

PREVENTION OF MARINE DEBRIS FROM SHELLFISH MARICULTURE

Best Management Practices for North Carolina Producers

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INTRODUCTION

Shellfish mariculture has an important place in the heritage of eastern North Carolina. Mariculture has the potential to become a major part of the state's coastal economy. North Carolina boasts over 1.4 million acres of coastal waters with biological and physical characteristics that make it well suited for farming shellfish. Significant industry growth is



Figure 1: New River Clam Digger, Onslow County, NC, c.a. 1939. From the Charles A. Farrell Photograph Collection, North Carolina State Archives.

possible with this ample space, clean water, and natural resources.

North Carolina has a long history of shellfish farming and it is a foundation for rural coastal economies. Since 1858, shellfish farming has been a means for North Carolina residents to make or supplement their livelihoods by working coastal resources granted through the leasing of public trust waters by the North Carolina Division of Marine Fisheries (NCDMF). Authority to issue leases rests with the

Secretary of the Department of Environmental Quality, who delegates this authority to the Director of NCDMF. However, all lease applications for new and expanding farms require extensive review and input by NCDMF, other state and federal agencies, and the public.

North Carolina has a great history of growing hard clams (*Mercenaria mercenaria*) and oysters (*Cassostrea virginica*). While other species of shellfish may be grown in the future, hard clams and oysters are regarded as the most valuable and sought after species with an exceptional reputation in the marketplace. Primarily driven by new technology for production of oysters for half-shell markets, the shellfish mariculture industry is gaining traction in the state and the industry is expected to increase rapidly over the next ten years. Validating this growth potential, North Carolina's shellfish mariculture industry has grown appreciably with only 1 water column lease application in 2011 compared to 33 in 2018. In 2017, NCDMF received 46 water column lease applications making this a record year. The decrease in applications received in 2018 is thought to be caused by Hurricanes Florence and Michael. As of January 2019, there are 79 water column leases in North Carolina totaling 228 acres.



Figure 2: Total lease applications for Bottom Leases and Water Column Leases from 2011 through 2018 (Data provided by NCDMF).

The NCDMF administers a Shellfish Lease and Franchise Program through the Habitat and Enhancement Section for the purposes of managing shellfish cultivation and aquaculture throughout North Carolina. A shellfish bottom lease in North Carolina allows shellfish to be grown on or within 18 inches of the bottom.

Hard clams have historically been grown by planting hatchery produced seed (young, small

clams) on the bottom, which are then covered with screens or other provisions to prevent access by stingrays, crabs, or other predators.

Cultch planting is the method traditionally used to grow oysters on the bottom. Cultch is a hard substrate, usually consisting of oyster shells, to which oyster larvae (spat) produced by wild spawning oysters will attach or 'set' onto and begin growing. Because of the unreliable nature of wild oyster larvae recruitment, there is an increasing interest in setting oyster larvae produced from hatcheries on shell substrate before planting, a method termed 'spat on shell production'. Regardless of the method used, oysters grown on the



Figure 3: Female clams marked for spawning.

bottom from cultch plantings are usually harvested in clumps; with large and small oysters culled and sorted to separate them according to market. A number of shellfish farmers have increased production for half-shell or other specialty single oyster markets by stocking hatchery produced oyster seed for grow-out in bottom cages or containerized systems that meet the rules and requirements for bottom leases.

More recently, off-bottom or water column oyster farming has attracted significant attention and investment for the intensive production of single oysters for the half-shell market. This method also increases the available leasable area to places where oysters would not survive on the bottom (e.g., high salinity areas where predation rates are high or where substrate is too soft). NCDMF allows for off-bottom culture of shellfish through the addition of a water column amendment to an existing shellfish bottom lease. This allows oysters and other shellfish species to be grown in containerized systems (baskets, bags, cages) that float near the surface or are suspended in the water column.





Figure 4: Bottom cages (left) vs Floating bags (right)

The growth of the shellfish mariculture industry not only promises to strengthen local economies, but also contributes to resilient, healthier coastal communities. Shellfish farming offers a legitimate use of the marine environment for development and sustainable food production. Clams, oysters, and other shellfish improve water quality by removing particulates and some unwanted nutrients from the water column. Farming shellfish can reduce harvest

pressure on wild stocks. Some farming practices generate structurally complex habitat that supports enhanced biodiversity.

MARINE DEBRIS AND SHELLFISH MARICULTURE

Despite the benefits provided by shellfish mariculture, if not properly sited and managed shellfish farms can have negative effects such as creating user conflicts as well as producing marine debris. Marine debris is any manufactured solid material that makes its way into the marine environment. The mariculture industry typically uses gear made of plastics and other synthetic materials due to their long lifespan and durability. It is these same characteristics that make such materials a concern if they are lost from a shellfish farm into the marine environment. Marine debris from shellfish farms can reduce profitability, pose a hazard to marine wildlife as well as humans working or using the waters recreationally, and can also contribute to negative public perception of the industry.



While many shellfish growers may not be purposefully careless, culture gear and associated infrastructure can inadvertently escape shellfish farms due to storms, ice flows, or other events. A coordinated plan for managing marine debris is needed for the industry, including measures to increase the resilience of shellfish farms to storms and unforeseen events.

Figure 5: Typical gear types: (clockwise from top left) floats and zip-ties, s-hoook clips, floating bag, bottom cage.

This document provides an overview of suggested best management practices (BMPs) for the shellfish mariculture industry in North Carolina, pertaining specifically to reducing the risk of marine debris. These BMPs were developed as part of a workshop to reduce the potential impacts of aquaculture marine debris within estuarine systems. The outcome of the workshop

and conversations with industry participants formed the basis upon which these BMPs were further developed by the authors. While not required by law, voluntary adherence to the BMPs will help to prevent gear and infrastructure loss, reduce the potential for detrimental effects on the environment, and aid in decreasing negative perceptions of shellfish farming in North Carolina. A new statute was passed in July 2019 which requires all gear and markers used in a shellfish lease operation to be cleaned up within 30 days of the lease being terminated.



Figure 6: Debris left behind at an abandoned clam operation in Carteret County, NC.

BEST MANAGEMENT PRACTICES

There are a number of factors or categories to consider when establishing and operating a shellfish farm in North Carolina. The following sections outline suggested best management practices for each category.

SITING

The first step to establishing a successful shellfish farm is proper siting. Shellfish leases should be located in productive waters. The farm should be protected from wave energy due to high winds, heavy seas, and high boat traffic if possible. Growers should attempt to site operations in sheltered areas away from inlets and large bodies of open water, and strongly consider prevailing wind direction and fetch. In addition, farms should be sited away from navigational channels such as the Atlantic Intracoastal Waterway or other areas of high boat traffic. Wave energy, whether manmade or by force of nature, is often overlooked and can result in lost gear and product. Constant water movement also increases wear and tear of gear and infrastructure.



Figure 7: Map of shellfish mariculture operations in Carteret County, N.C. Some farms are located in exposed locations. When evaluating a potential site, growers should also consider if there are docks, vessels, or large loose debris adjacent to the site that could break free and impact the farm during a storm event. In addition, growers should strive to be good neighbors with adjacent waterfront property owners, not only to minimize potential user conflict, but also to establish communication channels for the retrieval of displaced equipment and materials. Shellfish farms located near other farms or fishing communities should consider working together to assist with farm monitoring and marine debris recovery.

On the southeastern coast of North Carolina, tidal range should also be considered when siting a shellfish farm. The larger tidal range and higher tidal current velocities experienced in this region relative to the remainder of the coast should be factored in with the other considerations such as wave energy and may demand additional infrastructure.

Researchers at the University of North Carolina, Wilmington have produced an interactive siting tool for shellfish mariculture that incorporates data from multiple sources into an online mapping application. The N.C. Shellfish Siting Tool (<u>https://uncw.edu/benthic/sitingtool/</u>) provides valuable information a lease applicant can use to determine potential site viability. It is always important to consult with NCDMF, NC Sea Grant, and other growers at the beginning of the siting process to ensure the applicant has all the necessary information required to make an informed decision which will make the process more efficient.



Figure 8: The N.C. Shellfish Siting Tool provides users with data including salinity, submerged aquatic vegetation, utilized channels, depth, and much more. This information is invaluable for scoping the feasibility of a potential lease site.

QUICK SITING TIPS:

- ✓ Choose sites away from navigational channels and inlets.
- ✓ <u>Always</u> consider wave energy.
- Scope potential areas of debris spread that might come from your farm or from neighbors (docks, other farms, etc.).
- ✓ Be a good neighbor and communicate with adjacent riparian landowners and growers at the beginning of the siting process to avoid potential user conflicts.
- Shellfish farms located near other farms should consider working together to monitor and control marine debris.

FARM DESIGN

After locating and properly identifying the lease site, thoughtful development of the farm layout and design is a critical step towards developing a successful operation. Whenever possible, seek the advice of established farmers and mariculture supply companies to gain their input on farm infrastructure and gear orientation, placement of support structures, and materials to be used. If first starting out with little experience, farmers should start small and scale up over time to avoid becoming overwhelmed by gear maintenance and adjustments that



Figure 9: Well organized farm of floating bags providing ample space for working and ability to quickly notice missing gear.

will be required upon gaining working knowledge of a given site. Shellfish farms should be designed to withstand a hurricane, with larger lines and anchors than would be required for average wave energy. One example of smart farm design is to use larger mesh growout bags or cages with heavier gauge plastic or wire as a wave block for smaller nursery gear.

An often overlooked consideration is maintaining an organized, well-kept farm. Development of a well-organized farm will maximize production output, while remaining workable and avoiding debris creation. Attention to detail also allows for early detection of missing gear. Designing and operating a tidy farm is part of being a good neighbor and will help avoid user conflicts and public scrutiny.

FARM INFRASTRUCTURE AND GEAR SELECTION

With the growth of the industry, there is a burgeoning list of gear and materials being manufactured for shellfish mariculture operations. Farmers should always refer to the manufacturer data on strength and life span of gear and associated equipment. For example, overloading cages or lines can result in gear breaking loose. Again, consulting with an experienced designer who can calculate the maximum load for all of the gear is a crucial step.

MARKING BOUNDARIES AND GEAR

The NCDMF requires shellfish mariculture leases be clearly identified by the placement of three-inch diameter wood or plastic markers at lease corners extending at least four feet above the high-water mark. Each corner marker is required to have a sign displaying the lease or franchise number and the owner's name with the additional requirement of two anchored yellow buoys for water column leases. In addition, supplementary stakes of wood or plastic , not farther than 150 feet or closer together than 50 feet extending at least four feet above the high-water mark, must be placed along each boundary, except when such would interfere with the use of traditional navigation channels.. All markers used for a shellfish lease must not inhibit the public from entering navigable waters within the lease. It is important to note NCDMF cannot protect leases that do not meet marking requirements.





Figure 10: Properly marked leases warn other people on the water of the equipment.

Clearly marking the lease site alerts boat traffic to the presence of gear and infrastructure, and reduces the risk of collision and subsequent loss of gear and product. Although marking individual gear units is not required, this practice may be helpful especially in areas with tightly grouped leases. For example, small identification tags can be attached to gear, aiding in the recovery of lost gear and product. Marking gear may also aid in maintaining farm inventory and scheduling of operations.

QUICK FARM DESIGN TIPS:

- Seek advice from established farmers and mariculture professionals when designing your operation.
- ✓ Start small and scale up.
- ✓ Design for the inevitable hurricane.
- ✓ Maintain a well-organized and tidy farm.
- ✓ Be aware of the strength and life span of gear and associated equipment
- Clearly demarcate lease site in compliance with marking requirements to prevent vessel collisions.
- ✓ Mark gear units to aid in recovery.

FARM OPERATION

Derelict gear is one of the biggest sources of marine debris associated with shellfish farms. Once gear breaks free or is discarded, it becomes hazardous to people and wildlife, and can be an eyesore. All farms should attempt to minimize the loss of any gear, and when losses occur, should make every effort to recover lost items as quickly as possible. While severe storms that damage farms are unavoidable, lost or discarded gear that results from daily operations should not occur. Gear needs to be disposed of or recycled properly when it has exceeded its useful life expectancy. Frequent inspections, materials management, storm readiness, and community outreach programs are key to preventing marine debris associated with shellfish farming operations.

INSPECTIONS

Although mariculture gear is designed to withstand the elements, it will eventually degrade and fail. Mariculture gear should be replaced before it degrades to the point of failure. A consistent inspection schedule will aid in determining what gear needs to be replaced and when. A thorough inspection should be conducted twice a year. Once in early spring, as a pre-hurricane season precaution and after the heavy harvesting season is over. A second inspection should occur in late fall, when the water is clear, preparations for the harvest season are underway, and summers storms have passed allowing for a stock assessment. Farm owners who do not live on the coast should hire a local farm manager who can visit the site consistently.



Figure 11: N.C. oyster farmer surveys gear at sunset.

MATERIALS MANAGEMENT

The industry requires a large variety of gear, from plastic zip ties to cages and mooring systems. Keeping track of where all the gear is and where it should go is paramount to not only avoiding marine debris, but also for optimizing the profit margin. Farmers should avoid needless waste, such as excessive binding or ropes to decrease potential debris. The easiest action any farmer can take immediately is to bring a trash container to the site each trip. Simply having somewhere to put trash will decrease the

opportunities for items to fall in the water. In addition, it is best to ensure that the local landfill or waste facility is prepared to handle disposal of mariculture gear. It is important to get any derelict gear or materials off the shoreline so it does not have an opportunity to float away during storm events.

There are a few ways to help gear last longer and ensure a long service life, therefore reducing the cost of replacements over time. Ultraviolet sunlight degrades plastics. Degradation can be prevented by using plastic materials and ropes that have ultraviolet stabilizers. Additionally, some operations may keep lines and gear under the water surface because ultravioletdegradation decreases significantly with depth. Likewise, when gear and associated infrastructure are not in use it should be stored under a covering on land to prevent ultravioletdegradation of plastics.

Wave energy can cause wear and tear on farming equipment including cages, floats, lines, anchors, and shackles. Routine inspections and observations on the farm under varying conditions can help identify critical areas on a farm that are susceptible to wear and tear. Some manufacturers offer materials that are abrasion resistant. Additionally, some forms of rigging or tying gear with specific knots can reduce friction points and improve longevity.

Some metal cages, anchors, and tackle are susceptible to saltwater corrosion. Plastic-coated wire should be monitored for corrosion. Galvanized steel is by far the most affordable material

to offer corrosion resistance. Galvanized steel is produced by coating carbon steel with zinc. The zinc becomes the sacrificial anode and will corrode before the steel underneath corrodes. The lifespan for galvanized steel materials is dependent on the quality of zinc coatings. Galvanized materials may corrode at varying rates, which should be considered in farm design. Aluminum is highly resistant to corrosion, but it can be expensive and does



Figure 12: Floating gear has many components that could break loose including floats, straps, fasteners, and ropes.

not offer the strength of other materials. Stainless steel is strong, durable, and resistant to corrosion, but it is very expensive. There are over 150 types of stainless steel. Each type of stainless steel has a different measure of alloy metals, affecting its durability and costs. It is important to research the grade of stainless steel that is both cost-effective and best for specific saltwater applications.

STORM READINESS

North Carolina waters are prone to severe weather and strong storms at all times of the year. The highest threat to farms can be expected from tropical storms and hurricanes in the summer to early fall and nor'easters over the late fall into winter. These storms may produce high winds, heavy rains, coastal flooding, storm surge, and high surf.

Shellfish farms should develop a storm readiness plan, with preparedness triggered by specific levels of storm warning. It is not practical with most storm forecasts to remove shellfish and gear from the water and there are restrictions for moving shellfish gear with product offsite.Gear containing shellfish cannot be moved to an offsite location that is in restricted or prohibited shellfish growing waters. It is recommended shellfish gear be well secured per engineering and design specifications. When possible, gear may be secured near the bottom prior to a storm forecast arrival. After a storm event, the shellfish farm should be inspected for damage. Significant effort should be made to locate and remove any marine debris. Local authorities may have resources to assist with removal of large debris that originated from outside the farm boundaries and perhaps impedes farm operation (i.e., removal of derelict vessels). Some large debris removal or excavation may require state or federal permits.

As part of seasonal preparation for tropical storms, hurricanes, and nor'easters, farmers should check for and replace chafing lines or worn gear. Frequent inspection will alert farmers to degraded gear and critical control points. Sinking gear that floats under normal conditions will decrease its exposure to waves, but significant labor costs result from returning the gear to the surface.

Wind and waves are not the only concern from storms. Accumulated storm impacts on equipment add stress to anchors and lines, leading to faster degradation or the potential for it to break loose. This means getting out to the site after a storm should be a priority when life and other property is not endangered.

Lastly, freezing temperatures and ice can also wreak havoc on a shellfish farm. During extremely cold winters, ice flows in tidal creeks and along open waters of the sounds and estuaries can cause catastrophic damage to shellfish farms. These extreme weather events are especially damaging to culture systems that operate at or near the surface. Icing increases the load on gear, which can lead to lines or cages breaking under strain because mariculture gear is not designed to withstand these conditions. As previously discussed, sinking some gear types can decrease exposure to surface elements, but requires significant labor costs to restore operations.

All shellfish farmers should budget for and obtain crop insurance from the U.S. Department of Agriculture (USDA) Farm Service Agency (<u>https://www.fsa.usda.gov/state-offices/North-</u> <u>Carolina/index</u>) or other providers to help cover some economic losses associated with storm events. Having insurance will assist farmers in recovering from storm events.

QUICK FARM MANAGEMENT TIPS:

- ✓ Keep lines taut and keep gear neat and orderly.
- ✓ Regularly inspect gear and replace items that are worn.
- ✓ Keep lines intact so it is obvious when gear is missing.
- ✓ Dispose of or recycle gear once it is no longer usable.
- ✓ Stay tuned to the weather conditions.
- ✓ Prepare the farm for forecasted storms.
- ✓ Obtain federal crop insurance.
- ✓ Keep lines and materials as deep as possible.
- ✓ Pick up loose gear as soon as possible.

COMMUNITY ENGAGEMENT

The overall success of the shellfish mariculture industry relies on the open engagement of farmers with the general public. It is beneficial to not only be open about how gear can become debris, but to be proactive in recovering lost gear. Every farmer can become the face of the industry in their area. Joining or organizing local marine debris cleanup efforts shows the industry is invested in keeping the estuaries healthy.

APPENDIX

PHOTO CREDITS

Cover: Top: North Carolina Sea Grant Bottom: Smith Oyster Company

Figure 1: North Carolina State Archives

- Figure 3: North Carolina Coastal Federation
- Figure 4: Left: North Carolina Sea Grant, Right: North Carolina Coastal Federation

Figure 5: Products featured from Chesapeake Bay Oyster Co.

- Figure 9: North Carolina Coastal Federation
- Figure 10: Left: North Carolina Coastal Federation, Right: Cape Hatteras Oyster Co.
- Figure 11: Cape Hatteras Oyster Co.
- Figure 12: North Carolina Coastal Federation

Prevention of Marine Debris from Shellfish Mariculture

Best Management Practices for North Carolina Producers

The shellfish mariculture industry relies heavily on synthetic materials for oyster growout within the estuarine system. If these materials are lost from the farm, they become marine debris which can be detrimental to habitat, aquatic species and the people who work and play on the water. The North Carolina Coastal Federation worked with partners and shellfish growers to produce voluntary best management practices for the prevention of marine debris from shellfish leases.

SITING

The first step to establishing a successful shellfish farm is proper siting. There are many aspects that contribute to a farm's viability including frequency of closures, survivability of oysters, salinity, wave energy, other physical factors and public use conflicts.



QUICK SITING TIPS

- Choose sites away from navigational channels and inlets.
- Always consider wave energy.
- Scope potential areas of debris spread that might come from your farm or from neighbors (docks, other farms, etc.)
- Be a good neighbor and communicate with adjacent riparian landowners.
- Be aware of tidal range and strong tidal currents.

NC SHELLFISH SITING TOOL

Researchers at the University of North Carolina Wilmington have produced an interactive siting tool for shellfish mariculture that provides invaluable data for growers to scope the feasibility of a potential lease site. The tool includes continuously updated data on salinity, submerged aquatic vegetation, depth, utilized channels and much more. Find the tool at: uncw.edu/benthic/sitingtool



QUICK DESIGN TIPS

- Seek advice from established farmers and mariculture professionals when designing.
- Start small and scale up.
- Design for hurricanes.
- Maintain a well-organized and tidy farm.
- Consult design strength of gear from manufacturer.
- Clearly demarcate lease site to prevent vessel collisions.
- Mark gear units to aid in recovery.

- FARM OPERATION -

Once the farm is established, daily operations should be set in place that reduce the risk of marine debris generation. Good inspections, materials management, storm readiness and community outreach programs are key to preventing marine debris associated with shellfish farming operations.



FARM DESIGN

After locating and properly identifying the lease site, thoughtful development of the farm layout and design is a critical step toward developing a successful operation. Organization, gear selection and lease marking are important components of the design stage.



QUICK OPERATION TIPS

- Keep lines taut and keep gear neat and orderly.
- Regularly inspect gear and replace items that are worn.
- Keep lines full, so it is obvious when gear is missing.
- Dispose of or recycle used gear once it is no longer usable.
- Prepare the farm for forecasted storms.
- Obtain federal crop insurance.
- Keep lines and materials as deep as possible.
- Pick up loose gear as soon as possible.

For more information, visit nccoast.org/bmps.



North Carolina Coastal Federation Working Together for a Healthy Coast



