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Alabama current connection

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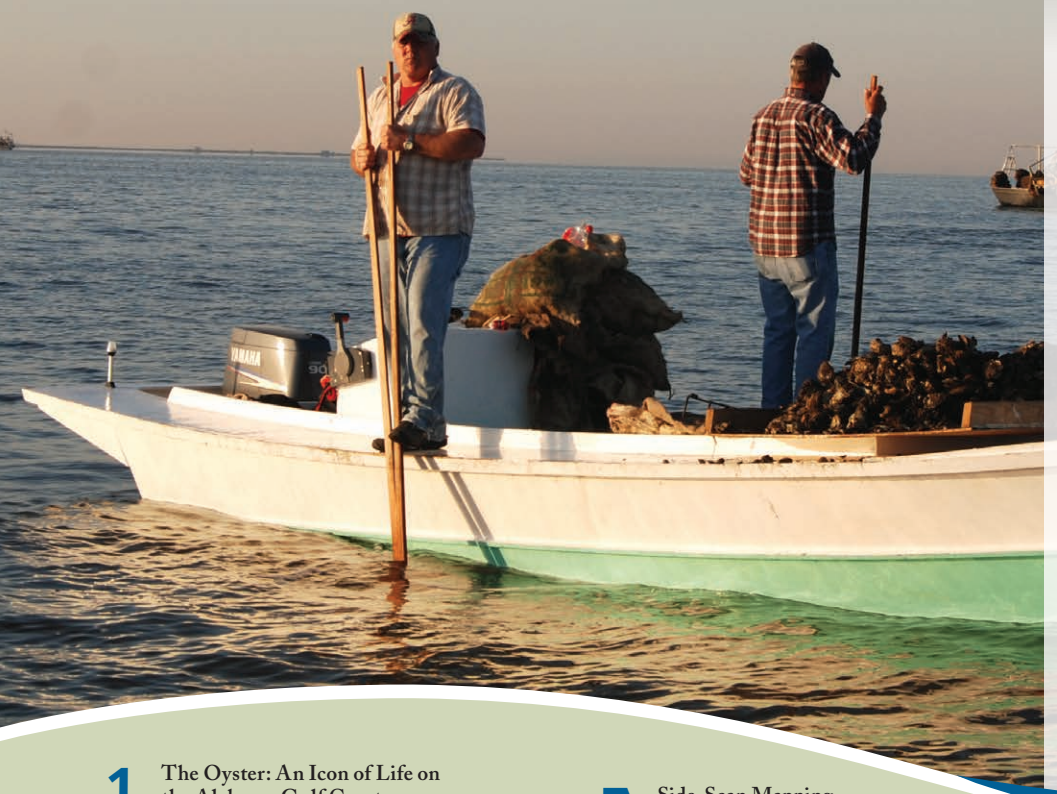
The Oyster: *An Icon of Life on the Alabama Gulf Coast*

By Roberta Swann, Director, Mobile Bay National Estuary Program



One thing I have learned since moving to Alabama 20 years ago is this: you can't beat the salty, creamy taste of an oyster grown in our waters. Wild or farmed, the oyster is an iconic representative of life along the Alabama coast. They are central to its heritage and culture, providing food, work, and a way of life to many of the folks in Bon Secour, Bayou La Batre, and other coastal communities. Having grown up in coastal Massachusetts, eating oysters has always been a part of my life. It wasn't until I moved to Dauphin Island that I discovered how good oysters could be and how important they are to the people who live and grew up here.

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Commercial oyster men tonging oysters near Cedar Point.

Currently Inside

The Oyster: *An Icon of Life on the Alabama Gulf Coast*

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The state of our oyster fishery is a cause for concern, given dwindling wild populations. Alabama's oyster reefs in Mobile Bay, Bon Secour Bay, around Cedar Point, and in Mississippi Sound are suffering. Harvests were historically low in 2016-2017 and 2017-2018, and surveys revealed so few harvestable oysters that no harvest was opened in 2018-2019. The factors underlying the reduced productivity are discussed by Alabama Marine Resources Division Director Scott Bannon in this issue, along with three separate measures AMRD is undertaking to better manage wild oyster populations.

And yet, there is great work being done to bring Alabama-grown oysters back to our tables. Gulf oysters grow rapidly and can reach maturity in as few as six months, compared to northeastern oysters which take four times that long. This simple fact provides a key for alternative methods of growing oysters. As you flip through the pages of this season's *Alabama Current Connection*, learn about how oyster gardening, an outreach activity initially conceived to improve productivity on our wild reefs, has given rise to a new and burgeoning industry: off-bottom oyster aquaculture. Some former oyster gardeners and new investors have expanded operations, providing hatchery-reared, single-set oysters with a lovely shape and appearance to the premium half-shell market by count.

This issue is of particular importance to the Swann family. As the leader of the Mississippi-Alabama Sea Grant Consortium, Dr. LaDon Swann has dedicated many years of oyster-related research as well as being a proponent of growing the State's aquaculture industry. In the following pages you will learn about the Sea Grant's significant role in the development and evolution of this exciting new industry.

When we moved to Alabama, did I ever imagine the little boy held tight on my lap as we plowed through Mobile Bay's waves would grow up to become an oyster farmer? The answer is unequivocally NO. But today LaDon and I stand proud of our son, Gage, who has a bright future ahead of him, harvesting an oyster bounty, carving out a life on the water, and keeping our plates full of the succulent, Alabama grown oyster. My heart is happy.

Oysters being loaded onto the Mobile Oyster Company barge on Dauphin Island.

The Problem: Diminished Wild Oyster Production in Alabama's Estuarine Waters

By Col. Scott Bannon, Director, Alabama Marine Resources Division

The Alabama Department of Conservation and Natural Resources Marine Resources Division (AMRD), with offices on Dauphin Island and in Gulf Shores, is charged with managing Alabama's marine fishery resources with assessment and monitoring, applied research, and enforcement programs. Alabama's iconic oyster fishery has been the focus of increased AMRD attention due to downward trends for the past several years for harvestable oysters. In fact, after extremely low harvests in 2016-2017 and 2017-2018, assessments of harvestable oysters were too low to even attempt an opening in fall of 2018 or spring of 2019. Restricted oyster harvest was opened by AMRD in late 2019.

To assess Alabama's public oyster reefs, AMRD divers annually perform counts within "quadrats" – one-square-yard areas randomly selected and falling along 300-foot lines stretched at intervals across the reef's footprint. Within each quadrat, the divers count legal-sized oysters (three inches or longer), sub-legal-sized oysters (between two and three inches long), oyster spat (tiny, young, recently settled oysters measuring less than two inches), and oyster drills (predators) and then calculate numbers of each per acre. These data are used to measure oyster productivity trends and determine status. Data have revealed a dramatic downward trend over recent years for harvestable oysters, despite spat counts remaining relatively high.

This inconsistency may be related to high spat mortality caused by low dissolved oxygen in some areas, low salinity events triggered by storm-related freshwater influx, or predation related to drought and the resulting higher salinities favored by oyster predators. Sufficient oxygen concentrations are necessary for spat growth, development, and survival, and hypoxic (low oxygen) conditions are common near the bottom of Mobile Bay.

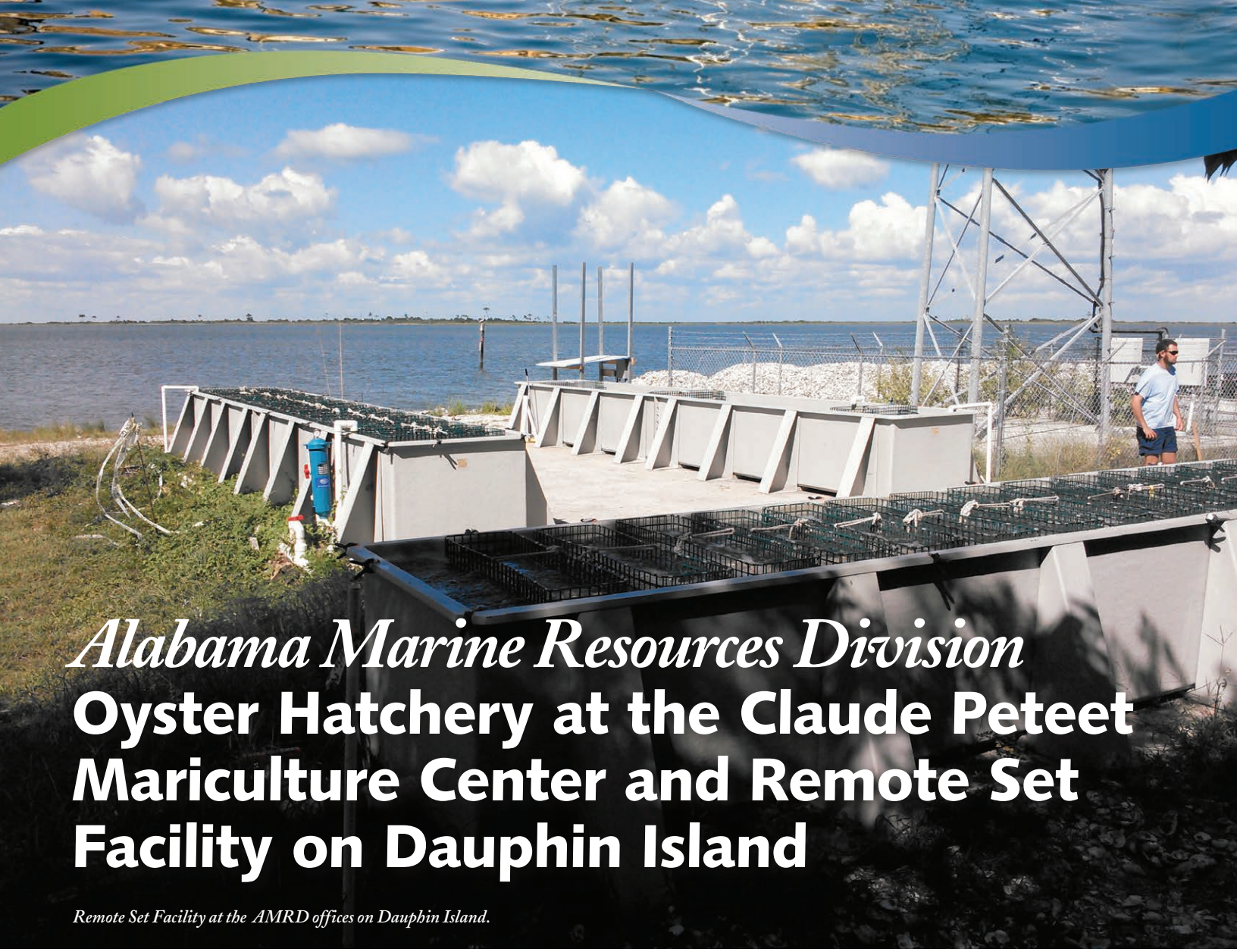
Wild oysters with irregular shapes caused by growing in clusters and typical barnacle fouling.

Salinity swings stress juvenile oysters in at least two ways. Spat recruitment has been found to be greatest in locations furthest from freshwater influence, and prolonged low salinity conditions caused by significant or prolonged rain events are particularly stressful to them. Conversely, while higher, less brackish salinities do not stress young oysters physiologically, they instead provide conditions preferred by the oyster's primary predator, the oyster drill.

Wild oyster production in Alabama is critical for several reasons. Oysters are a necessary part of a healthy estuary because of their impressive filtration capabilities and provision of food sources and complex habitat opportunities for a variety of fish, shellfish, and wildlife. Additionally, they provide a source of food for American consumers and income for communities in south Alabama. The decline in oysters for public harvest, indicated in AMRD surveys, forced the Division to look hard at this valuable resource.

While no single cause can be blamed for the decline that began around 2004, multiple negative influences have contributed. Hurricanes Ivan (2004) and Katrina (2005) caused physical damage to reefs, moved sediment into and around oyster beds, and triggered rapid changes in salinity by dumping inches of rainfall. These storms were followed by several years of drought, stimulating tremendous predation by drills, along with previously discussed hypoxia and then prolonged rain events reducing salinity to dangerous levels for extended periods of time, all contributing to declining oyster populations.

Over the next three years, AMRD staff will implement a management plan developed by the Alabama Trustee Implementation Group as part of the Natural Resource Damage Assessment (NRDA): the Deepwater Horizon Oil Spill Alabama Trustee Implementation Group Final Restoration Plan II and Environmental Assessment (https://www.gulfspillrestoration.noaa.gov/sites/default/files/2018-09%20AL%20RP%20II%20EA%20and%20Appendices_091318.pdf). This Plan recommends strategies to counter the stressors impacting wild oysters in Alabama waters. Recommended projects, with funding from NRDA, include stock enhancement through construction of an oyster hatchery at the Claude Peteet Mariculture Center in Gulf Shores and expansion of AMRD's remote set facility on Dauphin Island as a base for the "grow-out phase" of hatchery-produced oysters, benthic scanning to identify and prioritize locations in the upper and middle Bay capable of sustaining spawning stocks to support a regional oyster larval pool, and reef restoration using alternative methods of cultch placement to avoid hypoxia or other hydrologic stressors to oyster growth. These three projects are each described in this edition of the *Alabama Current Connection*.



Alabama Marine Resources Division
Oyster Hatchery at the Claude Peteet Mariculture Center and Remote Set Facility on Dauphin Island

Remote Set Facility at the AMRD offices on Dauphin Island.

By Col. Scott Bannon, Director, and Jason Hermann, Biologist II, Alabama Marine Resources Division

The State of Alabama is committed to investing in the long-term productivity of its oyster fishery. The Alabama Marine Resources Division (AMRD) will construct an oyster hatchery at the Claude Peteet Mariculture Center (CPMC) in Gulf Shores and expand their remote set facility on Dauphin Island. The oyster spat produced at these new and expanded facilities will be used to supplement and encourage oyster recruitment in portions of Mobile Bay with reduced oyster production compared to the early 20th century.

The CPMC provides an ideal location for broodstock maintenance and spawning. The 45-acre facility has ample space, a reliable water supply (via pumping stations from the Gulf and Intracoastal Waterway), outdoor ponds, and waterfront access to make transport of cultured oysters easier.

Operations at the new hatchery will entail collecting wild adult oysters from local waters and maintaining this "broodstock" in existing ponds. When water temperatures rise to near optimum spawning temperatures in spring, broodstock oysters will be gathered from the ponds and placed in tanks systems where temperatures are maintained low enough to prevent them from spawning. As needed, small batches of oysters will be retrieved from the holding tanks and induced to spawn, or release their sperm and eggs, in smaller, warmer, temperature-controlled systems.

Broodstock are adult oysters two to three years old, stimulated in the laboratory by warmer temperatures to spawn, or release eggs and sperm, which after fertilization, develop into tiny, free-swimming oyster larvae.
Photo courtesy of Texas A&M AgriLife Research

Spat are tiny oysters that have settled on cultch and begun to grow a shell.

After setting, spat attached to AMRD oyster shell cultch are fed natural algae pumped through from Bay waters.

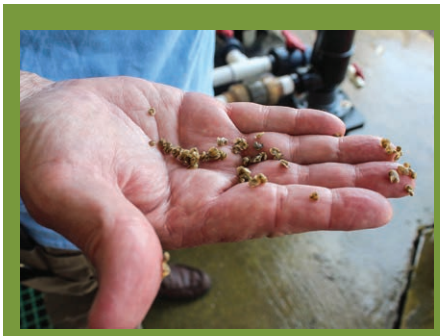
Released eggs and sperm will be combined to produced fertilized, free-swimming larvae, which will be moved into culture systems and fed rations of paste algae. After 14 to 20 days in the CPMC culture system, the larvae will grow and develop into "footed" larvae, ready to settle. At this point, the larvae will be transported across the Bay to setting tanks at the remote set facility on Dauphin Island, where they will be given approximately three days to "set" on cultch material while being fed live, concentrated algae. Tiny, newly set oysters attached to cultch material are called "spat."

Cultch is the hard material that provides an attractive settling substrate for oyster larvae.

After the setting period, the tanks will be switched to "flow through," and spat will feed on natural algae pumped into the system from the waters of Dauphin Island Bay, allowing them to grow for approximately two weeks before placement on a reef. These "seed oysters" will be placed on a contracted barge and transported to suitable areas for placement in Mobile Bay and Mississippi Sound locations identified by AMRD staff.

This static water culture system is anticipated to produce up to approximately 65 million 10-day-old spat each year.

The goal is to increase the productivity of Alabama's public oyster reefs.



Seed oysters are growing spat ready to be moved to restoration areas or growing cages.

Photo courtesy of Auburn University Shellfish Lab.

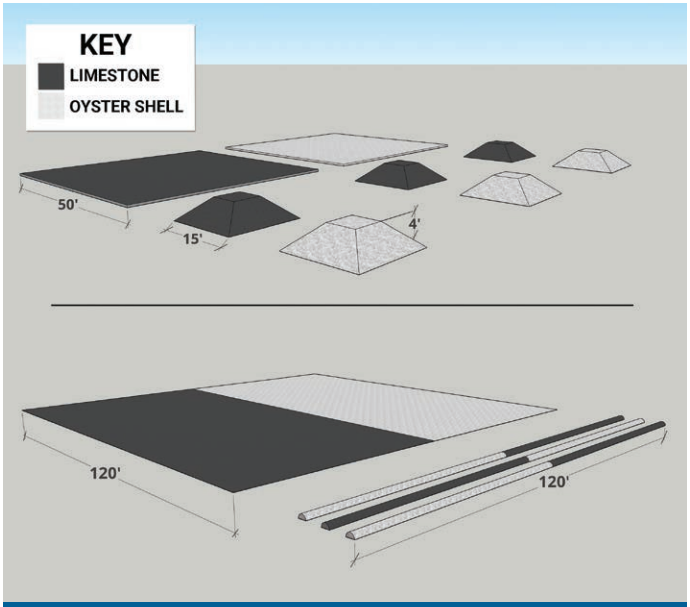
Oyster Cultch Relief and Reef Configuration – Mounds and Furrows

By Col. Scott Bannon, Director, and Jason Hermann, Biologist II, Alabama Marine Resources Division

The Alabama Marine Resources Division (AMRD) will investigate the advantages of arranging different types of cultch (materials to which oyster larvae attach) in different configurations to promote settlement and growth of oysters in selected reef areas in Mobile Bay. The project has three primary goals: (1) Determine if there are differences in oyster settlement, growth, and survival on reefs with different levels of vertical relief and/or orientation to currents; (2) determine the best reef material needed to restore oyster density in historical reef areas where oxygen concentration, salinity, and oyster recruitment and survival are highly variable; and (3) estimate the cost/benefits of deploying cultch material in certain configurations other than traditional cultch broadcast methods. The project will be funded through the Natural Resource Damage Assessment Restoration Program.

The initial design of the project involved arranging three types of cultch – cured oyster shell, limestone rock, and fossilized oyster shell – in two different experimental configurations: individual mounds and elongated mounds with furrows, with control plots built using typical cultch broadcasting methods. However, fossilized oyster shell stocks were depleted and unavailable, so only cured shell and limestone will be used as experimental cultch treatments.

Two sites were selected based on pre-project surveys: (1) the 70-acre Denton Reef, an artificial fishing reef, located on the northern portion of Whitehouse Oyster Reef, approximately three miles southeast of the mouth of East Fowl River and (2) a 36-acre reef where AMRD undertook a 2014 Reef Planting Project approximately one mile north-northeast of the mouth of East Fowl River. Physical conditions were used to determine which type of reef configuration would be tested in each project site. For example, data indicate conditions near the bottom at Denton Reef are consistently hypoxic (low oxygen) or anoxic (no oxygen) and not favorable for oyster growth. Therefore, Denton Reef was picked to test elevated mounds that might offer growing oysters settlement opportunities higher in the water column where more oxygen is available. At the other site, nearer to the mouth of Fowl River where currents and sediments impact oysters, lower-relief, elongated mounds will be used to test the effects of relief, reef material, and orientation relative to currents and wave energy on oyster survival and growth.



Schematic of oyster cultch relief experiments: Top: oyster mounds. Bottom: Elongated mounds and furrows.

At Denton Reef, six cultch mound pyramids with 15-foot-by-15-foot bases will each be built using 45 cubic yards of material. The mounds will rise approximately four feet off the bottom in 10 to 12 feet of water. Three mounds will be constructed from cured oyster shell and three from limestone rock to determine whether vertical position on the mound influences settlement, growth, and survival. Oyster success on mounds will be monitored for three years and compared to two adjacent "control" plots, each constructed with the same amount of material broadcast over a 50-foot-by-50-foot square area with 100 percent coverage six inches deep. One control plot will be constructed of cured shell and the other of limestone.

At the second site, three elongated mounds, two feet wide, one foot high, and 120 feet long, will each be constructed using 30 cubic yards of material. The three elongated mounds will be oriented parallel to one another and separated by a maximum of four feet to create furrows between them. Each elongated mound will be built with 60 feet of cured shell and 60 feet of limestone rock arranged in alternating orientation. As a control, forty-five cubic yards of cultch material will be broadcast over a 120-foot-by-120-foot area to attain 100 percent coverage to one-inch depth. Like the experimental plots, the control plots will be constructed with the first 60 feet of one type of cultch material and the second 60 feet with the other. Controls will be oriented to alternate with experimental mounds and separated from them by a minimum of twenty feet. Oyster settlement, growth, and survival on the elongated mounds will be monitored and compared to the control plot to measure the effects of shifting sand and silt related to currents and weather events.

Side-Scan Mapping of Mobile Bay Relic Oyster Reefs

By Col. Scott Bannon, Director, and Jason Hermann, Biologist II, Alabama Marine Resources Division

Recent larval flow modeling and recruitment studies have shown flow patterns and transport of oyster larvae from populations in northern Mobile Bay are carried southward down the Bay's western shore to oyster reefs in the lower Bay and then west towards Mississippi Sound. They contribute a significant portion of larval recruitment on Alabama's public reefs in the lower Bay and Mississippi Sound and help populate Cedar Point and Heron Bay reefs. Historically, Hollinger's Island and White House reefs, located in middle Mobile Bay, were productive oyster reefs that bridged the large gap between oyster populations in upper Mobile Bay and the public reefs of the lower Bay. Currently, Hollinger's Island Reef is moderately productive, but Whitehouse Reef is non-productive, due to persistent low dissolved oxygen near the water bottom.

The purpose of side-scan mapping is to (1) identify water bottoms in areas of mid-to-lower Mobile Bay suitable to support cultch material so that oyster populations can be re-established through efforts to seed reef areas with hatchery-raised oyster spat, and (2) survey the current extent and conditions of the relic oyster reefs identified in 1968 reef surveys contracted by the Alabama Marine Resources Division (AMRD) along with other bottoms not yet surveyed.

Mapping these areas with side-scan sonar will enhance our knowledge of natural larval production and better enable us to identify the most suitable locations to establish a network of "patch reefs," enhancing current "islands of productivity." Establishment of significant quantities of oysters on a network of patch reefs along a gradient of hydrological conditions in these areas could provide increased levels of natural larval recruitment to current commercial public reefs. It would also increase the resilience of the spawning stock and larval production within Alabama waters, should adverse environmental or man-made events occur. Approximately 8,847 acres of non-contiguous, State-owned water bottoms (Figure 1) have been targeted for side scan mapping in mid-to-lower Mobile Bay, based on a survey of living and relic oyster reefs conducted in 1968. An additional 5,153 acres of oyster bottoms have been identified for scanning in upper Mobile Bay to quantify the location and extent of existing oyster resources, which contribute to larval production and recruitment to lower Mobile Bay oyster reefs.

By identifying and prioritizing locations in areas of low productivity for enhancement, AMRD hopes to restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to Alabama's subtidal and nearshore oyster reefs.

Historic Oyster Reef Locations and Areas Proposed for Mapping

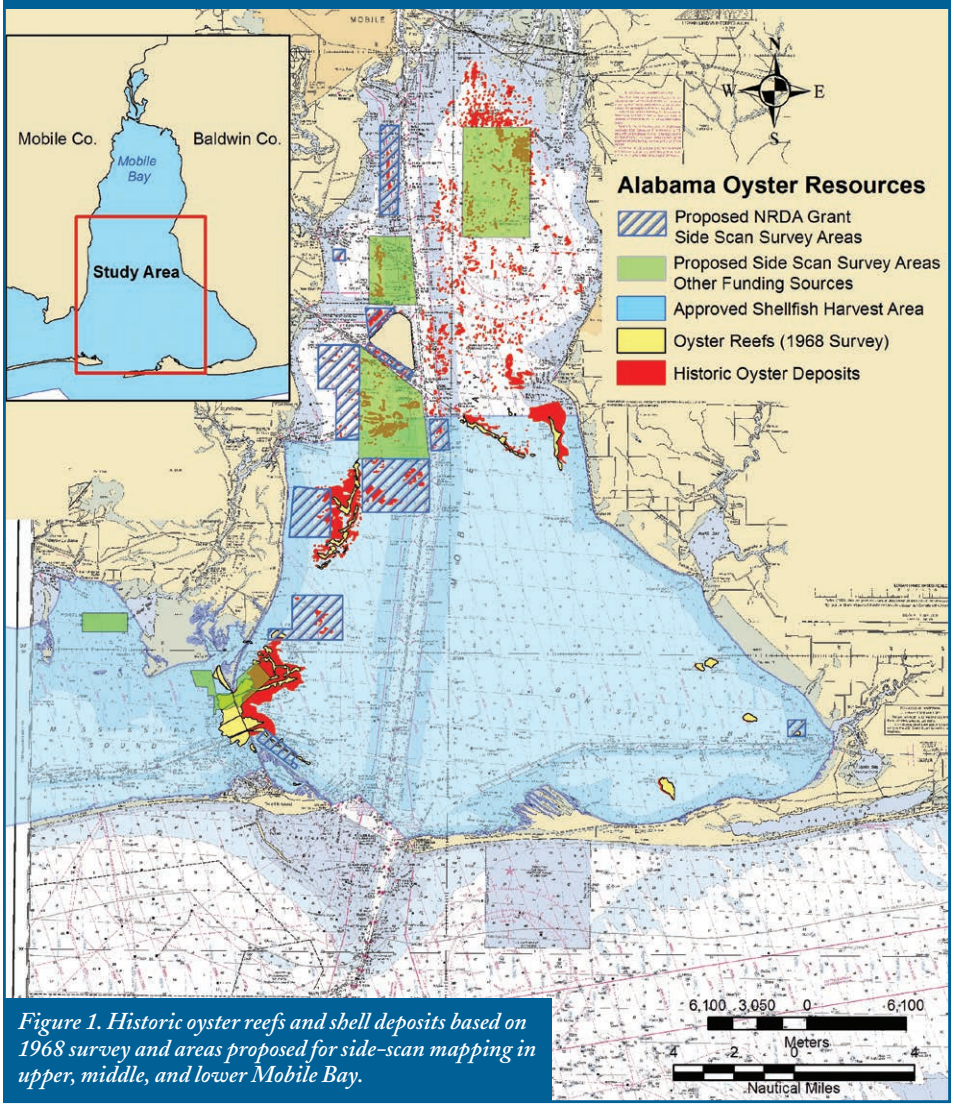


Figure 1. Historic oyster reefs and shell deposits based on 1968 survey and areas proposed for side-scan mapping in upper, middle, and lower Mobile Bay.

Guest Column

Q & A with Gage Swann

Our guest columnist is Gage Swann, a senior Management student at the University of South Alabama, who pays bills by working at the Mobile Oyster Company, an off-bottom oyster aquaculture operation in the salty waters on the west end of Dauphin Island.

Q: OK, senior at USA, former offensive lineman at Huntingdon College, and recently licensed charter boat captain Gage Swann, how did you become involved in off-bottom oyster aquaculture?

A: Before I got into all those other things you mentioned, I was just a Theodore High School graduate looking for a summer job while waiting for my first semester at Huntingdon to begin. My dad was actually the person who recommended me looking into working for an oyster farm. Somewhere along the search, I got in contact with a man who managed an oyster farm out in the Bayou (La Batre), back when there was a co-op of farmers out the mouth of West Fowl River. He lined up a training day for me, and from that moment, I have been working in off-bottom oyster aquaculture. Since then I have joined the team and am currently working for Cullan Duke at the Mobile Oyster Company.

Q: Describe a typical work day at the Mobile Oyster Company.

A: Our days at the Mobile Oyster Company usually begin around 8:00, when my buddy Aaron, other team members, and I meet to finish our morning coffee and discuss the goals we want to have accomplished for the day.

Sometimes we have a perfect day on Dauphin Island, and we use those days to maximize the work we do caring for the oysters on the farm itself. Every oyster farmer has a few basic obligations to the farm to grow and maintain beautiful oysters.

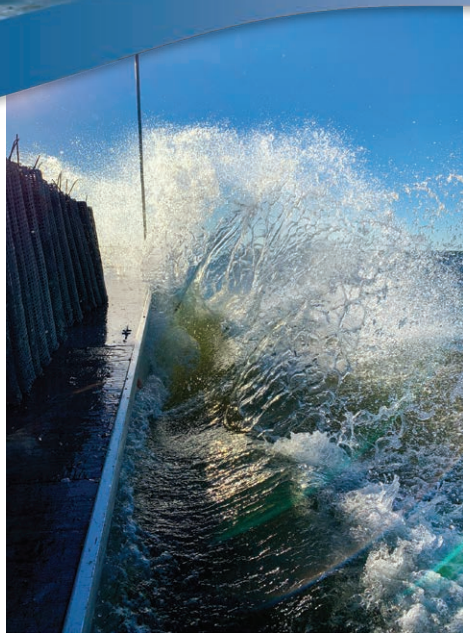
The most important obligation is making sure you have enough oysters counted and ready for a harvest. Having these bags already made up a few days before hand helps harvest run smoothly and in a quick time frame, which is really important during the summer time.

Another task we do on nice calm days would be desiccating our oysters (by raising and flipping our cages). During the summer time it is recommended we do this once a week or at least once every two weeks. This practice dries the outside of our equipment and the oysters to limit any sort of biofouling. Biofouling is basically growth of barnacles and algae, on our equipment and oysters. Flipping the cages is the reason our oysters come out so clean with so few barnacles or other growth on them.

Desiccation involves lifting oyster grow cages above the water surface for 24 hours, usually once per week, to control biofouling of oysters and baskets and to rattle the oysters, chipping off new growth, which, along with waves and boat wakes, produces a rounder, deeper-cupped oyster more valuable on the half-shell market.

The rest of our time on these types of days involves us splitting bags of growing seed oysters (to reduce bag density), so that the oysters do not overburden equipment with their increasing size and weight. We also spend time hand sorting and counting oysters for our harvest bags.

During the winter time, we get really strong north winds which makes working the farm in our location too much of a risk. We spend these days repairing any broken equipment, like worn down oyster grow cages for example, and also servicing our work boat.



Q: What's tougher, a mid-July work day or an early February work day? Why?

A: In my opinion, I would rather have a mid-July work day every day of the year compared to the mid-February work days! This has almost everything to do with the type of weather trend our location is subject to in the winter time. During the winter time of year, it is almost guaranteed the water will be in the upper 50s, and we usually have more strong north winds too. This makes the tasks of getting in the water to tend our oysters and driving the boat very difficult and uncomfortable. By the time summer comes around, we definitely become very thankful for the usual southerly flows of wind and the warm water.

Q: With regard to environmental issues, what stressors to wild oysters are oyster farmers able to avoid or control? What stressors present the major threats to farm-cultivated oysters?

A: I'm no expert on what has happened to our natural oysters reefs over the years but I do believe off-bottom oyster aquaculture helps avoid some of the obvious things that hurts the natural reefs.

• Oyster drills (the primary oyster predator) usually are not that big of a problem for us because of the fact our oysters stay in the top of the water column, rather than on the bottom.

• We are also able to avoid any issues with sediment covering oysters during big storms or from boat wakes, etc., again because we are at the top of the water column.

As to stressors for oyster farmers-

• Hurricanes and strong storms. These storms have the ability to take a toll on oyster farms and the equipment itself. Even when farmers don't sink their gear, strong storm surge and currents can bury our bags on the bottom and also chafe our main lines.

• Water quality. Things like red tides and shutdowns due to high counts of sewage-related bacteria in the water are also hard to predict and leave us idle for many weeks.

Q: As a student in management, what are the biggest challenges to managing an oyster farm?

A: I think finding the right workers who can handle the types of conditions we have to work in is sometimes our biggest problem. Currently we have a really solid team, which I am thankful for, but in the past good, reliable help has been hard to find.

Q: What is most rewarding about oyster farming?

A: I particularly like seeing our customers post pictures of our oysters on social media or hearing from people who say it is the best oyster they ever tasted.

Q: So, USA Management student, should I invest in Alabama off-bottom oyster farming operations?

A: Yes. This is a young industry in Alabama compared to other coastal areas in America, but in my opinion, the Gulf Coast and especially the central Gulf Coast has some of the richest waters for growing oysters. From the time I started five summers ago up until now, I have seen a lot of industry growth in Alabama and more people willing to give oyster aquaculture a try. They are all good people who, I think, can really make a name for the Alabama oyster nationwide. And if this doesn't sell you, just come on down to Mobile Oyster Company and try one yourself.

Off-Bottom Oyster Aquaculture – An Emerging Industry Along the Gulf Coast

By Dr. Bill Walton, Associate Professor and Extension Specialist, and Rusty Grice, Administrator II, Auburn University

Over the past 20 years, the culture and harvest of oysters in the United States has increased steadily, proving its potential for continued growth as an agricultural sector. Cultured oysters accounted for 61% of all cultured shellfish in 2008, and the industry was valued at $136 million annually, surpassing clams and salmon aquaculture. Coinciding with this increase in farmed oyster production are off-bottom culture methods, where oysters are maintained in floating cages or suspended baskets.

Off-bottom oyster farming is the culture of oysters, usually held in some type of mesh container (basket, bag, cage, etc.) kept above the seafloor (suspended or floating) in food-rich coastal waters. The final destination of these oysters is to be commercially sold as a food product for human consumption. Oysters grown this way are typically hatchery-reared, single-set oysters instead of clumps of oysters normally found in the wild. When properly operated, the containers provide protection from predators and eliminate burial in the sediment, allowing oysters to be cultured in areas where they would not survive on the bottom (e.g. high salinity areas with high predation rates, areas where the substrate is too soft, or areas affected by low dissolved oxygen/hypoxia near the bottom).

Traditionally, however, oyster production in the Gulf of Mexico has been dominated by on-bottom production from private leases and public oyster beds. While the Gulf of Mexico accounted for over 89% of the national 2008 harvest of the eastern oyster (*Crassostrea virginica*) by volume, the region only obtained 73% of the total dollar value of the U.S. harvest. Additionally, production from the natural fishery and on-bottom leases is highly cyclical and dependent on a number of environmental factors (e.g., freshwater input, predator regimes, natural set of larvae, etc.), thereby making it difficult to build a sustainable business using these methods.

In 2009, Mississippi-Alabama Sea Grant Consortium, Alabama Cooperative Extension, and the Auburn University Shellfish Lab partnered with Steve and Dema Crockett (with a parallel program in Louisiana led by Louisiana Sea Grant) to test different methods of off-bottom oyster farming to see which techniques might be most appropriate for the region. Based on this work, off-bottom farming of oysters using some type of routine desiccation technique showed promise. Through additional collaborative research, training programs, efforts by regulatory agencies, and investment of time and energy by industrious individuals, this new industry established itself, first in Alabama and Louisiana, then followed by Florida, Mississippi and, most recently, Texas.

In 2019, Alabama's shellfish aquaculture industry produced oysters through both wild harvest and through off-bottom farming. Based on current (2019) estimates, the industry now has a farmgate of at least $1 million with 22 commercial farms in operation, and permits pending for two to three more. These farms had over 37 acres in production, with at least 27 more acres permitted for off-bottom farming. In addition to the farms, several nurseries and one hatchery have also been established in Alabama with successful production. Oysters produced using off-bottom culture techniques are typically sold to the premium half-shell market by count.

Importantly, in addition to the economic impacts of the industry, off-bottom oyster farming has allowed individuals to continue cultural traditions of working on the water, especially in communities like Bayou La Batre. Furthermore, oyster farming has been documented as providing valuable ecosystem services, including provision of habitat for fish and other invertebrates.

Recycled oyster shells curing before placement.

Alabama's Oyster Shell Recycling Program

By Mark Berte, Executive Director, Alabama Coastal Foundation

In December 2015, the idea of an Alabama Oyster Shell Recycling Program (AOSRP) became a reality during one of the Alabama Coastal Foundation's (ACF's) Connect To Your Coast outreach events at the Flora-Bama Yacht Club. The Yacht Club chef suggested the ACF start a recycling program so he did not have to discard oyster shells into the waste stream. Two weeks later, a National Fish and Wildlife Foundation (NFWF) grant opportunity from their Gulf Coast Conservation Grants Program was made available, ACF secured funding, and later that year the Program was initiated.

The NFWF grant was for two years, and ACF's goals were not only to establish a sustainable program, but also to collect 380 cubic yards of shell (enough to cover five acres of bottom to a depth of one half inch depth) annually from a total of 30 participating restaurants. With good relationships with local restaurants already established, ACF was able to bring 30 restaurants onboard and collect 760 cubic yards (or 10 acres) of shell in the AOSRP's first 11 months.

As of December 2019, the Program had collected over 10 million shells, or approximately 1,900 cubic yards, enough to cover over 25 acres of Bay bottom. This volume of shell (weighing roughly the same as 210 elephants) would require about 158 dump trucks to transport.

While the grant was completed by the end of September 2017, the Program continues to thrive today for two reasons. First, participating restaurants pay the ACF to recycle their shells (rather than paying someone to haul them to a landfill), covering about 60% of Program costs. Second, the balance of costs is secured through the ACF #ShuckABuck donation platform through the secure online donation page at https://www.joinACF.org.

Oyster shells collected through the AOSRP are replaced into Alabama waters to provide substrate for wild oysters to grow. In addition to food value, oysters provide many other important ecosystem services, including:

- Improving water quality: Each adult oyster can filter 15 gallons of water per day.
- Providing habitat: Oyster reefs provide habitat for fish, shrimp, crabs, birds and other animals.
- Limiting erosion: Oyster reefs are natural breakwaters that protect shorelines.

In addition, the ACF is proud of the AOSRP Advisory Committee, comprising restaurant representatives, non-profits, State agencies (including the Alabama Marine Resources Division), and government leaders who help make decisions about the Program, including where to place the shells.

The ACF calls that approach "inclusive environmental stewardship." Names of and contact information for Committee members can be found on its web site.

What is next for the Program? The ACF is seeking grant opportunities to expand the Program to restaurants upstream in Birmingham, Montgomery, Auburn, and Tuscaloosa in the future. They are also exploring possibilities of allowing individuals to recycle their shells. The ACF solicits lower Alabamians interested in helping to bring either of those concepts into fruition to contact them or Advisory Committee members and let them know.

The Mississippi-Alabama Sea Grant Consortium's Support of the Oyster Industry: Past, Present and Future

Dr. LaDon Swann, Director, Mississippi-Alabama Sea Grant Consortium

Sea Grant is a science-based service organization that works at the boundary between science and policy. The Mississippi-Alabama Sea Grant Consortium (MASGC, http://masgc.org) was created in 1972 as a federal and state partnership supported by the National Oceanic and Atmospheric Administration (NOAA) and nine university partners in Alabama and Mississippi. Its mission is to provide integrated research, communication, education, extension and legal programs to coastal communities that lead to the responsible use of ocean and coastal resources. Additional support is provided through education funds through Alabama and Mississippi state governments.

MASGC's stakeholder-driven strategic plan is organized around four focus areas and include:

1. **Healthy Coastal Ecosystems**
2. **Sustainable Fisheries and Aquaculture**
3. **Resilient Communities and Economies**
4. **Environmental Literacy and Workforce Development**

MASGC's funding portfolio is balanced across these four focus areas. Within sustainable fisheries and aquaculture, MASGC invests in sound science to inform policy and economic decisions for marine species, including oysters. Over the past 48 years Sea Grant has supported 61 research projects involving oysters, with funding totaling around $14 million, which does not include funding for education, outreach, or extension. MASGC's oyster investments can be grouped into four major categories: seafood safety, farming, restoration, and ecosystem services of oyster reefs and farms, represented in Figure 1.

The progress made in sustainable oyster reefs and oyster farming has relied on strong partnerships between the private sector, state agencies, university partners, environmental non-profits, and funding agencies, such as MASGC. Not every Sea Grant-supported project has been a "home run," but sustained investments in needs-based, hypothesis-driven research supported by robust education, outreach, and extension programs has led to some important outcomes.

Seafood safety has been a major area of investment. Early investments in the 1970s through 1990s led to the application of research commonly used now. Before

Mississippi-Alabama Sea Grant Supported Oyster Research Projects and Funding

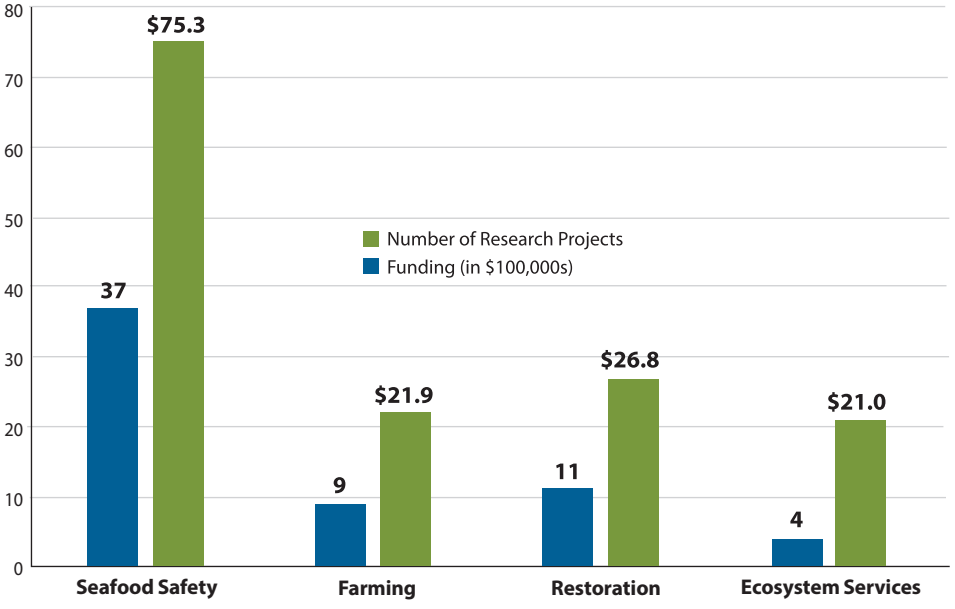


Figure 1. Number of Mississippi-Alabama Sea Grant supported oyster research projects and funding (2020 adjusted) between 1972 and 2020 grouped into seafood safety, farming, restoration and ecosystem services valuation.

there was a Mussel Watch Program (http://aquaticcommons. org/ 2232/1/ MWTwoDecades.pdf) to assess contaminant monitoring along the nation's coasts, MASGC was supporting the science to determine levels of chemical contaminates found in oysters. An early MASGC research project, funded in 1972, determined the distribution and significance of copper and lead in Mississippi Sound oysters. Sea Grant-funded research led to identifying most of the oyster genome, important in understanding oyster growth and survival, and refined the use of DNA polymerase chain reaction (PCR) methodologies, now used routinely to rapidly identify pathogenic bacteria like *Vibrio vulnificus* in oysters.

Perfectly shaped farm-raised oyster.

Sea Grant Extension work in the 1990s led to the development of Seafood Hazard Analysis Critical Control Point (HACCP), a systemic and broadly used approach to ensure the safety of the seafood we consume.

The development of a sustainable oyster farming industry in Alabama and Mississippi required strong partnerships and applied research. Sea Grant-supported research in 1972 revealed oysters raised in our region could be grown to market size in as little as eight months. The suite of research and extension projects supported by MASGC and others has led to the creation of more than a dozen oyster farms in Alabama and a growing number in Mississippi since 2010. Sustained research and extension funding, increased demand for alternative jobs, necessary infrastructure (e.g. hatcheries and production equipment), and supportive marine resource management agencies were all key to the success of this new sector for the commercial oyster industry. The outlook for oyster farming is favorable, and Sea Grant will continue to support the needs of this sector as it faces the challenges of a maturing industry.

Methods to optimize oyster reef restoration continue to improve. MASGC has supported work to identify compounds in oysters that cause larvae to set (1970s), determine the seasonal distribution and location of oyster spat in Mobile Bay and Mississippi Sound (1970s), understand the optimal size of spat for planting (1990s), and develop breeding programs for hypoxia-resistant oysters (2000s). In addition to applied research, Sea Grant helped establish the Mobile Bay Oyster Gardening Program. Led by Sea Grant-supported extension professionals, this Program directly connects with citizens living along Mobile Bay. The success of the Oyster Gardening Program in Mobile Bay led to its expansion into Little Lagoon and Mississippi.

Oysters are a foundational species in our estuaries and provide numerous ecosystem services, which can be defined as direct or indirect contributions to human well-being. From a practical standpoint, wild or farmed oysters:

- Provide jobs for commercial fishermen, processors, retailers, and for-hire and recreational fishing interests.
- Provide critical habitat for many species of marine animals.
- Mitigate against storm surge and shoreline erosion.
- Remove excess nutrients from the water.
- Provide cultural and spiritual experiences for coastal residents and tourists.

Translating the services provided by oysters into economic values is challenging, and Sea Grant has funded a great deal of research to determine the values of services provided by oyster reefs. Determined values vary widely, depending on the location and focus of the those making the calculations. MASGC has partnered with other funding programs to support regional research to calculate ecosystem service values for oyster reefs with valuation data available on the Gulf of Mexico Ecosystem Services Valuation Database (http://gecoserve.org).

MASGC is one of many organizations which supports the sustainability of oysters. Considering the needs of our coastal communities and the MASGC's available resources and sustained investments in oysters have resulted in multiple positive impacts on the environment and the economy.

Applying Research to Increase Oyster Restoration Success – *Using Predator Scent to Encourage Development of More Robust Shells*

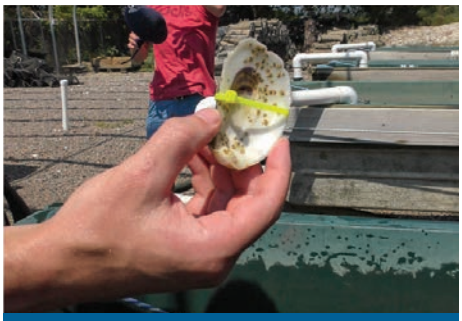
By Dr. Lee Smee, Senior Marine Scientist and University Programs Chair, Dauphin Island Sea Lab

Oysters begin life as plankton, swimming in the ocean as they select a place to settle and begin to grow. Once an oyster chooses where to settle, the choice is permanent. That makes an oyster's ability to react to changing conditions paramount to its survival. Dr. Lee Smee, Senior Marine Scientist and University Programs Chair at the Dauphin Island Sea Lab, and his research team found this past summer that oysters could alter their shell growth patterns to make themselves less vulnerable to predators. Specifically, oysters make their shells heavier and stronger when exposed to the scent of predators, reducing the likelihood that an oyster will be eaten. The next step will be to use these findings to enhance oyster reef restoration.

For over a century, commercial oyster harvesting has been a fundamental component of the economy and culture of Gulf Coast states. In addition to their value as a fishery, oysters provide numerous other benefits, including water filtration and shoreline protection. Oysters provide critical habitat for many other species of fish and invertebrates, including red drum and blue crabs, which are both commercially important.

Unfortunately, over 85% of global oyster reef habitat has been lost, and both Mississippi and Alabama have experienced astonishing deteriorations in the fishery. While off-bottom oyster farming, fueled by hatchery seed, has become established along the Gulf coast, this form of production produces only a fraction of traditional production levels, and yields a product best suited to the premium half-shell market.

Numerous restoration efforts have been implemented with varying degrees of success. In the northern Gulf of Mexico, restoration is often performed by cultching areas with hard substrate (crushed concrete, oyster shells) in hopes that oysters will settle and grow. Despite significant investment in cultching, surveys and harvest data suggest that natural oyster recruitment may be insufficient to rebuild the fishery. Recently, both Mississippi and Alabama have invested in oyster hatcheries for remote setting to enhance reef restoration. This technique involves setting hatchery reared oyster larvae onto oyster shells or other hard substrates and then deploying these oysters into estuaries. This practice is relatively new in the Gulf of Mexico but is well established in both the Chesapeake Bay and the Pacific Northwest coast.



Oyster spat attached to an oyster shell.

Oysters grown in a nursery A) with and B) without blue crab scent. The oysters grown with crabs are rounder, harder, and more resistant to being eaten by predators.

One concern regarding the remote setting of oysters is that newly settled oysters (termed "spat") are especially vulnerable to predation, particularly by oyster drills. Oysters, however, may adjust the thickness, weight, shape, and strength of their shells to deter predators. In summer 2019, Dr. Smee and his research lab found that oysters reacted to blue crab urine by growing stronger shells. When placed in the field, oysters exposed to predators had stronger shells and were three times more likely to survive than oysters without prior exposure to predators. Ongoing research is investigating the potential to expose remotely set oysters to predator cues in the hatchery to "toughen them up" prior to placement in the field. If survival can be increased, this will yield significant return on investment and facilitate oyster reef recovery. The next research step will be identifying the chemicals in crab urine that trigger oyster shell thickening. Once the chemicals that oyster respond to are characterized, then oyster hatcheries will be able to add these substances to the water in the setting tanks to enhance oyster shell growth and increase oyster survival, thereby increasing return on investment of remote setting and facilitating oyster reef restoration and recovery.

Oyster Gardening in Alabama

By P.J. Waters, Extension Specialist and Interim Director, Auburn University Marine Extension and Research Center

Oyster gardening in Alabama began in 2001 as a masters student's thesis project sponsored by the Mobile Bay National Estuary Program in partnership with Auburn University and the Mississippi-Alabama Sea Grant Consortium. Volunteers were introduced to the idea they could grow juvenile oysters (spat) as a community wide restoration effort. Nearly 20 years later, under leadership of AU and the MASGC, oyster gardening in Alabama has grown to two distinct program regions and spawned a sister program in Mississippi. Gardening oysters are set on parent shells at the AU Shellfish Lab. The parent shells come from the Alabama Oyster Shell Recycling Program, making it possible that the shells of oysters you enjoy this weekend at a local restaurant, will find their way into an oyster garden and back on a reef supporting a new generation of oysters. The 2019 season saw oyster gardening in Alabama exceed the 1,000,000-oysters-planted mark with no signs of slowing.

Gardening oysters are not for consumption, though some of the gardeners now count themselves among Alabama's premium oyster farmers. Rather, these oysters serve a higher purpose, being destined to be returned to restoration reefs in Mobile Bay. The next phase of oyster gardening will start in 2020. While each of the three programs continue to expand with additional sites and volunteers, attention is being turned to evaluate stocking strategies and protection measures against a voracious oyster predator generally referred to as a "drill." As these projects play out, oyster gardening will look to increase in both oyster production and the efficiency of its restoration efforts. It is anticipated that with the new information, a new era of volunteer gardening will be possible, resulting in more oysters with less labor over a longer period of time at each site.

If you are interested in oyster gardening, get in touch with us to learn more about your site's eligibility. In Mobile Bay or Mississippi, contact us at 251.438.5690 or oystergardening@auburn.edu. In Little Lagoon contact the Little Lagoon Preservation Society.

Alabama current connection

About the Mobile Bay National Estuary Program: The Mobile Bay National Estuary Program's mission is to lead the wise stewardship of water quality and living resources of the Mobile Bay and Tensaw Delta. The MBNEP serves as a catalyst for activities of estuary stakeholders, helping to build community-based organizational capacity for sound resource management and leveraging commitment and investment to ensure the estuary's sustainability. For more information, please contact the MBNEP office at 251-431-6409.

About ADCNR, State Lands Division, Coastal Section: In an effort to protect and enhance coastal resources and reduce potential conflicts between environmental and economic interests, the Alabama Coastal Area Management Program (ACAMP) was approved by the National Oceanic and Atmospheric Administration (NOAA) in 1979. The ACAMP is administered through the Alabama Department of Conservation and Natural Resources, State Lands Division, Coastal Section. For more information, please contact the Coastal Section office at 251-621-1216.

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Alabama Current Connection encourages reprinting of its articles in other publications. If you have recommendations for future articles or would like to subscribe, please contact the editor:

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Alabama current connection

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Oyster South:
Successful Farms and Healthy Waters

By Beth Walton, Executive Director, Oyster South

Oyster farming and the culture that accompanies it are the heartbeat of Oyster South. Founded in 2016, Oyster South is a 501 (c)(3) non-profit organization whose mission is to cultivate a south that encourages and includes successful oyster farms, healthy waters, and the birth of new traditions. We help spread the message of sustainable aquaculture and its positive economic, environmental, and cultural impacts. We also assist our farmer members by fundraising and helping them improve their farming and marketing efforts through first-hand information exchange. The use of modern equipment, techniques, and ideas is reinventing the tradition of southern oysters.

In addition to over 50 oyster farmers, the Oyster South community consists of retailers, wholesalers, shuckers, hatcheries, chefs, restaurants, marine extension agents, students, writers, media, cookware makers, photographers, and the general public.

We celebrate, elevate, and cultivate the southern sustainable farm-raised oyster through two of our signature events. The first is our fundraiser LANDLOCKED, which is held each October in Decatur, GA and is open to the general public. We also hold our annual Industry Symposium each February, alternating between Atlantic and Gulf coast sites. For more information, go to oystersouth.com.