Oyster Restoration and Management
in Coastal North Carolina

by

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Abstract

The once strong North Carolina oyster fishery has fallen on hard times over the last few decades due to overfishing, habitat loss, disease, and pollution. Currently, there are many actions being taken in an effort to reverse this downward trend. The North Carolina Coastal Federation has developed the “Oyster Action Plan,” a coast-wide effort involving many different state, federal, non-profit, and educational organizations to restore oysters and oyster habitat. As part of this effort, I worked with many of these organizations to determine and map priority areas for oyster habitat restoration along the coast. Additionally, as part of the current effort in North Carolina to create an oyster gardening program, I worked with people from other states who have existing oyster gardening programs to develop a series of recommendations for how to best go about constructing our program. This report will give the reader a background on oyster biology and ecology, as well as the history and current status of the fishery in North Carolina. Additionally, it will present my efforts within the oyster action plan, and make some general conclusions and recommendations about how to proceed in the future. The Oyster Action Plan is an ongoing process that will continue for years to come, and will hopefully be successful at returning large populations of oysters to our coast.
Section 1: Background
The Biology of *Crassostrea virginica*

*Habitat Preference*

The Easter Oyster, *Crassostrea virginica* Gmelin, is found along much of the east coast of North America, ranging from the Gulf of St. Lawrence in Canada south to Key Biscayne in Florida. Additionally, *C. virginica* is found in the Gulf of Mexico and the West Indies, and has been found as far south as Brazil (Gunter 1951; Bahr and Lanier 1981). Oyster reefs are generally found on hard, rocky bottoms or firm mud bottoms, and can inhabit both subtidal and intertidal zones (Galtsoff 1964). In North Carolina, oyster reefs north of Cape Lookout reside in areas unaffected by tides (i.e. Pamlico Sound), so are primarily subtidal, while those south of Cape Lookout are predominantly intertidal (DMF 2001). Oysters typically tolerate a wide range of temperatures, from -2° C up to 36° C, although they have been shown to survive at temperatures up to 49° C for a short time (Butler 1954; Galtsoff 1964; Ingle et al. 1971). *C. virginica* can also tolerate a wide range of salinities, from 5 to 42.5 parts per thousand (ppt) (Galtsoff 1964), although the optimum range is generally considered to be around 14-28 ppt (Butler 1949; Galtsoff 1964). Although many other factors influence the oyster throughout its lifecycle, temperature and salinity are considered by many to be the two most important factors determining the survival, reproduction, and growth of natural oyster populations (Shumway 1996).

*Reproduction and Early Development*

Temperature is considered by many to be the most important factor in determining spawning period in oysters, although nourishment levels, salinity, and pheromones can also play a role (Giese 1959; Sastry 1975; Shumway 1996; Thompson et al. 1996). More recently, it has been suggested that phytoplankton, which flourish under conditions similar to those necessary for successful oyster spawning, may in fact release a chemical signal which stimulates oysters to begin spawning (Starr et al. 1990). In either case, once the spawning signal is received, males release their sperm into the open water (Bahr and Lanier 1981; Thompson et al 1996). Chemical constituents from the sperm trigger the release of gametes from the female, ensuring the synchronous spawning of all nearby oysters (Bahr and Lanier 1981; Thompson et al 1996). Once sperm and egg reach the water column, fertilization occurs, and larval development commences (Bahr and Lanier 1981).

Growth and development of oyster larvae are dependent upon both salinity and oxygen availability, and are also influenced by temperature and food availability. Although larvae can withstand low O₂ concentrations for short periods, feeding and activity are reduced under these conditions, and thus growth and development are delayed (Widdows et al. 1989). At the same time, oysters prefer salinities at or around 22.5 ppt for egg development, and 17.5 ppt for larval growth (Davis 1958). Development typically takes 2-3 weeks, but the time to settlement can increase with depressed food availability or
suboptimal temperatures (Kennedy 1996). Generally, after fertilization, the oyster larvae pass through the blastula and gastrula stages before hatching from the egg. Upon hatching, the swimming, non-feeding trochophore larvae persist for 1-2 days (Bahr and Lanier 1981; Thompson et al. 1996), after which they begin to secrete a shell, and enter the veliger stage of development. The veliger larvae feed on bacteria and protozoans, and persist for 2-3 weeks, depending on food availability and environmental conditions (Baldwin and Newell 1991; Thompson et al. 1996). Near the end of the veliger stage, the larvae develop “eyespots,” a change which many consider an indication that the larvae is ready to settle (Bahr and Lanier 1981). Throughout their existence, the larvae are distributed horizontally by water flow, but can control their vertical movement by swimming, often in response to tidal changes in salinity or chemical cues (Wood and Hargis 1971; Seliger 1982; Turner et al. 1994). Young larvae are generally found closer to the surface, and migrate towards the bottom as they develop, finally reaching the benthic zone during the late veliger stage (Kennedy 1996).

In the benthic zone, swimming larvae encounter a series of chemical cues from the oyster substrate below that stimulate downward swimming and settlement. These cues include proteins and ammonia from adult oysters, proteins from the shell of both living and dead oysters, pheromones from settled larvae, and chemicals, including L-DOPA, from surface-film bacteria (Crisp 1967; Hidu 1969; Weiner et al. 1989; Fitt and Coon 1992; Tamburri et al. 1992; Turner et al. 1994; Zimmer-Faust and Tamburri 1994). These chemotactic reactions in response to cues from oyster reefs are important for the communal settlement of oyster larvae (Hidu 1969), which leads to large aggregations of adult oysters. Without this response, the possibility for simultaneous release of gametes would be greatly reduced, and thus the reproductive ability of oysters would decrease as well (Tamburri et al. 1992).

Upon contact with the substrate, the larvae crawl across the surface until desirable habitat is located. Often, oysters settle on the undersurfaces of shells (Kennedy 1996), or in pits and irregularities of the shell surface (Nelson 1953). The larvae then cement themselves to the surface, and begin metamorphosis into the adult form, which involves the degeneration of larval structures, the development of the gills, and the shifting of internal structures such as the mouth, anus, and adductor muscles (Kennedy 1996).

Feeding in Adult Oysters

Adult oysters are suspension feeders, filtering particles out of flowing water. Oysters can filter particles greater than 8 µm with high efficiency (Mohlenberg and Riisgard 1978), and can filter smaller particles as well, but with decreasing efficiency (Haven and Morales-Alamo 1970; Newell and Langdon 1996). There is minimal impact on filtering by changing tides, but water currents, food concentration, and season have all been shown to impact filtering rates (Berg and Newell 1986; Loosanoff and Nomejko
Although there is some controversy over the exact mechanism of filtering, it is suspected that currents created by ciliated gills serve to capture the particles out of suspension (Newell and Langdon 1996). After capture, particles are sorted by the cilia and labial palps, and inorganics and other indigestible material are rejected as pseudofeces (Shumway et al 1985; Newell and Langdon 1996). Ingested particles are brought into the digestive system through the mouth, and enter the stomach, where they are processed by digestive enzymes, as well as the crystalline style, which grinds up particles (Bahr and Lanier 1981; Langdon and Newell 1996). Absorption takes place in a digestive gland, and finally, digested material is passed through the intestine into the rectum, and is released from the anus as feces.

**The Ecology of Oyster Reefs**

**Oyster Reefs as Habitat**

Oyster beds serve as habitat for numerous types of organisms, including crabs, polychaete worms, mollusks, anemones, and fish, among others (Bahr and Lanier 1981; Harding and Mann 2001). The structural complexity and hard substrate of the reef provides a habitat component not otherwise available in estuarine ecosystems, and many different organisms take advantage of that fact (Meyer 1994; Kennedy 1996; Meyer and Townsend 2000). Crabs utilize the reef both for feeding (Elner and LaVoie 1983; Bisker and Cartagna 1987) and for protection from predators and environmental fluctuation (Meyer 1994). There is even a commensal crab that inhabits the interior of oyster shells and feeds off of material filtered by the gills of the oyster (Christensen and McDermott 1958). Lehnert and Allen (2002) found that numerous types of juvenile and larval fish use oyster shells as habitat and refuge, and Harding and Mann (2001) found that the size and abundance of adult fish increased with increasing structural complexity of habitat (i.e. oyster reefs). Inhabitants of oyster reefs are so varied and abundant, in fact, that a survey of oyster reef fauna on one oyster reef community in Georgia found over 40 distinct species (Bahr and Lanier 1981), while a survey of one estuary found over 300 distinct species on the reefs of the Newport River in North Carolina (Wells 1961).

**Oyster Reefs and Estuarine Community**

Beyond providing habitat for estuarine organisms, oysters are also important contributors to the stabilization and development of the estuarine community. Oyster reefs serve to reduce the turbidity of water through the filtration of particulate matter, as well as by enhancing sedimentation through reduced water flow (Dame et al. 1984; Meyer and Townsend 2000). This reduction in turbidity is important for the growth of submerged aquatic vegetation, which is considered by many to be a critical habitat for fish and other organisms (Meyer and Townsend 2000). Through filtration, oysters are able to assimilate organic carbon to make it available to higher consumers, and they are able to release phosphorus and
nitrogen in a form usable by primary producers (Bahr and Lanier 1981; Jordan 1987). Additionally, reefs provide protective structure for nearby salt marshes, reducing sediment loss and erosion (Bahr and Lanier 1981; Meyer et al. 1997). In fact, it was estimated that oyster reefs, at the proper size, could exert top-down control on pelagic ecosystems through the reduction in primary productivity, and the redistribution of that productivity to other organisms (Ulanowicz and Tuttle 1992). For many of these reasons, Dame (1976) described oysters as the most important primary consumer in the estuarine ecosystem.

**History of the Oyster and Oyster Fishery in North Carolina**

In some of the earliest surveys done on the North Carolina oyster population, it was found that, although not comparable to the Chesapeake Bay fishery, North Carolina oysters were generally large and healthy (Winslow 1889, Grave 1901). Caswell Grave, in reference to the Newport River, wrote, “A most conspicuous feature of the river is the oyster reefs which, at any but the time of high tides, can be seen standing out of the water…[the reefs] are a source of no little inconvenience to the navigation of the river” (Grave 1901). In North Carolina, the greatest commercial landing of oysters was 1.8 million bushels in 1902, and corresponded with the introduction of oyster dredges from the northern fisheries (DMF 2001). Oyster dredging increased consistently until the 1950s, although oyster landings generally decreased during this same time (DMF 2001). In fact, it has been estimated that annual landings have dropped about 90% during the 20th century (Ortega and Sutherland 1992). Early on, this population loss was largely due to a lack of regulation in the fishery, and more recently, has been influenced by pollution and disease (Ortega and Sutherland 1992; DMF 2001).

Currently, oysters are classified as a species of concern (DMF 2001) and catches have dropped to about 46,000 bushels in 2002 (Henderson 2004). Many actions are being taken to try and rehabilitate oyster stocks throughout the coast, including cultch plantings, sanctuary creation, and oyster reef construction (DMF 2000). However, one of the largest, most concerted efforts for oyster restoration is being organized by the North Carolina Coastal Federation, and is called the “Oyster Restoration and Protection Plan for North Carolina.”

On February 14, 2003, the North Carolina Coastal Federation hosted representatives from a variety of interests, including science, policy, education, and the fishing industry, to discuss the urgent need to protect and restore oysters in North Carolina. After much discussion, these organizations reached a general consensus on what actions should be taken, and a five year plan of action was constructed. The goal of the plan is to “Restore and protect North Carolina’s oyster populations and habitat so that estuaries are again robust, diverse and resilient ecosystems and build broad public awareness and support for the value of estuarine conservation and sustainable fisheries” (NCCF 2003). In order to achieve this goal, seven different actions were suggested, which will be summarized below.
**Action 1** – Organize and lead a coalition of interested partners to achieve oyster protection and restoration objectives.

Initially, a steering committee composed of groups currently working to restore and protect oysters will be constructed, and will work to combine their efforts to achieve the desired goals. This steering committee will ensure proper implementation of the oyster plan, and will work to obtain funds allowing for success.

Additionally, a public forum will be held to help to raise public interest in the plan, and to acquire public input for suggested actions. After completing this forum, a written report, available to the public, will be compiled summarizing the goals and results from the forum.

**Action 2** – Restore and increase oyster populations and habitat as a means to increase production, improve water quality, and provide critical habitat for marine life.

The overall goal of this action is to better coordinate existing and planned oyster management activities by developing a better understanding of the structure and function of oyster reefs in the wild, and by establishing unified objectives for management. Initially, a database of existing knowledge of oysters and oyster management will be created. This database will include a GIS analysis and hydrodynamic model of North Carolina’s estuaries, a review of scientific literature on oysters, standard guidelines and protocols for oyster reef creation, and reviews of completed oyster projects to determine what works best, and what needs to be improved. After constructing this database, it will be determined what information is missing, and research will be directed to fill in those gaps.

In addition to the creation of this informational database, restoration plans for distinct oyster growing areas will be developed and carried out. These plans will lay out measurable objectives, will be based on the existing pool of knowledge generated by the database, and will be developed based on the needs of each specific ecological region, including the Ablemarle-Pamlico region, the Core and Bogue Sound region, and the Southeastern region. Efforts will be made to enhance these restoration activities through the creation of an oyster shell recycling program, the acquisition of shell stockpiling sites, and the securing of long-term sources of spat, shell, and funding for such projects. It is hoped that funding for the Division of Marine Fisheries Shellfish Rehabilitation Program can be increased to allow for increased cultch plantings and reef creation throughout the state.

Finally, efforts will be made to adopt new laws and improve upon existing ones, to support the restoration and conservation of oysters throughout the state. Existing laws and practices will be evaluated to determine their impacts on oyster populations, and suggestions will be made for how to best go about working within the existing framework, or, if necessary, changing existing laws to help promote oyster conservation. It is hoped that, among other things, the Coastal Resources Commission will allow for the
creation of rules promoting natural alternatives to shoreline stabilization, allowing for the maintenance of
healthy estuarine systems in which oysters can grow and flourish. Additionally, efforts will be made to
create a citizen-based oyster gardening program, allowing for citizens to get involved in restoration efforts
through the creation of their own oyster reefs.

**Action 3** – Increase public awareness and understanding of the importance of the oyster
to North Carolina’s heritage and to the ecological health of estuarine waters,
and expand citizen support for the value of native oyster restoration activities.

For any restoration project to be completely successful, it is important to raise public awareness
and support. In order to achieve this goal, a series of educational guidebooks will be created, and public
workshops and seminars will be held. These guides will provide the public with a basic understanding of
the importance of oysters to the ecosystem, and will give direction on how to best go about carrying out
individual restoration efforts. Individual and community gardening will be promoted, and oyster shell
recycling will be encouraged. Finally, an effort will be made to encourage an understanding of the
importance of oysters beyond the fishery, including the water quality and population benefits that
unharvested oysters provide.

**Action 4** – Develop and market a sustainable native oyster fishery.

Oysters have a deep root in North Carolina history and culture, so it is important to maintain the
native oyster fishery. In addition to building public interest in North Carolina oysters, it is important to
ensure the safety of the product. Therefore, a set of best management practices for oyster mariculture will
be developed, and educational workshops will teach potential oyster farmers the best ways of setting up
and maintaining an oyster farm. To assist in this educational process, an oyster mariculture demonstration
park will be created.

**Action 5** – Protect and restore water quality throughout coastal waters and especially
near areas designated as oyster habitat.

Pollution is currently one of the strongest negative influences on oyster populations. With
improved water quality, oysters will grow larger and will be more able to resist disease. Additionally,
improving water quality will allow for more reefs to be opened to fishing on a regular basis, which will
greatly improve the oyster fishery. One of the best ways to prevent pollution from entering the estuarine
ecosystem is to protect the surrounding land. Efforts will be made to raise $5 million per year to acquire
and protect lands surrounding SA waters, and to target and clean up existing point and non-point sources
of pollution. Funding efforts will focus on acquiring numerous grants, including the Farm Bill, the Clean
Water Management Trust Fund, Department of Transportation mitigation funds, and the State Revolving
Fund.
Strong rules and effective enforcement can also help to enhance water quality. It is hoped that, through increased funding, the Division of Water Quality can hire more staff to increase their enforcement abilities. Additionally, stormwater rules must be improved and better enforced. Also, rules regarding land-use and development around priority growing areas need to be adjusted to better protect the water quality around existing oyster reefs.

Lastly, efforts must be made to actively clean up areas impacted by pollution. Shellfish Sanitation Growing Area surveys can provide insight into which areas experience the greatest input of pollution, so should be made more accessible to other enforcement agencies. Through enhanced surveying, point sources of pollution and stormwater runoff areas can be identified, and efforts can be made to eliminate them.

**Action 6** – Link oyster restoration and protection plan activities to ongoing planning efforts.

There are many ongoing efforts to protect estuarine habitat, including One North Carolina Naturally, Coastal Habitat Protection Plans, Basinwide Water Quality Plans, CAMA Land Use Plans, the Ablemarle-Pamlico Estuary Program, and the Basinwide Wetlands Restoration Plans. Achievement of oyster plan goals can be enhanced if activities are carried out as part of these active environmental programs.

**Action 7** – Demonstrate Success.

In order to win over the support of both government officials and the public at large, it is important to demonstrate progress and environmental improvement. To help keep all interested parties informed, yearly progress reports highlighting areas of progress and areas of need will be produced. Additionally, the press will be involved in many of the ongoing efforts, so that they can help to keep the public apprised of what is going on. Finally, oyster restoration will be made a priority throughout the state, which will bring about more publicity, and more interest from the public and the government.
Section 2: Determining Priority Areas for Action
Although it would be optimal to restore and maintain each and every oyster growing area in North Carolina, time and money constrain the amount of work that can be done. In order to best direct restoration efforts, an analysis of each growing area was carried out using information from Shellfish Sanitation Growing Area Reports, North Carolina Division of Water Quality 303d and 305b lists, the DMF Bottom Mapping Project, and Basin-Wide Water Quality Reports, and each area was classified as either high, medium, or low priority. In order to refine these classifications, a meeting was held with representatives from the NC Division of Marine Fisheries, NC Shellfish Sanitation Section, the North Carolina Coastal Federation, The Nature Conservancy, UNC-Wilmington, and Duke University. Each classification was reviewed, and adjustments were made according to input from those who have worked directly with the various sites.

Out of these analyses, biographies of each area were created, describing the sources of pollution in each area, ecosystem health, physical features of the water body, and lastly, making recommendations for restoration and management activities. Ecosystem health ratings were subjective values derived from various sources of information describing each water body. They were calculated based upon the status of the bottom in the area, the declared oyster production in the area (from SS reports), and some minor subjective input based on the types of pollution entering the area. Rankings ranged from 1 to 4, 1 being “Unsuitable for Oyster Growth,” and 4 being “Pristine.” Water quality ratings were calculated based on the amount of precipitation needed for a closure to be declared, as well as some minor subjective input based on the amount of pollution entering the area, with ranks 1 (Highly Degraded) to 4 (Pristine).
High Priority Sites
**Vital Statistics:**
- **Watershed Area:** 30 square miles
- **Water Acreage:** 1,350 acres
- **Closed Acreage:** 480 acres
- **Peak Population:** 25,000 people

**Ecosystem Health:**
- **Production Rating:** Good
- **Salinity Range:** 11-38 ppt
- **Significant Closures?** Yes
- **Water Quality Rating:** 1
- **Habitat Health Rating:** 3

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants, Restaurants, Septic Tanks

- **Runoff** – The town of Shallotte is a major source of runoff into the river. All of the stormwater from the streets, parking lots, and businesses drains directly into the river via culverts and ditches.

- **Marinas** – There are 4 marinas in this area.

- **Sewage Plants** – Shallotte runs a 300,000 GPD WWTP. There is also a 100,000 GPD package plant which services the Brick Landing Golf Course in the Saucepan Creek Area.

- **Restaurants** – Lloyds Oysters and Holdens Seafood both empty their process water directly into the river. Lloyds also has diesel and gasoline storage tanks.

**Suggested Action**

All of this area is either closed or conditionally classified. Working to improve stormwater management in the town of Shallotte is necessary to improve water quality. Aiming to give the Shallotte River a special classification in order to warrant it more protection, should be a focus here.
Area A-3 - Lockwoods Folly River Area

**Vital Statistics:**
- Watershed Area: 150 square miles
- Water Acreage: 1,650 acres
- Closed Acreage: 721 acres
- Peak Population: 45,000 people

**Ecosystem Health:**
- Production Rating: Good
- Salinity Range: Average = 33 ppt
- Significant Closures?: Yes
- Water Quality Rating: 1
- Habitat Health Rating: 3

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants, Septic Systems

- **Subdivisions** – This is a large golfing destination, with numerous golf clubs found on the mainland side of this area.

- **Runoff** – Runoff from the town of Long Beach flows directly into estuarine waters.

- **Marinas** – There are 2 marinas in this area, including the Blue Water Marina, and the Dutchman Creek Villas Marina.

- **Sewage Plants** – Dutchman Creek Villas and the St. James Plantation both utilize package treatment plants for their wastewater. Additionally, a large WWTP was in the planning stages as of 1997.

- **Septic Systems** – Most of the homes in this area are serviced by septic systems.

**Suggested Action**

A lot of effort has been made to improve this area, although it has been met with mixed success. A management plan was developed for the river a few years ago, but there are some questions as to whether that plan has been implemented effectively. A focus here should be making sure that the river management plan is being implemented and enforced, or else developing a new one that can be implemented immediately. Golf courses are proliferating in this area, so runoff is a big problem. Working to improve stormwater management in this area is also important.
### Vital Statistics:
- **Watershed Area:** ?
- **Water Acreage:** 1,325 acres
- **Closed Acreage:** 1,325 acres
- **Peak Population:** 35,000

### Ecosystem Health:
- **Production Rating:** Fair
- **Salinity Range:** 10-38 ppt
- **Significant Closures?** Yes
- **Water Quality Rating:** 1
- **Habitat Health Rating:** 2

### Possible Sources of Pollution:
- **Runoff** – Stormwater runoff from a growing number of buildings, streets, and parking lots in the Southport area are having a direct impact on regional water quality.
- **Marinas** – There are 5 marinas in this area.
- **Sewage Plants** – As of the time of this report, the Southport municipal sewage treatment plant was in need of major repairs. Three other locations, including Ocean Greens Arboretum, Caswell Dunes, and Dutchman Creek Villas, all run package treatment plants.
- **Septic Systems** – The Fort Caswell Baptist Assembly, the US Coast Guard Station on Oak Island, and a number of homes in the area are all treated by septic systems.

### Suggested Action

Water quality in this area is declining significantly as Southport grows, although there has been some improvement recently in the Elizabeth River area. Better stormwater management is imperative to improve the water quality further. Additionally, ditching and runoff from the St. James Plantation could be having a significant impact on the water quality, so an investigation and remedy for that problem is necessary. Southport is looking to remove their wastewater discharge from the estuary, so pushing them to do that will have a dramatic impact on the water quality of the area as well. The Army Corps is looking to utilize oysters here for stabilization purposes following their dredging in the Cape Fear River, so that might be a good source of restoration money.
**Vital Statistics:**

<table>
<thead>
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<th>Watershed Area:</th>
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<tr>
<td>Water Acreage:</td>
<td>2,150 acres</td>
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<tr>
<td>Closed Acreage:</td>
<td>700 acres</td>
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<td>Peak Population:</td>
<td>40,000 people</td>
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**Ecosystem Health:**

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<td>Salinity Range:</td>
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<tr>
<td>Significant Closures?:</td>
<td>Yes</td>
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<td>Water Quality Rating:</td>
<td>2</td>
</tr>
<tr>
<td>Habitat Health Rating:</td>
<td>3</td>
</tr>
</tbody>
</table>

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants, Industry, Septic Systems

- **Subdivisions** – There are 40 subdivisions.

- **Marinas** – There are 40 marinas in this area.

- **Sewage Plants** – Much of the sewage in this area is transported across the county to the South Side WWTP, which discharges into the Cape Fear River. A few of the pump stations in this area have had problems dealing with the steadily increasing growth in population. There is one package WWTP operated by the Oyster Point subdivision.

- **Industry** – The LaQue Center for Corrosion Technology studies the corrosive effects of salt water on various materials, and has a permit to discharge 0.2 million gpd into Banks Channel.

**Suggested Action**

Development is the biggest problem here, and the Howe Creek ORW is failing. However, planting effort here is extremely high (around 10,000 bushels a year), and this area generally has good oyster production. Spat set is high, so reef creation is the best strategy here. However, the stockpile site was recently lost, so finding a new one is a priority. If the logistics can be worked out, this area should be the focus increased efforts.
Vital Statistics:

- Watershed Area: 53 square miles
- Water Acreage: 4,700 acres
- Closed Acreage: 443 acres
- Peak Population: 36,000 people

Ecosystem Health:

- Production Rating: Good
- Salinity Range: 15-39 ppt
- Significant Closures?: Yes
- Water Quality Rating: 1
- Habitat Health Rating: 3

Possible Sources of Pollution: Subdivisions, Runoff, Marinas, Sewage Plants, Septic Systems

- **Marinas** – There are 4 marinas in this area.

- **Sewage Plants** – The town of Holly Ridge, as well as the Thorn Apple Valley Foods Facility, both utilize small WWTPs to treat their waste. All other sewage is transported inland for treatment.

- **Septic Systems** – Because of high water levels during high tide, there is extensive flooding in parts of this area, leading to septic failure. A sewer system has been constructed, so hopefully homes will begin connecting to that, and the problem will begin to disappear.

**Suggested Action**

Water quality here is deteriorating, due mainly to runoff. There is extensive ditching in this area, including some illegal ditching, so addressing that problem is a priority. Land acquisition would also go a long way towards minimizing the impacts of development and helping to improve water quality. Harvest is high in this area, and seems to be outpacing the oyster population, so plantings are a necessity. However, there are no suitable stockpiling sites at this time, so locating one is a priority. Morris Landing, which could serve as a good site for stockpiling, has recently been acquired, and will help efforts in this area. Removal of the Permuda Island Causeway is also being discussed, which would help improve water quality as well. In order to reduce some of the fishing pressure on the oysters, sanctuary creation or special restrictions on fishing in this area are necessary. Finally, this is a very shallow area, so boating has a big impact on oyster habitat. Working to educate the public, or possibly restricting the boating area here, would help the populations survive and grow.
**Vital Statistics:**
- Watershed Area: 250 square miles
- Water Acreage: 18,250 acres
- Closed Acreage: 7,196 acres
- Peak Population: 145,000 people

**Ecosystem Health:**
- Production Rating: Good
- Salinity Range: 7-38 ppt
- Significant Closures?: Yes
- Water Quality Rating: 3
- Habitat Health Rating: 2

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants, Restaurants, Septic Systems

- **Marinas** – There are 7 marinas in this area.
- **Sewage Plants** – The French’s Creek WWTP is located here.
- **Restaurants** – There are 5 seafood houses and 2 restaurants on the waterfront, which house docking areas, as well as on-site septic systems.
- **Septic Systems** – Leaking septic systems have been found to degrade water quality in this area regularly.

**Suggested Action**

Water quality is improving in this area since the consolidation of many of the WWTPs into the French’s Creek Facility. However, the oysters here are slow growing, and fishing effort is high, so the oyster populations in this area are struggling to survive. Creation of a sanctuary or special fishing restrictions in this area are necessary to help maintain the oyster population. More shell is placed here by the state than anywhere else, and the area has good access (via Camp Lejeune), so this area is a priority for effort in the future.
Vital Statistics: 

- Watershed Area: 80 square miles
- Water Acreage: 8,500 acres
- Closed Acreage: 2,992 acres
- Peak Population: 13,000 people

Ecosystem Health: 

- Production Rating: Good
- Salinity Range: 0-36 ppt
- Significant Closures?: Yes
- Water Quality Rating: 1
- Habitat Health Rating: 3

Possible Sources of Pollution: Subdivisions, Agriculture, Runoff, Marinas, Sewage Plants, Septic Systems

- **Subdivisions** – There are 25 subdivisions.

- **Runoff** – Runoff from farmland and residential areas is considered the major source of pollution in this area.

- **Marinas** – There are 8 marinas.

- **Sewage Plants** – The Swansboro WWTP discharges into the White Oak River. There is also one package treatment plant located at the Cedar Point Villas.

Suggested Action

This area has such strong oyster growth that there are problems with overcrowding in the southern portion of the river. Moving some of the oysters out of the southern portion and into the middle and upper portions of the river has yielded large, healthy populations of oysters. Getting this area open is a priority, as it currently is closed for much of the year. A focus on restoration and BMPs in the upstream section of the watershed is very important. Additionally, the people of Swansboro are very receptive toward actions to improve the oyster fishery in the area, so an educational campaign could yield great rewards. Finally, pushing the Swansboro WWTP to switch from discharge into the river to a land application discharge would help water quality immensely. This area is one of four Shellfish Sanitation pilot areas for improved monitoring, so it would be useful to focus efforts here.
Area E-4 - Newport River Area

**Vital Statistics:**
- Watershed Area: 175 square miles
- Water Acreage: 8,600 acres
- Closed Acreage: 2,693 acres
- Peak Population: 30,000 people

**Ecosystem Health:**
- Production Rating: Good
- Salinity Range: 7-35 ppt
- Significant Closures?: Yes
- Water Quality Rating: 1
- Habitat Health Rating: 3

**Possible Sources of Pollution:** Subdivisions, Agriculture, Runoff, Marinas, Ports, Sewage Plants, Industry, Septic Systems

- **Runoff** – Runoff into from streets and commercial areas is a very large problem.
- **Marinas** – There are 7 marinas and 2 haul out/maintenance facilities in this area.
- **Ports** – The state port could cause chemical contamination problems.
- **Sewage Plants** – The Morehead City WWTP discharges directly into Calico Creek, and the Newport Municipal WWTP discharges into the upper portion of the Newport River. There are also two package treatment plants near shellfish growing areas (Deerfield Shores/Brandywine Bay).
- **Industry** – Jarrett Bay Marine Industrial Park, as well as the commercial docking facility located on-site, could have impacts on water quality due to high levels of impervious surface. Additionally, water from the Walmart complex drains directly into the river.

**Suggested Action**

Oyster populations here are good at the present time, but this is one of the most highly impacted sites in NC, so efforts at restoration should be focused here. Stormwater runoff is the most significant problem, and needs to be addressed before any significant strides can be made in water quality improvement. The WWTP discharge into Calico Creek is also a problem, so removal of that source (by switching to land application), would help water quality immensely. There are sedimentation issues in the headwater areas, and shrimp trawling has an impact on oyster habitat, so those problems must be addressed as well. This is one of the four Shellfish Sanitation pilot project areas. Formation of a workgroup to address all of the issues in this area, and to carry out example projects in oyster restoration, is a high priority here. This has been suggested by many to be the highest priority area anywhere in NC.
| **Vital Statistics:** | **Watershed Area:** | 40 square miles |
| | **Water Acreage:** | 10,000 acres |
| | **Closed Acreage:** | 1,005 acres |
| | **Peak Population:** | 5,000 people |

| **Ecosystem Health:** | **Production Rating:** | Good |
| | **Salinity Range:** | 12-36 ppt |
| | **Significant Closures?** | Yes |
| | **Water Quality Rating:** | 2 |
| | **Habitat Health Rating:** | 3 |

**Possible Sources of Pollution:** Subdivisions, Agriculture, Forestry, Runoff, Marinas, Industry, Septic Systems

- **Subdivisions** – There are 20 subdivisions in this area.
- **Forestry** – There is regular clear cutting throughout the area.
- **Runoff** – Runoff from impervious surfaces, farms, and yards is listed as the major source of contamination in this area.
- **Marinas** – There are 8 marinas in this area.
- **Industry** – Core Sound Marine Services, Pigott’s Rail Yard, and a small auto salvage yard could all potentially contribute toxins to the water.
- **Septic Systems** – Failing septic systems is a chronic problem.

**Suggested Action**

Sleepy Creek and Wards Creek are two of the best oyster spots in the area. However, there are sedimentation problems due to the high amount of ditching throughout the watershed. This is the site of one of Shellfish Sanitation’s pilot projects, and NCCF is working to improve water quality through land acquisition and wetlands creation, so efforts to supplement that work would be very useful.
Vital Statistics:

- Watershed Area: ?
- Water Acreage: ?
- Closed Acreage: ?
- Peak Population: 9,300 people

Ecosystem Health:

- Production Rating: Fair
- Salinity Range: ?
- Significant Closures?: No
- Water Quality Rating: 3
- Habitat Health Rating: 3

Possible Sources of Pollution: Subdivisions, Agriculture, Forestry, Runoff, Marinas

- **Subdivisions** – There are 20 subdivisions in this area.

- **Agriculture/Runoff** – The most significant source of pollution in this area is runoff from farming. Row crop agriculture, including corn, soybeans, and cotton, is prevalent throughout most the watershed. Drainage from these farms contributes high amounts of sediments and nutrients.

  **Suggested Action**

Historically, this area was one of the better oyster producing areas in the state. However, many of the oyster rocks which used to sustain high populations have been worn down and destroyed by trawling and dredging. A focus on changing the fishing practices here to reduce or eliminate both trawling and dredging could allow some of those rocks to begin to become productive once again. Sanctuary creation would also go a long way towards maintaining a steady population of oysters in this area. Lastly, restoration work to help rebuild some of those damaged oyster rocks would be very helpful towards rehabilitating the oyster population. The area around Gum Thicket is under conservation easement, so work might best be focused there.
Vital Statistics:
- Watershed Area: ?
- Water Acreage: 68,000 acres
- Closed Acreage: 1,300 acres
- Peak Population: 1,700 people

Ecosystem Health:
- Production Rating: Fair
- Salinity Range: 1-23 ppt
- Significant Closures?: No
- Water Quality Rating: 3
- Habitat Health Rating: 4

Possible Sources of Pollution: Agriculture, Forestry, Runoff, Marinas, Sewage Plants

- **Agriculture** – Agriculture is one of the main industries of this area, and much of the land that was cleared in the past is now planted with row crops. The drainage from many of the fields is controlled by tide gates, which leads to large pulses of runoff at certain times. Three hog farms also operate within this area.

- **Forestry** – There has been significant logging, especially around the Rose Bay area.

- **Marinas** – There are 8 marinas in this area.

- **Sewage Plants** – The Mid-East WWTP is a tertiary treatment plant servicing 40,000 gallons a day. Discharge from this plant drains into Fordrey Creek.

**Suggested Action**

This was historically one of the best oystering areas in the state, and the Rose Bay area was famous for its oysters. This area still serves to provide the bulk of the catch each year from the Pamlico Sound region. However, populations have declined drastically due to disease and habitat loss. First, land acquisition here would help to improve water quality and reduce stress on the oysters. Most of this area is farmland, so farm bill acquisitions might be the easiest way to develop a buffer around the waterways here. Elimination of some of the ditching and draining systems would also help water quality greatly. Planting efforts should be increased here, and sanctuaries should be created to allow the oyster populations a foothold. Dredging here has had a large impact on oyster habitat, so limiting and strictly monitoring those practices is very important for oyster success.
Medium Priority Sites
Vital Statistics: Watershed Area: 30 square miles
Water Acreage: 1,800 acres
Closed Acreage: 1,198 acres
Peak Population: 51,000 people

Ecosystem Health: Production Rating: Good
Salinity Range: 6-37 ppt
Significant Closures?: Yes
Water Quality Rating: 1
Habitat Health Rating: 3

Possible Sources of Pollution: Subdivisions, Runoff, Marinas, Sewage Plants, Septic Systems

- **Subdivisions** – This is a large golfing destination, with a total of 16 golf clubs located in the area.

- **Runoff** – Many of the homes in this area are located right on the shore, with lawns mowed directly up to the water line. Without a vegetated buffer zone, much of the runoff from this area enters directly into estuarine waters with little or no filtration.

- **Marinas** – There are 4 marinas in this area, including Pelican Pointe, Marsh Harbor, Captain Jim’s, and Calabash Marina.

- **Sewage Plants** – There are 5 WWTPs in this area, including Carolina Shores, Oyster Bay, Ocean Isle, Bricklanding Plantation, and Sea Trails.

Suggested Action

All of this area is either closed or conditionally classified, and most of the closings are due to problems with stormwater runoff. Many of the homeowners in this area maintain their lawns up to the water’s edge, allowing water to run directly into the estuary with no filtering at all. Educating those homeowners on proper land management is a priority here, and will go a long way towards reducing the runoff problem in the area. Cultch plantings have been done in Old Channel and Soles Creek, so these should be maintained as well. Mitigation money from the high-rise bridge project to Sunset Beach might be available to assist work in this area.
Vital Statistics:
Watershed Area: ?
Water Acreage: 20,000 acres
Closed Acreage: 15,875 acres
Peak Population: 120,000 people

Ecosystem Health:
Production Rating: Fair
Salinity Range: 2-36 ppt
Significant Closures?: Yes
Water Quality Rating: 1
Habitat Health Rating: 2

Possible Sources of Pollution: Subdivisions, Runoff, Marinas, Ports, Sewage Plants, Industry, Septic Systems

- **Marinas** – There is 1 marina in this area, and the Fort Fisher Ferry has a docking facility here as well.

- **Ports** – The Wilmington Port is located in this area. This port contains petroleum storage tanks, farms, piers, loading facilities, and a large sewage plant.

- **Sewage Plants** – The town of Carolina Beach operates a 3 million GPD WWTP in this area. The Cape Golf Course and Subdivision runs an onsite package plant. A 3.5 million GPD WWTP is maintained by the Archer Daniels Midland facility for treatment of waste from citric acid production.

- **Industry** – The Archer Daniels Midland facility has a sulfuric acid storage area in addition to a citric acid production area. There is a CP&L Nuclear Power Station located adjacent to the ADM facility, which uses water from the river for cooling (which it then discharges back into the river). The Fort Fisher Ferry Terminal contains storage for diesel fuel and waste oil.

Suggested Action

North of the Fort Fisher Ferry Terminal, habitat quality is poor, and water quality is worse, so no action should be taken there at this time. However, south of the ferry terminal, oysters have the potential to grow well, so creation of an oyster sanctuary would be the best action. The Army Corps and UNC-W have both shown an interest in working on sanctuary creation here, so pushing that along should be the focus of efforts in this area.
### Vital Statistics

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Watershed Area</td>
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<tr>
<td>Water Acreage</td>
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<tr>
<td>Closed Acreage</td>
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### Ecosystem Health

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<td>Water Quality Rating</td>
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</tr>
<tr>
<td>Habitat Health Rating</td>
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</tr>
</tbody>
</table>

### Possible Sources of Pollution: Subdivisions, Runoff, Marinas, Sewage Plants, Septic Systems

- **Subdivisions** – There are 22 subdivisions within this area.
- **Runoff** – All of the stormwater runoff from the streets and parking lots at the Carolina Beach Boat Basin flows directly into the water.
- **Marinas** – There are 25 marinas in this area, including 13 concentrated at the Carolina Beach Boat Basin.
- **Sewage Plants** – The Carolina Beach WWTP serves about 96% of the residences and businesses in this area. The Dolphin Bay subdivision operates a package treatment plant. However, both of these discharge into the Cape Fear River, so do not impact this region.

### Suggested Action

Water quality in this area seems to be declining, so action must be taken to reverse that trend. There is a high level of private dock development along the canals, and CAMA permitting seems to be going forward in excess, so working to lessen that problem through education is a priority. Because this area is in a Phase 2 Stormwater County, an education program is required of the city and the county, so that might be the best avenue to achieve that goal. Minimal efforts at habitat restoration and plantings are exerted here at present, because of the lack of a suitable staging area, so acquiring land to serve that purpose should be another focus. This area has great potential for success, so efforts here could result in high rewards.
### Vital Statistics:
- **Watershed Area:** ?
- **Water Acreage:** 1,600 acres
- **Closed Acreage:** 382 acres
- **Peak Population:** 10,000 people

### Ecosystem Health:
- **Production Rating:** Good
- **Salinity Range:** 16-39 ppt
- **Significant Closures?** Yes
- **Water Quality Rating:** 2
- **Habitat Health Rating:** 3

### Possible Sources of Pollution:
- **Subdivisions** – There are 38 subdivisions in this area.
- **Agriculture** – Farms housing horses, pigs, and game fowl are found in this area.
- **Marinas** – There are 2 marinas in this area.
- **Industry** – There is a demolition landfill operated by the county road maintenance crew.

### Suggested Action
This rapidly developing area is at high risk for increasing problems with pollution and runoff. However, there is good substrate for oyster growth, and this is a popular oystering area for the region, so efforts would be well received by the public. The Soil and Water Conservation District in Wilmington has recently acquired conservation easements around Hewletts Creek, so supplementing that effort would be useful towards minimizing the impacts of development in the area. Additionally, there is a possible plan in the works to dredge the mouth of Hewletts Creek, which could lead to improved circulation in the area, and improvements in water quality.
**Vital Statistics:**

- **Watershed Area:** ?
- **Water Acreage:** 5,700 acres
- **Closed Acreage:** 664 acres
- **Peak Population:** 40,000 people

**Ecosystem Health:**

- **Production Rating:** Good
- **Salinity Range:** 21-38 ppt
- **Significant Closures?** No
- **Water Quality Rating:** 3
- **Habitat Health Rating:** 3

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants, Industry, Septic Systems

- **Subdivisions** – There are 40 subdivisions in this area.
- **Marinas** – There are 8 marinas in this area.
- **Sewage Plants** – Olde Point, Belvedere Plantation, Topsail Greens, Queens Grant, and Serenity Point all utilize package treatment plants. Surf City operates a WWTP.

**Suggested Action**

This region contains large amounts of suitable substrate for oyster growth and has a high water quality rating. However, this area is developing quickly, so water quality might be threatened in the near future. Property purchases for conservation will help to ease this threat. There is also strong interest from homeowners in the area to improve water quality, so a public education campaign could yield great results. This area contains a stockpile site, so cultch plantings are relatively easy, and would result in great benefits.
Vital Statistics:

- Watershed Area: 16 square miles
- Water Acreage: 500 acres
- Closed Acreage: 210 acres
- Peak Population: 0 people

Ecosystem Health:

- Production Rating: Fair to Good
- Salinity Range: 18-37 ppt
- Significant Closures?: Yes
- Water Quality Rating: 2
- Habitat Health Rating: 2

Possible Sources of Pollution: Forestry, Runoff

- Forestry – There is extensive forest management occurring in this area, including clear cutting and controlled burns. These practices often result in runoff problems throughout the area.

Suggested Action

There are many oysters in the creeks (esp. Freemans Creek), so working with the military to initiate BMPs in their forestry practices to help improve water quality would be the best option here.
**Area D-1 - Bear Creek Area**

**Vital Statistics:**
- **Watershed Area:** 8,320 acres
- **Water Acreage:** 700 acres
- **Closed Acreage:** 70 acres
- **Peak Population:** 1,000 people

**Ecosystem Health:**
- **Production Rating:** Good
- **Salinity Range:** 23-37 ppt
- **Significant Closures?** Yes
- **Water Quality Rating:** 1
- **Habitat Health Rating:** 3

**Possible Sources of Pollution:** Subdivisions, Agriculture, Forestry, Runoff, Septic Systems

- **Agriculture** – Crop land is abundant in this area, including corn, tobacco, soybeans, and winter wheat.

- **Forestry** – The forests on the Camp Lejeune side of the water are used for harvesting and are managed with controlled burns.

- **Runoff** – There is a public boat ramp in this area that is noted by many to be a significant problem. Runoff from a large area of farm, as well of from the road, is all siphoned down the boat ramp and into the water during periods of rain.

- **Septic Systems** – Septic systems have been found to cause water quality problems in this area.

**Suggested Action**

Runoff is the largest problem in this area. Without better runoff management, the water quality will continue to degrade. Working to eliminate the runoff problem at the boat ramp would be a good start. Restoration projects or property purchases to create a buffer zone around the agricultural and silvicultural areas would also be helpful in minimizing the impacts of runoff. Additionally, initiating BMPs on the military’s forestry practices would help a lot. There are significant quantities of good substrate in this area to serve as oyster habitat, so with improvements in water quality, the oyster population could grow exponentially.
**Vital Statistics:**
- Watershed Area: 50 square miles
- Water Acreage: 2,100 acres
- Closed Acreage: 890 acres
- Peak Population: 8,500 people

**Ecosystem Health:**
- Production Rating: Good
- Salinity Range: 11-36 ppt
- Significant Closures?: Yes
- Water Quality Rating: 2
- Habitat Health Rating: 3

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants, Industry, Septic Systems

- **Subdivisions** – There are 18 subdivisions in this area.

- **Runoff** – Stormwater runoff is listed as the most significant threat to water quality in this area because of the hilly terrain, as well as numerous stormwater culverts draining directly into the creek.

- **Marinas** – There are 5 ten-slip docking facilities.

- **Sewage Plants** – There are 4 package treatment plants in this area, although only one discharges into this watershed (Hewitt’s Mobile Home Park).

- **Industry** – There are two large auto salvage yards which have the potential to contribute toxins to the water. There is also a large asphalt plant.

- **Septic Systems** – Septic system failure is a chronic problem.

**Suggested Action**

Shellfish Sanitation has stated that this area contains very high quality oyster habitat. Unfortunately, sedimentation seems to be increasing. In order to maintain the high quality oyster habitat, better stormwater management practices must be adopted. Property purchase or restoration projects to protect and enhance land that can serve as a buffer would be very helpful. Additionally, a public education campaign to reach those living on the shore could help to improve land use practices along the river. There is minimal fishing effort here, so any oyster populations that take hold would have the opportunity to grow well without much human impact.
Vital Statistics:
- Watershed Area: ?
- Water Acreage: 4,900 acres
- Closed Acreage: 1,246 acres
- Peak Population: 60,000 people

Ecosystem Health:
- Production Rating: Fair
- Salinity Range: 20-37 ppt
- Significant Closures?: Yes
- Water Quality Rating: 1
- Habitat Health Rating: 2

Possible Sources of Pollution: Subdivisions, Runoff, Marinas, Ports, Sewage Plants, Industry, Septic Systems

- **Runoff** – Runoff from the Atlantic Beach Shopping Center, as well as other locations throughout the watershed, have caused large problems with water quality.

- **Marinas** – There are 27 marinas in this area.

- **Ports** – The NC State Port poses problems from chemical contamination and runoff, although BMPs have reduced this risk somewhat.

- **Sewage Plants** – There are package treatment plants at the large resort condos and two of the large motels in Atlantic Beach.

- **Industry** – Corroding storage containers on the old railroad property could release oils and other toxins into the water.

Suggested Action

Despite the high levels of pollution in this area, the substrate throughout much of Bogue Sound is very suitable for oyster growth. With constant dredging in the harbor for shipping, the area left to work with is small, but sanctuary creation in strategic locations could greatly benefit both oyster populations and water quality. Property purchases, as with Hoop Pole Creek, would be useful to minimize the further impacts of development as much as possible.
Area E-5 - Taylor Creek Area

Vital Statistics:
- Watershed Area: ?
- Water Acreage: 6,250 acres
- Closed Acreage: 450 acres
- Peak Population: 3,000 people

Ecosystem Health:
- Production Rating: Fair
- Salinity Range: 16-36 ppt
- Significant Closures?: Yes
- Water Quality Rating: 1 in Taylors Creek, 4 south of Carrot Island
- Habitat Health Rating: 2

Possible Sources of Pollution: Subdivisions, Runoff, Marinas, Sewage Plants, Industry, Septic Systems

- Runoff – Most of the land in this watershed has been completely developed, leading to large problems with runoff.
- Marinas – There are 11 marinas in this area.
- Sewage Plants – The Beaufort WWTP discharges directly into Taylor Creek.
- Industry – Beaufort Fisheries and Atlantic Veneer have the potential to degrade water quality in this area. Additionally, there are two shipyard facilities which have the potential to leak chemicals into the water.

Suggested Action

This area is highly degraded, and there is not much oyster habitat found here. However, there is an effort to remove the Beaufort WWTP discharge from Taylor Creek, which would be an immense help for water quality. The area surrounding Carrot Island and the Rachel Carson Reserve provides good oyster habitat. In addition to encouraging the removal of the WWTP discharge from the area, sanctuary creation within the Reserve or around Carrot Island would help water quality and oyster populations.
Area F-4 - Cedar Island Area

Vital Statistics:
- Watershed Area: 300 square miles
- Water Acreage: 63,000 acres
- Closed Acreage: 13 acres
- Peak Population: 340 people

Ecosystem Health:
- Production Rating: Good
- Salinity Range: 2-36 ppt
- Significant Closures?: No
- Water Quality Rating: 3
- Habitat Health Rating: 4

Possible Sources of Pollution: Marinas, Agriculture

- Marinas – The Cedar Island Ferry Terminal is located in this area.

- Agriculture – A horse/cattle farm is located adjacent to the ferry landing. This farm is directly on the beach, and with regular horse tours along the shoreline, runoff from animal wastes can impact water quality.

Recommended Action

Most of this area has been designated as a National Wildlife Refuge, so property acquisition is not necessary here. Thorofare Bay has great substrate for oyster growth, and the area around Portsmouth Island is considered one of the better oyster producing areas in the state. More recently, an area around Wainwright Island has become very productive. There is a high planting effort here currently, so maintaining that level of work should be the priority.
**Area F-6 - Bay River Area**

**Vital Statistics:**
- **Watershed Area:** 60 square miles
- **Water Acreage:** 20,000 acres
- **Closed Acreage:** 2,853
- **Peak Population:** 4,100 people

**Ecosystem Health:**
- **Production Rating:** Fair to Poor
- **Salinity Range:** 1-16 ppt
- **Significant Closures?** No
- **Water Quality Rating:** 2
- **Habitat Health Rating:** 2

**Possible Sources of Pollution:** Subdivisions, Agriculture, Runoff, Marinas, Sewage Plants, Industry

- **Agriculture** – Agriculture is the primary land use in this area. A hobby farm is located on the north shore of Bay River, containing about 500 fowl.

- **Sewage Plants** – The Bay River Metropolitan Sewage District is located near Bayboro. During inspection, it was found to have some problems, which were later corrected.

- **Industry** - There are two seafood operations present in Vandemere Creek, and a third located along the Intercoastal Waterway, which could have an impact on water quality.

**Suggested Action**

Runoff from agricultural fields is the most significant source of pollution here, so action should be taken to minimize runoff. Jones Bay is historically a good oyster site, and there have been high efforts at cultch plantings, so land acquisition around the Bay is the best course of action. Habitat restoration will help assist those cultch plantings in catching hold and striving. Sanctuary creation in the Bay River area, as well, will help maintain some stable populations of oysters in the area.
**Area G-5 - Long Shoal Area**

**Vital Statistics:**
- **Watershed Area:** ?
- **Water Acreage:** 46,000 acres
- **Closed Acreage:** 1,954 acres
- **Peak Population:** 1,800 people

**Ecosystem Health:**
- **Production Rating:** Fair
- **Salinity Range:** 0-25 ppt
- **Significant Closures?:** No
- **Water Quality Health:** 3
- **Habitat Health Rating:** 3

**Possible Sources of Pollution:** Subdivisions, Agriculture, Forestry, Runoff, Marinas, Industry, Septic Systems

- **Agriculture** – The majority of the land use is agriculture. The largest farm is Lux Farms, covering most of the northeast part of Engelhart. There are also 6 hog farms in this area, but 5 have been abandoned or are no longer in business.

- **Marinas** – There are 2 marinas in this area.

- **Industry** – Due to lack of funds, no wastewater treatment plant has been built here. Instead, 31 businesses or residences have permits to utilize straight pipe discharge to release their wastes into Far Creek. There is the potential that Engelhart might construct a WWTP which would encompass these areas.

- **Septic Systems** – This area has a high rate of septic failure, due to the combination of a high water table and poor soil.

**Suggested Action**

Over the past few years, Lux Farms has been clearing out the forested and vegetated lands between crops in order to increase farming acreage. This has the potential to increase runoff and siltation in the area. Working with them and the other farms in the area to encourage healthy farming practices would help to reduce the runoff problems. Clean up of the abandoned hog farms would also help, especially in the event of a hurricane or other significant flooding event. Although the farms are no longer in use, the lagoons are still present, and serve as a large potential source of pollution. More research is necessary to better understand what is needed in this area.
Area G-6/H-4/H-5 - Outer Banks

**Vital Statistics:**
- **Watershed Area:** ?
- **Water Acreage:** 85,000 acres
- **Closed Acreage:** 690 acres
- **Peak Population:** 40,000 people

**Ecosystem Health:**
- **Production Rating:** Fair
- **Salinity Range:** 15-38 ppt
- **Significant Closures?** No
- **Water Quality Rating:** 3
- **Habitat Health Rating:** 3

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants, Industry, Septic Systems

- **Subdivisions** – The area around Silver Lake in Ocracoke is experiencing a high rate of growth. Oyster Creek, a 35-acre subdivision, is located on the northeast side of the village.

- **Marinas** – All 3 marinas are located in Silver Lake. Ferries operate on the island’s ends.

- **Industry** – There are two fish packing operations around Silver Lake.

**Suggested Action**

Historically, this is not a good oyster area, although recently, Ocracoke has improved in production. Closures are increasing here, and development is increasing exponentially, so working to stem that and improve water quality is important. However, the biggest problem is the lack of good resources for reef construction and cultch planting. There is no good stockpile site around here, so oyster shell needs to be hauled across the sound in order to be used. Additionally, the only vessels suitable for work in this area need to be shipped up from Wilmington, which is very time consuming and inconvenient. Before any sustained effort at restoration can be made here, a suitable stockpile site needs to be located, and a vessel dedicated specifically to this area needs to be purchased. Once those two goals are accomplished, other actions can move forward.
Area H-1 - Roanoke Sound Area

**Vital Statistics:**
- **Watershed Area:** ?
- **Water Acreage:** 20,500 acres
- **Closed Acreage:** 2,200 acres
- **Peak Population:** 40,000 people

**Ecosystem Health:**
- **Production Rating:** Fair
- **Salinity Range:** 1-34 ppt
- **Significant Closures?** No
- **Water Quality Rating:** 2
- **Habitat Health Rating:** 3

**Possible Sources of Pollution:** Subdivisions, Marinas, Sewage Plants, Industry

- **Subdivisions** – There are 12 subdivisions.
- **Marinas** – There are 8 marinas.
- **Sewage Plants** – The Manteo Municipal WWTP is a tertiary treatment plant which is located in H-2 and discharges into Shallowbag Bay in area H-1. A tertiary treatment plant also serves the Villas Condominiums in north Nags Head. The Village at Nags Head subdivision uses a 500,000 gpd treatment plant, and the Soundings Factory Outlet Mall utilizes a 17,000 gpd package plant. The grossly oversized package treatment plant at Southside Pavilion has a 35,000 gpd capacity and receives only about 1,000 to 5,000 gpd on average.
- **Industry** – Nags Head and Manteo have both developed rapidly over the past few years, and there is a large concentration of businesses in the center of town. Additionally, the Wanchese Seafood Industrial Park, located in Wanchese Harbor, consists of 23 seafood-related businesses.

**Suggested Action**

Oyster production in this area is stable, although the oysters here are relatively slow growing. Dredging has a big impact on oyster habitat, so that problem needs to be dealt with. There is one sanctuary present here, so cultivation of that area is important to improve oyster production throughout the area. Additionally, land acquisition would be useful, to help stem the excessive development that has plagued other regions of the Outer Banks.
**Vital Statistics:**
- Watershed Area: ?
- Water Acreage: 42,000 acres
- Closed Acreage: 891 acres
- Peak Population: 3,000 people

**Ecosystem Health:**
- Production Rating: Good
- Salinity Range: 1-30 ppt
- Significant Closures?: No
- Water Quality Rating: 2
- Habitat Health Rating: 3

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Industry, Septic Systems

- **Subdivisions** – There are 2 subdivisions.
- **Marinas** – There are 3 marinas.
- **Industry** – Construction of the new bridge between Manns Harbor and Manteo has had a significant affect on the region. On-site facilities constructed to speed up the construction process cause problems with runoff and change in land use. Additionally, the bridge spans an area of wetland, so some of that important habitat has been lost during construction. There is a demolition landfill on the mainland side which is used for disposal of construction debris and large items such as appliances. There are several ditches draining this landfill.

**Suggested Action**

Other than the bridge construction site, this area is generally free of pollution. Oyster production is considered good in the Wanchese area only, so efforts should be focused in and around that region. This area will be the site of the first large scale (30 acres) oyster sanctuary in North Carolina. This will help reduce the impact of trawling and dredging on the oysters here, and will allow a significant population to grow unimpacted by humans.
Low Priority Areas
Area B-2 - Buzzard Bay Area

**Vital Statistics:**

- **Watershed Area:** ?
- **Water Acreage:** 2,850 acres
- **Closed Acreage:** 117 acres
- **Peak Population:** 5,000 people

**Ecosystem Health:**

- **Production Rating:** Good
- **Salinity Range:** 6-36 ppt
- **Significant Closures?:** No
- **Water Quality Rating:** 3
- **Habitat Health Rating:** 4

**Possible Sources of Pollution:** Subdivisions, Runoff, Marinas, Sewage Plants

- **Subdivisions** – Development on Bald Head and Middle Island is increasing rapidly.

- **Marinas** – There is 1 marina in this area.

- **Sewage Plants** – A tertiary WWTP serves Bald Head Island.

**Suggested Action**

This is a pristine area, with limited access and only a moderate fishing effort. However, oysters grow very well here, and because of the low fishing effort, the population seems to be maintaining itself well. Working to supplement the populations in Bald Head Creek would be useful, although equipment access is difficult here, so the time and money might not be worth it. Education of the homeowners along the creek would help to improve water quality there. There is a project in the works to dredge the mouth of the creek. It is stated that the goal of this project is to improve water circulation to the back of the creek, which would help the oyster population immensely. However, this dredging project will allow the homeowners along the creek access to their docks for large boats. This could have a large negative impact on oyster populations, so must be studied before action is taken to dredge the channel.
Vital Statistics:

Watershed Area: ?
Water Acreage: 275 acres
Closed Acreage: 1 acre
Peak Population: 0 people

Ecosystem Health:

Production Rating: Poor
Salinity Range: 6-36 ppt
Significant Closures?: No
Water Quality Rating: 3
Habitat Health Rating: 1

Possible Sources of Pollution: Marinas, Septic Systems

Marinas and Septic Systems – The Fort Fisher Ferry landing is in this area. The septic system at the landing has a history of failure.

Suggested Action

There is very little oyster production in this area, except along the edges of the water. This low production is due to a lack of suitable substrate for oyster growth. If reefs could be established here, they would probably be successful, but this area experiences extensive shoaling, so sand covers over good habitat on a regular basis. Additionally, water quality seems to be deteriorating since the inlet here closed a few years ago. Investigation into the impact of that closing would be useful. Overall, access is limited in this area, as there are no good staging areas for oyster shell, and it is hard to get equipment into the area, so efforts might be better spent elsewhere at this time.
### Area D-4/E-1/E-2 - Deer Creek, Broad Creek, and Western Bogue Sound

#### Vital Statistics:
- **Watershed Area:** ?
- **Water Acreage:** 14,000 acres
- **Closed Acreage:** 880 acres
- **Peak Population:** 89,000 people

#### Ecosystem Health:
- **Production Rating:** Poor
- **Salinity Range:** 9-37 ppt
- **Significant Closures?** Yes
- **Water Quality Rating:** 2
- **Habitat Health Rating:** 1

#### Possible Sources of Pollution:
- Subdivisions, Agriculture, Runoff, Marinas, Sewage Plants, Septic Systems

- **Runoff** – Continued development will lead to increasing deterioration of water quality as natural vegetation is lost and runoff subsequently increases.

- **Marinas** – There are 21 marinas in this area.

#### Suggested Action

Stormwater is a significant problem in this area. However, there is a minimal presence of oysters here due to the natural condition of the system, so oyster rehabilitation efforts here would not be of great benefit.
**Vital Statistics:**
- **Watershed Area:** 20 square miles
- **Water Acreage:** 8,100 acres
- **Closed Acreage:** 32 acres
- **Peak Population:** 500 people

**Ecosystem Health:**
- **Production Rating:** Fair
- **Salinity Range:** 16-36 ppt
- **Significant Closures?** No
- **Water Quality Rating:** 4
- **Habitat Health Rating:** 4

**Possible Sources of Pollution:** Subdivisions, Marinas

- **Subdivisions** – There are 2 subdivisions in this area.
- **Marinas** – There are 7 marinas and 2 commercial docking facilities, and they are the major source of pollution.

**Suggested Action**

This area could be considered one of the most pristine along the whole North Carolina coast. The only significant pollution comes from runoff from Harkers Island. There is very little possibility for land acquisition here, and it is very difficult to do any reef creation due to the shallow nature of the sound, so it might be best to leave this area as it is.
### Area E-8/E-9 - Core Sound Area

#### Vital Statistics:
- **Watershed Area:** ?
- **Water Acreage:** 38,000 acres
- **Closed Acreage:** 650 acres
- **Peak Population:** 4,000 people

#### Ecosystem Health:
- **Production Rating:** Fair
- **Salinity Range:** 12-37 ppt
- **Significant Closures?:** Yes
- **Water Quality Rating:** 3
- **Habitat Health Rating:** 3

#### Possible Sources of Pollution:
- **Runoff** – Runoff from farms in this area has a big impact on water quality.
- **Industry** – There are five seafood operations involving the mooring of vessels, which serve as the main source of pollution in this area.

#### Suggested Action
Historically, this area had outstanding oyster production, but now this area produces predominantly clams. There are a few good growing areas, but interest in oysters is low here. Efforts to improve water quality by creating buffers along the farm land would help, but because of the low interest and low production, efforts might be better expended elsewhere.
Vital Statistics:
- Watershed Area: 30 square miles
- Water Acreage: 22,000 acres
- Closed Acreage: 12 acres
- Peak Population: 55 people

Ecosystem Health:
- Production Rating: Fair
- Salinity Range: 2-36 ppt
- Significant Closures?: No
- Water Quality Rating: 4
- Habitat Health Rating: 4

Possible Sources of Pollution: None

Suggested Action

With the exception of the Bombing Range and the small community around North Bay, this area is entirely wilderness. The 1999 DMF cultch planting in West Bay was particularly successful at producing oysters, and there is a sanctuary present here already. There are no sources of pollution, and oyster habitat is good in the West Bay region, so additional oyster reef creation or cultch plantings would help oyster production improve. Monitoring area development and buying property in order to keep this area pristine is recommended.
Vital Statistics:

- Watershed Area: ?
- Water Acreage: 46,000 acres
- Closed Acreage: 650 acres
- Peak Population: 1160 people

Ecosystem Health:

- Production Rating: Poor
- Salinity Range: 0-26 ppt
- Significant Closures?: No
- Water Quality Rating: 2
- Habitat Health Rating: 3

Possible Sources of Pollution: Subdivisions, Agriculture, Forestry, Runoff, Industry

- **Subdivisions** – There are 6 subdivisions.
- **Agriculture** – There are several large expanses of fields used for row crops in this area.
- **Forestry** – There has been extensive clear-cutting around Pamlico Beach, Ross Creek, North Creek, and Campbells Creek.
- **Runoff** – This area is very low-lying, so many of the developments use ditching to drain their lands, leading to extensive drainage into the estuary. The areas that have been clear-cut also experience an increase in runoff.
- **Industry** – There are 4 seafood restaurants located on the water in this area, including Paul’s Seafood, Debbie’s Seafood, Crab Ranch, and the Pamlico Grocery and Marina. Castle Hayne Fisheries is an upland aquaculture facility located in this area.

**Suggested Action**

There is little if any oyster production in this area. The only places known to support oyster populations are Goose (mostly open) and North Creeks (closed), although Oyster Creek has begun to support a population recently as well. Most of the population is scattered, so sanctuary creation or the construction of new oyster rocks could help maintain a more sustainable population, but this area is currently low in priority due to its low production and low potential for growth.
Vital Statistics: Watershed Area: ?
Water Acreage: 21,200 acres
Closed Acreage: 8,175 acres
Peak Population: 3,000 people

Ecosystem Health: Production Rating: Poor
Salinity Range: 1-22 ppt
Significant Closures?: No
Water Quality Rating: 3
Habitat Health Rating: 2

Possible Sources of Pollution: Subdivisions, Agriculture, Runoff, Marinas, Sewage Plants, Industry

- Subdivisions – The 14 subdivisions are mostly well-established, with little potential for growth.

- Agriculture – Agriculture is the main industry, with much of the land-use devoted to row crops. There is also a large seed farm near the upper Pungo River and 14 animal farms within the area.

- Marinas – There are 9 marinas.

- Sewage Plants – The Belhaven Municipal WWTP is a 1 million gallon capacity activated sludge system, which discharges into Battalina Creek. The Dowry Creek Subdivision operates a 50,000-gpd package plant.

- Industry – There is a small commercial area in Belhaven, which includes several marinas and two crab houses.

Suggested Action

Water quality here is generally stated to be good, but much of the area is closed due to runoff problems from the towns. Better stormwater management practices should be adopted. Since there is minimal oyster production here, efforts might be better focused elsewhere.
**Area H-3 - Stumpy Point Area**

**Vital Statistics:**
- **Watershed Area:** ?
- **Water Acreage:** 5,500 acres
- **Closed Acreage:** 265 acres
- **Peak Population:** 230 people

**Ecosystem Health:**
- **Production Rating:** Fair
- **Salinity Range:** 2-26 ppt
- **Significant Closures?**: No
- **Water Quality Rating:** 3
- **Habitat Health Rating:** 3

**Possible Sources of Pollution:** Industry, Septic Systems

- **Industry** – There are two seafood operations around Lake Worth. There is a dredge spoil area used to contain material from dredging of the Stumpy Point Bay Emergency Ferry Terminal.

- **Septic Systems** – Because much of the area is unsuitable for septic systems, some homes have tanks with straight pipes that empty into Lake Worth.

**Suggested Action**

Most of this area is located within the Alligator River Wildlife Refuge, so efforts at property purchase and conservation are unnecessary. Maintenance of current efforts is probably adequate at this time.
Section 3: Oyster Gardening: Models From Other States
Introduction

The once booming North Carolina oyster fishery, the top shellfishery in the state until the 1970s (DMF 2001), has been in decline since the turn of the 20th century. Persistent overfishing, disease, habitat loss, and pollution have all contributed to this demise, which has led to the loss of a large percentage of the oyster population over the last 100 years. Without changes in current land-use, water-use, and fishing practices, it is possible that oyster populations could continue to decline until the fishery becomes completely extinct.

Many actions are currently being taken to reverse this trend, and to restore a significant population of oysters to North Carolina estuaries. Management techniques ranging from reef creation to on-land buffer zone restoration projects are currently in place to improve the habitat and water-quality in oyster-sustaining waters. One of the most highly debated methods of oyster population enhancement in recent years is called oyster gardening. This process involves private citizens using their docks, and occasionally the public bottom, to grow and maintain oysters. Some of these oysters are used for seed in restoration projects, while others are harvested as food by the grower. This method has the potential to assist with the recovery of the oyster population to a degree, and to increase public awareness and involvement with the resource and its restoration, but it is not without controversy. Some cite the violation of public trust doctrine as their biggest objection, while others talk about public health risks. Still others argue that allowing wide-spread private gardening will put a significant new burden upon the already over-burdened organizations in charge of regulating the fishery.

Other states have faced these same issues, and have developed programs similar to the one proposed here in North Carolina. This paper will review some of the many different programs other states have developed to make oyster gardening a successful venture, and then make a series of recommendations on how North Carolina can proceed with its own oyster gardening program while still addressing the concerns of those opposed to the idea. Hopefully, some middle ground can be reached, and in the end, the prime beneficiary will be the oyster.

Chesapeake Bay Region

One of the most successful oyster gardening ventures in the United States takes place in the Chesapeake Bay, which is divided between two states, Maryland and Virginia. One of the primary organizations promoting oyster gardening in this region is the Chesapeake Bay Foundation (CBF), which operates out of both states. CBF holds workshops throughout the year to train gardeners in the best methods for growing oysters, helps them build oyster floats, and gives them 2000 seed oysters to start their garden. About once a year, the oysters grown in these gardens are given back to the CBF, and planted on restored reefs throughout the estuary (Chesapeake Bay Foundation).
In addition to the CBF, there are other state specific organizations in both Maryland and Virginia. Much of the oyster gardening effort in Virginia has been spearheaded by the Virginia Institute of Marine Sciences (VIMS). To encourage gardeners, VIMS has released a pamphlet entitled “An Introduction to Culturing Oysters in Virginia,” which explains the importance of oysters, illustrates the various methods for oyster aquaculture, and provides contact information for people knowledgeable in these areas. Additionally, they have set up the ‘Gardener Research Extension Network’ (GREEN), which is a cooperative between VIMS researchers and volunteer noncommercial gardeners. Through this program, VIMS works with volunteers to grow and test various strains of oysters for resistance to disease (Virginia Institute of Marine Sciences).

In Maryland, organizations such as the Oyster Recovery Partnership and the Assateague Coastal Trust are involved extensively with oyster gardening and restoration. Both organizations serve similar functions as the CBF, in that they train volunteers, provide them with spat, and use the grown oysters for restoration projects around the Bay.

Each state also has specific organizations charged with regulating oyster gardening. In the state of Virginia, the Virginia Marine Resources Commission (VMRC) and the Virginia Department of Environmental Health (VDEH) have joined forces to ensure a safe, unintrusive oyster gardening program. VMRC focuses on permitting, while the VDEH is in charge of monitoring the health of the waters in which oyster gardens are located, and each of these organizations operates under a specific set of state laws. Prior to 1998, there was extensive unauthorized gardening occurring throughout the Virginia coast, and concerns arose about the possibility of people getting sick by consuming oysters from closed areas (Neikirk 2003). In response to these concerns, in January of 1998, the VMRC created General Permit #3 (Appendix 1), a permit for “noncommercial riparian shellfish growing (i.e. gardening) activities…” (4 VAC 20-336). VMRC, rather than attempting to create a new set of regulations, simply created a “streamlined, no-cost version of a subaqueous permit” (Neikirk 2003) for oyster gardening. This permit allows structures not exceeding 160 square feet to be placed anywhere within the permit holder’s riparian area, as long as the structure does not impact existing stands of submerged aquatic vegetation (4 VAC 20-336-40).

The VMRC also administers the “Abbreviated Joint Permit Application For Noncommercial Riparian Shellfish Aquaculture Structures” (Appendix 2), a shortened, streamlined version of the General Permit #3. This no-cost permit application asks a few questions about the size and location of the planned garden, and requires maps of the area to be submitted along with the application. Once approved by the VMRC, the application is forwarded to the VDEH and a local Wetlands Board for review. Once the VDEH has contacted the permittee to advise them on the risks of consuming oysters from polluted waters
(as gardens are allowed in closed areas), and to offer suggestions on how to relay those oysters to open waters for depuration, the permit is issued, and is valid for five years (Neikirk 2003).

Within the state of Maryland, the Maryland Department of Natural Resources (MDNR), as well at the Department of Health and Mental Hygiene (MDHMH), handle issues related to oyster gardening. Noncommercial oyster culture is allowed under a private dock without a permit, and consumption of these oysters is allowed. This rule has come about because the rulemakers in Maryland felt that all of the issues that come about during the construction of an oyster garden were addressed during the permitting process for the dock (i.e. building in navigable waters, constructing on wetlands or SAV) (Bohn 2003).

If one hopes to grow oysters for any other purpose, then an aquaculture permit, issued by MDNR, is required (Appendix 3). This permit asks general questions about the actions to be taken and the location of the intended project. In addition to this, a joint MDNR/Army Corps of Engineers permit is required. This permit, the ‘Joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Non-Tidal Wetland in Maryland,’ (Appendix 4) is required for any three-dimensional use of the water column. This permit requires public notification, and if the area requested is over 5000 square feet, another lease from the Board of Public Works is required, setting a yearly rent. If the oysters being grown are intended for human consumption beyond personal use, then the water needs to be tested, and the area needs to be certified as safe by the MDHMH.

Although the two states have very different rules and governing bodies to regulate oyster gardening, both have experienced both successes and problems with implementing and carrying out the program. Virginia has not experienced problems with public trust issues, or with enforcement. Because of the “relatively small size, location of the structures within the riparian area of the permittee, and noncommercial nature of the activity,” (Neikirk 2003), regulators did not see any conflict with public trust doctrine. In fact, some would say that the public has benefited from the program “via improved water quality, restoration efforts, etc.’ (Oesterling 2003). Additionally, because most oysters are not commercially produced, MDHMH can classify the floats as part of their general classification for an area (Croonenberghs 2003), so can easily determine whether the garden is in a safe area, thus eliminating and additional workload.

Maryland, on the other hand, has had problems appear with public trust issues and enforcement as the popularity of oyster gardening has grown. Although the bottom and water-column leasing rules specify that leases can only be granted in naturally unproductive areas, yearly fluctuations in oyster productivity can lead to the private leasing of highly productive oyster grounds. Oyster bars typically fluctuate in productivity, so some fishermen monitor this fluctuation and apply for a lease during unproductive years. At this point, the bar is removed from the public domain, and is privately controlled
when it returns to a natural state of higher productivity. These issues have brought about revisions in the rules behind leasing, and have introduced required site inspections before the leases are granted (Bohn 2003). Additionally, although laws currently prevent oyster production of any kind in closed areas, “there are certainly oysters being raised in prohibited places” (Bohn 2003). Although MDHMH and MDNR are both working very hard to monitor these situations, funding problems prevent them from doing a thorough job. The problem has gotten so bad that Maryland may soon require permit applicants to pay a fee for their own water testing, thus providing MDHMH and MDNR with extra funds for monitoring (Bohn 2003).

Both states have expressed worries about public health issues. In the nearshore area, “activities such as the unforeseen failure of [a] neighbor’s septic system, drainage of water from yards where pets are kept, and other factors can introduce human disease causing organisms…” (MDE 1997). Because most water sampling is done closer to the main channel of any given body of water, the potential exists that pollutants present only in the near-shore region would not be identified during water quality testing (Croonenberghs 2003). Thus, both states recommend against consuming oysters grown on private docks, and are looking to increase shoreline survey efforts in order to minimize this risk.

New York State

Private oyster gardening in the state of New York is regulated by the state Department of Environmental Conservation (DEC). The DEC provides a ‘Shellfish Culture Permit,’ which is a “commercial permit that would allow a person to raise and possess shellfish for cultivation purposes at a location approved by DEC” (Barnes 2003). If this site is located in an open area, then the permit holder is allowed to eat or sell the oysters as they choose. However, if a site is located in a closed area, then the oysters must be transplanted to an open area for a minimum of 21 days before they can be consumed (Barnes 2003).

Much of the oyster gardening in the state, though, is administered through the Southold Project in Aquaculture Training (SPAT). This is a non-profit program run by the Cornell University Cooperative Extension Marine Program. SPAT organizers have made arrangements with the DEC to acquire a blanket ‘Scientific Collectors Permit’ each year, allowing for people who have joined the program to maintain oyster gardens as part of the research being carried out by SPAT, as long as they agree to abide by a set of rules settled on by both SPAT organizers and the DEC (Foster 2003). One can join SPAT at a number of levels, including ‘Commercial Shellfish Sponsor’ ($100), a ‘Sustaining SPAT Member’ ($100), a ‘Master Shellfish Gardener’ ($150), an ‘Ambassador’ ($250), or a ‘Corporate Sponsor’ ($500+).
As a master shellfish gardener, members receive mailings and training, but also rights to their own “test garden plot” at Cedar Beach Creek Cornell Cooperative Extension Management Area. They are also given 2,000 seed oysters to help start their garden. Under this program, members may keep 50% of the oysters they grow for personal use, and must return at least 50% to the SPAT program for use in restoration projects.

As an ambassador or corporate sponsor, members are allowed to maintain private gardens from their own docks or piers. However, with this freedom comes added responsibility. Plots are restricted to an area of 10’ by 10’, and no gardens can be maintained within closed areas. Each member must acquire a Southold Special Collectors Permit (free with membership), and must attend regular training sessions in order to achieve ‘Master Gardener’ certification. Finally, all members at this level must sign a release form before starting, releasing the program and the DEC from liability, and again must donate at least 50% of their harvest back to the SPAT program for use in restoration projects (Cornell Cooperative Extension).

So far, the program has been a success. In the first three years of the program, about 800,000 oysters were grown to maturity, and half of those were used to construct an oyster reef/sanctuary. SPAT organizers are currently developing protocols to monitor changes in water quality and spat set due to these projects, so evaluations of the ecological impacts of the project will be available in the coming years (Foster 2003).

The greatest success of this program so far though, has been in improving community awareness and stewardship for the environment. Through media reports, SPAT has spread their message throughout the state, and even the world. These efforts have resulted in a total of 5,412 volunteer hours from the community over the past three years, and have gotten people excited about helping oysters in New York (Foster 2003). Unfortunately, this program has recently experienced problems with funding, so may not be able to continue to carry out their efforts to restore oysters to New York waters.

Alabama

The Alabama Department of Conservation and Natural Resources (ADCNR) is in charge of regulating oyster gardening within their state waters. However, they do not have much authority, as an 1872 state law gives waterfront property owners riparian rights extending 600 yards from shore. Once registered with the ADCNR, these property owners are granted exclusive rights to plant and gather oysters as they please (Wallace et al., 1999). One of the largest oyster gardening programs in the state though, encourages these property owners to utilize that right for ecological, rather than personal benefit. The Mobile Bay National Estuary Program, in conjunction with Auburn University, ADCNR, and the Alabama Department of Health, has worked to restore oysters to the Gulf Coast through a volunteer
growing network. Volunteers with docks located in open areas are given oyster seed, and are asked to
maintain those oysters over the summer months. After the growing period, the oysters are recollected and
deposited on restored reefs along the coast (Mobile Bay National Estuary Program). Volunteers in this
program agree not to eat any of the oysters grown on their dock, and are not even in possession of them
when they reach legal size, so the public health issue is a moot point here. In its first year of operation,
this program netted 40,000 oysters for restoration purposes, and in year two (2002), they were hoping for
up to 80,000 more (Smith 2002).

**North Carolina: Current Status**

Current laws in North Carolina permit the secretary of the Department of Environment and
Natural Resources to grant bottom and water column leases for oyster growing to interested parties.
Under these rules, leases may be granted as long as the area to be leased does not contain a natural
shellfish bed, the area must be classified as open, and as long as the granting of that lease will not impinge
upon anyone else’s riparian rights (NC G.S. 113-202). Additionally, oysters can be developed privately
for educational, commercial, and scientific purposes. Under NCAC 15A-3O.0503(g), individuals and
agencies can obtain a “Scientific/Educational Collection Permit,” which allows for the creation of
research sanctuaries. NCAC 15A-3O.0503(f) allows anyone to obtain an “Aquaculture Operation
Permit,” which allows for commercial aquaculture. However, oyster gardening with the intention of
private consumption, possessing undersized oysters, and growing oysters in closed areas are not permitted
under any state laws.

Currently, there is growing public sentiment to begin a coast-wide oyster gardening program.
Some believe that it will bring immense ecological benefits to the state, while others want to utilize oyster
gardening as a means to maintain their own private crop of oysters to eat. Leaders of this current effort
include NC Sea Grant and the Nature Conservancy. However, besides the problems with permitting,
other road-blocks exist keeping private oyster gardening from becoming a reality. There are issues with
handling undersized oysters (NCAC 15A-3K.020), with growing oysters in closed areas (NCAC 15A-
3K.0101(a)), with liability and property rights, and with public health risks (Marshall 2003). It is only
through changes in state law that a situation could arise under which private gardens for private
consumption would be allowed.

A pilot program was recently announced which will allow for 50 sites along the coast to develop
private gardens. These gardens will work with NC Sea Grant and the Division of Marine Fisheries
(DMF) to grow oysters around their docks. They will be allowed 90 square feet of cage per site, and no
sites will be located in polluted areas. This program will allow DMF and other agencies to see oyster
gardening in action, and to evaluate whether the worries currently prohibiting oyster gardening are valid.
After two years, DMF will analyze the results of the program, and will then be able to make recommendations to the General Assembly for rule changes based on hard evidence. These results will also be presented in an updated Oyster Fisheries Management Plan in 2006/2007 (Marshall 2003). Once this process is complete, if it goes well, the state’s view on oyster gardening may begin to change. If unsuccessful though, and if the fears of regulators are confirmed, oyster gardening may remain prohibited to private growers, and allowed only as a means of restoration and education.

**Recommendations**

Based on what other states have accomplished, it is apparent that there are many different ways to create a successful oyster gardening program. Some require permits, while others do not. Some restrict gardening to open areas, while others hope that permitting oyster culture in closed areas will help to improve water quality. Although there are differences among the various state programs, each has been successful in its own way. Based on the experiences of these other programs, the benefits of oyster gardening, both public and private, outweigh the negatives. Keeping this in mind, I make the following recommendations for how North Carolina can begin to develop a successful oyster gardening program that will be a benefit to all of its citizens.

1) **Interested and responsible parties should begin to work with legislators and NCDMF to draft regulations allowing for the creation of a private gardening permit, containing the following stipulations:**
   a. *Prohibit the sale of any oysters grown under this permit.*
   b. *No private oyster gardening should be allowed in closed areas* – Many states, including North Carolina, believe that allowing oyster production of any kind for consumption is too much of a public health risk in closed areas. Prohibiting oyster production of any kind in closed areas eliminates this risk, as well as the need for added monitoring, the construction of depuration plants, and the time-consuming work of watching over oyster transfers.
   c. *Establish a permit fee of at least $100* – This fee will serve several purposes. First, it is not a high enough cost to be prohibitively expensive, but it is high enough to dissuade those not truly serious about oyster gardening from undertaking the project. By eliminating those not willing to fulfill the amount of work needed to properly maintain an oyster garden, the risk to public health and safety is significantly reduced. Although permit fees would not be a significant source of money, they would help to offset the costs of administering the program. Applications should be reviewed on a case-by-
case basis, and a fee waiver should be available to those demonstrating significant financial need.

d. **Mandate that 25% of all oysters grown in any private garden be donated to an oyster restoration project** – As part of the permitting process, growers should be mandated to submit evidence of the number of spat planted on a particular garden. From this, the permit administrator will be able to determine how many oysters are being grown, and mandate that 25% of those oysters be submitted after one year of growth for use in an oyster restoration project. This requirement is beneficial for everyone involved. The grower maintains the right to grow and keep a regular supply of oysters, while the state and others involved in oyster restoration get a steady supply of mature oysters for use in their projects. This rule is also important because current public trust doctrine in North Carolina claims all submerged or tidally influenced land (including that land under docks or piers) for the public domain. Thus, all oyster gardens will technically be placed on public land. If the oyster garden was solely for personal use, then that would be making use of public land for personal benefit, which would be a violation of public trust doctrine. By providing a service back to society, the oyster gardeners are providing a public benefit from their garden, and thus are not in violation of public trust doctrine.

e. **Create a waiver of liability, releasing the state and other program administrators from responsibility for anything pertaining to the oyster garden, including health risks and damage** – In many states with existing programs, people applying for an oyster gardening permit must sign a waiver of liability which “protects the state from lawsuits related to backyard shellfish gardening operations and absolves the state from any responsibility to monitor and protect backyard shellfish gardens from damage or theft” (Fox 2003). Additionally, despite all possible warnings from health departments, there is still a chance that someone will ignore those warnings, and consume or sell oysters not fit for human consumption. To reduce the possibility of any liability to the state and other organizers of gardening, all gardeners should be required to sign a release form, releasing the state and organizers from responsibility.

f. **Allow oyster gardening from floats attached to and contained below docks and piers only, and restrict the size of the garden to less than 100 square feet** – This allows gardeners ample space to work, while at the same time minimizing the encroachment upon public waters.
g. *Initiate a public comment period to question the permitting of any private garden* – There are certain areas that are simply too valuable to the public or to commercial fishermen to have them closed off and under private control. The comment period will allow anyone to voice their concerns, and, if the sentiment against the project is strong enough, the permit can be denied.

h. *Permit holders must obtain and use NC native oyster spat or obtain* *Crassostrea virginica* *spat from a licensed in-state dealer* – Promoting and using native oysters is vital to the overall recovery efforts. If native *C. virginica* is not available, then certified *C. virginica* larvae from other states may be used. However, there are strict NC state and intra-state protocols for the importation and testing of live shellfish larvae. Only licensed dealers and aquaculture operators are capable of complying with these standards.

i. *Permit holders and community gardeners must attend two training seminars sponsored by NC Sea Grant, DMF, or other designated organization* – The training will include instruction on maintaining the oysters and the equipment; seasonal needs; basic oyster ecology; monitoring protocols and how to monitor oyster growth/viability. Permit holders will receive an instruction manual.

j. *Permit holders will be required to monitor oyster growth and viability and submit quarterly reports to the designated organization or agency. If the responsible agency or organization deems that a permit holder has not complied with the conditions of the permit, the permit may be revoked* – As occurs in other states, those undertaking oyster gardening should be responsible for monitoring and reporting on their own garden. Evidence of claims should be turned in along with the quarterly reports, and inconsistencies should be checked by the permitting agency.

2) **Change current rules in order to encourage community organizations to take advantage of the educational/scientific permit:** Current rules require that an organization classified as “scientific or educational” oversee the construction and maintenance of any oyster reef created under this permit. However, this mandate puts an enormous burden upon those organizations, as they are responsible for all documentation and management of the reef, and are liable for anything that goes wrong. Community organizations such as rotary clubs and boy-scout troops have expressed interest in constructing their own reefs, but no qualified groups are willing to help them out because of the added liability and workload. Rules should be changed to allow organizations such as community groups to obtain their own permit, rather than
having to work through an educational or scientific intermediary. The result would be more reefs, and more citizens would be involved with and aware of the work going on with oysters.

3) **Begin an extensive oyster shell recycling program:** One of the biggest impediments in any oyster culture project is the availability of oyster shell. Working with restaurants, catering agencies, and others, a shell recycling program should be set up and managed by DMF. This program should resemble the one currently in operation in South Carolina, where ‘drop-off sites’ have been set up around the state by the South Carolina Department of Natural Resources (South Carolina Oyster Restoration and Enhancement). If a significant stock of shell can be obtained in this manner, it will greatly reduce the cost burden on any organization attempting to grow oysters, and will allow many more projects to go forward.

4) **Increase public education efforts:** Almost every successful gardening program has a large public education component, including workshops, newsletters, and written guides on the best methods to grow oysters. Public education should be a key component of North Carolina’s program as well. Organizations such as NC Sea Grant and the NC Coastal Federation have already taken steps in this direction, so could help in coordinating this portion of the program.

5) **Begin locally, expand slowly:** DMF and other responsible organizations should select a few sites, spread out along the coast, that would most benefit from oyster gardening, and initially restrict permitting to those areas. As sponsors of the program gain experience, the program should be allowed to slowly expand, adding a few new areas each year, until eventually the entire coast is included. Keeping the program small initially will minimize the amount of money spent trying to work out problems, and will allow permitting agencies and others time to perfect the project before it spreads throughout the coast.

6) **Locate and secure funding sources, both short and long term, before beginning the project:** Before gardening begins, the program should look to acquire enough funds to maintain the project for many years. Many of the projects currently in existence are suffering from a lack of funding, and may not be able to continue in the near future. If a long term source of money is not available, serious consideration should be given before undertaking the project, as a lack of funding might lead to mismanagement and more problems than benefits over time.

7) **Organize and maintain a regular source of spat:** It is important that spat be available in-state to oyster gardeners. State and environmental organizations should work with NC Sea Grant to expand their native oyster breeding program so that spat will be regularly available to
all interested parties. Spat could be made available through individual sale, or could come as part of the permit agreement.

8) **Centralize the administration of this program under one organization**: Although DMF would have final responsibility for granting permits under this program, they are already understaffed, so some other organization should be in charge of the oyster gardening program. Perhaps, as in other states, Sea Grant could undertake this venture. Otherwise, a consortium of interested parties, under agreement with and guidance from DMF, could form a panel in charge of running the program. Without centralized organization, it will be difficult for the program to become a success.

**Summary/Conclusions**

Overall, it is apparent that oyster gardening would be a good thing for the North Carolina coast, but it is not without its drawbacks. Program administrators would have to work to carefully formulate the laws and procedures guiding the program so that people do not misuse the privilege, or put the state or public health at risk. Following the guidance of other states, it is possible to develop a strong oyster gardening program from which everyone can benefit, and with the creation of that program, we can all hope that is helps to make oysters common once again through North Carolina waters.
Section 4: General Conclusions and Directions for the Future
Oysters are a critical piece of estuarine ecosystems throughout the east coast of the United States, especially here in North Carolina. Not only do they provide unique habitat for numerous invertebrates and fish, but they also serve to protect valuable wetlands, clean the water, and provide a source of food and employment for humans. Oystering has been part of North Carolina culture for centuries, but many oystering families have been put out of business by the declining stocks, increasing polluted areas, and spread of oyster disease. In fact, as Craig Hardy of the NC DMF described, “We’re probably at the lowest point in recent years, even the past couple of centuries” (Henderson 2004). Without action, this critical piece of the ecosystem, and of North Carolina culture, could be lost forever.

Thankfully, many people who still care about oysters are taking action to save this valuable species. Cultch plantings through DMF continue and grow each year, and continue to help the oyster fishery. Scientists from the UNC Institute of Marine Science are considering using sterile, fast-growing, disease resistant Asian oysters to enhance farmed stocks of oysters, although that project has met with much controversy, so is still being studied and reviewed. Five oyster sanctuaries, where harvest is prohibited, have been created, and four more are planned for the near future (Henderson 2004). Numerous land-based habitat restoration projects are underway, including one at North River Farms in Carteret County, which hope to restore water quality in oyster growing areas. All of these efforts are now being coordinated under the umbrella of the North Carolina Coastal Federation’s “Oyster Restoration and Protection Plan for North Carolina.” Through a concerted effort, it is hoped that oyster restoration efforts can be enhanced and accelerated. Although this process will continue for years to come, it is important that efforts be made now to save the North Carolina oyster population, for without it, a large part of North Carolina history and ecology could be lost forever.
Acknowledgements

I would like to thank Todd Miller and everyone at the North Carolina Coastal Federation for their assistance and guidance in carrying out these projects. I would also like to thank Dr. Bill Kirby-Smith for his guidance and support throughout the composition of this document. Thanks also to Dr. Mike Orbach for his input on the oyster gardening section. I want to thank my family for all of their help and support throughout this process. Finally, I would like to thank Arthur Fisher and Kimbrough Mauney for their assistance in researching and putting together the oyster biographies.
**Works Cited**


Loosanoff, V.L. and C.A. Nomejko. 1946. Feeding of oysters in relation to tidal stages and to periods of


Oesterling, M. “VA Oyster Gardening.” E-mail to Skip Kemp. 18 April 2003.


Shumway, S.E. 1996. “Natural Environmental Factors.” Pages 467-514 in V. Kennedy, R. Newell, and
A.Eble (eds.). The Eastern Oyster. Maryland Sea Grant College, College Park, MD.


Widdows, J., R.I.E. Newell, and R. Mann. 1989. Effects of hypoxia and anoxia on survival, energy
VMRC GENERAL PERMIT FOR NONCOMMERCIAL RIPARIAN SHELLFISH GROWING (I. E. "GARDENING") ACTIVITIES WHICH CONFORM TO CERTAIN CRITERIA AND ARE UNDERTAKEN OVER OR ON STATE-OWNED SUBAQUEOUS LANDS IN TIDAL WATERS OF THE COMMONWEALTH.

4 VAC 20-336-10 AUTHORITY - EFFECTIVE DATE.

(a) This General Permit is promulgated pursuant to the authority contained in § 28.2-103 and Chapter 12 of Title 28.2 of the Code of Virginia.

(b) This General Permit conforms with current Commission policy in its establishment of general permits for projects which meet certain restrictive criteria.

(c) The effective date of this General Permit is January 1, 1998.

4 VAC 20-336-20 DEFINITIONS.

For the purposes of this general permit, riparian shellfish gardening is defined as the grow-out of native shellfish species in protective structures such as floats, bags, cages, etc. adjacent to a private, noncommercial pier or otherwise within a waterfront property owner's riparian area, exclusively for private, noncommercial purposes.

4 VAC 20-336-30 DISCUSSION.

(a) A principal objective of the permit streamlining efforts of this agency is the achievement of a single permit wherever possible for minor projects with minimal cumulative impacts.

(b) The Norfolk District of the U. S. Army Corps of Engineers has approved a Regional Permit (97-RP-19) for certain aquaculture/mariculture activities in waters of the Commonwealth of Virginia which are authorized by a local wetlands board or the Virginia Marine Resources Commission, or both.

4 VAC 20-336-40 PROCEDURES.

The Chief, Habitat Management Division, will administer the General Permit and assure:

(a) That the approved Local-State-Federal Permit Application form, or General Permit #3 Application Form, is completed and filed in accordance with the instructions contained therein.

(b) That aquaculture activities authorized by this permit achieve the policy and standards implicit in Chapter 12 of Title 28.2 of the Code of Virginia and reasonably accommodate guidelines promulgated by the Commission.
(c) That riparian shellfish gardening structures proposed meet the following criteria: (1) the proposed structures must be secured to a private pier which meets the criteria set forth in §28.2-1203 (5) of the Code of Virginia, or other duly authorized structure in such a manner that they do not adversely impact navigation and are wholly within the Permittee's riparian area, (2) shellfish grown in such structures will not be commercially marketed, (3) the Permittee shall be responsible for complying with Virginia Department of Health requirements and fisheries regulations regarding shellfish grown in condemned or otherwise restricted waters, (4) structures being used will not exceed 160 square feet in total area, (5) structures will be located so as not to impact existing stands of submerged aquatic vegetation (SAV).

(d) Projects which do not meet the criteria in (a) through (c) above will be processed for an individual permit with appropriate fees and royalties.

4 VAC 20-336-50 AUTHORIZATION AND CONDITIONS.

All proposals for noncommercial shellfish aquaculture structures to encroach in, on or over State-owned subaqueous land which meet the criteria in paragraph 4 (a) through (c) above are hereby approved subject to the following conditions:

(1) This permit grants no authority to the Permittee to encroach upon property rights, including riparian rights, of others.

(2) The duly authorized agents of the Commission shall have the right to enter upon the premises at reasonable times, for the purposes of inspecting the work being done pursuant to this permit.

(3) The Permittee shall comply with the water quality standards as established by the Department of Environmental Quality and all other applicable laws, ordinances, rules and regulations affecting the conduct of this project. The granting of this permit shall not relieve the Permittee of the responsibility of obtaining any and all other permits or authorization for this project.

(4) The permit shall not affect or interfere with the right vouchsafed to the people of Virginia concerning fowling and the catching of and taking of oysters and other shellfish in and from the waters not included within the terms of this permit.

(5) The Permittee shall, to the greatest extent practicable, minimize adverse impacts of the project on adjacent properties and wetlands and upon the natural resources of the Commonwealth.

(6) This permit may be revoked at any time by the Commission upon the failure of the Permittee to comply with the terms and conditions hereof or at the will of the General Assembly of Virginia.

(7) There is expressly excluded from this permit any portion of the waters within the Baylor Survey (Public Oyster Ground).
(8) This permit is subject to any lease of oyster planting ground in effect on the date of this permit. Nothing in this permit shall be construed as allowing the Permittee to encroach on any lease without the consent of the leaseholder. The Permittee shall be liable for any damages to such lease.

(9) The issuance of this permit does not confer upon the Permittee any interest or title to the beds of the waters.

(10) All structures authorized by this permit which are not maintained in good repair or displaced to areas not authorized shall be completely removed from State-owned bottom within 30 days after notification by the Commission or its designated representatives.

(11) The Permittee agrees to indemnify and save harmless the Commonwealth of Virginia from any liability arising from the establishment, operation or maintenance of said project.

(12) This permit authorizes no claim to archaeological artifacts which may be encountered during the construction or operation of the project. If, however, archaeological remains are encountered, the Permittee agrees to notify the Commission, who will, in turn, notify the Virginia Department of Historic Resources. The Permittee further agrees to cooperate with agencies in the recovery of archaeological remains if deemed necessary.

(13) The Permittee agrees to respond to any inquiries or studies conducted by the Commission concerning the Permittee's aquaculture efforts.

(14) This General Permit shall remain valid for a period of five (5) years from the date of issuance. It may be extended upon a request from the applicant, provided the request is made prior to the permit expiration.

(15) This General Permit should be retained by the Permittee for the life of the project as evidence of authorization.
Preface

The attached application is intended to be used by persons applying for permits to deploy up to 160 square feet of aquaculture structures in the tidal waters of Virginia, for the noncommercial culture of shellfish. The Virginia Marine Resources Commission’s General Permit #3 defines riparian shellfish gardening as “the grow-out of native shellfish species in protective structures such as floats, bags, cages, etc. adjacent to a private, noncommercial pier or otherwise within a waterfront property owner’s riparian area, exclusively for private, noncommercial purposes.” The General Permit also specifies that the structures shall not adversely impact navigation or existing stands of submerged aquatic vegetation. If you do not believe your project will meet these requirements for the General Permit you should complete the standard Joint Permit Application rather than the attached abbreviated form. You may obtain a standard Joint Permit Application by contacting the Virginia Marine Resources Commission (VMRC) at (757) 247-2252 or the U. S. Army Corps of Engineers (Corps) at (757) 441-7652.

Application Process

The applicant needs only to fill out one copy of the application, including the required drawings, and return it to VMRC for processing. To expedite the review of your application, please ensure that your application is complete and that the required drawings are clear and contain the requested information.

VMRC will forward copies of the application to the Health Department and your Local Wetlands Board for their review. The Health Department may contact you regarding shellfish handling and harvesting procedures if your project is being conducted in polluted waters.

If the project qualifies for VMRC’s General Permit #3, the Corps of Engineers has determined that it will also qualify for either their Regional Permit Number 17 or Number 19. In most cases, you will not receive any correspondence from the Corps. Should you care to review the conditions contained in the Corps’ Regional Permits, you may obtain copies by contacting the Corps at the number listed above.

Please return your completed application to:

Virginia Marine Resources Commission
Habitat Management Division
2600 Washington Avenue, 3rd Floor
Newport News, Virginia 23607-0756
Abbreviated Joint Permit Application For
Noncommercial Riparian Shellfish Aquaculture Structures

1. Applicant’s name and complete mailing address:
   Telephone numbers:
   Home ( )
   Work ( )

2. Physical address of the project site (if different from above):
   Street address: ________________________________
   OR
   Local Tax Map No.:

3. Waterbody at the project site:
   a tributary to ___________________________ in __________ County/City

4. Please provide accurate directions to the project site from the nearest intersection of two state roads:

5. Description of the aquaculture structures to be employed:
   Floats: Size (LxWxH in inches) _________ Number to be used
   Bottom Cages: Size (LxWxH in inches) _________ Number to be used
   Other structures: Please provide a description including the size and number to be used.

6. (A) Will the structures be secured to an existing private pier?
   (B) If yes, will they extend beyond the end of the pier?
   (C) If yes, how far channelward of the pier will they extend and what is the distance to the recognized channel? ______ feet. What is the width of the waterway at the project site (mean low water to mean low water)? ______ feet.

7. If you answered NO to question 6 (A) above, will they be located in the waters immediately opposite your shoreline? ______ Describe how will the structures be secured.

Note: If new pilings are required to secure the structures, a standard permit may be required. Please call VMRC for details at (757) 247-2252.
8. What is the Health Department’s current classification of the growing waters at the project site? 
**Open for direct harvesting, Seasonally closed, Permanently closed, or Uncertain.** (Circle one)

9. Please provide the following required drawings:

   **1. Vicinity Map** - Use a map to depict the exact location of the project site. Please indicate the name of the map used. USGS quadrangle maps, street maps, or county maps are preferred.

   **2. Plan View Drawing** - This drawing must depict the proposed structures as if viewed from above. The drawing must include, a north arrow, the waterway name, the location of mean high water and mean low water, the location of any submerged aquatic vegetation at the site, the width of the waterway, the direction of ebb and flood of the tide, your property lines and shoreline, the opposite shoreline if the waterway is less than 500 feet wide, the depth of water at the project site, and the location of the existing navigation channel. A recent plat of the property, if available, provides a good scaled template for the plan view drawing.

   **3. Cross Sectional Drawing** - The cross sectional drawing must show the dimensions of the proposed structures as viewed from the side. It should include the depth of the water and any structures which will be used secure the floats or cages. **If the application is for floats which will be secured to your existing pier, a cross sectional drawing will not be required.**

**ALL APPLICANTS MUST SIGN**

I hereby apply for all necessary permits for the activities described herein. I agree to allow the duly authorized representatives of any regulatory or advisory agency to enter upon the premises of the project site at reasonable times to inspect and photograph site conditions.

I hereby certify that the information submitted in this application is true and accurate to the best of my knowledge.

__________________________  ___________________________
APPLICANT’S SIGNATURE       APPLICANT’S NAME (PRINTED/TYPED)

DATE
### Apprend 3

**MARYLAND DEPARTMENT OF NATURAL RESOURCES**

**FISHERIES SERVICE**

**APPLICATION FOR AQUACULTURE PERMIT**

#### INSTRUCTIONS

A. COMPLETE ALL INFORMATION (BOTH SIDES OF APPLICATION). PLEASE PRINT OR TYPE.

B. RETURN COMPLETED APPLICATION TO TAMARA O'CONNELL, FISHERIES SERVICE, 321 TAYLOR AVENUE, ANNAPOLIS, MD 21401.

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<th>1. NAME AND TITLE OF PRINCIPAL OFFICER</th>
<th>2. MAILING ADDRESS</th>
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<th>3. PHONE: WORK</th>
<th>4. EMAIL (OPTIONAL)</th>
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<tr>
<th>5. FACILITY NAME</th>
<th>6. FACILITY ADDRESS</th>
<th>7. COUNTY WHERE FACILITY IS LOCATED</th>
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<th>8. DO YOU LEASE THIS FACILITY?</th>
<th>9. NAME AND ADDRESS OF LANDOWNER</th>
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<th>10. TYPE OF OPERATION (Check appropriate category)</th>
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<tr>
<td>OYSTER CULTURE</td>
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<td>OTHER (Please specify):</td>
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11. FACILITY SPECIFICS

- NUMBER OF ACRES
- NUMBER OF BUILDINGS
- FLOOR SPACE (sq. ft.)
- NUMBER OF PONDS
- SURFACE AREA OF EACH POND (sqm)
- NUMBER OF TANKS
- SIZE OF EACH TANK (gal)
- WATER SOURCE AND AMOUNT TO BE USED
- AMOUNT OF DISCHARGE FROM OPERATION
- TYPE OF TREATMENT FOR DISCHARGE

12. SPECIES TO BE CULTURED AND ORIGIN OF EACH

I HEREBY APPLY FOR THE ABOVE PERMIT AND CERTIFY UNDER PENALTY OF PERJURY THAT THE INFORMATION HEREBIN IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE, INFORMATION, AND BELIEF.

SIGNATURE OF APPLICANT:____ DATE:____

[Contact: FISHERIES SERVICE, MAJOR ACADIAN PARK DRIVE, HANOVER, MD 21076; 410-825-8228]
INFORMATION TO BE SUPPLIED WITH THIS APPLICATION INCLUDE:

PROPER HEALTH CERTIFICATION AND ORIGIN OF SPECIES TO BE USED IN THE AQUACULTURAL ACTIVITY. IF PRESENTLY UNKNOWN, YOU MUST NOTIFY THE DEPARTMENT PRIOR TO RECEIPT OF ANY SHIPMENT OF FISH.

A MAP SHOWING THE LOCATION OF THE FACILITY WITH DIRECTIONS FROM THE NEAREST MAJOR ROADWAY.

A DESCRIPTION OF THE CULTURE OPERATION AND A SKETCH OF THE FACILITY, PONDS, ETC., INCLUDING ANY INFLOW OR EFFLUENT FROM THE FACILITY.

THE LOCATION OF THE NEAREST BODY OF WATER THAT COULD RECEIVE DISCHARGE EFFLUENT.

A SOLID WASTE MANAGEMENT PLAN.

IF ANY HYBRID OR NON-NATIVE SPECIES ARE TO BE CULTURED PROVIDE A DESCRIPTION OF TREATMENT AND ENTRAPMENT SYSTEMS TO PREVENT CULTURED ORGANISMS FROM ENTERING STATE WATERS.

STATE THE GOALS OF YOUR OPERATION (I.E. COMMERCIAL PRODUCTION, PRODUCTION FOR HOME USE, HOBBY, RESEARCH) AND AMOUNT THAT YOU EXPECT TO PRODUCE.

IF EMPLOYING ONE OR MORE PERSONS, A CERTIFICATE OF COMPLIANCE WITH STATE WORKMEN’S COMPENSATION LAWS PERSUANT TO §1-401 OF THE NATURAL RESOURCES ARTICLE, ANNOTATED CODE OF MARYLAND. AN EMPLOYER-APPLICANT MAY PROVIDE, AS EVIDENCE OF INSURANCE, A WORKMEN’S COMPENSATION INSURANCE POLICY NUMBER OR BINDER NUMBER, IN LIEU OF SUBMITTING A CERTIFICATE OF COMPLIANCE.

IN ADDITION TO THE ABOVE THE PERMITTEE MUST:

HAVE ALL NECESSARY PERMITS AND COMPLY WITH ALL APPLICABLE HEALTH AND ENVIRONMENTAL LAWS AND REGULATIONS.

MAINTAIN SHIPPING AND RECEIVING RECORDS BY SPECIES ON A QUARTERLY BASIS WHICH ESTIMATE STOCKS ON HAND AT THE FACILITY AND THE DISTRIBUTION OF FISH OR AQUATIC PLANTS TO OR FROM THE FACILITY. ALL RECORDS SHALL BE MAINTAINED AT THE FACILITY, OR AT A SPECIFIED LOCATION OTHER THAN THE FACILITY FOR THREE (3) YEARS, AND BE MADE AVAILABLE TO THE DEPARTMENT FOR INSPECTION UPON REQUEST.

NOTIFY THE DEPARTMENT IMMEDIATELY UPON DISCOVERY OF ANY DISEASE AFFECTING THE FISH OR PLANTS AT THE FACILITY THAT HAS THE POTENTIAL TO CONTAMINATE NATIVE OR NATURALIZED PLANTS OR ANIMALS.

SUBMIT AN ANNUAL REPORT OF ACTIVITIES UNDER THE PERMIT ON A FORM PROVIDED BY THE DEPARTMENT.

ALLOW THE DEPARTMENT TO INSPECT THE FACILITY, EQUIPMENT AND FISH OR AQUATIC PLANTS AT REASONABLE HOURS.

NOTIFY THE DEPARTMENT IF ANY SIGNIFICANT CHANGES OR ADDITIONS TO A FACILITY ARE MADE AFTER A PERMIT IS ISSUED BY FILLING OUT A SUPPLEMENTAL APPLICATION SUMMARIZING MODIFICATIONS.

AFTER THIS APPLICATION IS REVIEWED AN INSPECTION OF THE FACILITY IS REQUIRED BEFORE THE PERMIT IS ISSUED. PERMITS ARE VALID FOR FIVE YEARS FROM THE DATE OF ISSUANCE.

FOR OFFICE USE ONLY

Date Received

Date of Site Visit

Approved by (list comments/restrictions below)

CHUCK STENCE

STEVE MINKKINEN

Comments/Restrictions:
Appendix 4

JOINT FEDERAL / STATE APPLICATION FOR THE ALTERATION OF ANY FLOODPLAIN, WATERWAY, TIDAL OR NON-TIDAL WETLAND IN MARYLAND

• All applications must be accompanied by plan drawings which show the location and character of the proposed work. For specific information on what is required on the plans, refer to the instruction package. 8-1/2” x 11” black & white drawings are required for every application. Full construction plans are required for projects submitted to the Waterway Permits Division.
• Any application which is not completed in full or is accompanied by poor quality drawings may be returned and will result in a time delay to the applicant.
• If you need help understanding how to fill out the application form, please refer to the instruction booklet.

APPLICATION NUMBER:
(To be assigned by the agencies)

1. APPLICANT INFORMATION:
Name: __________________________________________ Telephone: __________________________.
Address: ________________________________________________________________________
City: __________________ State: __________________ Zip: ________________________________

2. AGENT / ENGINEER INFORMATION:
Name: __________________________________ Telephone: ____________________________
Address: ______________________________________________________________________
City: __________________ State: __________________ Zip: ______________________________

3. PRINCIPAL CONTACT, if not the applicant:
Name: __________________________________ Telephone: ____________________________

4. PROJECT DESCRIPTION:
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

5. PROJECT PURPOSE:
   Shore Erosion Control        Storm Drain/Stormwater Management
   Utility Installation        Erosion/Sediment Control        Marina
   Create Waterfowl Habitat     Improve Navigable Access        Fill
   Temporary Construction       Improve Fish Habitat         Bridge
   Beach Nourishment           Stream Channelization        Dam
   Residential/Commercial Development Small Pond       Culvert
   Other: (describe) __________________________________________

CERTIFICATION:
I hereby designate and authorize the agent named above to act on my behalf in the processing of this application and to furnish any information that is requested. I certify that the information on this form and on the attached plans and specifications is true and accurate to the best of my knowledge and belief. I understand that any of the agencies involved in authorizing the proposed works may request information in addition to that set forth herein as may be deemed appropriate in considering this proposal. I grant permission to the agencies responsible for authorization of this work, or their duly authorized representative, to enter the project site for inspection purposes during working hours. I will abide by the conditions of the permit or license if issued and will not begin work without the appropriate authorization. I also certify that the proposed works are not inconsistent with Maryland’s Coastal Zone Management Plan.

APPLICANT MUST SIGN: ___________________________ Date ____________________

PLEASE COMPLETE THE REVERSE SIDE
6. PROJECT LOCATION:  This project is in  Tidal         Non-Tidal Waters.  (Please Ccheck One)

County:___________________________ Name of Waterway:________________________________________

Site Address or Location:___________________________________________________________________

______________________________________________________________________________________

Directions from nearest intersection of two state roads:________________________________________

______________________________________________________________________________________

County Book Map (A.D.C.) Coordinates:    Map:_________________    Letter:_________________    Number:____________

7. TYPE OF PROJECT:

Work Proposed | Overall Length (in feet) | Average Width (in feet) | Maximum Distance Channelward From Mean High Water | For projects in tidal waters (in feet)
--- | --- | --- | --- | ---
Bulkhead | | | | 
Revetment | | | | 
Vegetative Stabilization | | | | 
Gabions | | | | 
Groins or Jetties | | | | 
Boat Ramp | | | | 
Pier | | | | 
Breakwater | | | | 
Road Crossing | | | | 
Utility Line | | | | 
Outfall Construction | | | | 
Dredging | | | | 
New | | | | 
Maintenance | | | | 
Hydraulic | | | | 
Mechanical | | | | 
Other: For other projects, please supply project dimensions including the area of disturbance (acreage), volume of fill (cubic yards), type of fill, and area (acreage) of wetlands to be impacted.____________________________________________________

8. PROPOSED STARTING DATE: ____________________________________________________________

9. CONTRACTOR’S NAME (If Known): ______________________________________________________

10. LAND USE:

Current Use Is:   Agriculture  Wooded  Marsh/Swamp   Meadow  Developed
Present Zoning Is:  Residential  Commercial  Agriculture   Other:___________________________

11. OTHER PERMITS REQUIRED:  Building Permit  Soil Conservation District  Other:______________

12. NOTIFICATION OF ADJACENT PROPERTY OWNERS:

The applicant/agent will be informed by the permitting agencies when notification of adjacent property owners is required.
Appendix 5
Organizations Involved in Oyster Gardening Activities

Alabama
1) Alabama Department of Conservation and Natural Resources – [www.dcnr.state.al.us/mr/index.html](http://www.dcnr.state.al.us/mr/index.html)
2) Mobile Bay National Estuarine Program – [www.mobilebaynep.com](http://www.mobilebaynep.com)

Connecticut
1) Connecticut Department of Agriculture – [www.state.ct.us/doag/](http://www.state.ct.us/doag/)
2) Connecticut Department of Environmental Protection – [www.dep.state.ct.us/](http://www.dep.state.ct.us/)

Maryland
1) Maryland Department of Natural Resources – [www.dnr.state.md.us/](http://www.dnr.state.md.us/)
2) Maryland Sea Grant – [www.mdsg.umd.edu/oysters](http://www.mdsg.umd.edu/oysters)
3) Oyster Recovery Partnership – [www.oysterrecovery.org](http://www.oysterrecovery.org)

New York
1) New York Department of Environmental Conservation – [www.dec.state.ny.us](http://www.dec.state.ny.us)
2) New York-New Jersey Baykeeper Program – [www.nynjbaykeeper.org](http://www.nynjbaykeeper.org)
3) Southold Project in Aquaculture Training – [www.cce.cornell.edu/suffolk/MARprograms/SPAT.htm](http://www.cce.cornell.edu/suffolk/MARprograms/SPAT.htm)

South Carolina
2) South Carolina Department of Natural Resources – [www.dnr.state.sc.us](http://www.dnr.state.sc.us)
3) South Carolina Oyster Restoration and Enhancement – [www.csc.noaa.gov/scoysters](http://www.csc.noaa.gov/scoysters)

Virginia
1) Virginia Department of Health – [www.vdh.state.va.us/shellfish/](http://www.vdh.state.va.us/shellfish/)
2) Virginia Marine Resources Commission – [www.mrc.state.va.us/](http://www.mrc.state.va.us/)
3) Virginia Institute of Marine Sciences – [www.vims.edu/abc](http://www.vims.edu/abc)

United States
2) Chesapeake Bay Foundation – [www.cbf.org/oysters](http://www.cbf.org/oysters)
5) Tidewater Oyster Gardening Association – [www.oystergardener.org](http://www.oystergardener.org)