, Tommy McArthur, Jaclyn McGarry, Michael McKnight, Johnnie Mercer, Steve Murphey, Trish Murphey, Clifton Parker, Logan Prochaska, Mike Quidley, Summer Rich, Ronald Scheffield, Jerry Schill, Mike Shutak, Tracy Skrabal, Kari Signor, Glenn Skinner, Sherri Smith, David Sneed, Mackenzie Taggart, Jacob Torok, Madeline Tripp, Adam Tyler, Leslie Vegas, Keith Walls, Steve Weeks, Ted Wilgis, and Melissa Wood.

Appendix B. Non-Recurring and Recurring Costs to Enact Recommendations

Recommendation		Cost	
#	Summary	Non-Recurring Appropriation ($)	Recurring Appropriation ($)
1	Embrace a $100 Million Industry Valuation Goal	$0	$0
2	Provide FCIC/RMA Concept Proposal Start-Up Funds	$30,000	$0
3	Establish a Low-Interest Loan Program	$2,000,000	$60,000
4	Specify Eligibility of Shellfish Growers for Agriculture Disaster Funds	$0[!]	$0
5	Commission a Market Analysis	$30,000	$0
6	Fund a Shellfish Mariculture Advisory Panel at NCDA&CS	$0	$30,000
7	Fund Development of North Carolina Oyster Trail	$0	$200,000
8	Establish a Shellfish Mariculture Governance Advisory Committee	$0	$30,000
9	Establish a Shellfish Leasing Section at NCDMF	$0	$165,000*
10	Amend G.S. 113-202: Increase Secretary's Discretion	$0	$0
11	Establish Shellfish Enterprise Areas (SEAs)	$0	$0
12	Permit a capped number of larger leases	$0	$0
13	Increase Utilization Requirement	$0	$0
14	Increase Penalties for Theft from Shellfish Leases	$0	$0
15	Allow Nurseries in Prohibited Waters	$0	$0
16	Appropriate Funding for Additional NCDEQ Water Resources Staff	$0	$183,000*
17	Revise State Grant Scoring to Benefit High Priority Growing Areas	$0	$0
18	Require Low-Impact-Development for State Projects	$0	$0**
19	Establish a Shellfish Mariculture Grant Program	$0	$250,000
20	Establish a Mariculture Resource Grant Program	$0	$150,000
21	Fund an Additional Position at North Carolina Sea Grant	$0	$80,000[$]
Totals		$2,060,000	$1,138,000

[!] Not a special ask for shellfish growers: Eligibility for disaster relief funds available to other forms of agriculture.

* Three Full Time Equivalent Positions (fringe included)

** Unknown indirect cost

[$] One Full Time Equivalent Assistant Position (fringe included)

Appendix C. Further Analysis of North Carolina Oyster Trail Potential

Prepared by:
The UNC Kenan-Flagler Business School
in collaboration with
The North Carolina Policy Collaboratory

PRIMARY GOAL

The UNC Kenan-Flagler team was asked to provide recommendations for the North Carolina Oyster Trail in the larger context of seeking economic development opportunities for less-economically-developed coastal communities. The team's primary goal is to boost the economies of Tier 1 and Tier 2 coastal counties and other rural coastal areas.

APPROACH

Economic impact will be driven in two ways:

1. Through increases in the unit price of North Carolina Oysters and in the number of oysters sold
2. Through increases in direct tourism spending

The long-term growth of the North Carolina oyster industry is dependent on exporting oysters in large quantities and gaining market share from established producers in Virginia and other states/provinces. This is the channel that will yield the largest economic impact.

The team's recommendations outline plans to create and develop:

1. The North Carolina Oysters brand
2. The North Carolina Oyster Trail
3. The managing entity that will oversee the brand and Trail

The team does not recommend creating a North Carolina Oyster Festival because creating a festival or endorsing an existing festival as "The North Carolina Oyster Festival" would force several other existing community festivals (that already serve a similar purpose) to compete.

1. NORTH CAROLINA OYSTERS BRAND

The team's recommendations are centered around building a nationally-recognized brand for North Carolina Oysters. Differentiating North Carolina Oysters through branding will lead consumers to choose North Carolina Oysters over other oysters and to pay more for North Carolina oysters. Increasing the number of units sold and the price paid per unit adds value to North Carolina Oysters.

Napa Valley model

North Carolina's oyster branding efforts should emulate the successful model established by Napa Valley Wine. Imagery is an important component of the Napa Valley Wine brand. Similar to the importance of terroir, the characteristic taste and mouthfeel of a wine impacted by the environment in which it was produced, the make Napa Valley wines sought after and unique, educating consumers about the merroir, defined as the taste, size, shape, color, and texture of oysters imparted by its growing environment, will be critical to building the North Carolina Oyster brand. Additionally, establishing imagery for North Carolina Oysters will be important for establishing this new brand. The North Carolina Oysters brand should leverage recognized imagery of North Carolina, including beaches and lighthouses.

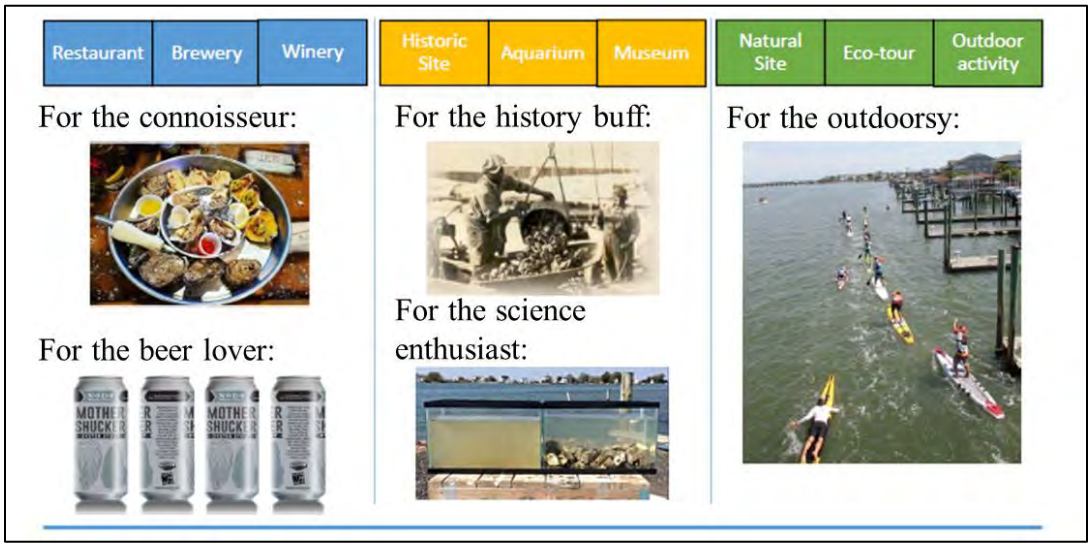
Development of brand imagery

An important factor in establishing imagery and tying it to North Carolina Oysters will be the North Carolina Oyster Trail. The Oyster Trail will focus on reaching residents and visitors in places they already live and travel. It will pull these residents and visitors toward oyster-related businesses and activities that are convenient for them to access and related to their interests. It will also focus on increasing economic activity through increased direct tourism spending—particularly spending on oysters.

2. NORTH CAROLINA OYSTER TRAIL

Site mix

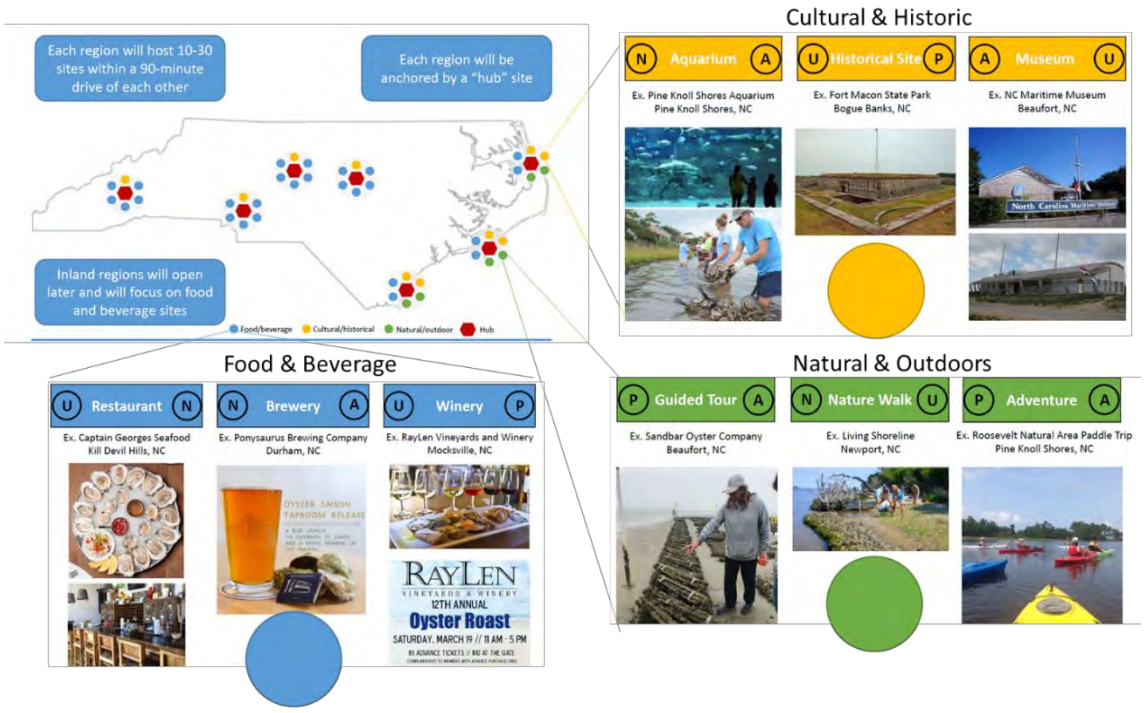
The North Carolina Oyster Trail should include a variety of site types, including restaurants, museums, aquariums, and natural areas that cater to a diverse group of user interests (Appendix C, Fig. 1). Participating sites will help educate visitors and act as North Carolina Oyster brand evangelists. The Trail will, in turn, provide these businesses and organizations with value-adding benefits—primarily in the form of marketing.



Appendix C, Figure 1. North Carolina Oyster Trail interest-specific attractions.

Regional hub-and-spoke model

The Oyster Trail will be divided into regions. Each region will be approximately 90 minutes of travel time in diameter and contain between 10 and 30 different sites (spokes; Appendix C, Fig. 2). Each region will be anchored by a single highly-committed site called a hub. A hub should be a non-profit organization to ensure fairness and neutrality and will act as the concierge to visitors for the entire region. Hubs will dedicate space and labor to educating visitors about oysters and helping them plan their trips. Hubs will also act as liaisons between their regions' sites (spokes) and the statewide Oyster Trail administrators.



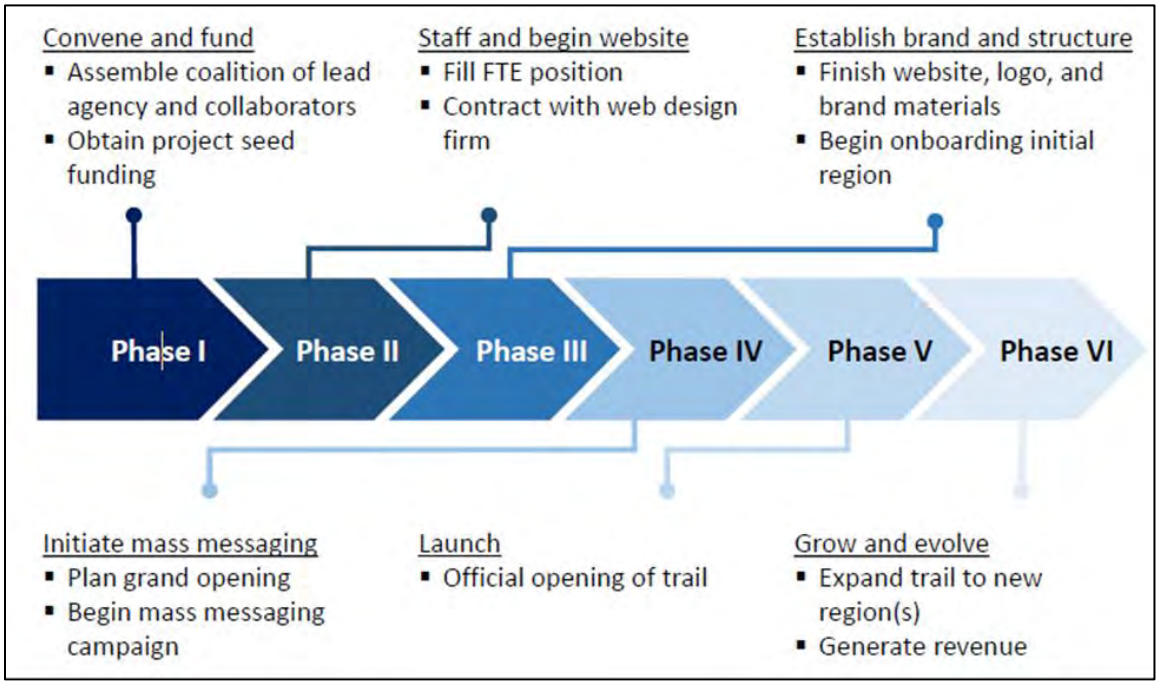
Appendix C, Figure 2. Regional hub and spoke model with examples of each type of interest-specific attraction.

Regional expansion to inland areas

Regions should be located both on the coast as well as in inland areas. Regions should be launched gradually, starting with one or two coastal regions, then by adding a third coastal region and expanding inland. Inland regions will be composed primarily of food and beverage establishments. Inland regions will allow inland visitors and inland residents to participate in the Oyster Trail and learn about oysters without traveling to the coast. Inland sites will also encourage people to travel to the coast to learn and see more. The economic benefits of the Oyster Trail will be focused on coastal communities, but will be shared with inland communities as well.

Six-Phase Oyster Trail Rollout

The North Carolina Oyster Trail should be rolled out following a six-phase plan (Appendix C, Fig. 3). Phases 1-5 will occur in year one. Phase 1 include obtaining seed funding (cost: $105,203) and organization of lead and collaborating agencies. Phase 2 includes creation of a website (cost: $4,800-$20,800), hiring a permanent director for the Oyster Trail (cost: $36,000-$112,000), and designing a logo (cost: $488-$1,060, a cost already covered if the Oyster Trail utilizes either of the designs commissioned by the Kenan-Flagler/Policy Collaboratory, Appendix C, Fig. 4). Phase three commences onboarding of coastal regions and creation of hub displays and exhibits (cost: $26,000-$46,000). Phase four will initiate marketing the Oyster Trail marketing campaign. This conservative approach is intended to grow market share and recognition over 10-20 years. Phase five is the launch of the Oyster Trail, which should be held on a high-visitation weekend, coincide with local festivals, and incorporate celebrity appearances. Phase six, which encompasses year 2 and beyond, will focus on continually adding sites and evaluating potential for geographic expansion. Suggestion regional expansion launch order should be as follows: (1) Crystal Coast/Outer Banks; (2) Wilmington; (3) Research Triangle/Charlotte; (4) Asheville; and (5) Greensboro/Winston-Salem/High Point.



Appendix C, Figure 3. North Carolina Oyster Trail six-phase rollout plan.

Appendix C, Figure 4. Potential North Carolina oyster logos that could also be used for the Oyster Trail.

3. MANAGING ENTITY

Full time employee

The North Carolina Oyster Trail should be led by a single statewide office and should employ **at least one full-time employee** with significant marketing and project management expertise. Hiring this employee is a high priority step in getting the Oyster Trail up and running.

Home agency

The Department of Natural and Cultural Resources is in many ways an ideal choice to house the Oyster Trail office. However, additional funding for the administration of the Oyster Trail must be provided.

Collaborating organizations

The North Carolina Oyster Trail should be administered in close strategic collaboration with several other organizations, stakeholders, and state agencies. These may include the Department of Commerce, the Department of Agriculture and Consumer Services, the Economic Development Partnership of North Carolina, the North Carolina Shellfish Growers Association, the North Carolina Coastal Federation, North Carolina Division of Marine Fisheries, and North Carolina Sea Grant.

Funding

There is a wide range of possible activity and funding intensity. Due to uncertainty in how quickly oyster production will grow and how effective the Oyster Trail will be in driving oyster sales and tourism early on, starting with a conservative investment (outlined above) is recommended. The minimum effective budget for the early years of the Oyster Trail is about **$200,000 per year**. However, after no fewer than five years, the Oyster Trail may be able to become self-sustaining.

As much as **$1.5 million** could be spent effectively, but not until later in the Oyster Trail's lifecycle. Investing too much too early may result in inefficient use of those funds without having tested which investments drive the most value. It may also result in

overstimulating demand for North Carolina Oysters well beyond what current production levels can support. This could be very damaging to the long-term prospects of the North Carolina Oyster Trail and the North Carolina Oysters brand.

IMPACT

Demand driven, in part, by the North Carolina Oyster Trail and supported by steady production growth may yield **more than $500 million** in economic impact to North Carolina by Year 10 (Appendix C Table 1).

This value can be broken into three components (cumulative over 10 years):

1. Farm-gate value of oysters—**$145 million**
2. Induced/indirect spending—**$218 million**
3. Added value of oyster sales in North Carolina restaurants—**$170 million**

However, this 10-year impact cannot be achieved until measures to ensure long-term growth in North Carolina oyster cultivation are in place. These values are based on 80% of the farm-gate value growth rate observed in Virginia between 2005 and 2014. Prior to 2005, Virginia was still in the process of implementing measures to grow its oyster cultivation industry. North Carolina will likely not be poised for similar growth until after 2019.

Appendix C, Table 1. Farm-gate value of oysters, induced/indirect spending, and added value of oyster sales in North Carolina restaurants. Assumes $1.1 million farm-gate value of mariculture grown in Year 1 (2016 North Carolina estimate) and year-over-year sales growth equivalent to 80% of that experienced by Virginia.

	Farm Gate Value	YoY Growth	Down Stream Oyster Sales (Total)	% of Oysters Sold Out of State	NC Downstream Oyster Sales	Induced and Indirect Spending
Year 1	$1,100,000	230%	$2,933,333	10%	$2,640,000	$1,650,000
Year 2	$3,630,000	44%	$9,680,000	17%	$8,023,644	$5,445,000
Year 3	$5,222,516	83%	$13,926,710	24%	$10,553,351	$7,833,774
Year 4	$9,574,613	23%	$25,532,301	31%	$17,532,180	$14,361,919
Year 5	$11,763,096	27%	$31,368,256	38%	$19,308,904	$17,644,644
Year 6	$14,974,608	30%	$39,932,287	48%	$20,605,060	$22,461,912
Year 7	$19,511,294	16%	$52,030,116	55%	$23,517,613	$29,266,940
Year 8	$22,726,889	16%	$60,605,037	61%	$23,514,754	$34,090,333
Year 9	$26,363,191	16%	$70,301,843	68%	$22,777,797	$39,544,787
Year 10	$30,581,302	16%	$81,550,137	74%	$21,203,036	$45,871,952
10 year	**$145,447,508**		**$387,860,019**		**$169,676,339**	**$218,171,261**

Appendix D. Administrative Rules Revisions

SECTION .0200 – LEASES AND FRANCHISES
15A NCAC 03O .0201 STANDARDS FOR SHELLFISH BOTTOM AND WATER COLUMN LEASES

(a) All areas of the public bottoms underlying coastal fishing waters shall meet the following standards in addition to the standards in G.S. 113-202 in order to be deemed suitable for leasing for shellfish cultivation purposes:

~~G.S. 113-202 in order to be deemed suitable for leasing for shellfish cultivation purposes:~~

~~(1) The lease area must not contain a natural shellfish bed which is defined as 10 bushels or more of shellfish per acre.~~

~~(2) The lease area must not be closer than 100 feet to a developed shoreline, except no minimum setback is required when the area to be leased borders the applicant's property or the property of riparian owners who have consented in a notarized statement. In an area bordered by undeveloped shoreline, no minimum setback is required.~~

(1) Deleted since this is now addressed in Statute.

(2) Deleted since this is now addressed in Statute.

(3) The proposed lease area shall not be less than one-half acre and shall not exceed five acres for all areas except those areas open to the mechanical harvest of oysters where proposed lease area shall not exceed 10 acres. This Subparagraph shall not be applied to reduce any holdings as of July 1, 1983.

(b) Persons holding five or more acres under shellfish lease or franchise shall meet the standards established in Paragraph (c) of this Rule prior to acceptance of applications for additional shellfish lease acreage.

(c) Franchises recognized pursuant to G.S. 113-206 and shellfish bottom leases shall meet the following standards in addition to the standards in G.S. 113-202. In order to avoid termination, franchises and shellfish bottom leases shall:

___(1) Produce and market ~~10~~40 bushels of shellfish per acre per year~~; and~~; or

___(2) ~~Plant 25 bushels~~Provide evidence of purchasing 30,000 seed ~~shellfish per~~ acre~~per~~ year^{-1} or ~~50 bushels~~

(3) Provide evidence of planting a minimum of 250,000 remote-set spat acre^{-1} year^{-1}.

~~cultch and seed shellfish where the percentage of required cultch planted and the percentage of required seed shellfish planted totals at least 100 percent.~~

(d) The following standards shall be applied to determine compliance with Subparagraphs (1) and (2) of Paragraph (c) of this Rule:

___(1) Only shellfish planted, produced or marketed according to the definitions in 15A NCAC 03I .0101 shall be submitted on production/utilization forms for shellfish leases and franchises.

~~on production/utilization forms for shellfish leases and franchises.~~

___(2) If more than one shellfish lease or franchise is used in the production of shellfish, one of the leases or franchises used in the production of the shellfish must be designated as the producing lease or franchise for those shellfish. Each bushel of shellfish may be

produced by only one shellfish lease or franchise. Shellfish transplanted between leases or franchises may be credited as planting effort on only one lease or franchise.
~~franchises may be credited as planting effort on only one lease or franchise.~~

___(3) Production and marketing information and planting effort information shall be compiled and averaged separately to assess compliance with the standards. The lease or franchise must meet the production requirement and the planting effort requirement within the dates set forth to be judged in compliance with these standards.
~~effort requirement within the dates set forth to be judged in compliance with these standards.~~

___(4) In determining production and marketing averages and planting effort averages for information not reported in bushel measurements, the following conversion factors shall be used: (A) 300 oysters, 400 clams, or 400 scallops equal one bushel; and
(B) 40 pounds of scallop shell, 60 pounds of oyster shell, 75 pounds of clam shell and 90 pounds of fossil stone equal one bushel.

___(5) In the event that a portion of an existing lease or franchise is obtained by a new owner, the production history for the portion obtained shall be a percentage of the originating lease or franchise production equal to the percentage of the area of lease or franchise site obtained to the area of the originating lease or franchise.
~~portion obtained shall be a percentage~~ ___

(6) Fulfillment of ~~the originating lease or franchise production equal to the percentage of the~~
~~area of lease or franchise site obtained to the area of the originating lease or franchise.~~
~~(6) The~~Utilization requirements with production and marketing ~~rates shall~~will be ~~averaged:~~
averaged over the consecutive previous full three calendar years remaining on the lease contract after December 31 following the fourth anniversary of initial bottom ~~leases~~lease and ~~franchises.~~
~~(B) over the consecutive full calendar years beginning January 1 of the final year of the previous lease term and~~
~~ending December 31 of the final year of the current lease contract for renewal leases.~~
~~(C) over the first five year period for initial~~ Franchise or water--column ~~leases~~lease and over the most recent ~~five~~three year period thereafter ~~for renewal water column leases.~~. Production and marketing rate averages shall be computed irrespective of transfer of the shellfish lease or franchise.
(7) All bushel measurements shall be in U.S. Standard Bushels.
(e) Water columns superjacent to leased bottoms shall meet the standards in G.S. 113-202.1 in order to be ~~deemed suitable for leasing for aquaculture purposes.~~
~~(f) Water columns superjacent to~~ franchises recognized pursuant to G.S. 113-206 shall meet the standards in G.S. 113-202.2 in order to be deemed suitable for leasing for aquaculture purposes.
~~be deemed suitable for leasing for aquaculture purposes.~~

___(g) Water column leases must produce and market ~~40~~100 bushels of shellfish per acre per year to meet the minimum commercial production requirement or ~~plant 100 bushels of cultch or~~ provide evidence of purchasing 45,000 shellfish ~~per~~ acre ~~per year to meet commercial production by planting~~$^{-1}$, annually.

~~effort. The standards for determining production and marketing averages and planting effort averages shall be the same for water column leases as for bottom leases and franchises set forth in Paragraph (d) of this Rule except that either the produce and market requirement or the planting requirement must be met.~~

History Note: Authority G.S. 113-134; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52; Eff. January 1, 1991; Amended Eff. May 1, 1997; March 1, 1995; March 1, 1994; September 1, 1991; Temporary Amendment Eff. October 1, 2001; Amended Eff. October 1, 2008; April 1, 2003.

15A NCAC 03O .0202 SHELLFISH BOTTOM AND WATER COLUMN LEASE APPLICATIONS

(a) Application forms are available from the Division's office headquarters at 3441 Arendell Street, Morehead City, NC 28557 for persons desiring to apply for shellfish bottom and water column leases. Each application shall be accompanied by a map or diagram prepared at the applicant's expense including an inset vicinity map showing the location of the proposed lease with detail sufficient to permit on-site identification and must meet the information requirements pursuant to G.S. 113-202(d).

(b) As a part of the application, the applicant shall submit a management plan for the area to be leased on a form provided by the Division which meets the following standards: (1) States the methods through which the applicant will cultivate and produce shellfish consistent with the minimum requirements set forth in 15A NCAC 03O .0201; (2) States the time intervals during which various phases of the cultivation and production plan will be achieved; (3) States the materials and techniques that will be utilized in management of the lease; (4) Forecasts the results expected to be achieved by the management activities; and (5) Describes the productivity of any other leases or franchises held by the applicant.

(c) The completed application, map or diagram, and management plan for the requested lease shall be accompanied by the non-refundable filing fee set forth in G.S. 113-202(d1). An incomplete application shall be returned and not considered further until re-submitted complete with all required information.

(d) Applicants and transferees not currently holding a shellfish cultivation lease, and applicants and transferees holding one or more shellfish cultivation leases which are not meeting production requirements, shall complete and submit an examination, with a minimum of 70 percent correct answers, based on an educational package provided by the Division of Marine Fisheries. The examination shall demonstrate the applicant's knowledge of: (1) the shellfish lease application process; (2) shellfish lease planting and production requirements; (3) lease marking requirements; (4) lease fees; (5) shellfish harvest area closures due to pollution; (6) safe handling practices; (7) lease contracts and renewals; (8) lease termination criteria; and (9) shellfish cultivation techniques.

(e) After an application is deemed to have met all requirements and is accepted by the Division, the applicant shall identify the area for which a lease is requested with stakes at each corner in accordance with 15A NCAC 03O .0204(a)(1)(A). The applicant shall attach to each stake a sign, provided by the Division containing the name of the applicant, the date the application was filed, and the estimated acres.

History Note: Authority G.S. 113-134; 113-201; 113-202; 143B-289.52; Eff. January 1, 1991; Amended Eff. April 1, 2011; September 1, 2005; May 1, 1997; September 1, 1991.
15A NCAC

03O .0203 SHELLFISH LEASE APPLICATION PROCESSING

(a) Upon acceptance of a completed application, the proposed lease area shall be inspected by agents of the Division. Proposed lease areas inconsistent with applicable standards contained or referenced in 15A NCAC 3O .0201 shall result in the return of applications for amendment to remove the inconsistencies. If the boundaries of the proposed lease area are modified, the stakes identifying such areas shall be relocated accordingly by the applicant. The failure of applicants to amend applications or modify lease area identification, when required, shall result in denial of such applications.

(b) If the initial or amended lease application is deemed consistent with all applicable requirements, the Secretary or his designee shall notify the applicant and publish notices of intention to lease in accordance with standards in G.S. 113-202(f).

(c) The Secretary shall consider the lease application, the Division's proposed lease area analysis, and public comments, and may in his discretion lease or decline to lease the proposed lease area or any part thereof. Special conditions may be imposed so that leases may be issued which would otherwise be denied. Should an applicant decide not to accept any special condition imposed on the lease by the Secretary, the application shall be considered denied.

(d) Upon approval of leases by the Secretary, applicants shall mark the shellfish bottom leases in accordance with 15A NCAC 3O .0204(a)(1), water column leases in accordance with 15A NCAC 3O .0204(a)(2), and shall within 90 days submit to the Division acceptable surveys of the areas approved for leasing except that a water column lease which entirely covers a shellfish bottom lease or franchise with an accepted survey on file does not require another survey. Such surveys shall be made at the expense of applicants and must meet the following standards: (1) Surveys and maps shall meet all the requirements of 21 NCAC 56 .1600, Standards of Practice for Land Surveying in North Carolina, which is hereby incorporated by reference including subsequent amendments and editions. This material is available for inspection and copies may be obtained from the Marine Fisheries Division, Marine Fisheries Building, 3441 Arendell St., P.O. Box 769, Morehead City, North Carolina 28557, at no cost. (2) Maps shall bear the certificate: "I _____ certify that this map was (drawn by me) (drawn under my supervision) from (an actual survey made by me) (an actual survey made under my supervision); that the error of closure as calculated by latitudes and departures is 1:

_____, that the area is _____ acres. Witness my hand and seal this _____ day of _____ AD _____." _____ Surveyor or Engineer (3) The phrase "other appropriate natural monuments or landmarks" in 21 NCAC 56 .1604(e)(9) shall include bridges, roads, highways, intersections, publicly maintained aids to navigation, houses and other permanent buildings, radio, telephone, TV, and water towers; docks; piers, and bulkheads; but does not include stakes marking the boundaries of adjoining leases, points of marsh, junctions of streams, or other landmarks which are particularly subject to change through natural processes, storms, or the effect of man. (4) A written description of the survey suitable for official documents shall be provided with the survey. (5) Locations of all corner markers in latitude and longitude shall be provided with the survey and presented in an eight digit format. The relative accuracy of the corner marker locations shall be equal to or less than two meters. Information on the method of measurement, make and model of equipment, and coordinate system used to determine the latitude and longitude shall be included.

(e) Proposed shellfish bottom lease areas remain public bottom until a lease contract has been executed by the Secretary.

(f) Proposed water column lease areas superjacent to shellfish bottom leases and recognized perpetual franchises remain
public water until a lease contract has been executed by the Secretary.

History Note: Authority G.S. 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. October 1, 2008; March 1, 1994; September 1, 1991.

15A NCAC 03O .0204 MARKING SHELLFISH LEASES AND FRANCHISES

(a) All shellfish bottom leases, franchises, and water column leases shall be marked as follows:

(1) Shellfish bottom leases and franchises shall be marked by:

(A) Stakes of wood or plastic material at least three inches in diameter at the water level and extending at least four feet above the high water mark. The stakes shall be firmly jetted or driven into the bottom at each corner.

(B) Signs displaying the number of the lease or franchise and the name of the owner printed in letters at least three inches high must be firmly attached to each corner stake.

(C) Supplementary stakes of wood or plastic material, not farther apart than 50 yards or closer together than 50 feet and extending at least four feet above the high water mark, must be
placed along each boundary, except when such would interfere with the use of traditional navigation channels.

(2) Water column leases shall be marked by anchoring two yellow buoys, meeting the material and minimum size requirements specified in 15A NCAC 3J .0103(b) at each corner of the area or by larger buoys, posts and signs as identified and approved by the Secretary in the Management Plan.

(b) Stakes marking areas of management within shellfish bottom leases or franchises, as approved in the management plan, must conform to Subparagraph (a)(1)(C) of this Rule and may not exceed one for each 1,200 square feet. Marking at concentrations of stakes

greater than one for each 1,200 square feet constitutes use of the water column and a water column lease is required in accordance with G.S. 113-202.1 or G.S. 113-202.2.
(c) All areas claimed in filings made pursuant to G.S. 113-205 as deeded bottoms through oyster grants issued by the county clerk of court or as private bottoms through perpetual franchises issued by the Shellfish Commission shall be marked in accordance with Paragraph (a) of this Rule, except the sign shall include the number of the franchise rather than the number of the lease. However, claimed areas not being managed and cultivated shall not be marked.
(d) It is unlawful to fail to remove all stakes, signs, and markers within 30 days of receipt of notice from the Secretary pursuant to Departmental Rule 15A NCAC 1G .0207 that a G.S. 113-205 claim to a marked area has been denied.
(e) It is unlawful to exclude or attempt to exclude the public from allowable public trust use of navigable waters on shellfish leases and franchises including, but not limited to, fishing, hunting, swimming, wading and navigation.
(f) The Division has no duty to protect any shellfish bottom lease, franchise, or water column lease not marked in accordance with Paragraph (a) of this Rule.

History Note: Authority G.S. 76-40; 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2;
113-205;143B-289.52; Eff. January 1, 1991;
Amended Eff. September 1, 1997; March 1, 1994; October 1, 1992; September 1, 1991.

15A NCAC 03O .0205 LEASE RENEWAL
(a) Lease renewal applications shall be provided to lessees as follows:
(1) For shellfish bottom leases, renewal applications shall be provided in January of the year of expiration.
(2) For water column leases, renewal applications shall be provided at least 90 days prior to expiration dates.
(b) Lease renewal applications shall be accompanied by management plans meeting the requirements of 15A NCAC 03O .0202(b). The non-refundable filing fee set forth in G.S. 113-202(j) shall accompany each renewal application for shellfish bottom leases.
(c) A survey for renewal leases shall be required at the applicant's expense when the Division determines that the area leased to the renewal applicant is inconsistent with the survey on file.
(d) When it is determined, after due notice to the lessee, and after opportunity for the lessee to be heard, that the lessee has not complied with the requirements of this Section or that the lease as issued is inconsistent with this Section, the Secretary may decline to renew, at the end of the current terms, any shellfish bottom or water column lease. The lessee may appeal the Secretary's decision by initiating a contested case as outlined in 15A NCAC 03P .0102.
(e) Pursuant to G.S. 113-202(a)(6), the Secretary is not authorized to recommend approval of renewal of a shellfish lease in an area closed to shellfishing by reason of pollution. Shellfish leases partially closed due to pollution must be amended to exclude the area closed to shellfishing prior to renewal. For purposes of lease renewal determinations, an area shall be considered closed to shellfish harvest by reason of pollution when the area has been classified by the State Health Director as prohibited or

has been closed for more than 50 percent of the days during the final four years prior to renewal except shellfish leases in areas which have been closed for more than 50 percent of the days during the final four years prior to renewal and continue to meet established production requirements by sale of shellfish through relay periods or other depuration methods shall not be considered closed due to pollution for renewal purposes.
(f) If the Secretary declines to renew a lease that has been determined to be inconsistent with the standards of this Section, the Secretary, with the agreement of the lessee, may issue a renewal lease for all or part of the area previously leased to the lessee that contains conditions necessary to conform the renewal lease to the requirements of this Section for new leases. History Note: Authority G.S. 113-134; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52; Eff. January 1, 1991; Amended Eff. September 1, 2005; May 1, 1997; March 1, 1995; March 1, 1994; October 1, 1992; September 1, 1991. 15A

NCAC 03O .0206 LEASE PROTEST
(a) Should any person object to the granting of any initial or renewal lease, he has the right to protest its issuance prior to the granting of the lease by the Secretary. The protestant may file a sworn statement of protest with the Division stating the grounds for protest. The Secretary shall notify both the prospective lessee and the protestant upon receipt of a protest, and shall conduct such investigation as he deems necessary, and shall notify both parties of the outcome of his investigation. Protestants or applicants receiving an adverse recommendation on the lease application from the Secretary may appeal this decision as outlined in G.S. 113-202(g).
(b) Any member of the public shall be allowed an opportunity to comment on any lease application during the public hearing at which the lease application is being considered by the Secretary. History Note: Authority G.S. 113-134; 113-201; 113-202; 143B-289.52; Eff. January 1, 1991; Amended Eff. March 1, 1994; September 1, 1991.

15A NCAC 03O .0207 PRODUCTION REPORTS
(a) The owners of shellfish leases and franchises shall provide annual production reports to the Division showing the amounts of material planted, purchased, and harvested in connection with management for commercial production. Reporting forms will be provided to owners of shellfish bottom leases and recognized franchises during the period that annual notices of rent due are provided to owners of shellfish bottom leases in accordance with G.S. 113-202(j). Reporting forms will be provided to owners of water column leases prior to each annual anniversary date. (b) Failure to furnish the required production report, correct and in detail requested, or filing a report containing false information, can constitute grounds for termination. History Note: Authority G.S. 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52; Eff. January 1, 1991; Amended Eff. September 1, 1991. 15A NCAC 03O .0208 CANCELLATION (a) In addition to the grounds established by G.S. 113-202, the Secretary shall begin action to terminate leases and franchises for failure to produce and market shellfish or for failure to maintain a planting effort of cultch or seed shellfish in accordance with 15A NCAC 03O .0201 (b) Action to terminate a shellfish franchise shall begin when there is reason to believe that the patentee, or those claiming under him, have done or omitted an act in violation of the terms and conditions on which the letters patent were granted, or have by any other means forfeited the interest acquired under the same. The Division shall

investigate all such rights issued in perpetuity to determine whether the Secretary should request that the Attorney General initiate an action pursuant to G.S. 146-63 to vacate or annul the letters patent granted by the state. (c) Action to terminate a shellfish lease or franchise shall begin when the Fisheries Director has cause to believe the holder of private shellfish rights has encroached or usurped the legal rights of the public to access public trust resources in navigable waters. (d) In the event action to terminate a lease is begun, the owner shall be notified by registered mail and given a period of 30 days in which to correct the situation. Petitions to review the Secretary's decision must be filed with the Office of Administrative Hearings as outlined in 15A NCAC 03P .0102. (e) The Secretary's decision to terminate a lease may be appealed by initiating a contested case as outlined in 15A NCAC 03P .0102.
History Note: Authority G.S. 113-134; 113-201; 113-202; 113-202.1; 113-202.2; 143B-289.52; Eff. January 1, 1991; Amended Eff. May 1, 1997; March 1, 1995; March 1, 1994; October 1, 1992; September 1, 1991; Temporary Amendment Eff. January 1, 2002; October 1, 2001; Amended Eff. April 1, 2003.

15A NCAC 03O .0209 TRANSFER OF INTEREST
(a) Within 30 days after transfer of ownership of all or any portion of interest in a shellfish lease or franchise, the new owner shall notify the Division, and provide the number of the lease or franchise and the county in which it is located. Such notification shall be accompanied by a management plan prepared by the new owner in accordance with 15A NCAC 03O .0202(b).
(b) If the new owner obtains a portion of an existing shellfish bottom lease or franchise, it shall not contain less than one-half acre and the required notification to the Division shall be accompanied by a survey prepared in accordance with the standards in 15A NCAC 03O .0203(d).
(c) Within six months after transfer of ownership, the new owner shall complete shellfish cultivation lease training as specified in 15A NCAC 03O .0202(d). (d) Water column leases are not transferrable except when the Secretary approves such transfer in accordance with G.S. 113-202.1(f) and G.S. 113-202.2(f). (e) In the event the transferee involved in a lease is a nonresident, the Secretary must initiate termination proceedings.

History Note: Authority G.S. 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2; 113-205; 143B-289.52; Eff. January 1, 1991; Amended Eff. April 1, 2011; March 1, 1994; September 1, 1991.

15A NCAC 03O .0210 SHELLFISH FRANCHISES

(a) The resolution of claims filed under G.S. 113-205 is governed by standards in Departmental Rules 15A NCAC 1G .0200 and .0300. Following receipt of notification that a claim has a valid chain of title, the owner shall provide to the Division within 90 days a survey prepared in accordance with the standards in 15A NCAC 03O .0203(d). Failure to provide the required survey within the time period specified will result in denial of the claim.

(b) Acceptable management plans, prepared in accordance with the standards in 15A NCAC 03O .0202(b), shall be provided to the Division within 30 days following formal recognition of a valid chain of title and at ten-year intervals thereafter.
(c) The survey and management plan requirements in Paragraphs (a) and (b) of this Rule, and all other requirements and conditions of this Section affecting management of franchises, shall apply to all valid shellfish franchises recognized prior to September 1, 1989.
(d) Commercial production requirements for franchises shall be identical to that required for leases in 15A NCAC 03O .0201(c) averaged over the most recent three-year period after January 1 following the second anniversary of the dates of recognition of claims as valid shellfish franchises and continuing throughout the term of management plans required in Paragraph (b) of this Rule. Annual reporting of commercial production shall be submitted upon receipt of forms provided by the Division for that purpose.
History Note: Authority G.S. 113-134; 113-201; 113-202; 113-205; 143B-289.52; Eff. January 1, 1991; Amended Eff. October 1, 2008; September 1, 1991. 15A

NCAC 03O .0211 PROTECTION OF PRIVATE SHELLFISH INTEREST
It is unlawful to use any trawl net, long haul seine, swipe net, dredge, or mechanical method for clams or oysters on any shellfish lease or franchise unless it has been duly authorized by the Fisheries Director as provided in 15A NCAC 3K .0206 and .0303.
History Note: Authority G.S. 113-134; 113-182; 113-201; Eff. October 1, 1992; Amended Eff. August 1, 1998.

Appendix E. North Carolina Generate Statutes Chapter 113 Article 16 Suggested Modifications.

Article 16.

Cultivation of Shellfish.

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

(a) The General Assembly finds that shellfish cultivation provides increased seafood production and long-term economic and employment opportunities. The General Assembly also finds that shellfish cultivation provides increased ecological benefits to the estuarine environment by promoting natural water filtration and increased fishery habitats~~.~~, and as such is an important part of the State's wildlife conservation and management. The General Assembly declares that it is the policy of the State to encourage the development of private, commercial shellfish cultivation ~~in ways that are compatible with other public uses of marine and estuarine resources such as navigation, fishing, and recreation~~.

(b) The Marine Fisheries Commission is empowered to make rules and take all steps necessary to develop and improve the cultivation, harvesting, and marketing of shellfish in North Carolina both from public grounds and private beds. In order to assure the public that some waters will remain open and free from shellfish cultivation activities, the Marine Fisheries Commission may limit the number of acres in any area that may be granted as shellfish cultivation leases.

(c) The ~~Marine Fisheries Commission shall adopt rules to~~Secretary shall establish training requirements for persons applying for new shellfish cultivation leases and for persons acquiring shellfish cultivation leases by lawful transfer. These training requirements shall be designed to encourage the productive use of shellfish cultivation leases. Training requirements established pursuant to this subsection shall not apply to either:

(1) An applicant who applies for a new shellfish cultivation lease if, at the time of the application, the applicant holds one or more shellfish cultivation leases and all of the leases meet the shellfish production requirements established by the Marine Fisheries Commission.

(2) A person who receives a shellfish cultivation lease by lawful transfer if, at the time of the transfer, the person holds one or more shellfish cultivation leases and all of the leases meet the shellfish production requirements established by the Marine Fisheries Commission. (1921, c. 132, s. 1; C.S., s. 1959(a); 1965, c. 957, s. 2; 1973, c. 1262, s. 28; 1983, c. 621, s. 2; 1987, c. 827, s. 98; 2004-150, s. 1; 2009-433, s. 3.)

(d) The Secretary shall have authority to establish Shellfish Enterprise Areas that are pre-approved for shellfish mariculture in which cultivation of shellfish is allowed by permit issued by the Secretary.

§ 113-201.1. Definitions.

As used in this Article:

(1) "Natural shellfish bed" means an area of public bottom where oysters, clams, scallops, mussels or other shellfish are found to be growing in sufficient quantities to be valuable to the public, excluding areas subject to a shellfish cultivation leases in the two years preceding the application.

(2) "Riparian owner" means the holder(s) of the fee title to land that is bordered by waters of an arm of the sea or any other navigable body of water.

(3) "Shellfish" means oysters, clams, scallops, mussels or any other species of mollusks that the Marine Fisheries Commission determines suitable for cultivation, harvesting, and marketing from public grounds and private beds.

(4) "Single family unit" means the husband and wife and any unemancipated children in the household.

(5) "Water column" means the vertical extent of water, including the surface, above a designated area of submerged bottom land. (1983, c. 621, s. 3; 1987, c. 641, s. 15; 2015-241, s. 14.10C(a).)

§ 113-202. New and renewal leases for shellfish cultivation; termination of leases issued prior to January 1, 1966.

(a) To increase the use of suitable areas underlying coastal fishing waters for the production of shellfish, the Secretary may grant shellfish cultivation leases to persons who reside in North Carolina under the terms of this section when the Secretary ~~determines, in accordance with his duty to conserve the marine and estuarine resources of the State, that the public interest will benefit from issuance of the lease. Suitable areas for the production of shellfish shall meet the following minimum standards~~in the exercise of his discretion, determines the following:

(1) The area leased must be suitable for the cultivation and harvesting of shellfish in commercial quantities.

(2) The area leased must not contain a natural shellfish bed~~.~~

~~(3) Cultivation~~that is being used regularly for commercial or significant recreational harvest of shellfish. ~~in the.~~

(3) The area leased ~~area~~ must not be ~~compatible~~within 50 feet of marked or unmarked established navigation channels.

(4) The shellfish lease will not unreasonably interfere with other lawful utilization by the public of other marine and estuarine resources. Other public uses which may be considered include, but are not limited to, navigation, fishing and recreation.

~~(4)~~ 5) Cultivation of shellfish in the leased area will not ~~impinge upon~~unreasonably impair the rights of riparian owners. A shellfish cultivation lease shall not be located within 100 feet of privately owned shoreline realty without the written consent of the riparian landowner.

~~(5)~~ 6) The area leased must not include an area designated for inclusion in the Department's Shellfish Management Program.

~~(6)~~ 7) The area leased must not include ~~an area which the State Health Director has recommended beany~~ waters that are permanently closed to shellfish harvest by ~~reason~~the N.C. Division of ~~pollution~~Marine Fisheries.

(b) The Secretary may delete any part of an area proposed for lease or may condition a lease to protect the public interest with respect to the factors enumerated in subsection (a) of this section. The Secretary may not grant a new lease in an area heavily used for recreational purposes~~.~~ demonstrated through the lease application investigation in accordance with subsection (f). Except as prohibited by federal law, the Secretary shall not exclude any area from leasing solely on the basis that the area contains submerged aquatic vegetation and shall make specific findings based on the standards set forth in subsection (a) of this section prior to reaching a decision not to grant or renew a lease for shellfish cultivation for any area containing submerged aquatic vegetation.

(c) No person, including a corporate entity, or single family unit may acquire and hold by lease, lease renewal, or purchase more than 50 acres of public bottoms under shellfish cultivation leases. For purposes of this subsection, the number of acres of leases held by a person includes acres held by a corporation in which the person holds an interest. The Marine Fisheries Commission may adopt rules to require the submission of information necessary to ensure compliance with this subsection.

(d) Any person desiring to apply for a lease must make written application to the Secretary on forms prepared by the Department containing such information as deemed necessary to determine the desirability of granting or not granting the lease requested. Except in the case of renewal leases, the application must be accompanied by a map or diagram made at the expense of the applicant, showing the area proposed to be leased.

(d1) The map or diagram must conform to standards prescribed by the Secretary concerning accuracy of map or diagram and the amount of detail that must be shown. If on the basis of the application information and map or diagram the Secretary deems that granting the lease would benefit the shellfish culture of North Carolina, the Secretary, in the case of initial lease applications, must order an investigation of the bottom proposed to be leased. The investigation is to be made by the Secretary or his authorized agent to determine whether the area proposed to be leased is consistent with the standards in subsection (a) of this section and any other applicable standards under this Article and the rules of the Marine Fisheries Commission. In the event the Secretary finds the application inconsistent with the applicable standards, the Secretary shall deny the application or propose that a conditional lease be issued that is consistent with the applicable standards. In the event the Secretary authorizes amendment of the application, the applicant must furnish a new map or diagram meeting requisite standards showing the area proposed to be leased under the amended application. At the time of making application for an initial lease, the applicant must pay a filing fee of ~~two~~five hundred dollars ($~~2~~500.00).

(e) The area of bottom applied for in the case of an initial lease or amended initial lease must be as compact as possible, taking into consideration the shape of the body of water, the consistency of the bottom, and the desirability of separating the boundaries of a leasehold by a sufficient distance from any known natural shellfish bed to prevent the likelihood of disputes arising between the leaseholder and members of the public taking shellfish from the natural bed.

(f) Within a reasonable time after receipt of an application that complies with subsection (d), the Secretary shall notify the applicant of the intended action on the lease application. If the intended action is approval of the application as submitted for approval with a modification to which the applicant agrees, the Secretary shall conduct a public hearing in the county where the proposed leasehold lies. The Secretary must publish at least two notices of the intention to lease in a newspaper of general circulation in the county in which the proposed leasehold lies. The first publication must precede the public hearing by more than 20 days; the second publication must follow the first by seven to 11 days. The notice of intention to lease must contain a sufficient description of the area of the proposed leasehold that its boundaries may be established with reasonable ease and certainty and must also contain the date, hour and place of the hearing.

(g) After consideration of the public comment received and any additional investigations the Secretary orders to evaluate the comments, the Secretary shall ~~notify the applicant in person or by certified or registered mail~~make written findings with respect to the factors enumerated in subsection (a) of this section and any other considerations the Secretary deems relevant, and then notify the applicant in writing of the decision on the lease application. The Secretary shall also notify persons who submitted comments at the public hearing and requested notice of the lease decision. An applicant who is dissatisfied with the Secretary's decision ~~or another person aggrieved by the decision~~ may commence a contested case by filing a petition under G.S. 150B-23 within 20 days after receiving notice of the Secretary's decision. The following persons, if aggrieved by the decision, may also commence a contested case by filing a petition under G.S. 150B-23 within 20 days after receiving notice of the Secretary's decision:

1. an adjacent riparian owner alleging impaired riparian rights insufficiently protected by the decision;
2. a submerged land owner asserting an ownership claim to all or a portion of the leased area, which ownership claim has been registered and recognized in accordance with G.S. 113-205;
3. any other person aggrieved to the extent such person alleges a failure of the Secretary to follow mandatory procedures in the leasing process.

In the event the Secretary's decision is a modification to which the applicant agrees, the lease applicant must furnish an amended map or diagram before the lease can be issued by the Secretary.

(h) Repealed by Session Laws 1993, c. 466, s. 1.

(i) After a lease application is approved by the Secretary, the applicant shall submit to the Secretary information sufficient to define the bounds of the area approved for leasing with markers in accordance with the rules of the Commission. The information shall conform to standards prescribed by the Secretary concerning accuracy and the amount of detail to be shown. When information is submitted, the boundaries are marked and all fees and rents due in advance are paid, the Secretary shall execute the lease on forms approved by the Attorney General. The Secretary is authorized, with the approval of the lessee, to amend an existing lease by reducing the area under lease or by combining contiguous leases without increasing the total area leased. The information required by this subsection may be based on coordinate information produced using a device equipped to receive global positioning system data.

(j) Initial leases begin upon the issuance of the lease by the Secretary and expire at noon on the first day of July following the tenth anniversary of the granting of the lease. Renewal leases are issued for a period of 10 years from the time of expiration of the previous lease. At the time of making application for renewal of a lease, the applicant must pay a filing fee of one hundred dollars ($~~100~~500.00). ~~The rental for initial leases is one dollar ($1.00) per acre until noon on the first day of July following the first anniversary of the lease~~. Thereafter, for initial leases and from the beginning for renewals of leases entered into after that date, the rental is ~~ten~~ fifty dollars ($~~1~~50.00) per acre per year. Rental must be paid annually in advance prior to the first day of July each year. Upon initial granting of a lease, the pro rata amount for the portion of the year left until the first day of July must be paid in advance at the rate of ~~one~~fifty dollars ($~~1~~50.00) per acre per year; then, on or before the first day of July next, the lessee must pay the rental for the next full year.

(k) Except as restricted by this Subchapter, leaseholds granted under this section are to be treated as if they were real property and are subject to all laws relating to taxation, sale, devise, inheritance, gift, seizure and sale under execution or other legal process, and the like. Leases properly acknowledged and probated are eligible for recordation in the same manner as instruments conveying an estate in real property. Within 30 days after transfer of beneficial ownership of all or any portion of or interest in a leasehold to another, the new owner must notify the Secretary of such fact. Such transfer is not valid until notice is furnished the Secretary. In the event such transferee is a nonresident, the Secretary must initiate proceedings to terminate the lease.

(l) Upon receipt of notice by the Secretary of any of the following occurrences, he must commence action to terminate the leasehold:

(1) Failure to pay the annual rent in advance.

(2) Failure to file information required by the Secretary upon annual remittance of rental or filing false information on the form required to accompany the annual remittance of rental.

(3) Failure by new owner to report a transfer of beneficial ownership of all or any portion of or interest in the leasehold.

(4) Failure to mark the boundaries in the leasehold and to keep them marked as required in the rules of the Marine Fisheries Commission.

(5) Failure to utilize the leasehold on a continuing basis for the commercial production of shellfish.

(6) Transfer of all or part of the beneficial ownership of a leasehold to a nonresident.

(7) Substantial breach of compliance with the provisions of this Article or of rules of the Marine Fisheries Commission governing use of the leasehold.

(8) Failure to comply with the training requirements established by the ~~Marine Fisheries Commission~~Secretary pursuant to G.S. 113-201(c).

(l1) The Marine Fisheries Commission is authorized to make rules defining commercial production of shellfish, based upon the productive potential of particular areas climatic or biological conditions at particular areas or particular times, availability of seed shellfish, availability for purchase by lessees of shells or other material to which oyster spat may attach, and the like. Commercial production may be defined in terms of planting effort made as well as in terms of quantities of shellfish harvested. Provided, however, that

if a lessee has made a diligent effort to effectively and efficiently manage his lease according to accepted standards and practices in such management, and because of reasons beyond his control, such as acts of God, such lessee has not and cannot meet the requirements set out by the Marine Fisheries Commission under the provisions of this subsection, his leasehold shall not be terminated under subdivision (5) of subsection (l) of this section.

(m) In the event the leaseholder takes steps within 30 days to remedy the situation upon which the notice of intention to terminate was based and the Secretary is satisfied that continuation of the lease is in the best interests of the shellfish culture of the State, the Secretary may discontinue termination procedures. Where there is no discontinuance of termination procedures, the leaseholder may initiate a contested case by filing a petition under G.S. 150B-23 within 30 days of receipt of notice of intention to terminate. Where the leaseholder does not initiate a contested case, or the final decision upholds termination, the Secretary must send a final letter of termination to the leaseholder. The final letter of termination may not be mailed sooner than 30 days after receipt by the leaseholder of the Secretary's notice of intention to terminate, or of the final agency decision, as appropriate. The lease is terminated effective at midnight on the day the final notice of termination is served on the leaseholder. The final notice of termination may not be issued pending hearing of a contested case initiated by the leaseholder.

Service of any notice required in this subsection may be accomplished by certified mail, return receipt requested; personal service by any law-enforcement officer; or upon the failure of these two methods, publication. Service by publication shall be accomplished by publishing such notices in a newspaper of general circulation within the county where the lease is located for at least once a week for three successive weeks. The format for notice by publication shall be approved by the Attorney General.

(n) Upon final termination of any leasehold, the ~~bottom in question is thrown~~subject bottom may be: (1) re-leased (in whole or in part) by the Secretary following an expedited review process in which the Secretary has discretion to eliminate the requirements for mapping, surveys, public notice, and removal of markers and gear; (2) incorporated (in whole or in part) into a Shellfish Enterprise Area; or (3) open to the public for use in accordance with laws and rules governing use of public grounds generally. ~~Within~~For those areas incorporated into a Shellfish Enterprise Area or returned to public use, within 30 days of final termination of the leasehold, the former leaseholder shall remove all abandoned all gear and markers denominating the area of the leasehold as a private bottom. The State may, after 10 days' notice to the owner of the abandoned markers thereof, remove the abandoned structure and have the area cleaned up. The cost of such removal and cleanup shall be payable by the owner of the abandoned markers and the State may bring suit to recover the costs thereof.

(o) Every year between January 1 and February 15 the Secretary must mail to all leaseholders a notice of the annual rental due and include forms designed by him for determining the amount of shellfish or shells planted on the leasehold during the preceding calendar year, and the amount of harvest gathered. Such forms may contain other pertinent questions relating to the utilization of the leasehold in the best interests of the shellfish culture of the State, and must be executed and returned by the leaseholder with the payment of his rental. Any leaseholder or his agent executing such forms for him who knowingly makes a false statement on such forms is guilty of a Class 1 misdemeanor.

(p) All leases and renewal leases granted after the effective date of this Article are made subject to this Article and to reasonable amendment of governing statutes, rules of the Marine Fisheries Commission, and requirements imposed by the Secretary or his agents in regulating the use of the leasehold or in processing applications of rentals. This includes such statutory increase in rentals as may be necessitated by changing conditions and refusal to renew lease after expiration, in the discretion of the Secretary. No increase in rentals, however, may be given retroactive effect.

The General Assembly declares it to be contrary to public policy to the oyster and clam bottoms which were leased prior to January 1, 1966, and which are not being used to produce oysters and clams in commercial quantities to continue to be held by private individuals, thus depriving the public of a resource which belongs to all the people of the State. Therefore, when the Secretary determines, after due notice to the lessee, and after opportunity for the lessee to be heard, that oysters or clams are not being produced in commercial quantities, due to the lessee's failure to make diligent effort to produce oysters and clams in commercial quantities, the Secretary may decline to renew, at the end of the current term, any oyster or clam bottom lease which was executed prior to January 1, 1966. The lessee may appeal the denial of the Secretary to renew the lease by initiating a contested case pursuant to G.S. 150B-23. In such contested cases, the burden of proof, by the greater weight of the evidence, shall be on the lessee.

(q) Repealed by Session Laws 1983, c. 621, s. 16.

(r) A lease under this section entered into prior to January 1, 2020 shall include the right to place devices or equipment related to the cultivation or harvesting of marine resources on or within 18 inches of the leased bottom. ~~Devices~~For leases entered into after January 1, 2020 utilizing such devices or equipment and for all leases using devices or equipment not resting on the bottom or extending more than 18 inches above the bottom will require a water column lease under G.S. 113-202.1. (1893, c. 287, s. 1; Rev., s. 2371; 1909, c. 871, ss. 1-9; 1919, c. 333, s. 6; C.S., ss. 1902-1911; Ex. Sess. 1921, c. 46, s. 1; 1933, c. 346; 1953, cc. 842, 1139; 1963, c. 1260, ss. 1-3; 1965, c. 957, s. 2; 1967, c. 24, s. 16; c. 88; c. 876, s. 1; 1971, c. 447; 1973, c. 476, s. 128; c. 1262, ss. 28, 86; 1983, c. 601, ss. 1-3; c. 621, ss. 4-16; 1985, c. 275, ss. 1-3; 1987, c. 641, s. 16; c. 773, s. 11; c. 827, s. 98; 1989, c. 423, s. 2; c. 727, s. 99; 1991 (Reg. Sess., 1992), c. 788, s. 2; 1993, c. 466, s. 1; c. 539, s. 840; 1994, Ex. Sess., c. 24, s. 14(c); 2004-150, ss. 2, 3, 4; 2009-433, ss. 4, 5; 2011-398, s. 35; 2015-241, ss. 14.10(a), (b), 14.10C(b); 2015-263, s. 11(a); 2016-94, s. 14.11(a).)

§ 113-202.1. Water column leases for aquaculture.

(a) To increase the productivity of leases for shellfish culture issued under G.S. 113-202, the Secretary may amend shellfish cultivation leases to authorize use of the water column superjacent to the leased bottom under the terms of this section when he determines the public interest will benefit from amendment of the leases. Leases with water column amendments must produce shellfish in commercial quantities ~~at fourten times the minimum production rate of leases issued under G.S. 113-202~~ at 100 bushels per acre or show purchase of 45,000 juvenile shellfish, or any higher quantity required by the Marine Fisheries Commission through duly adopted rules.

~~(b) Suitable areas for the authorization of water column use shall meet the following minimum standards:~~

~~(1) Aquaculture use of the leased area must not significantly impair navigation;~~

~~(2) The leased area must not be within a navigation channel marked or maintained by a state or federal agency;~~

~~(3) The leased area must not be within an area traditionally used and available for fishing or hunting activities incompatible with the activities proposed by the leaseholder, such as trawling or seining;~~

~~(4) Aquaculture use of the leased area must not significantly interfere with the exercise of riparian rights by adjacent property owners including access to navigation channels from piers or other means of access; and~~

~~(5) Any additional standards, established by the Commission in duly adopted rules, to protect the public interest in coastal fishing waters.~~

(b) The Secretary may grant shellfish cultivation leases to persons who reside in North Carolina under the terms of this section when the Secretary in the exercise of his discretion, makes the determinations set forth in G.S. 113-202(a), taking into consideration the specific method of water column mariculture described in the application.

(c) The Secretary shall not grant or amend shellfish cultivation leases to authorize uses of the water column involving devices or equipment ~~not~~(including equipment resting on the bottom ~~or that extend more than 18 inches above the bottom~~) unless:

(1) The leaseholder submits an application, accompanied by a nonrefundable application fee of ~~one~~ five hundred dollars ($~~100~~500.00), which conforms to the standards for lease applications in G.S. 113-202(d) and the duly adopted rules of the Commission;

(2) The proposed amendment has been noticed consistent with G.S. 113-202(f);

(3) Public hearings have been conducted consistent with G.S. 113-202(g);

(4) The aspects of the proposals which require use and dedication of the water column have been documented and are recognized by the Secretary as commercially feasible forms of aquaculture which will enhance shellfish production on the leased area;

(5) It is not feasible to undertake the aquaculture activity outside of coastal fishing waters; and

~~(6) The authorized water column use has the least disruptive effect on other public trust uses of the waters of any available technology to produce the shellfish identified in the proposal.~~

~~(d)~~ (6)

(d) New shellfish cultivation leases authorizing use of the water column are issued for a period of 10 years. Amendments of shellfish cultivation leases to authorize use of the water column are issued for a period of 10 years or the remainder of the term of the lease, whichever is shorter. The annual rental for a new or renewal water column amendment is ~~one~~two hundred and fifty hundred dollars ($~~10~~250.00) an acre. If a water column amendment is issued for less than a 12-month period, the rental shall be prorated based on the number of months remaining in the year. The annual rental for an amendment is payable at the beginning of the year. The rental is in addition to that required in G.S. 113-202.

(e) Amendments of shellfish cultivation leases to authorize use of the water column are subject to termination in accordance with the procedures established in G.S. 113-202 for the termination of shellfish cultivation leases. Additionally, such amendments may be terminated for unauthorized or unlawful interference with the exercise of public trust rights by the leaseholder, agents and employees of the leaseholder.

(f) Amendments of shellfish cultivation leases to authorize use of the water column may be transferred only with the superincumbent bottom lease for the remainder of the term of the amendment at the same rental rate and term as set forth in subsection (d) of this section and so long as notice of the transfer is provided to the Secretary as required by G.S. 113-202(k).

(g) After public notice and hearing consistent with subsection (c) of this section, the Secretary may renew an amendment, in whole or in part, when the leaseholder has produced commercial quantities of shellfish and has otherwise complied with the rules of the Commission. Renewals may be denied or reduced in scope when the public interest so requires. Appeal of renewal decisions shall be conducted in accordance with G.S. 113-202(p). Renewals are subject to the lease terms and rates established in subsection (d) of this section.

(h) The procedures and requirements of G.S. 113-202 shall apply to proposed amendments or amendments of shellfish cultivation leases considered under this section except more specific provisions of this section control conflicts between the two sections.

(i) To the extent required by demonstration or research aquaculture development projects, the Secretary may amend existing leases and issue leases that authorize use of the bottom and the water column. Demonstration or research aquaculture development projects may be authorized for five years with no more than one renewal and when the project is proposed or formally sponsored by an educational institution which conducts research or demonstration of aquaculture. Production of shellfish with a sales value in excess of five thousand dollars ($5,000) per acre per year shall constitute commercial production. Demonstration or research aquaculture development projects shall be exempt for the rental rate in subsection (d) of this section unless commercial production occurs as a result of the project. (1989, c. 423, s. 1; 1989 (Reg. Sess., 1990), c. 1004, s. 4; c. 1024, s. 22; 1993, c. 322, s. 1; c. 466, s. 2; 2004-150, s. 5; 2015-241, s. 14.10C(c); 2015-268, s. 5.6; 2016-94, s. 14.11(b); 2016-123, s. 6.1(a); 2017-102, s. 33.4(a).)

§ 113-202.2. Water column leases for aquaculture for perpetual franchises.

(a) To increase the productivity of shellfish grants and perpetual franchises for shellfish culture recognized under G.S. 113-206, the Secretary may lease the water column superjacent to such grants or perpetual franchises (hereinafter "perpetual franchises") under the terms of this section when it determines the public interest will benefit from the lease. Perpetual franchises with water column leases must produce shellfish in commercial quantities ~~at four times the minimum production rate of leases issued under G.S. 113-202~~of 100 bushels acre^{-1} or provide evidence of investment outlines, or any higher quantity required by the Marine Fisheries Commission by rule. Alternatively, water column lease holders may provide evidence of purchasing 45,000 shellfish seed acre^{-1}, annually.

~~(b) Suitable areas for the authorization of water column use shall meet the following minimum standards:~~

(1) Aquaculture use of the leased water column area must not significantly impair navigation;
(2) The leased water column area must not be within a navigation channel marked or maintained by a State or federal agency;
(3) The leased water column area must not be within an area traditionally used and available for fishing or hunting activities incompatible with the activities proposed by the perpetual franchise holder, such as trawling or seining;
(4) Aquaculture use of the leased water column area must not significantly interfere with the exercise of riparian rights by adjacent property owners including access to navigation channels from piers or other means of access;
(5) The leased water column area may not exceed 10 acres for grants or perpetual franchises recognized pursuant to G.S. 113-206;
(6) The leased water column area must not extend more than one-third of the distance across any body of water or into the channel third of any body of water for grants or perpetual franchises recognized pursuant to G.S. 113-206; and
(7) Any additional rules to protect the public interest in coastal fishing waters adopted by the Commission.

(c) The Secretary shall not lease the water column superjacent to oyster or other shellfish grants or perpetual franchises unless:
(1) The perpetual franchise holder submits an application, accompanied by a nonrefundable application fee of ~~one~~ five hundred dollars ($~~100~~500.00), which conforms to the standards for lease applications in G.S. 113-202(d) and rules adopted by the Commission;
(2) Notice of the proposed lease has been given consistent with G.S. 113-202(f);
(3) Public hearings have been conducted consistent with G.S. 113-202(g);
(4) The aspects of the proposals which require use and dedication of the water column have been documented and are recognized by the Secretary as commercially feasible forms of aquaculture which will enhance shellfish production;
(5) It is not feasible to undertake the aquaculture activity outside of coastal fishing waters.
~~(6) The authorized water column use has the least disruptive effect on other public trust uses of the waters of any available technology to produce the shellfish identified in the proposal.~~

(d) Water column leases to perpetual franchises shall be issued for a period of 10 years and may be renewed pursuant to subsection (g) of this section. The rental for an initial water column lease issued under this section is the same as the rental set in G.S. 113-202.1 for an initial water column amendment issued under that section, and the rental for a renewed water column lease issued under this section is the same as the rental set in G.S. 113-202.1 for a renewed water column amendment issued under that section.

(e) Water column leases to perpetual franchises may be terminated for unauthorized or unlawful interference with the exercise of public trust rights by the leaseholder or his agents or employees.

(f) Water column leases to perpetual franchises may be transferred only with the superincumbent perpetual franchise for the remainder of the term of the lease at the same rental rate and term as set forth in subsection (d) of this section and so long as notice of the transfer is provided to the Secretary as required by G.S. 113-202(k).

(g) After public notice and hearing consistent with G.S. 113-202(f) and (g), the Secretary may renew a water column lease, in whole or in part, if the leaseholder has produced commercial quantities of shellfish and has otherwise complied with this section and the rules of the Commission. Renewals may be denied or reduced in scope when the public interest so requires. Appeal of renewal decisions shall be conducted in accordance with G.S. 113-202(p). Renewals are subject to the lease terms and rates set out in subsection (d) of this section.

(h) The procedures and requirements of G.S. 113-202 shall apply to proposed water column leases or water column leases to perpetual franchises considered under this section except that more specific provisions of this section control conflicts between the two sections.

(i) Demonstration or research aquaculture development projects may be authorized for five years with no more than one renewal and when the project is proposed or formally sponsored by an educational institution which conducts aquaculture research or demonstration projects. Production of shellfish with a sales value in excess of five thousand dollars ($5,000) per acre per year shall constitute commercial production. Demonstration or research aquaculture development projects shall be exempt from the rental rate in subsection (d) of this section unless commercial production occurs as a result of the project. (1989 (Reg. Sess., 1990), c. 958, s. 1; 1993, c. 322, s. 2; c. 466, s. 3; 2016-94, s. 14.11(c); 2016-123, s. 6.1(b); 2017-102, s. 33.4(b).)

§ 113-203. Transplanting of oysters and clams.

(a) Repealed by Session Laws 2009-433, s. 6, effective August 7, 2009 (subdivision (a)(2)), and by Session Laws 2014-120, s. 26, effective September 18, 2014 (remainder of subsection (a)).

(a1) Repealed by Session Laws 2014-120, s. 26, effective September 18, 2014.

(a2) It is unlawful to do any of the following:

(1) Transplant oysters or clams taken from public grounds to private beds except when lawfully taken during open season and transported directly to a private bed in accordance with rules of the Marine Fisheries Commission.

(2) Transplant oysters or clams taken from permitted aquaculture operations to private beds except from waters in the approved classification.

(3) Transplant oysters or clams from public grounds or permitted aquaculture operations utilizing waters in the prohibited, restricted or conditionally approved classification to private beds except when the transplanting is done in accordance with the provisions of this section and implementing rules.

(a3) Unless the Secretary determines that the nursery of shellfish in an area will present a risk to public health, ~~I~~it is lawful to transplant seed oysters or seed clams taken from permitted aquaculture operations that occur within or draw water from ~~use~~ waters ~~in the~~ classified as prohibited, restricted or conditionally approved by shellfish sanitation ~~classification~~ to private beds pursuant to an Aquaculture Seed Transplant Permit issued by the Secretary that sets times during which transplant is permissible and other reasonable restrictions imposed by the Secretary under either of the following circumstances:

(1) When transplanting seed clams less than 12 millimeters in their largest dimension.

(2) When transplanting seed oysters less than 25 millimeters in their largest dimension."

(a4) It is unlawful to conduct a seed transplanting operation pursuant to subsection (a3) of this section if the seed transplanting operation is not conducted in compliance with its Aquaculture Seed Transplant Permit.

(b) It is lawful to transplant from public bottoms to private beds oysters or clams taken from waters in the restricted or conditionally approved classifications with a permit from the Secretary setting out the waters from which the oysters or clams may be taken, the quantities which may be taken, the times during which the taking is permissible, and other reasonable restrictions imposed by the Secretary for the regulation of transplanting operations. Any transplanting operation which does not substantially comply with the restrictions of the permit issued is unlawful.

(c) Repealed by Session Laws 2009-433, s. 6, effective August 7, 2009.

(d) It is lawful to transplant to private beds in North Carolina oysters taken from natural or managed public beds designated by the Marine Fisheries Commission as seed oyster management areas. The Secretary shall issue permits to all qualified individuals who are residents of North Carolina without regard to county of residence to transplant seed oysters from said designated seed oyster management areas, setting out the quantity which may be taken, the times which the taking is permissible and other reasonable restrictions imposed to aid the Secretary in the Secretary's duty of regulating such transplanting operations. Persons taking such seed oysters may, in the discretion of the Marine Fisheries Commission, be required to pay to the Department for oysters taken an amount to reimburse the Department in full or in part for the costs of seed oyster management operations. Any transplanting operation which does not substantially comply with the restrictions of the permit issued is unlawful.

(e) The Marine Fisheries Commission may implement the provisions of this section by rules governing sale, possession, transportation, storage, handling, planting, and harvesting of oysters and clams and setting out any system of marking oysters and clams or of permits or receipts relating to them generally, from both public and private beds, as necessary to regulate the lawful transplanting of seed oysters and oysters or clams taken from or placed on public or private beds.

(f) The Commission may establish a fee for each permit established pursuant to this subsection in an amount that compensates the Division for the administrative costs associated with the permit but that does not exceed ~~one~~five hundred dollars ($~~100~~500.00) per permit.

(g) Advance Sale of Permits; Permit Revenue. - To ensure an orderly transition from one permit year to the next, the Division may issue a permit prior to July 1 of the permit year for which the permit is valid. Revenue that the Division receives for the issuance of a permit prior to the beginning of a permit year shall not revert at the end of the fiscal year in which the revenue is received and shall be credited and available to the Division for the permit year in which the permit is valid. (1921, c. 132, s. 2; C.S., s. 1959(b); 1961, c. 1189, s. 1; 1965, c. 957, s. 2; 1967, c. 878; 1973, c. 1262, s. 28; 1977, c. 771, s. 4; 1987, c. 641, s. 6; c. 827, s. 98; 1989, c. 727, s. 100; 1997-400, s. 5.7; 2007-495, s. 3; 2009-433, s. 6; 2013-360, s. 14.8(s); 2014-120, s. 26.)

§ 113-204. Propagation of shellfish.

The Department is authorized to close areas of public bottoms under coastal fishing waters for such time as may be necessary in any program of propagation of shellfish. The Department is authorized to expend State funds planting such areas and to manage them in ways beneficial to the overall productivity of the shellfish industry in North Carolina. The Department in its discretion in accordance with desirable conservation objectives may make shellfish produced by it available to commercial fishermen generally, to those in possession of private shellfish beds, or to selected individuals cooperating with the Department in demonstration projects concerned with the cultivation, harvesting, or processing of shellfish. (1921, c. 132, s. 1; C.S., s. 1959(a); 1961, c. 1189, s. 1; 1965, c. 957, s. 2; 1973, c. 1262, s. 28; 1977, c. 771, s. 4; 1989, c. 727, s. 101.)

§ 113-205. Registration of grants in navigable waters; exercise of private fishery rights.

(a) Every person claiming to any part of the bed lying under navigable waters of any coastal county of North Carolina or any right of fishery in navigable waters of any coastal county superior to that of the general public must register the grant, charter, or other authorization under which he claims with the Secretary. Such registration must be accompanied by a survey of the claimed area, meeting criteria established by the Secretary for surveys of oyster and clam leases. All rights and titles not registered in accordance with this section on or before January 1, 1970, are hereby declared null and void. The Secretary must give notice of this section at least once each calendar year for three years by publication in a newspaper or newspapers of general circulation throughout all coastal counties of the State. For the purpose of this subsection, "coastal county" shall mean all the following counties: Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Halifax, Hertford, Hyde, Martin, New Hanover, Northampton, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell, and Washington. The provisions of this section shall not apply to the land lying under any private fish pond or irrigation pond.

(b) The Marine Fisheries Commission may make reasonable rules governing utilization of private fisheries and may require grantees or others with private rights to mark their fishery areas or private beds in navigable waters as a precondition to the right of excluding the public from exercising the private rights claimed to be secured to them. Nothing in this section is to be deemed to confer upon any grantee or other person with private rights the power to impede navigation upon or hinder any other appropriate use of

the surface of navigable waters of North Carolina. (1965, c. 957, s. 2; 1971, c. 346, s. 1; 1973, c. 1262, s. 28; 1987, c. 827, s. 98.)

§ 113-206. Chart of grants, leases and fishery rights; overlapping leases and rights; contest or condemnation of claims; damages for taking of property.

(a) The Secretary must commence to prepare as expeditiously as possible charts of the waters of North Carolina containing the locations of all oyster and clam leaseholds made by the Department under the provisions of this Article and of all existing leaseholds as they are renewed under the provisions of this Article, the locations of all claims of grant of title to portions of the bed under navigable waters registered with him, and the locations of all areas in navigable waters to which a right of private fishery is claimed and registered with him. Charting or registering any claim by the Secretary in no way implies recognition by the State of the validity of the claim.

(a1) If a claim is based on an oyster or other shellfish grantor a perpetual franchise for shellfish cultivation, the Secretary may, to resolve the claim, grant a shellfish lease to the claimant for part or all of the area claimed. If a claim of exclusive shellfishing rights was registered based upon a conveyance by the Literary Fund, the North Carolina Literary Board or the State Board of Education, and the claimant shows that the area had been cultivated by the claimant or his predecessor in title for the seven-year period prior to registration of the claim, the Secretary may, to resolve the claim, grant a shellfish lease to the claimant for all or part of the area claimed, not to exceed ten acres. A shellfish lease granted under this subsection is subject to the restrictions imposed on shellfish leases in G.S. 113-202, except the prohibition against leasing an area that contains a natural shellfish bed in G.S. 113-202(a)(2). This restriction is waived because, due to the cultivation efforts of the claimant, the area is likely to contain a natural shellfish bed.

(b) In the event of any overlapping of areas leased by the Department, the Secretary shall recommend modification of the areas leased as he deems equitable to all parties. Appeal from the recommendation of the Secretary lies for either party in the same manner as for a lease applicant as to which there is a recommendation of denial or modification of lease. If there is no appeal, or upon settlement of the issue upon appeal, the modified leases must be approved by the Marine Fisheries Commission and reissued by the Secretary in the same manner as initial or renewal leases. Leaseholders must furnish the Secretary surveys of the modified leasehold areas, meeting the requisite criteria for surveys established by the Secretary.

(c) In the event of any overlapping of areas leased by the Department and of areas in which title or conflicting private right of fishery is claimed and registered under the provisions of this Article, the Secretary must give preference to the leaseholder engaged in the production of oysters or clams in commercial quantities who received the lease with no notice of the existence of any claimed grant or right of fishery. To this end, the Secretary shall cause a modification of the claim registered with him and its accompanying survey to exclude the leasehold area. Such modification effected by the Secretary has the effect of voiding the grant of title or right of fishing to the extent indicated.

(d) In the interest of conservation of the marine and estuarine resources of North Carolina, the Department may institute an action in the superior court to contest the claim of title or claimed right of fishery in any navigable waters of North Carolina registered with the Secretary. In such proceeding, the burden of showing title or right of fishery, by the

preponderance of the evidence, shall be upon the claiming title or right holder. In the event the claiming title or right holder prevails, the trier of fact shall fix the monetary worth of the claim. The Department may elect to condemn the claim upon payment of the established owners or right holders their pro rata shares of the amount so fixed. The Department may make such payments from such funds as may be available to it. An appeal lies to the appellate division by either party both as to the validity of the claim and as to the fairness of the amount fixed. The Department in such actions may be represented by the Attorney General. In determining the availability of funds to the Department to underwrite the costs of litigation or make condemnation payments, the use which the Department proposes to make of the area in question may be considered; such payments are to be deemed necessary expenses in the course of operations attending such use or of developing or attempting to develop the area in the proposed manner.

(e) A person who claims that the application of G.S. 113-205 or this section has deprived him of his private property rights in land under navigable waters or his right of fishery in navigable waters without just compensation may file a complaint in the superior court of the county in which the property is located to contest the application of G.S. 113-205 or this section. If the plaintiff prevails, the trier of fact shall fix the monetary worth of the claim, and the Department may condemn the claim upon payment of this amount to him if the Secretary considers condemnation appropriate and necessary to conserve the marine and estuarine resources of the State. The Department may pay for a condemned claim from available funds. An action under this subsection is considered a condemnation action and is therefore subject to G.S. 7A-248.

The limitation period for an action brought under this subsection is three years. This period is tolled during the disability of the plaintiff. No action, however, may be instituted under this subsection after December 31, 2006.

(f) In evaluating claims registered pursuant to G.S. 113-205, the Secretary shall favor public ownership of submerged lands and public trust rights. The Secretary's action does not alter or affect in any way the rights of a claimant or the State. (1965, c. 957, s. 2; 1969, c. 44, s. 69; c. 541, s. 11; 1973, c. 1262, s. 28; 1977, c. 771, s. 4; 1985, c. 279; c. 762; 1989, c. 423, s. 3; c. 727, s. 102; 1989 (Reg. Sess., 1990), c. 869, ss. 1, 2; 1993 (Reg. Sess., 1994), c. 717, ss. 1-3; 1998-179, s. 1; 2006-79, s. 11.)

§ 113-207. Taking shellfish from certain areas forbidden; penalty.

(a) Repealed by Session Laws 2009-433, s. 7, effective August 7, 2009.

(b) It is unlawful for any person to take shellfish within 150 feet of any part of a publicly owned pier beneath which the Division of Marine Fisheries has deposited cultch material.

(c) A person who violates this section is guilty of a Class 3 misdemeanor. (1977, c. 515, s. 1; c. 771, s. 4; 1989, c. 727, s. 103; 1993, c. 539, s. 841; 1994, Ex. Sess., c. 24, s. 14(c); 1999-143, s. 1; 2009-433, s. 7.)

§ 113-208. Protection of private shellfish rights.

(a) It is unlawful for any person, other than the holder of private shellfish rights, to take or attempt to take shellfish from any privately leased, franchised, or deeded shellfish bottom area without written authorization of the holder and with actual knowledge it is a

private shellfish bottom area. Actual knowledge will be presumed when the shellfish are taken or attempted to be taken:

(1) From within the confines of posted boundaries of the area as identified by signs, whether the whole or any part of the area is posted, or

(2) When the area has been regularly posted and identified and the person knew the area to be the subject of private shellfish rights.

A violation of this section in which shellfish are taken or attempted to be taken from private shellfish bottom area containing growing gear (e.g. cages, bags, netting) shall constitute a ~~Class A1 misdemeanor, which may include a fine of not more than five thousand dollars ($5,000).~~ Class I felony, which may include a fine no less than two thousand five hundred dollars ($2,500). Those convicted who hold a commercial shellfish license, first offense will result in a one-year loss of license, and second offenses will result in permanent loss of license. A violation of this section in which shellfish are taken or attempted to be taken from gear-less shellfish bottom area will constitute a Class A1 misdemeanor, which may include a fine of not more than five thousand dollars ($5,000) for first time offenses and a Class I felony, which may include a fine no less than two thousand five hundred dollars ($2,500), for repeat offenders. Upon conviction of any person for the violation of this section, the court shall order restitution be paid to the owner of the private shellfish rights from whom shellfish were taken. The written authorization shall include the lease number or deed reference, name and address of authorized person, date of issuance, and date of expiration, and it must be signed by the holder of the private shellfish right. Identification signs shall include the lease number or deed reference and the name of the holder.

(b) The prosecutor shall dismiss any case brought for a violation of this section if the defendant produces a notarized written authorization in conformance with subsection (a) which states that the defendant had permission to take oysters or clams from the leased area at the time of the alleged violation; except the prosecutor may refuse to dismiss the case if he has reason to believe that the written authorization is fraudulent. (1979, c. 537; 1987, c. 463; 1989, c. 281, s. 2; 1993, c. 539, s. 842; 1994, Ex. Sess., c. 24, s. 14(c); 1998-225, s. 3.7.)

§ 113-209. Taking polluted shellfish at night or with prior conviction forbidden; penalty.

(a) It is unlawful for any person between sunset and sunrise to willfully take or attempt to take shellfish from areas closed to harvest by statute, rule, or proclamation because of suspected pollution.

(b) It is unlawful for any person to willfully possess, sell or offer for sale shellfish taken between sunset and sunrise from areas closed to harvest by statute, rule, or proclamation because of suspected pollution.

(c) It is unlawful for any person who has been convicted of an offense under this Chapter within the preceding two years involving shellfish taken from areas closed because of suspected pollution to willfully take, attempt to take, possess, sell or offer for sale shellfish from areas closed to harvest by statute, rule, or proclamation because of suspected pollution.

(d) Any person violating any provisions of this section shall be guilty of a Class I felony which may include a fine no less than two thousand five hundred dollars ($2,500). Upon conviction of any person for a violation of this section, the court shall

order the confiscation of all weapons, equipment, vessels, vehicles, conveyances, fish, and other evidence, fruit, and instrumentalities of the offense. The confiscated property shall be disposed of in accordance with G.S. 113-137. (1989, c. 275, s. 1; 1993, c. 539, s. 1301; 1994, Ex. Sess., c. 24, s. 14(c).)

§ 113-210. Under Dock Oyster Culture.

(a) Under Dock Oyster Culture Permit. - An Under Dock Oyster Culture Permit authorizes the holder of the permit to attach up to 90 square feet of oyster cultivation containers to a dock or pier owned by the permit holder.

(b) Application. - The owner of a dock or pier who wishes to obtain an Under Dock Oyster Culture Permit shall apply to the Director of the Division of Marine Fisheries.

(c) Issuance. - The Director of the Division of Marine Fisheries shall issue an Under Dock Oyster Culture Permit only if the Director determines all of the following:

(1) That the dock or pier is not located in an area that the State Health Director has recommended be closed to shellfish harvest due to pollution or that has been closed to harvest by statute, rule, or proclamation due to suspected pollution.

(2) That the owner of the dock or pier has satisfied the training requirements established by the Marine Fisheries Commission pursuant to subsection (j) of this section.

(3) That the attachment of the oyster cultivation containers to the dock or pier will be compatible with all lawful uses by the public of other marine and estuarine resources. Other lawful public uses include, but are not limited to, navigation, fishing, and recreation.

(d) Duration. - An Under Dock Oyster Culture Permit is valid for a one-year period from the date of issuance.

(e) Renewal. - The Director of the Division of Marine Fisheries shall renew an Under Dock Oyster Culture Permit only if the Director determines the requirements of subsection (c) of this section continue to be satisfied and the holder of the permit is attempting to utilize the permit to cultivate oysters on a continuing basis.

(f) Reporting Requirements. - The holder of an Under Dock Oyster Culture Permit shall comply with the biological data sampling and survey programs of the Marine Fisheries Commission and the Division of Marine Fisheries.

(g) Posting of Signs. - The holder of an Under Dock Oyster Culture Permit shall post signs that indicate the presence of the oyster cultivation containers and that the oyster cultivation containers and their contents are private property.

(h) Sale of Oysters Prohibited. - It is unlawful for the holder of an Under Dock Oyster Culture Permit to sell oysters cultivated pursuant to the permit.

(i) Assignment and Transfer Prohibited. - An Under Dock Oyster Culture Permit is not assignable or transferable.

(j) Oyster Cultivation Training Requirements. - The Marine Fisheries Commission, in consultation with the Sea Grant College Program at The University of North Carolina, shall develop and adopt rules for the training of individuals who cultivate oysters pursuant to this section.

(k) Revocation of Permit. - If the Director of the Division of Marine Fisheries determines that the holder of an Under Dock Oyster Culture Permit has failed to comply

with any provision of this section, the Director shall revoke the Permit. The owner of the dock or pier shall remove the oyster cultivation containers that were authorized by the revoked permit within 15 days of revocation.

(l) Repealed by Session Laws 2014-100, s. 14.9(h), effective July 1, 2014.

(m) Repealed by Session Laws 2014-120, s. 33(a), effective July 1, 2014. (2004-124, s. 12.7B; 2013-360, s. 14.8(t); 2014-100, s. 14.9(h); 2014-120, s. 33(a).)

§§ 113-211 through 113-220: Reserved for future codification purposes.

Appendix F. State by State Analysis of Shellfish Mariculture Programs

Organizational Structure of Governance

Governance of shellfish mariculture industry is a complex task that involves management on multilevel scales: environmental regulation, lease applications, user conflicts, applied research, promotion of the industry, and other issues. In the United States, different states have created a variety of governmental bodies to manage the shellfish mariculture industry.

Departmental Structure

One way to categorize different organizational approaches to shellfish mariculture is to consider the hierarchy of governance structure and where in it shellfish mariculture has been nested. For example, some states have treated shellfish mariculture as a form of agriculture. The lead agency for shellfish mariculture in states that take this approach falls under the state's Department of Agriculture (or similar). Connecticut's Bureau of Aquaculture, Florida's Bureau of Shellfisheries, and New Jersey's Office of Aquaculture Coordination fall within this category (Appendix F, Table 1).

Other states house shellfish mariculture in departments aimed at conserving natural resources. For example, Maryland's Aquaculture and Industry Enhancement Division is housed in its Department of Natural Resources and New York's shellfish program is housed in its Department of Environmental Conservation. Additionally, Virginia, Maine, Rhode Island, and Massachusetts house their programs in agencies specifically devoted to the conservation of coastal or marine resources (Appendix F, Table 1).

Although housed in departments with inherently different approaches, programs often have overlapping goals given that shellfish mariculture is both a resource conservation and use activity. For example, Maryland's program is housed in a resource conservation agency but its "Aquaculture and Industry Enhancement Division" promotes industry growth, and Florida's program in it Department of Agriculture and Consumer Services but also works to conserve natural resources.

The significance of these varying approaches lies in the resources and relationships these different agencies have access to rather than the ultimate goals of those states regarding shellfish mariculture. Agriculture-related agencies often have more experience with marketing and have the ability to promote and grow an industry whereas resource use agencies can better and more easily manage and protect marine resources.

Cooperation and Diversification

Because shellfish mariculture management requires input and expertise from various stakeholders and officials, it is common for these governing bodies to cooperate with and allocate tasks to other departments or a variety of sub-groups within the lead department. Maryland provides a good example of how mariculture programs can take an interdepartmental approach. In Maryland, the General Assembly recognized aquaculture as both an agricultural and a fisheries management activity in 2011. Currently, the

Aquaculture and Industry Enhancement Division of the Department of Natural Resources manages aquaculture leases, laws, and regulations. The Aquaculture Coordinator leads the department and is aided by the Aquaculture Coordinating Council, which provides recommendations for industry advancement, and the Aquaculture Review Board, which handles policy and leasing issues. Responsibility for "promoting, marketing, and coordinating aquaculture and its products" has been allocated to the Department of Agriculture. Maryland's approach in which multiple specialized bodies within the same department and different departments manage separate aspects of the industry highlights a common strategy found in many states.

Advisory Groups for Industry Input

One common problem faced by many governments is a lack of information regarding industry dynamics and how to efficiently and effectively grow shellfish mariculture sectors. It is not surprising that government staff devoted to policy or regulation do not have this information nor the means with which to collect it. Furthermore, it can be seen as a conflict of interest for governing bodies to both promote and regulate the industry.

To solve these issues, many governments have created advisory boards or councils that aim to advance the aquaculture industry and facilitate communication between government agencies and industry leaders. Many of these groups, such as Florida's Aquaculture Review Council, Virginia's Aquaculture Advisory Board, Massachusetts' Shellfish Advisory Panel, and Maine's Aquaculture Advisory Council, are composed entirely of industry members and are charged by state law to provide recommendations to policy-making entities. Other groups, such as the Maryland Aquaculture Coordinating Council, New Jersey's Aquaculture Advisory Council, and Connecticut's Aquaculture Advisory Council, also provide recommendations, but are composed of a mix of government officials, scientists, and industry members. In contrast to industry only groups, these bodies are charged with wider responsibility to organize development plans, facilitate research, and even participate in the leasing approval process.[1]

Research Priorities

Beyond a need for industry insight, governments have also found academic research to be an important part of mariculture programs. Many state governments have created research collaboratives. For example, Rhode Island's Governor, along with many partners, launched the Rhode Island Shellfish Initiative in 2017 and the Maine legislature established the Maine Aquaculture Innovation Center in 1988. Furthermore, state sponsored mariculture plans, reports, and surveys, such as the annual Florida Aquaculture Plan or the Virginia Shellfish Aquaculture Crop Reporting Survey, provide industry updates and recommendations for growth.

Additionally, mariculture research and education programs function under federal law. The 1914 Smith-Lever Act established the Cooperative Extension Service which has allowed states to extend university-based research to the general public. The University

[1] Although many of these councils focus on "aquaculture" in general, shellfish mariculture is well represented and promoted by these groups given its environmental and economic benefits. Furthermore, the governing statutes often specifically mandate shellfish farming representation in these groups.

of Florida IFAS Shellfish Aquaculture Extension Program, the University of Maryland Extension's Oyster Aquaculture and Education Program, and Massachusetts' three regional Aquaculture Centers all operate under this law and provide research and education outreach. Furthermore the 1966 National Sea Grant College Program Act created the Sea Grant program. State Sea Grant programs have proved to be important actors and partners in state research programs. For example, the Connecticut Sea Grant and University of Connecticut Extension collaborated with NOAA to create the Connecticut Shellfish Initiative.

Siting: Competing Uses of State Waters

Shellfish mariculture is conducted in brackish or salt waters, often in estuaries or bays. In North Carolina, these favorable shellfish-growing areas are mostly located in state-held public waters known as public trust waters. Under North Carolina common law, public trust waters are a resource of all the citizens of the State. The State grants citizens' public trust rights to "navigate, swim, hunt, fish, and enjoy all recreational activities in" these waters (NC G.S. § 1-45.1). Because shellfish mariculture leases often interfere with these public trust rights, the siting processes involves balancing competing uses. This process often arouses public opposition as individuals' public rights come in conflict with the interest of the mariculture industry, which has been found to be in the best interest of the state.

Due to this complexity, siting can be a very controversial issue. Although the concept of "public trust waters" varies among states, the issue of siting aquaculture in waters under state jurisdiction is ubiquitous and is managed in a variety of ways.

Public Process

Leasing of public waters goes through an established public process in all states. In general, the public process ensures that concerned stakeholders receive both ample notification of proposed leases and a fair opportunity to publicly express opposition to these leases. Because leasing processes are laid out in state law, however, these processes vary among states.

One common feature among leasing processes is a public comment period. Many states feature comment periods that are usually 30 days and occur during a specific window after the submission of a lease applications and before the final decision is made. During these periods, individuals can submit comments expressing opposition to a proposed lease. The leasing authority gathers this input, and in some states, uses it to decide whether a public hearing is needed based on the level of opposition.

Regardless of public comments received, most states require public hearings where individuals can voice opposition in person (Appendix F, Table 2). Representatives of the leasing authority often hold these meetings or are at least present at them, allowing officials to assess conflicts and to make suggestions or modifications to applications. In states that do not employ official public comment periods, adequate notice of public hearings serves the same function as comment periods; pre-hearing notification grants individuals time to gather comments that can then be expressed at a public meeting rather than through writing.

Compared to other states, Connecticut and Florida have particularly relaxed public process requirements with no established public comment periods and limited

public hearings (Appendix F, Table 2). In both states this most likely reflects limited conflicts largely due to the nature and location of their leases. These states provide a good example of how procedures can vary based on local conditions.

Despite differences in public comment or hearing procedures, all states employ a specific notification process. In general, this process includes direct notification of riparian owners and public advertising efforts. For riparian owner notification, in some states applicants are tasked with acquiring signatures from shoreline owners acknowledging their notification, or with sending public notices to these owners. In this case where the notification burden falls on the applicant, the agency will often assist in the process. In other states, the agency will send a notice on the applicant's behalf. In terms of general public notification, local newspaper advertisements and notices posted on agency websites compose the majority of notification efforts. The amount of time these advertisements are required to be published ranges from 1 day to 4 weeks (O'Connell, 2018).

Overall, the notification process helps avoid litigation by ensuring a fair process and by giving the siting/leasing authority an opportunity to revise applications with the public's comments in mind. The process also helps identify individuals with concerns early in the process, allowing agencies the opportunity to communicate and discuss concerns with these individuals to reduce the likelihood of appeal.

Size Caps and Lease Parameters

One common center of conflict revolves around the fear that shellfish mariculture can expand to take over the majority of a water body. In New York and Rhode Island acreage caps have been used to curb fears in areas of high residency and water use. Suffolk County has established an acreage cap of 60 acres that can be leased each year for new leases, and in Rhode Island, a maximum of five percent of a coastal salt pond can be leased for shellfish mariculture. These size limitations attempt to allow shellfish mariculture to get started while easing community concerns as individuals learn more about farm operations. If the community's concerns are not realized with these restrictions, further expansion may be more easily achieved. On the other hand, if their concerns are realized, they can better present these concerns when future proposal arise (O'Connell, 2018).

Additionally, residency requirements aim to soothe concerns that out of state business will establish large mariculture operations that can harm smaller, local farmers and cause a variety of public trust issues. The following states have implemented residency requirements for leases:

1. MA - Most towns require applicants to be residents.
2. CT- Non-residents with leases prior to 1985 can renew. Non-residents from only those states that will lease to CT resident.
3. SC
4. LA
5. TX- residency required, but non-resident can apply if they assign a resident agent,
6. NC

Beyond size caps and residency requirements, leases are subject to a variety of parameters in different states that limit their expansion such as lease terms, physical restrictions, and other parameters (Appendix F, Table 3).

Small Scale Operations to Gain Approval

In Maine and Rhode Island small scale, limited liability leases function as community acceptance tools (see Reducing Barriers for more info on these leases). These short-term leases, which are limited to small area, provide an opportunity for community members and water uses to learn about how a shellfish farm operates. It also gives them a chance to interact with growers and get a sense of how they could work together to mitigate concerns (O'Connell, 2018).

Pre-approved versus Applicant Proposed Leases

Given the involved process of approving individual leases, some states have chosen to designate large areas where shellfish mariculture is pre-approved and allowed by permits. In these cases, the state sites a large tract of water for shellfish aquaculture which is then subdivided to smaller leases. These shellfish mariculture zones are designed to help streamline the leasing process. Growers can apply for these leases without going through the strenuous siting process. As detailed in Goal 3 (d), Florida, Maryland, New Jersey, New York, and Alaska have at some point implemented this strategy.

Examples: (more detail in Goal 3 d)

Florida

- Aquaculture Use Zones (AUZs) – Florida has 21 Shellfish AUZs located in 10 counties.

Maryland

- Aquaculture Enterprise Zones (AEZs) – A statute, enacted in 2009, designated 176 acres of pre-approved areas distributed between two Aquaculture Enterprise Zones.

New Jersey

- Aquaculture Development Zones (ADZs) – 1,250 acres that allows the use of structure (e.g., cages, racks, bags, floats, etc.) for grow-out culture operations.

Massachusetts

- Block Permitting - towns designate larger tracts (50 to 100 acres) of intertidal and/or subtidal areas for shellfish aquaculture development.

The level of utilization of Shellfish Enterprise Areas is often inversely related to the ease of leasing outside of these pre-permitted zones. For example, in Maryland, demand for leases in Aquaculture Enterprise Zones has declined as the leasing process for individual leases has improved with streamlining and consolidation. As such, a measured approach of establishing a few pre-permitted zones and gauging the level of interest is critical to ensuring their availability is commensurate with demand.

Proactive Consultation from Experienced Leasing Body

In most states, siting authorities work to communicate concerns regarding potential conflicts during the review process. Florida, Maryland, New Jersey, and Virginia manage siting bodies that when reviewing applications, provide notice to applicants if issues arise. At this point, the siting body may provide recommendations or set conditions on applications that would allow the plan to proceed in the face of conflict.

Some states, however, take a more proactive approach. In Maine and Rhode Island, the leasing bodies require pre-application meetings with applicants to discuss potential conflicts. In Rhode Island, the CRMC requires that applicants complete a Preliminary Determination process which involves meeting with regulating agencies, town officials, and the RI Department of Environmental Management to discuss proposed plans. Similarly, in Maine, the Department of Marine Resources mandate that applicants have a pre-application meeting to discuss proposed operations with the Department, harbormaster(s), and/or the municipal officers of the town in which the applicant wishes to apply. In both states, these meetings allow officials who are familiar with competing uses in the area to advise applicants of potential conflicts so that they have to opportunity to modify applications before final submittal. Although Connecticut does not mandate such a meeting, the Bureau also recommends that a pre-screening meeting with the State Aquaculture Coordinator (or the local Shellfish Commission if the project is within town waters) before submitting an application.

Decision-Making Entity

Although siting bodies try to mitigate conflict during the process, final siting decisions must be made. In most states, the same statewide authorities that handle the application process make the final decisions regarding conflicting uses for leases (Table 2). These bodies, having compiled the required information regarding the proposed plans, essentially prioritize uses by approving leases. This situation occurs in Virginia, Maine, Maryland, and Rhode Island (Table 2). Florida and New Jersey are unique in how their leasing authority does not directly make final decisions. In Florida, the FDACS recommends to the Governor and Cabinet, who act as the Board of Trustees of the Internal Improvement Trust Fund, whether a lease should be approved. Similarly, in New jersey the Shellfisheries Commission submits recommendations to the Commissioner of the NJDEP regarding individual leases. In both scenarios, the leasing authority retains de facto authority over the decision.

Massachusetts and New York prove unique exceptions in that their siting decisions occur on a localized basis. In New York, oyster cultivation is allowed exclusively on privately owned land or on underwater lands specifically ceded to counties or towns by the state for the purpose of shellfish mariculture. Although the underwater lands are granted by the state, local governments are charged with developing leasing programs to handle the logistics of shellfish farming on these underwater lands. As a result, local governments, as opposed to statewide agencies, manage use of public waters. Similarly, in Massachusetts, the city council or mayor of each municipality has the authority to issue shellfish aquaculture licenses which function as leases. Although in both of these states leasing decisions are made on a local level, statutory requirements enforced by state and federal agencies still play a part in the determining the non-public policy aspects of the process.

Connecticut is also an interesting exception in that state and bodies make leasing decisions. In Connecticut, State waters are leased by the Department of Agriculture and town waters, (waters North of the State Jurisdiction Line), are leased by local shellfish commissions.

Productivity Requirements

Given the existence of competing uses, it is important that shellfish mariculture leases are efficient and productive to justify leases in state waters. Many states enforce productivity requirements that require certain minimum levels of effort and cultivation on leases. The three most common techniques used to gauge productivity are reviews or audits conducted by state authorities, annual or monthly reports compiled by leaseholders and submitted to state authorities, or minimum cultivation requirements (Appendix F, Table 4).

Reducing Barriers to Entry

Barrier: Cumbersome Leasing/Permitting Process

Shellfish mariculture requires various federal and state permits. The time and involvement required to complete the process in many states deters prospective farmers. Additionally, farmers looking to explore the feasibility of production in new areas are deterred for the same reason. The application process for permits therefore proves to be a significant barrier to entry that slows industry growth and innovation.

Coordinate and Streamline

In many states the permitting process has been streamlined through the use of joint agency permit applications. Joint agency permit applications simplify the permitting process by allowing applicants to complete one application which is reviewed by a variety of state and federal agencies. These agencies then administer the required permits to the applicant if they have met the necessary requirements. In states where these joint applications do not exist, applicants must independently determine which permits they need and which agencies to contact. These joint applications thus reduce the number of forms to be completed by the permit applicant, facilitate interagency review, and shift the burden of the permitting process from the applicant to the responsible agencies.

States with Joint Federal/State Permit Applications include: ME, NH, MA, RI, CT, NY, MD, VA, SC, MS, and WA. FL has a state programmatic permit that substitutes.

States without Joint Federal/State Permit Applications include: NJ, DE, NC, GA, LA, TX, CA, OR, AK.

Examples of JPA's:
-Application for Joint Programmatic General Permit for Aquaculture (CT) – link
-Tidewater Joint Permit Application (VA) – link
-Joint Application for State Commercial Shellfish Aquaculture Lease and Corps of Engineers Federal Permit (MD) – link

*General permits usually expire every five years. Applications are therefore subject to periodic modifications.

Delegate Federal Authority

On the federal level, one of the main agencies involved in permitting shellfish aquaculture is the United States Army Corps of Engineers (Corps). Applicants who wish to conduct any form of aquaculture involving structures or discharge in navigable waters must obtain a general permit from the Corps under Section 404 (e) of the Clean Water Act and Section 10 of the Rivers and Harbors. The Corps authorizes aquaculture under three types of general permits: Nationwide Permit 48 (NWP), Regional General Permits (RGPs), and Programmatic General Permits (PGPs).

In most states the Corps must review joint or individual applications to issue general permits for shellfish mariculture projects. In Florida and Virginia, however, federal authority has been delegated to state agencies to ease the burden on the Corps and to increase the efficiency of the permitting process. Florida's permitting employs programmatic general permit SAJ-99. Programmatic general permits are a specific kind of general permit are developed jointly by the USACE and a state or local regulatory agency wherein the state or local agency evaluates actions covered by the permit and verifies on behalf of the Corps that activities meet the terms and conditions of that PGP. Under SAJ-99 Florida has the authority to approve shellfish mariculture projects given that they comply with the state's Best Management Practices and the PGP's conditions. This process ensures that federal conditions are met without requiring individual review from federal agencies. Similarly, the Corps in Virginia operates under state verification for all shellfish lease activities with the exception of float culture, although this practice has not been finalized in a permit agreement. Both of these processes have been found to improve the efficiency of the permitting process (O'Connell, 2018).

Tiered Project Levels for General Permits

The New England Corps District has been a leader in establishing categories for permit review levels that help simplify the permitting process. These categories establish thresholds that determine the amount of review needed by the Corps. The District suspended NWP 48 and established a tiered, category system because they realized that small shellfish mariculture operations using bottom culture or transient gear, of which there are many in New England, do not require extensive review. This system allows the Corps to prioritize resources for reviewing more intensive projects using cages and float culture methods. Furthermore, because each tier features different notification and review requirements, the approach as a whole allows the applicant to complete a permitting process that is more specialized and appropriate for their particular project (O'Connell, 2018).

Limited Site Suitability Leases

Maine and Rhode Island offer limited suitability leases which allow shellfish farmers to experiment with small scale shellfish aquaculture operations. These leases feature expedited permitting processes and smaller fees that attempt to encourage innovation and expansion that the extended permitting process would otherwise thwart. The two

programs are summarized in Appendix F, Table 5 and compared to the standard leases in each state.

Barrier: Lack of Skills or Knowledge

Entry into shellfish mariculture requires a variety of specialized skills and knowledge that prospective aquaculturists often lack, this includes gear and site selection, seed handling, harvest procedures, and other information. Proper education works to ensure that growers are well-prepared to effectively farm leases.

Educational Opportunities

In many states cooperative extension programs provide classes that introduce potential growers to the fundamentals of shellfish mariculture. The University of Florida IFAS Shellfish Aquaculture Extension Program, the University of Maryland Extension's Oyster Aquaculture and Education Program, and Southeastern Massachusetts' Aquaculture Center all offer online classes and/or in person workshops to educate potential growers. Class range from the basics of mariculture to more specialized classes, like Maryland's Remote Setting Training Program. These programs receive federal money through the Cooperative State Research, Education, and Extension Service (CSREES) and other federal agencies, but certain programs require course fees. Oftentimes, in addition to hosting classes, Extension programs post archived course materials, lecture videos, and other resources on their websites. Florida's Extension even has an entire website that serves as a comprehensive "Online Resource Guide for Shellfish Aquaculture." These resources work to help growers establish profitable aquaculture businesses.

Sea Grant Programs also assist in grower education. In Maine, the "Aquaculture in Shared Waters" program coordinated by Maine Sea Grant and primarily funded by NOAA Sea Grant offers free courses for prospective shellfish mariculturists. The course primarily targets fishermen who could benefit from a more diversified income, allowing them to move from one fishery to another during the year. Similarly, in Rhode Island, Roger Williams University offers a 14-week course for aspiring shellfish farmers. A team that includes Rhode Island Sea Grant, the Coastal Resources Management Council, and others, is currently working on a two-year NOAA-funded effort to expand the course and create an interactive "Applied Shellfish Farming" webpage with various resources. The RI CRMC considers the course an unofficial requirement for prospective shellfish farmers.

Mandatory Workforce Training

Some states have developed mandatory training requirements. These requirements tend to focus on sanitation issues and harvest procedures as they help states comply with the National Shellfish Sanitation Program (NSSP).

- Virginia has mandatory online shellfish sanitation training module which helps growers get a better sense of how to prevent contamination. https://webapps.mrc.virginia.gov/public/training/register.php.
- Rhode Island has a mandatory online shellfish harvester education course. http://www.dem.ri.gov/programs/water/shellfish/shellfish-harvester-education.php

- Florida leaseholder must annually take an in-person or online workshop to obtain a Certificate of Harvester Education and Training (online or in person).

http://shellfish.ifas.ufl.edu/news/shellfish-harvester-educational-training-program/

Barrier: Lack of Capital

Shellfish mariculture startup expenses can run from $5,000 to more than $100,000 depending on the scope of the enterprise according to the Maryland Agricultural & Resource-Based Industry Development Corporation. Furthermore, traditional commercial lenders are hesitant to grant loans to mariculturists for small enterprises; the two-three year growing period, along with prospective farmers' lack of business planning, available business equity, and collateral security, deters potential lenders.

Loan Programs

Alaska and Maryland have mariculture loan programs for current or prospective shellfish mariculturists. Maryland's program is co-run by Maryland Agricultural and Resource-Based Industry Development Corporation (MARBIDCO) and Maryland Department of Natural Resources. A Shellfish Aquaculture Financing Committee composed of representatives from the Department of Natural Resources, University of Maryland Extension, a Maryland Farm Credit Association, and MARBIDCO, review the creditworthiness of borrowers and the viability of their mariculture business plans. The program is subsidized by Maryland's oyster restoration budget and all payments return to a revolving fund for future rounds of funding. In Alaska, the Department of Commerce, Community, and Economic Development offers a mariculture loan for the planning, construction, and/or operation of a mariculture business. The maximum loan amount is $100,000 per year with an aggregate maximum of $300,000 per borrower.

Business Support

Comprehensive business plans have been found to assist in obtaining financial aid and improving the chances for success. In Delaware, Alaska, and North Carolina Business plans are required by state rules and/or applications.

Beyond requiring plans, many states offer business planning tools to prospective growers:

- Maryland
    - University of Maryland Extension and MARBIDCO business plan guidance document outlines the sections that are contained in a good business plan. The fill in the blank format provides an easy to use road map for writing a strong plan http://www.marbidco.org/Business%20Plan%20Development%2019%20Oct%2010.pdf
    - University of Maryland Extension "Remote Setting Cost Analysis" document and spreadsheet help growers decide whether remote sensing is feasible for them https://extension.umd.edu/sites/extension.umd.edu/files/_images/programs/aquaculture/Remote%20Setting%20Cost%20Analysis%20Full%20publication.pdf
- Alaska:

    - AK Sea Grant Marine Advisory Program has an online, interactive fishery business planning tool that allows mariculturists to create business plans online. https://seagrant.uaf.edu/map/aquaculture/shellfish/index.html
- Alabama
    - AL has an agricultural and fisheries small business planning website tool. https://agtransitions.umn.edu/PublicPages/GettingStarted.aspx
- Virginia:
    - VA Sea Grant has an oyster enterprising budgeting user guide that helps growers estimate costs and earnings. It is downloadable off the VIMS website (below) http://www.vims.edu/research/units/centerspartners/map/aquaculture/index.php
- Connecticut:
    - CT Sea Grant developed a document entitled "Developing an Aquaculture Business Plan" http://media.ctseagrant.uconn.edu/publications/aquaculture/busplan.pdf

Leasing Process Costs

Although labor and materials compose the majority of mariculture start-up costs, the leasing process also has a variety of fees. States manage these fees and thus determine values that do not pose excessive barriers to entry. A snapshot of leasing expenses across a variety of states is provided in Appendix F, Table 6.

Promotion of the Shellfish Industry

State Government Marketing Programs

State governments support shellfish mariculture through their general seafood marketing campaigns typically lead by states' departments of agriculture. These campaigns focus on creating seafood brands through a variety of strategies.

One main tool used by many states is to create a seafood marketing website. These websites help states develop brands for their seafood products by featuring slogans and logos and including links to their social media sites. On the websites, shellfish may have their own pages or are mentioned more generally throughout the site. Marketing features include maps allowing consumers to locate shellfish farms within their state, recipes that feature shellfish, lists of seafood restaurants, and details regarding the sustainability of shellfish mariculture. A summary of a few of these sites is included in Appendix F, Table 7.

In terms of shellfish mariculture, one downfall of these sites is that they are designed to supporting existing commercial fisheries that are struggling, rather than to promote mariculture, which is a newer, distinct industry. Therefore, they often fail to highlight the benefits of oyster mariculture and resort to promoting oysters in general, which can be farmed or wild caught. If there is a mariculture page, it is often buried within the site and one would almost have to be specifically looking for it to find it.

Beyond, websites, state governments also employ a variety of other techniques. Marketing bodies attend trade shows, cooperate with wholesalers and restaurants, print

branded labels, and try to increase awareness about local seafood and sustainability. Furthermore, some specialized programs focus on shellfish mariculture. Maryland, for example, has an Oyster Pledge program where restaurants can apply to be certified as Oyster Pledge vendors if they agree to keep at least one Maryland oyster on their menu at all times. Certified restaurants are allowed to use the oyster pledge seal which assures premium Maryland quality.

Tourism Websites

State tourism websites also help in promoting shellfish mariculture. These sites are either state-run or are managed by corporations created as private/public partnerships. As opposed to seafood marketing sites, these tourism websites focus on farmed shellfish more as an experience than a seafood product. The sites highlight growers that offer tasting experiences and restaurants that have a wide selection of shellfish.

- Virginia does an exceptional job of incorporating oysters into their website and tourism brand with their "Virginia is for Oyster Lovers" webpage.
    - https://www.virginia.org/oysters
- New England's tourism page, www.visitnewengland.com, features articles highlighting farmed oysters throughout New England. Here is an example in Maine:
    - https://www.visit-maine.com/greaterportlandcascobay/80-great-things-to-do-in-maine/

Oyster Trails

Oyster trails in many states feature tours of oyster farms, oyster-themed art, and restaurants with large oyster selections. These trails aim to attract consumers to oyster hubs and are marketed as valuable educational, cultural, and culinary experiences. The trails were created by a variety of bodies including tourism corporations, industry groups, research collaboratives, and city governments. A summary of major trails is featured below:

- Rhode Island Oyster Trail
    - Founder: Ocean State Aquaculture Association (OSAA)
    - https://rioystertrail.com/
- Maryland Crab and Oyster Trail
    - Founder: Maryland Office of Tourism Development
    - https://www.visitmaryland.org/article/maryland-crab-oyster-trail
- The Oyster Trail of Maine
    - Founder: Maine Sea Grant, University of Maine Extension, Maine Aquaculture Association, and Maine Aquaculture Innovation Center.
    - https://seagrant.umaine.edu/maine-oyster-trail
- Virginia Oyster Trail
    - Founder: Artisans Center of Virginia (ACV)
    - http://virginiaoystertrail.com/index.php/home/about
- Panama City (FL) Oyster Trail
    - Founder: Panama City
    - https://destinationpanamacity.com/oyster-trail/

Self Promotion

Individual mariculture enterprises operate as businesses and thus independently develop their own marketing campaigns. This promotion encompasses a variety of strategies; farms create websites, make logos, run blogs, advertise on social media, offer tours, and take other measures. One particular strategy common among growers is to emphasize the locality and site-attachment aspects of their oysters. This helps their brand by establishing a unique quality standard for their shellfish and improves their ability to sell to out of state vendors who profit from selling a diverse selection. It is important to note that the extent to which a farm advertises often depends on the local market conditions and whether they sell their own shellfish directly to consumers or restaurants, or to wholesalers.

Marketing Resources

In Maine and Florida efforts have been made to help growers self-promote. The Northeast Regional Aquaculture Center funded a shellfish marketing workshop at the University of Southern Maine in 2010. Over 50 shellfish growers, seafood buyers, scientists, and others gathered at the event. A variety of speakers gave presentations on the essentials of shellfish marketing. Maine Sea Grant has kept many of presentations and documents from the workshop on their website, providing a great resource for shellfish growers and others. In Florida, the University of Florida, the Department of agriculture and consumer services, and FL Sea Grant held a "Harvesting and Marketing Cultured Oysters" workshop in 2015."

Appendix F Tables

Appendix F, Table 1: Governance of Mariculture Programs Among States.

State	Mariculture Program	Administering Body	Advisory Groups
Maryland	Aquaculture and Industry Enhancement Division	Department of Natural Resources	Aquaculture Coordinating Council
Connecticut	Bureau of Aquaculture	Department of Agriculture	Aquaculture Advisory Council
Florida	Bureau of Shellfisheries	Department of Agriculture and Consumer Services	Aquaculture Review Council
Virginia	*Undefined	Marine Resources Commission	Aquaculture Advisory Board
Maine	Aquaculture Program	Department of Marine Resources	Aquaculture Advisory Council
New Jersey	Office of Aquaculture Coordination	Department of Agriculture	Aquaculture Advisory Council
New York	Undefined	Department of Environmental Conservation	None
Massachusetts	Shellfish Program	Department of Marine Fisheries	Shellfish Advisory Panel
Rhode Island	Undefined	Coastal Resources Management Council	None

*Undefined = shellfish mariculture program does not have a specific name or organizational level w/agency

Color Key: Marine or coastal resources, Agriculture, Resource conservation

Appendix F, Table 2: Siting Process Conflicting Issues Components Among States.

State	Leasing Decision Maker	Notification Process	Comment Period	Required Public Hearing
North Carolina	NC DEQ Division of Marine Fisheries (DMF) Director	DMF runs two public notices in a local newspaper, issues a press release, and notifies DMF proclamation lists of the proposed site.	Yes; 30 days	Yes
Connecticut	Connecticut Department of Agriculture (advised by local Shellfish Commission if in town waters)	Notice of the application is advertised by the Commissioner of Agriculture for one day in a newspaper having a daily circulation in the town or city where the oyster grounds are located and on the Department of Agriculture's website. Advertisements must appear at least ten days before the date set for the bid opening. It is the policy of the Department of Agriculture that all new leases are posted to the DOA website on or before the 15th of the month with the bid opening the first week of the following month.	No, but 10 days notice of public hearing	Yes for town leases; conditional for state leases
Florida	Board of Trustees of the Internal Improvement Trust Fund (advised by FDACS)	FDACS will notify riparian property owners who reside within 500 feet of the proposed lease site, and prepare a notice for the local newspaper.	No.	Yes, if substantial objections are received, particularly from affected upland property owners, a public meeting may be scheduled in the area.
Virginia	Virginia Marine Resources Commission Commissioner	1. Notice of the application is posted by the Commission for not less than 30 days on its website. 2. Oyster farmers with land contiguous to land being applied for and the owners of any riparian property located within 200 feet of the ground applied for are notified by certified mail. 3. The application is public noticed once a week for four consecutive weeks in a local newspaper, also posted in two prominent publicly accessible locations in the area of the application and posted at the local courthouse of the locality where the application is submitted.	If no protest within 60 days of posting of notices, survey is conducted. 30-day waiting period after approval.	If the objections cannot be resolved the matter is then scheduled for a full hearing at a monthly Commission meeting for final action by the Commission.
Maine	Department of Marine Resources Commissioner	Department shall make a copy of the completed application available to the known riparian owners within 1,000 feet of the proposed lease and to the officials of the municipality or municipalities. Personal Notice of Public Hearing and Public Notice of Public Hearing are sent out by the Department.	No, but 30 days notice of public hearing	Yes
Maryland	Maryland Department of Natural Resources	Department will notify adjacent property owners with a map of the proposed lease location and a project description through U.S. Mail. The Department will also issue a public notice with this information through the Department's website and social media sites, a county newspaper, and to the Chair of the County Oyster Committee in the county of the proposed activity. State law requires advertising for 2 consecutive weeks followed by a 30-day public comment period.	Yes; 30 days	Yes but only if requested; any person can request.
Massachusetts	The city council or mayor	Public hearing with ample notice required; notice of hearing must be posted in 3 or more public places and printed in the local newspaper at least 10 days before	Not required	Yes
Rhode Island	Coastal Resources Management Council	Public notices posted on CRMC website. Also, public notice is sent on formal applications and/or starred (*) administrative applications to immediate abutters, appropriate municipal agencies in the area or areas so affected by the activity, appropriate quasi-municipal and state agencies which may be affected by the proposed activity, appropriate citizen interest groups, as well as state and local officials in the area or areas of the proposed activity	Yes; 30 days	Yes, if enough comments are received during comment period.
New York	Municipalities	Varies **Suffolk County** Subsequent to the close of the lease application period, there is a mandatory 60-day public notice period during which the public, regulatory agencies and municipalities may submit written comments to the Department that pertain to the lease sites that were applied for under a given application cycle. All comments will be summarized and presented to the Aquaculture Lease Board (ALB).	Varies	Varies

Appendix F, Table 3: Lease Conditions and Parameters Among States.

Parameter	Lease Term	Bottom Lease Max Height	Maximum acreage per lease	Maximum acreage per person
North Carolina	10 years/renewable	18 inches (2015 S.L.)	5-10 acres No more than 50 acres	50 acres
Connecticut	3-10 years / renewable	No	50 acre minimum and 200 acre maximum per bid. It is the policy of the Department of Agriculture that lease be square or rectangular in shape	No
Florida	10 years/renewable	6 inches	By law 10 acres for oysters and 5 acres for clams but the Division has generally recommended a maximum of 5 acres per applicant	No
Virginia	10 years/renewable	12 inches	Up to 250 acres per lease. A person may not lease more than 3,000 total acres of water for aquaculture, except in the Chesapeake Bay, where 5,000 acres of aquaculture leasehold may be assigned to a person in waters 15-feet deep or greater	No
Maine	LPA: 1 calendar year, all LPAs expire Dec 31 each year (renewable) Experimental: Up to 3 years, start date flexible within 1 yr. of lease decision (Nonrenewable except for research) Standard: Up to 20 years (Renewable-must apply no later than 6 months before expiration of current lease)	No	4 acres (experimental) ≤ 400 sq ft of gear around a central point (LPA) 100 acres (standard)	1,000 acres
Maryland	20 years/1 renewal	3 inch shell 18 inch cages required water column	Under USACE GP 50 acres bottom 5 acres with bottom cages 3 acres with floating cages	No
Rhode Island	10 years/renewable	No	Maximum 5% of any coastal pond	No

Appendix F, Table 4: Productivity Requirements Among States.

State	Review/Audit	Report	Cultivation Requirements
Florida	Annual audit (conducted by FDACS) to ensure cultivation requirements are being met	X	Must pant a minimum 100,000 clam seed or 70,000 oyster seed per acre, per year -The leaseholder also agrees to have cultivated at least ½ of the leased area within the second year of obtaining the lease and at least ¼ of the leased area each year thereafter until the entire leased area is under cultivation.
Virginia	X	Monthly harvest report must be submitted to the Commission.	X
Maine	The Commissioner conducts an annual review of each aquaculture lease and the Department of Marine Resources monitors leases on an annual basis. If no substantial aquaculture or research has been conducted on the site the Commissioner may initiate revocation proceedings.	Throughout the duration of the lease the applicant is required to submit an annual report containing seed and harvest count.	X
Maryland	X	Leaseholders are also required to submit a Monthly Shellfish Aquaculture Harvest Report and an annual use report. Failure to submit any report or maintain active use of a lease site may result in lease termination.	The active use requirement agreed to in the application allows growers to apply for as much acreage as they need with the stipulation that they must file a production plan and meet minimum planting requirements. These requirements include annually planting at least ¼ of the leased area at a minimum density of one million shellfish seed per acre.
Massachusetts	X	The state of Massachusetts requires each licensee to submit an annual report to the Director of the Division of Marine Fisheries and the local shellfish constable containing the total number of each kind of shellfish planted, produced or marketed during the previous year and an estimate of the total number of each kind of shellfish currently on the lease site.	Upon granting a license, the local municipality may specify a reasonable market value to be produced by each shellfish project. If the licensed project fails to meet this value for three consecutive years the licensee may be forced to forfeit their license and site area.
New Jersey	X	A permittee is required to maintain records for the first three years of production by documenting lease operations including the quantities of shellfish harvested, by species. This metric is also used to determine whether or not a permittee will be granted a renewal upon re-applying.	X
Rhode Island	X	Leaseholders are required to file an annual report to the CRMC that includes the planting number, seed source, inventory, number harvested and number sold.	X

Appendix F, Table 5: Leasing Specifications Compared Between Maine and Rhode Island

	Maine		**Rhode Island**	
	Limited Purpose Aquaculture (LPA) Lease	Standard Lease	Commercial Viability Permit (CVP)	Standard Lease
Application Fee	$50	$1,500	$25	≥ $75
Rent	No	$100/acre/year	No	≥ $75
Max Size	400 sq ft	100 acres	Up to 1000 sq ft	None except maximum 5% of any coastal pond
Average time to obtain	1-12 months depending on gear used	10-15 months	2-3 months	8-9 months
Term	1 calendar year	10 years	Up to 3 years	10 years
Renewable?	Yes	Yes	No	Yes

Appendix F, Table 6: Leasing Expenses Among States.

State	Application Fee	Fee for Containers	Annual Rent	Survey Fee	Other Fees
North Carolina	$200 bottom $100 water column	No	$10/acre bottom $100/acre column	Varies	No
Connecticut	$100	No	Determined through bidding process for 1 year's rental fee (minimum $4.00 per acre)	$35.00 per corner fee for surveying	Legal notice fee - $100 (more or less)
Florida	$200	No	$16.73/acre bottom leases and $10.00 surcharge/acre $33.46/acre water column and $10.00 surcharge/acre		Aquaculture Certificate of Registration $100 fee to apply or renew (annual)
Virginia	$25	Yes $125-$1000	$1.50/acre	$675	Floating cages - $217.80/acre; use fees - vary Notification of adjoining leaseholders and highland property owners - $5.20; plat charge -$100; recording fee - $12; assignment fee $1.50
Maine	$100 experimental lease $50 LPA (resident); $300 LPA (nonresident) $1,500 standard lease bottom	No	$100/acre/yr (experimental) $50/yr (LPA) $100/acre/yr (standard)	No	Renewal fees in 10 yrs for standard leases
Maryland	$300 bottom IP $300 water column IP	No	$3.50/acre bottom $25/acre water column	No	$1 million liability insurance required for water column use
Rhode Island	$25.00 fee for Preliminary Determination (before full application) Full application fee varies based on estimated project cost, minimum $50	Yes Cost Determined by square footage ($75.00) 0-600 sq feet ($100.00) 601-1,200 sq feet ($150.00) 1,201-2,400 sq feet ($75.00) for each additional 1,200 sq feet	The annual fee is seventy-five ($75.00) for half an acre or less, one hundred and fifty dollars ($150.00) for a half to one acre, and one hundred dollars ($100.00) for each additional acre.	No	$200 annual fee for aquaculture license

Appendix F, Table 7: Seafood Marketing Websites Among States.

State	Florida	Virginia	Maryland	Rhode Island
Site Manager	Florida Department of Agriculture, Bureau of Seafood and Agriculture Marketing	Virginia Department of Agriculture and Consumer Services, Virginia Marine Products Board	Maryland Department of Aquaculture	The Rhode Island Seafood Marketing Collaborative, chaired by the RI Department of Environmental Management.
Shellfish Farming Site Features	Oyster recipes brochure, clam cooking information, general overview of oyster and clam farming information.	Oyster grower locator map and directory, shellfish recipes, shellfish species fact sheets.	Aquaculture operations finder map, shellfish recipes, information on environmental sustainability and shellfish farming.	Newport Oyster Festival advertisement, list of seafood vendors.
Slogan	"Fresh from Florida"	"Wild. Sustainable. Available."	"Maryland's Best Seafood: Fresh - Local"	None
Link	https://www.freshfromflorida.com/Divisions-Offices/Marketing-and-Development/Consumer-Resources/Buy-Fresh-From-Florida/Seafood-Products/Oysters	http://www.virginiaseafood.org/the_trade/retail_buyers/index.htm	http://seafood.maryland.gov/oyster-aquaculture/	http://www.dem.ri.gov/riseafood/about.php
Corresponding Facebook Page	https://www.facebook.com/FloridaAgriculture/	https://www.facebook.com/virginiaseafood	https://www.facebook.com/Marylands-Best-Seafood-502161626787957/	https://www.facebook.com/rhodeislandseafood/

State Websites Referenced.

Alaska

https://seagrant.uaf.edu/map/aquaculture/shellfish/index.html

Alabama

https://agtransitions.umn.edu/PublicPages/GettingStarted.aspx

Connecticut

http://www.ct.gov/deep/cwp/view.asp?a=2705&q=431902&depNav_GID=1622

https://www.lawserver.com/law/state/connecticut/ct-laws/connecticut_statutes_26-194

http://www.nae.usace.army.mil/portals/74/docs/regulatory/StateGeneralPermits/CT/Aquaculture_permitguide_2014_update.pdf

https://www.cga.ct.gov/2017/pub/chap_491.htm#sec_26-192m

http://www.ct.gov/doag/lib/doag/aquaculture/2017/SeaGrant_PermitGuide2017.pdf

Florida

https://www.freshfromflorida.com/content/download/76600/2214244/FDACS-P-01758_final_5-2017_2_(1).pdf

https://www.freshfromflorida.com/Divisions-Offices/Aquaculture

https://www.freshfromflorida.com/Business-Services/Advisory-Councils-and-Committees/Aquaculture-Review-Council

https://www.freshfromflorida.com/content/download/75596/2204776/FDACS-P_00076.pdf

http://shellfish.ifas.ufl.edu/getting-started/

https://www.freshfromflorida.com/content/download/63235/1446462/arc_florida_aquaculture_plan_oct_2015.pdf

http://www.saj.usace.army.mil/Missions/Regulatory/Public-Notices/Article/1247422/saj-2007-03138-pgp-deb/

Maine

https://www.maine.gov/dmr/aquaculture/forms/index.html

https://www.maine.gov/dmr/laws-regulations/regulations/documents/Chapter2_031918%20.pdf
http://www.mainelegislature.org/legis/statutes/12/title12sec6080.html

https://www.seagrant.umaine.edu/aquaculture/aquaculture-in-shared-waters

http://www.nae.usace.army.mil/Portals/74/docs/regulatory/StateGeneralPermits/ME/Maine_General_Permit_2015.pdf

https://www.maine.gov/dmr/commercial-fishing/licenses/documents/2018/shellfish-worm-greencrab-aquaculture.pdf

Maryland

https://law.justia.com/codes/maryland/2015/article-gnr/title-4/subtitle-11a/section-4-11a-09/

http://dnr.maryland.gov/fisheries/Documents/Shellfish-Lease-Application-Instructions.pdf

https://msa.maryland.gov/msa/mdmanual/21dnr/html/21agen.html

http://dnr.maryland.gov/fisheries/Pages/mgmt-committees/acc-index.aspx

http://dnr.maryland.gov/fisheries/pages/aquaculture/index.aspx

http://dls.maryland.gov/pubs/prod/NatRes/Fostering-Shellfish-Aquaculture-Production-in-Maryland-and-Other-States.pdf

Massachusetts

https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIX/Chapter130/Section57

https://www.capecodextension.org/marine/semac/

New Jersey

https://www.nj.gov/dep/fgw/pdf/marine/shellfish_leasing_policy_atlantic.pdf

New York

http://assembly.state.ny.us/leg/?default_fld=&bn=A07120&term=2011&Summary=Y&Actions=Y&Votes=Y&Memo=Y&Text=Y

Rhode Island

http://www.crmc.state.ri.us/applicationforms/AquaApp.pdf

http://www.shellfishri.com/ri-shellfish-initiative/

http://www.dem.ri.gov/riseafood/documents/rishellfishmktguide012017.pdf

http://www.appliedshellfishfarming.org/about/

Virginia

http://www.mrc.state.va.us/Shellfish_Aquaculture.shtm

https://law.lis.virginia.gov/vacode/title28.2/chapter6/

https://www.hampton.gov/DocumentCenter/View/6299/Oyster-Ground-Leasing-Public-Information-questions

https://law.justia.com/codes/virginia/2016/title-3.2/chapter-26/

http://www.nao.usace.army.mil/Portals/31/docs/Revised_Standard_JPA_FillableForm_MAR201
4.pdf

http://www.mrc.virginia.gov/regulations/MRC_Scanned_Regs/Shellfish_Mix/fr1130_12-01-07.pdf

http://www.nao.usace.army.mil/Portals/31/docs/regulatory/RPSPdocs/17-SPGP01%20SOP%20with%20attachments.pdf?ver=2017-06-30-141232-937

Appendix G. Past and Future Metrics of Success

Major Legislative Accomplishments in Support of the North Carolina Shellfish Mariculture Industry		
Actions to Support the Shellfish Industry	**Outcome Achieved**	**Complete**
Appropriate funding for shellfish pathology lab	Position funded at NCSU CMAST	✓*
Appropriate funds to reopen the northern Shellfish Sanitation	Re-opening of administratively closed waters	✓*
Funding a research shellfish hatchery at UNCW	Significant progress in development of superior performing broodstock	✓*
Commission a Shellfish Mariculture Advisory Committee	Identification of actions for ecologically, economically, and socially sustainable growth of the shellfish farming industry in NC	✓
		*Strongly Recommend Continuation of State Support

Metrics of Success in Fulfilling the SMAC Strategic Plan for Shellfish Mariculture: Present through 2030			
Recommendation		**Metrics of Success**	**Complete**
#	**Summary**		
1	Embrace a $100 Million Industry Valuation Goal	Provide additional resources to growers, regulatory body, and promotional agency	
2	Petition for Farm Bill Insurance and Support NCSGA efforts to develop a Shellfish Mariculture Insurance Program	Successful submission of Concept Proposal, Shellfish growers covered under Farm Bill Insurance	
3	Establish a Low-Interest Loan Program	Establish funding mechanism and have fewer growers report financing as a major challenge compared to Turano *et al.* 2011	
4	Specify the Eligibility of Shellfish Farmers for Agricultural Disasters Relief Funds	All future disaster relief funds appropriated to the NCDA&CS specify mariculture inclusion	
5	Commission a Market Analysis	Market analysis completed	
6	Fund a Shellfish Mariculture Advisory Panel at NCDA&CS	Establishment of advisory committee	
7	Fund Development of North Carolina Oyster Trail	Completion of Implementation Phases 1-6 (Appendix D) by 2022	
8	Establish a Shellfish Mariculture Governance Advisory	Establishment of Advisory Committee	
9	Establish a Shellfish Leasing Section at NCDMF	Section established, reduced lease application backlog	
10	Amend G.S. 113-202: Increase Secretary's Discretion	Reduction in percentage of challenged lease decisions	
11	Establish Shellfish Enterprise Areas (SEAs)	Establishment of at lease one SEA	
12	Permit a Capped Number of Single-Application 50-Acre Leases	Larger leases available by early 2020s; Feedback on impacts available early 2026	
13	Increase Utilization Requirement	All leases meeting utilization requirement, 100% monitoring	
14	Increase Penalties for Those Convicted of Illegal Taking of Shellfish from Leases	Statutory language changed. Increased average penalties for convicted shellfish poachers	
15	Afford the Secretary discretion to permit shellfish nurseries in prohibited waters	Statutory language changed	
16	Appropriate Funding for Additional NCDEQ Water Resources Staff	Three new staff positions funded	
17	Revise State Grant Scoring to Benefit High Priority Growing Areas	Scoring criteria modified. Increased proportion of funding going to projects benefitting high priority growing waters	
18	Require Low-Impact-Development for State Projects	New statute passes requiring EISA-like LID standards for state funded construction	
19	Establish a Shellfish Mariculture Grant Program	Recurring funds appropriated for grant program	
20	Establish a Mariculture Resource Grant Program	Recurring funds appropriated for grant program. Affirmation of value by the NCSFA	
21	Fund an Additional Position at North Carolina Sea Grant	Additional position at North Carolina Sea Grant funded	

Appendix H. Research and Development: Current Priorities

Spatial Planning

Siting shellfish mariculture requires a balance between ecological, social, and economic considerations. Effective spatial planning can facilitate sustainable development of shellfish mariculture and reduce user conflicts, an increasing problem as demonstrated by the growing number of contested lease decisions in North Carolina (Fig. 14). Marine and estuarine spatial planning considers uses from multiple sectors and provides an opportunity for open participation, increasing trust in scientifically-based management. There are numerous examples demonstrating the value of marine spatial planning for reducing user conflict (e.g. Mallorca, Bay of Biscay, Scotland) (Douvere 2008). Specific to mariculture, the German government has utilized spatial planning to investigate suitability of their EEZ for mariculture as well as other competing uses based on biophysical characteristics, generating maps of areas where each activity is best suited (Gimpel et al 2015). Indeed, North Carolina has already benefitted extensively from marine spatial planning to inform siting of shellfish leases. The NC Shellfish Siting Tool (https://uncw.edu/benthic/sitingtool/), created by UNC Wilmington researchers and collaborators, that incorporates a range of biological (fish nursery area, submerged aquatic vegetation), physical (salinity, depth, bottom type, land cover), management (shellfish growing areas classification, military danger zone), and conflicting use (submerged land claims, existing leases, utilized channel) layers is generally a first step recommended to prospective shellfish growers. However, funding is required to build upon the existing siting tool by collating additional information into layers that would further inform lease siting decisions and likely reduce litigation associated with those decisions. North Carolina is now also part of NOAA's National Shellfish Initiative which will provide additional technical assistance and help leverage state and federal funds, matched with cost share programs, to grow an ecologically and economically beneficial shellfish mariculture industry. Specifically, NOAA is committed to working with North Carolina partners, both public and private, on research focused on spatial planning, environmental impact, farming practice efficiency, and improving management efficiency.

Selective breeding for better performing shellfish

The General Assembly has already demonstrated its commitment to supporting the shellfish mariculture research by appropriating one-time and recurring funds to construct and support a breeding program for oysters, respectively, the Shellfish Research Hatchery (SRH) located at the University North Carolina Wilmington. SMAC strongly recommends the General Assembly continues to appropriate funds for the breeding program. The hatchery has already made tremendous strides in selectively breeding North Carolina oysters to generate lines that perform (survive and grow) well in North Carolina waters. Such lines can be used as broodstock (parents) that can produce seed for aquaculture that exhibits that same high performance. The budget allocated to the SRH currently supports the breeding, larval culture, seed production and lines testing on the Aquaculture Demonstration Lease (ADL) at UNCW. It also supports genetic analysis of the oyster lines and disease monitoring on the ADL to provide information of the efficacy of the breeding program to achieve the advances in performance without sacrificing

genetic diversity. There aren't sufficient funds to conduct the large-scale field tests of the performance of these lines throughout state waters (e.g. working with growers and researchers across the state to conduct rigorous, multifactorial experiments examining differential growth and mortality). Providing a mechanism to fund this research will be critical to ensuring the best use of past and continuing investment in the SRH's breeding program as well as provide resources to apply these approaches to other species, allowing crop diversification for the farmers.

Shellfish Pathogen Ecology

In 2018, the North Carolina General Assembly took a major step in funding a shellfish pathology position to be located at North Carolina State University. This position will largely address diseases that impact the health of shellfish, research of vital importance to both cultured and wild stocks. The position will likely conduct considerably less research on pathogens present in shellfish that can affect human health. These pathogens are largely a concern for the raw shellfish, predominantly oysters, market. *Vibrio,* a pathogen ubiquitous in marine environments, is omnipresent in shellfish, but, proper handling (i.e. icing/refrigerating after harvest, appropriate depuration practices), helps to minimize the post-harvest growth of *Vibrio* which can be harmful if consumed. However, *Vibrio,* particularly the highly pathogenic *Vibrio vulnificus*, can cause serious illness and death in people with certain health conditions such as liver disease, hemochromatosis, diabetes, and those who are immunocompromised because of certain types of cancer or HIV infection (Stahr et al. 1989). Indeed, those with chronic liver disease are 80x more likely to develop infection from *V. vulnificus* and 200x more likely to die from the infection than those without chronic liver disease (Control and Prevention 1993).

Between 1973 and 2006, there were 2 confirmed seafood-associated outbreaks in North Carolina and 188 in the entire United States, leading to 4,020 illnesses, 161 hospitalizations, and 11 deaths (Iwamoto et al. 2010). During the same period, there were 9 multistate outbreaks related to consumption of widely distributed oysters, most of which occurred after the mid 1990's (Iwamoto et al. 2010) This is likely a low estimate; however, as the number of seafood-associated illness in the database increased significantly in 1998, the year when increased reporting began. In the late 1990s and through most of the first decade of the 2000s, outbreaks per year across the Nation averaged between 5 and 17, affecting between 200 and 750 people annually (Iwamoto et al. 2010). More recent data from the Centers from Disease Control suggests that, between 2007 and 2015, *Vibrio parahaemolyticus*, which largely leads to non-life-threatening gastrointestinal illness (e.g. diarrhea, abdominal cramping, nausea), has accounted for ~3225 cases of vibriosis and its incidence has been on the rise (Burdette 2017). Specifically, incidence of foodborne illness, largely from raw oysters, increased from ~0.06 cases per 100,000 population to ~.15 cases per 100,000 population (Burdette 2017).

While the odds of contracting vibriosis and other human pathogens from shellfish are low compared to other foodborne illness like salmonellosis (17.2 per 100,000 in 2017, CDC) the stakes are high. Besides the impact to those sickened, disease outbreaks from shellfish are often given wide media coverage, often with devastating impacts on the demand for a state or region's shellfish. For example, front page coverage in the *New York Times* and

Daily News about *V. vulnificus* in Gulf of Mexico oysters, surveys respondent in New York routinely responded that Gulf oysters were unsafe and surveyed New York restaurants stopped carrying Gulf oyster (Bartholomew 1999). West Coast distributors similarly reported unwillingness to purchase Gulf oysters due to negative publicity (Hardesty 2001). Subsequent to the *Vibrio* event, dockside prices for Gulf oysters declined 30 to 50% (Keithly Jr and Diop 2001). Research conducted by the USDA may explain some of this phenomenon. In a study examining consumer behavior after separate disease outbreaks from melons contaminated by either *Salmonella* or *Listeria monocytogenes*, they found that, despite the coverage of the *L. monocytogenes* outbreak resulted in reduced consumer demand, while coverage of *Salmonella* did not have the same effect (Kuchler 2015). Although *L. monocyogenes* primarily poses a serious health risk to a small group of consumers (pregnant women, newborns, and adults with weakened immune system), similar to *V. vulnificus*, and has an incidence rate of less than 0.5 per 100,000, its potential severity resulted in much greater avoidance than reports of salmonellosis, which has an incidence of 36 per 100,000, but almost never results in fatalities (Kuchler 2015). Thus, initiatives that investigate factors correlating with increases presence and *Vibrio* and practices that minimize the risk of human contraction of disease would represent money well spent toward protecting not only human health but the reputation of and demand for North Carolina's shellfish mariculture products.

Shellfish Relay

Bivalves, such as oysters, clams, and scallops, feed by filtering phytoplankton from the water column. As they do so, any pollutants in the water they filter, including bacteria, viruses, heavy metals, and polyaromatic hydrocarbons are also incorporated into their tissue (Richards 1988). Resulting contamination of shellfish from polluted waters can render them pathogenic and/or toxic to humans. The potential for disease outbreaks (e.g. cholera, typhoid fever, norovirus, hepatitis) stemming from consumption of contaminated shellfish has been recognized for over a century (Richards 1988). As early as the late 1800s, scientists became aware that shellfish moved from contaminated to clean waters could purge themselves of bacteria (>99%) over the course of a few days (Johnstone 1908, 1914). Having identified a means of making a formerly unusable resource available to shellfish growers, the practice of moving polluted shellfish to clean waters where they will purge accumulated contaminants and later be harvested, referred to as shellfish relay, became a widely embraced technique in both the United States and abroad (Easley Jr 1982).

In North Carolina, shellfish relay is an allowed practice under two separate permits. The first, the Polluted Area Relay Permit allows lease holders the opportunity to relay clams and oyster from certain polluted areas to their lease between in April 1 and May 15 of each year. After the collected shellfish are placed on a lease, it must remain closed for a minimum of 21 days. The Seed Oyster Management Area Permit allows lease holders to collect a maximum of 100 bushels $acre^{-1}$ or 1000 bushels $lease^{-1}$, whichever is less, from Shellfish Seed Management Areas. Although the shellfish mariculture industry has evolved considerably in the time since, ~70% of respondents to a 2011 survey of North Carolina Shellfish growers said they obtained at least a portion of the their oyster seed through oyster relay (Turano et al. 2011).

While relay is recognized as an effective means of rapidly purging bacteria from contaminated shellfish, it is less effective at purging viruses (Kingsley and Richards 2003, Richards 2006). Recognition of the slow rate at which viruses are cleared from shellfish tissue and that this may have contributed to outbreaks of hepatitis A and norovirus stemming from consumption of shellfish has prompted states to enact longer depuration period for relayed shellfish (Rippey 1994, Iwamoto et al. 2010, McLeod et al. 2017). While longer depuration periods (4+ weeks) appear to have considerably reduced illness associated with relayed shellfish, they still cannot be guaranteed to be virologically safe (McLeod et al. 2017). Further research of viral depuration rates and best practices could significantly increase product safety. There is also very limited information on the rate at which shellfish depurate other contaminants, such as heavy metals. For example, a study from the University of Delaware found that oysters accumulate mercury to 1,400-2,800x environmental concentrations and full purification was not achieved within a 6-month period. Furthermore, while some studies have found half-lives (i.e. 50% elimination) of heavy metals in oyster to be a little as 23 days (Okazaki and Panietz 1981), others have found half-lives exceeding 150 days (Chan et al. 1999). Differences in purging rates among oysters are likely attributable to factors such as species, size, weight, environmental conditions, and initial metal concentration (Cunningham and Tripp 1975, Okazaki and Panietz 1981). Research is necessary in order to better understand these dynamics, how to best determine the suitability of areas for shellfish relay, and whether depuration periods should be modified.

In addition to the economic benefits of shellfish relay to growers, namely allowing fishers to access an otherwise unharvestable resource, it is also sometimes argued that harvesting can increase an area's productivity. Indeed, there is location-specific evidence that harvesting's redistribution of oysters from isolated clumps to more expansive areas may increase subsequent spat settlement (Kennedy and Breisch 1981, Manzi 1985, Allen and Turner 1989). There is also research that suggests that harvest methods that overturn bottom sediments may create a substrate more favorable for clam settlement and that removal of adult clams may increase subsequent recruitment (Pfitzenmeyer 1972, Kyte and Chew 1975). However, there considerable evidence pointing to negative or no effect of harvesting on shellfish recruitment (Drobeck and Johnston 1982, Kassner et al. 1991, Johnson 2002, Mackenzie Jr 2007, Green et al. 2009). Almost certainly, impacts of harvesting on subsequent recruitment are dependent on a wide range site-specific factors. The SMAC believes that research investigating how local site dynamics, both abiotic and biotic, harvesting practice, etc. influence the impact of relay on productivity would be beneficial determining its impact on North Carolina's wild shellfish populations and guiding the identification of sustainable harvest areas and practices.

Socio-economic implications of shellfish mariculture's expansion

Aquaculture is well positioned to help the world adapt to declines in wild capture fisheries, rising demand for seafood sourced protein, and the need for economic development, particularly in rural areas (Tidwell and Allan 2001). Among aquaculture practices, shellfish mariculture is often considered uniquely attractive due to the ecosystem services it provides in addition to its economic benefits (Shumway et al. 2003). Undoubtedly, shellfish aquaculture represents an economic opportunity for North Carolina's coastal communities; however, research on the broader social and cultural

impacts of shellfish mariculture remains limited (McKindsey et al. 2006, Byron et al. 2011, Coulthard et al. 2011, Silver 2013). Much like a given area will have a physical carrying capacity, defined as the geographic availability of physically and chemically suitable sites for aquaculture, and an ecological carrying capacity, defined as the amount of aquaculture that an area can support without unacceptable impacts on ecological processes and community dynamics, researchers are increasingly recognizing the importance of social carrying capacity. As it pertains to aquaculture, social carrying capacity refers to the upper limit of aquaculture operations, either number or areal extent, that a society believes is, on balance, beneficial (McKindsey et al. 2006). Beyond this threshold, socially detrimental effects outweigh the benefits and further development of aquaculture becomes socially unacceptable.

Continued growth of North Carolina's shellfish mariculture industry has the potential to provide both direct employment for people living in rural coastal communities as well to benefit auxiliary industries such as processors, distributors, and restaurants. It would be myopic to only focus on these benefits without considering the potential for shellfish farms to reduce the "value" of the public trust waters they occupy. For example, other users of estuarine waters may find shellfish farms incompatible with their cultural (e.g. heritage fishing practice), commercial (e.g. trawling), recreational (e.g. fishing or hunting), or aesthetic (e.g. bird watching) uses of these waters (Inglis et al. 2000). Balancing these impacts against the employment and economic benefits yielded from the growth of the shellfish mariculture industry requires researchers, through extensive stakeholder engagement, to develop consensus around the different opportunities provided by a given area, the relationship between level of farm development and social impacts, and the appropriate levels of impact that is socially acceptable (Shelby and Heberlein 1984, 1986).

Social carrying capacity is inherently location specific and the amount of shellfish farming that is socially acceptable within an area will likely vary considerably among regions of coastal North Carolina. As demonstrated by past studies, peoples' perception of how a shellfish farm impacts the "naturalness" of an area depends not only by the presence of other physical and biological attributes of an area (e.g. vegetation, presence of other species, other signs of human modifications), but also on the personal attachment and associations people have with the site (Kaplan and Kaplan 1989). Thus, the social impacts of shellfish farm development are often greater in areas with less human modification and in regions where coastal resource users highly value the natural character of the area (Herzog et al. 2000, Primavera 2006), which is likely a contributing factor to the contentiousness of shellfish leasing in Core Sound.

While research into the social implications of expanding shellfish mariculture in North Carolina cannot guarantee that there will not be conflict, research efforts that aim to understand and monitor conflict and stakeholder perceptions can inform useful/necessary legislation or policy moving forward. These efforts will can help identify social sustainability conflict resolution approaches and are critical to developing a holistic understanding of the relationship of this emerging industry with North Carolina's coastal communities.

Interactions between bivalve shellfish culture and the environment

The impact of bivalve shellfish mariculture on the surrounding environment has been shown to vary based upon the species that is being cultured, the method of culture, and characteristics of the environment receiving the impacts (O'Beirn et al. 2013). As the SMAC's mission was to provide recommendations for an economically *and ecologically* beneficial shellfish mariculture industry, we recommend that the research is needed in order to better understand the suite of ecological/environmental implications of a growing shellfish industry, whether beneficial or deleterious, and develop performance standards to guide future regulations and inform Best Management Practices. See Appendix H Table 1 for an overview of potential environmental/ecological interactions with shellfish mariculture that merit further investigation.

Appendix H, Table 1: Abiotic and Biotic Implications of Environment-Mariculture Interactions

Environment-Mariculture Interaction	Abiotic Implications	Biotic Implications
Hydrological modification	Changes to the sediment particle size composition; sedimentation; scouring	Altered benthic infauna; Sedimentation of biogenic habitats
Increased organic matter	Changes to sediment chemistry: Redox, Sulfide Reduction	Altered benthic infauna; Impact on seagrasses
Shading: Reduced solar irradiance	NA	Effects on photosynthetic species (e.g. macroalgae, seagrasses)
Water Filtration: Increased solar irradiance	Increased water clarity	Effects on photosynthetic species (e.g. macroalgae, seagrasses)
Water Filtration: Seston filtration	NA	Impacts of ecological carrying capacity; Altered phytoplankton and zooplankton communities
Habitat Provision	NA	Increased nekton production; Effects on seabirds and mammals; Aggregation of nuisance species
Disease Vector or Reservoir	NA	Altered disease prevalence in wild stocks

For a more comprehensive overview, consult the following references:

1. Solomon, O. , and O. Ahmed. (2016) Ecological consequences of oyster culture: a review. Int. J. of Fish. Aquat. Stud 4: 1-6.

2. Shumway, S. E., ed. (2001) Shellfish aquaculture and the environment. John Wiley & Sons.

3. Gallardi, D. (2014) Effects of bivalve aquaculture on the environment and their possible mitigation: a review. Fish Aquac J 5:105.

Appendix I. List of Acronyms and Definitions

Acronyms

ACC: Aquaculture Coordinating Council

ADZ: Aquaculture Development Zone

AEZ: Aquaculture Enterprise Zone

APR: Annual Percentage Rate

APNEP: Albemarle-Pamlico National Estuary Partnership

AUZ: Aquaculture Use Zone

BMP: Best Management Practices

BRACO: Blue Ribbon Advisory Council on Oysters

CAT: Catastrophic Coverage

CCCC: Carteret County Community College

CRMC: Coastal Resource Management Council

DNR: Department of Natural Resources

EEZ: Exclusive Economic Zone

EDPNC: Economic Development Partnership of North Carolina

EISA: Energy Independence and Security Act

EPA: Environmental Protection Agency

FCIC: Federal Crop Insurance Corporation

FRG: Fisheries Resource Grant

GPD: Gross Domestic Product

HAB: Harmful Algal Bloom

LID: Low-Impact-Development

MARBIDCO: Maryland's Agricultural & Resource-Based Industry Development Corporation

METF: Maximum Extent Technically Feasible

MFC: Marine Fisheries Council

MSX: Multi-Nucleated Sphere Unknown

NAP: Noninsured Crop Disaster Assistant Program

NCAC: North Carolina Administrative Code

NCDA&CS: North Carolina Department of Agriculture and Consumer Services

NCDEMLR: North Carolina Division of Energy, Mineral, and Land Resources

NCDEQ: North Carolina Department of Environmental Quality

NCDMF: North Carolina Division of Marine Fisheries

NCDWR: North Carolina Division of Water Resources

NCMFC: North Carolina Marine Fisheries Commission

NCSG: North Carolina Sea Grant

NCSGA: North Carolina Shellfish Growers Association

NCSU: North Carolina State University

NCSU CMAST: North Carolina State University Center for Marine Science and Technology

NERRS: National Estuarine Research Reserve System

NGO: Non-Governmental Organization

NOAA: National Oceanic and Atmospheric Administration

NPDES: National Pollution Discharge Elimination System

NPS: Non-Point Source program

NPSP: Non-Point Source Pollution

NRCS: Natural Resources Conservation Service

NSSP: National Shellfish Sanitation Program

PGP: Programmatic General Permits

PVC: Polyvinyl Chloride

QPX: Quohog Parasite Unknown

RFID: Radio-Frequency Identification

RGP: Regional General Permit

RMA: Risk Management Agency

ROI: Return on Investment

SA: Shellfishing Area

SAE: Shellfish Enterprise Area

SLFAC: Sustainable Local Foods Advisory Committee

SMAC: Shellfish Mariculture Advisory Committee

SMAP: Shellfish Mariculture Advisory Panel

STI: Soil Topographic Index

SWAT: Soil and Water Assessment Tool

USACE: United States Army Corp of Engineers

USDA: United States Department of Agriculture

UNC IMS: University of North Carolina Institute of Marine Sciences

UNCW: University of North Carolina at Wilmington

WFRP: Whole Farm Revenue Protection

WREP: Wetlands Reserve Enhancement program

WRP: Wetlands Reserve Program

Definitions

B

Bottom-culture: Cultivating oysters or clams by planting either directly on bottom or within cages or bags placed on bottom.

C

Cage: Metal apparatus that holds nursery bags of oyster seed to protect from predators.

Cage-culture: Cultivation of shellfish within cages during their grow out phase

Closed-System: A system in which all aspects are contained from the external environment.

Cull: To select and sort shell by quality and size.

D

Downweller: A system used in shellfish hatcheries to set spat on micro-cultch.

Dredge: To harvest shellfish by dragging a rake and bag along bottom behind a boat.

F

Fecal Coliform: A bacteria generally originating in the intestines of warm-blooded animals. Used as an indicator for water quality by Shellfish Sanitation.

Fouling: Organisms that colonize the surface area of a shellfish's shell, such as barnacles, tunicates, and bryozoans.

G

Grade: To class or sort oysters dependent on size, shape, and quality.

Growout: The period during which a shellfish grows from seed to market size.

H

Hatchery: A facility that spawns shellfish to produce seed for aquaculture operations.

M

Merroir: An oyster's characteristic taste and flavor imparted by its environment.

N

Nursery: A system that protects and provides food to juvenile shellfish prior to attaining grow-out size.

O

Open-System: A system in which water enters from and returns to an external source.

P

Phytoplankton: Plankton consisting of microscopic plants. A food source for most bivalve shellfish.

Purge: To remove unwanted contaminants from bivalve shellfish by placing in clean water.

R

Rack-and-bag culture: Cultivating shellfish (usually oysters) in bags that sit on racks.

Rake: Harvest shellfish by using a shellfish rake.

Riparian: Relating to the land situated on the banks of or adjacent to a water body.

S

Spat: Baby oysters after they have set or attached to a growing surface.

Spawn: The release of shellfish eggs and sperm into the water column.

Surface-culture: Cultivating oysters in floating trays, bags, or rafts.

Suspended Culture: Cultivating oysters in suspended trays, bags, or rafts. Oysters do not touch the ocean bottom or float at the surface.

U

Upweller: A water flow system that pushes nutrient rich water up through the nursery or silos to feed juvenile shellfish. Can be an open or closed system.

W

Wild Set: Wild shellfish that have set naturally on bottom or other substrates.