STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
RICHARDSON & ROBBINS BUILDING
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

OFFICE OF THE SECRETARY

PHONE
(302) 739-9000

MEMORANDUM

TO: Theresa Smith, Regulatory Specialist

THROUGH: Patrick J. Emory, Division of Fish and Wildlife Director
John H. Clark, Fisheries Section Administrator

FROM: Zina Hense, Fisheries Scientist

DATE: February 19, 2024

SUBJECT: Technical Response Memorandum – Docket #2022-R-F-0014: 7 DE Admin. Code 3801-Shellfish Aquaculture

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The Fisheries Section has considered the public comments received regarding the proposed amendments to 7 DE Admin. Code 3801 Shellfish Aquaculture and determined that the proposed amendments should be approved as written. Sixteen comments were received, two spoken and fourteen written, and the comments focused on several parts of the regulation. Since many of the comments provided were similar, where possible, they have been combined and edited for clarity and brevity in the tables. Verbatim statements can be found in the public comments posted on the DNREC webpage and in the Hearing Transcript, also posted on the DNREC webpage.

We appreciate the thoughtful comments submitted on the proposed amendments. Given the feedback during the public regulatory process, the Division of Fish and Wildlife has three additional revisions to suggest to Delaware's shellfish aquaculture regulation at this time and believes that the other proposed changes, as published in the Register, should be adopted as written.

Oysters and Water Quality
Comments: • *It is time to do something positive to make the water quality increase. Oyster farming will perform miracles if the regulations would be modified. Please consider the environmental impact in bringing more oysters into the bay.* • *We really need to get as many farmers and oysters in the watershed to clean up the water. The more oysters, the cleaner the water. Everyone would benefit.* • *Our inland bays are in poor health due to excess nutrients. These excess nutrients cause high growth rates of algae. The algae block the sun light and kills the sub-aqueous grasses. At night the algae decays, falls to the bottom and causes hypoxic (low oxygen) zones. Clams and Oysters (bivalves) remove the algae from the waters and are critical to the health of the bays.* • *Their oyster farming even at reduced levels will promote improved water and aquatic quality programs that will eventually benefit all Delawareans.*

Response

Shellfish aquaculture is considered a green industry because farming shellfish reduces pressure on wild stocks and because the bivalves take in their food from the environment. If bivalve shellfish are being considered as a water quality tool, it is critical to recognize the complex ways in which bivalves interact with different variables in their environment and necessary for scientists and organizations to communicate realistic ecological expectations. Claims that oysters filter an extraordinary number of gallons per day have been repeated for years with little basis in fact. Published research shows that there is variability in how oysters and other shellfish filter and feed in different specific environments, different seasons, with different stressors, and across different time scales. These differences impact both the positive and negative effects of shellfish aquaculture. The claims for bivalve filtration are typically from lab experiments where oysters are held in water set at their preferred temperature and salinity, the water has controlled flow, there are larger oysters being fed amply with their preferred food, and disadvantages for the animals are minimized. These claims for gallons/day filtered per oyster will be much lower outside of the lab in nature. As animals, oysters have preferences and stressors that impact their filtering and feeding behavior. Oysters are subject to seasonal variation; higher filtering and feeding rates are measured during the summer. But not too hot--oysters are stressed by too warm conditions. Oysters filter and feed best in water temperatures from the mid 60s to high 70s Fahrenheit. And not too chilly, reduced filtering and feeding occur in fall and spring, with very slow- to nearly-stopped metabolic function in a typical mid-Atlantic winter. Looking at historic data, for at least half the year, the water temperature in Rehoboth Bay, as measured by DNREC's Water Section at the Buoy 7 station[1], is not within the ideal range for oyster filtering and feeding. Oysters close and stop filtering and feeding completely if the water is too turbid, or if there are too many predators in the vicinity. Other variables that influence oyster filtering and feeding include time in and out of water, local hydrodynamics, salinity, food available and quantity, oyster size, oyster ploidy, oyster place in the water column, and other energetic demands. Oysters live in water where there's an incoming and outgoing tide; in their filtering

[1] Delaware Water Quality Portal (udel.edu)

and feeding, the oysters recirculate some of the same water as it comes in and then flows back out. Oysters are not magic erasers, they also have output in the form of feces and psuedofeces (together, "biodeposits") from water that they filter. The fate of biodeposits, whether they stay very local or are dispersed more widely, is in-part determined by local current flushing rates and should be considered in local nutrient models. Another important consideration of bivalve filter feeders as a water quality tool is that these bivalves filter and feed on phytoplankton only after nutrients have already entered and impacted the waterway. It would be far healthier for the Inland Bays to prevent excess nutrients from entering the water.

Several comments stated that having more oysters equals cleaner water and one comment said that clams and oysters would remove the algae from the water. It is important to not overestimate the potential impact of aquaculture oysters as a water filtration tool, especially if leases would have the low densities of oysters preferred by some commenters. A study[2] conducted on Virginia oyster farms hypothesized that the filtering properties of oysters would remove measurable amounts chlorophyll and decrease turbidity within the aquaculture leases compared to the surrounding environments. What the data analyses found instead was that, across multiple sites and seasons, chlorophyll was never significantly lower inside compared to outside of the leases. The impacts of the leases on local water quality were negligible compared to natural variation among sites and seasons[2]. The leases in that study were stocked with as many as an estimated 500,000 oysters, although smaller farms were included. The authors concluded that farms of this size and scope are likely to process only a very small portion of water volume passing through each lease during a tide cycle[2]. In their measurements, the oyster lease with 500,000 total oysters was estimated to filter 5.5% of the water passing through the cages. Not the water in the bay or the water in close proximity to the lease, but the estimated fraction of the volume of water passing through only the portion of the lease area with cages that could possibly be filtered by the oysters. The authors point out that their calculation is an overestimation of filtration rate for simplicity. Their calculation assumes all oysters to be adult, a constant velocity of water, an even distribution of water contact with oysters, a constant filtration rate by oysters. Their calculation uses the maximum summer filtration rate, and does not account for refiltration of the same water passing through the lease on both ebb and flow tides. The farm with 117,000 oysters was likewise estimated to filter 3.3% of the water passing through its cages on the lease, the farm with 136,000 oysters was estimated to filter 2.7% of the water flowing through its gear on the lease, and the farm with 2000 oysters was optimistically estimated to filter 0.1% of water flowing through its lease's gear.

In a report section titled "Unrealistic Expectations and Common Misconceptions," the National Research Council addresses what they refer to as Myth II: Oyster Restoration, Whether Native or Nonnative, Will Dramatically Improve Water Quality in the Chesapeake Bay. The authors point out that while much is made of the oyster's filtering capacity, "*it is a fault of logic to assume that all of the bay's current water quality problems are the consequence of the loss of the oyster population and therefore can be corrected by efforts to restore this population. Other ecosystem stressors have intensified since the late 19th century, including increased nutrient runoff, higher*

[2] Turner, J.S., M.L. Kellogg, G.M. Massey, C.T. Friedrichs. 2019. Minimal effects of oyster aquaculture on local water quality: examples from southern Chesapeake Bay. PLOS One, 14: 1-22

sediment loads, climate shifts, and more toxic chemical pollution." The authors state that intensive (high density) aquaculture may contribute some impact on a local growing area, most especially if the water body is shallow, small, and has low flow, but as far as oysters being able to bring dramatic improvement of water on a larger scale, they state, "*this myth, though it has served to make political bedfellows of diverse stakeholders who share the goal of increasing the oyster population in the bay, should be replaced by the more realistic assumption that declining water quality results from multiple stressors that cannot be reversed by simply stocking more oysters in the bay. Oysters are only one part of the solution to the complex problems that affect water quality in this region*[3]."

The small proportion of studies where there are measurable effects from shellfish on local water quality indicate that density of oysters is one of the major determinants. One such study of a small estuary in Florida showed that the physical footprint of oysters in the estuary didn't factor into the water filtration equation as much as the density and location of those oysters. In this study of a small location, the oysters covered only 4% of the bottom, but the density of oysters in reefs was measured at up to 1,855 oysters per square meter[4] (about equal to 7,505,330 oysters/ acre). According to a direct quote from the lead author talking about this study to Chesapeake Bay Magazine[5], "*To have really meaningful water quality improvements, you need to have really dense populations of oysters, and they need to be placed in the right spots*." Similarly, in a Danish mussel farm study that showed significant depletion of chlorophyll inside the farm, there was a high density of mussels on a 46 acre farm[6].

Local factors are important to oysters. As oysters are not native to the Inland Bays, studies on oysters in this particular environment are only recently being conducted and analyzed. But based on the work that has been done locally, there are even more indications for being conservative in the estimates of filtration and sequestration of nutrients by Inland Bays aquaculture oysters. A recent study was conducted comparing the filtering, feeding, and biodeposition rate of aquaculture oysters on a Rehoboth Bay oyster lease to a lease in Delaware Bay, NJ and a lease in Barnegat Bay, NJ. This study found that, of the three locations studied, Rehoboth Bay oysters were the least active of those studied[7]. In comparing gaping (opening the shell to actively filter) oysters at each farm, the proportion of opened Rehoboth Bay oysters was significantly less than that of oysters in Delaware Bay and in Barnegat Bay[7]. The study found that the median clearance rate (the volume of water cleared of particles per unit of time) of Barnegat Bay aquaculture oysters was 217% higher than the median clearance rate of Rehoboth

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[3] National Research Council. 2004. Nonnative Oysters in the Chesapeake Bay. Washington, DC: The National Academies Press. https://doi.org/10.17226/10796

[4] Gray, M.W., D. Pinton, A. Canestrelli, N. Dix, P. Marcum, D. Kimbro, and R. Grizzle. 2022. Beyond residence Time: Quantifying factors that drive the spatially explicit filtration services of an abundant native oyster population. Estuaries and Coasts, 45: 1343-1360

[5] Wheeler, T.B. FL Oyster Reef Study Gives Chesapeake Clues. 2022. Chesapeake Bay Magazine. FL Oyster Reef Study Gives Chesapeake Clues | Chesapeake Bay Magazine

[6] Nielsen, P., P.J. Cranford, M. Maar, and J.K. Petersen. 2016. Magnitude, spatial scale and optimization of ecosystem services from a nutrient extraction mussel farm in the eutrophic Skive Fjord, Denmark. Aquatic Environment Interactions, 8: 312-329

[7] Barr, J.M. 2022. Wild and farm eastern oyster (Crassostrea virginica) contributions to improved water quality in the mid-Atlantic: contemporary and future climate estimates. Thesis submitted to Rutgers, The State University of New Jersey.

Bay aquaculture oysters[8]. Further evidence of the limitations of bivalves alone to make a significant difference in Inland Bays' water quality has been seen in the past five years of aquaculture. In DNREC's publicly-available dataset from 2019-2022, there have been over five million oysters planted in the Inland Bays; these have been added in complement to a healthy and stable native hard clam population and natural ribbed mussel population. The Center for the Inland Bays (CIB) released the newest of their five year state of the bays report, measuring parameters during the same period, the data collection ending in 2021. In spite of the addition of over 5 million oysters to the bays, the CIB's water quality conclusion was "*overall, water quality in the Bays is poor to fair*[9]." Shellfish aquaculture, especially at the very low densities requested by several commenters, cannot be expected to result in visibly cleaner local water.

Reduce the Cost of Entry and Operation through Regulation
Comments: • *Please modify the aquaculture regulations to reduce cost of entry and operation of an oyster farm in the Rehobeth* [sic] *and Indian river bays* [sic]. • *We need DNREC to lower the cost of entry into Aquaculture in the Delaware inland bays.* • *Please modify the aquaculture regulations to reduce the cost of entry into this honorable profession.* • *The effects of regulatory burdens on aquaculture is a topic of upmost importance to the continued growth and expansion of domestic aquaculture. The National Aquaculture Association has a page (https://www.nationalaquaculture.org/aquaculture-regulatory-burden/) on their website dedicated to this topic….Here in DE where shellfish aquaculture is a new industry that is comprised of small, independent owner/operators, regulations have an outsized impact on these farmers' ability to be successful.*

Response

One of the submitted comments cites a page from the National Aquaculture Association about estimated costs of complying with regulations specifically in the U.S. salmonid industry, the U.S. baitfish and sportfish industry, the Florida ornamental aquaculture industry, and the Pacific coast's shellfish industry. The comment raises a good point about awareness of regulatory burden to industry. While DNREC is sensitive to the effects of regulatory burdens on aquaculture businesses, the fish aquaculture industries are quite dissimilar to Inland Bays shellfish aquaculture, and the Pacific coast raises entirely different species of shellfish than the East coast. Additionally, the cited page identifies some categories of costs that are not covered by the 3801 shellfish aquaculture regulation. Legal and labor standards are listed, but all businesses in Delaware and in the United States must comply with labor laws, this is not a cost imposed specifically on shellfish aquaculture and is not addressed in the 3801 shellfish

[8] Barr, J.M., D. Munroe, J.M. Rose, L. Calvo, K.M. Cheng, S. Bayer, and D. Kreeger. 2023. Seasonal feeding behavior of aquaculture Eastern Oysters (*Crassostrea virginica*) in the mid-Atlantic. Estuaries and Coasts. https://doi.org/10.1007/s12237-023-01293-9

[9] Walch, M., A. McGowan, L. Swanger, C. Chaney, and M. Goss. 2023. State of the Delaware Inland Bays, 2021. Delaware Center for the Inland Bays, March 2023, 104 pp.

aquaculture regulation. Food safety is also a category of regulatory cost on this page. Again, this category is not part of the 3801 shellfish aquaculture regulation, but these regulations are intended to keep the consumer of the product safe. Because shellfish are often consumed raw, the federal and state governments have stringent regulations on shellfish harvest and handling to prevent human illness and death. A 2022 FDA fact sheet warns that *V. vulnificus* infection may occur within 24 to 48 hours of ingestions of shellfish, and that high risk individuals have a 50% fatality rate[10]. The United States has more environmental and safety regulations on many different categories of business than are imposed by other countries and these are not specific to the Delaware 3801 shellfish aquaculture regulation.

Shellfish aquaculture is expensive, particularly in the first years of establishing a lease. However, Delaware's shellfish aquaculture regulation does not lead to start up or operational costs dissimilar to what shellfish growers in other states face, nor is Delaware unique in having a significant portion of small independent owner/operator lessees. One comment submitted states that planting 100,000 oysters on an acre costs $30,000 to $50,000, and DNREC agrees this is a realistic estimate of capital required to get in the industry. A Florida Sea Grant information sheet says "*You need at least $17,000 to $22,000 to get started (even if you have a boat and a truck). You are most likely going to lose money in the first year while you wait for your oysters to grow to market size*[11]." Texas Parks and Wildlife outlines, "*In addition to the costs associated with applying for/setting up the permitted area, there are ongoing costs of maintaining and working the permit to consider. Start up costs for oyster mariculture can run from $32,500 to $60,000 per acre depending on the type of gear used. There are many additional ongoing costs associated with oyster mariculture*[12]." The Alabama Seafood Marketing Commission has a message for prospective lessees, "*Just like any start-up business, oyster farming takes a significant investment in time, funding, and exposure to risk of loss*[13]" and estimates in the state are that "*the startup costs are between $50,000 to $100,000 per acre. Some fishermen say that if there were subsidies or loans available, starting an oyster farm might be more feasible*[14]." A North Carolina grower was interviewed and shared, "*In a smaller-scale investment, a farmer could spend between $30,000 and $70,000 in initial costs*[15]." And to the north, Maine oyster growers responded to a survey conducted by a graduate student and identified that the labor required, the difficulty in getting an investment, and the delayed income were barriers to entry for most growers. One Maine lessee was quoted in the survey "*We're learning like for investors it's just too long. It's too risky. So, you get all these part timers out there trying to make the switch from the security of a job they don't like to something they really love but just economically is not sustainable*." The master's student conducting the survey concluded

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[10] Vibrio vulnificus Health Education Kit Fact Sheet. 2022. www.fda.gov/food/health-educators/vibrio-vulnificus-health-education-kit-fact-sheet

[11] Ropicki, A. Apalachicola Bay Oyster Aquaculture Economics. Food and Resource Economics-University of Florida Apalachicola-Bay-Oyster-Aquaculture-Economics.pdf (ufl.edu)

[12] Oyster Mariculture in Texas-FAQs webpage by Texas Parks and Wildlife. Texas Cultivated Oyster Mariculture-Main

[13] Alabama Seafood Marketing Commission. 2023. Prospective Farmers | Alabama Oyster Aquaculture (alaquaculture.com)

[14] Wilson, A 2019. With Gulf Coast ecosystems under threat, the seafood industry's next generation adapts. In Southerly. With Gulf Coast ecosystems under threat, the seafood industry's next generation adapts – Southerly (southerlymag.org)

[15] O'Neal, C. 2017. Oyster Entrepreneurs. In WilmingtonBiz. Oyster Entrepreneurs | WilmingtonBiz

"*Without outside investment or immediate revenue, many new or potential oyster farmers have a difficult time foreseeing economic sustainability*[16]."

Delaware shellfish lessees are not alone in facing the need for a substantial input of capital, especially in starting or growing a lease. And Delaware is not alone in seeing slowed growth of the shellfish aquaculture industry attributed to the cost of starting a lease. But, in economic analyses of shellfish aquaculture conducted in other states, the proposed solution has not been to reduce the amount of oysters grown to reduce costs on an oyster lease. In fact, economic analyses of aquaculture show the opposite—that growers must plant more shellfish to be economically viable. There is research[17] that suggests that the source of capital obtained by a lessee may improve the financial profitability of oyster aquaculture. For example, Maryland has the Maryland Agricultural & Resource Based Industry Development Corporation (MARBIDCO) that offers below-market interest rates, a period of interest-only repayment, and potential for some principal forgiveness. For loans offered by MARBIDCO, the original funds were part of federal disaster-relief funding granted to Maryland blue crab fishermen. In a dissertation analyzing models of oyster farms of various production levels that were self-funded vs those started with MARBIDCO loans vs those started with conventional loans, it was noted, "*In all simulations at all production scales, firms were more financially successful when MARBIDCO financing was used to fund and operate the oyster aquaculture operation rather than when personal funds or conventional financing was used due to the substantially lower cost of lending.*" The conclusion also stated of water column oyster aquaculture "*There was a clear economy of size before break-even profits were realized. Yet, increasing the production is a 'doubled-edged sword' because as production scale increases so does the amount of capital needed. Many potential entrants to this industry may not have the needed capital to start their operation and have no other choice than to utilize some form of debt financing.*[18]"

North Carolina was having difficulty growing its shellfish aquaculture program, so a Strategic Plan for the state's shellfish aquaculture was written. The plan stated, "*North Carolina has not yet made the leaps evident in some other states relative to shellfish mariculture growth, resulting in significant opportunity costs accruing….As such, North Carolina sits at a crossroad relative to operating under the status quo in supporting this nascent industry, or making bold decisions and, as necessary, adopting innovative strategies to realize the potential of shellfish mariculture to support traditional and entrepreneurial fishermen, coastal communities, tourism, and the estuarine environment unique to this state. We also recognize that North Carolina requires a model for growth that suits the unique attributes of our coastal waters and communities, and that we seek responsible growth and adaptive management to respect both the investments already made by current shellfish growers, as well as the complex issues associated with public trust waters. Most notably, the recommendations comprising this report advocate for a model of growth in which North Carolina shellfish growers are supported to strive for high unit-area production to meet the State's farm-gate sale targets. This stands in stark contrast to states*

[16] Feldman, S. 2021. Adding value through sustainability: Incentivizing an ecosystem approach to oyster aquaculture in Maine. Thesis submitted to University of New England

[17] Parker, M., D. Lipton, and R.M. Harrell. 2020. Impact financing and aquaculture: Maryland oyster aquaculture profitability. World Aquaculture Society. 51,4: 874-895

[18] Parker, M. 2019. Effects of different capital sources on Maryland oyster aquaculture operations. Dissertation submitted to University of Maryland, College Park

characterized by low unit-area productivity across leases, necessitating large footprints across public trust bottoms to support the seafood industry in those states[19]" Several recommendations were made in the plan, including one to establish a low-interest loan program for shellfish aquaculture and one to increase the minimum planting or harvest requirement for leases and to strictly monitor and enforce a 'use it or lose it' policy for leases. The result of this Plan was that the next year, North Carolina increased its production requirement for shellfish leases and commissioned a low interest loan program study for shellfish aquaculture. The study found "*Lack of financing opportunities for the shellfish aquaculture industry has historically represented an important barrier for business start-up and expansions. Approximately 40 percent of surveyed shellfish lease holders in 2011 in North Carolina identified lack of capital as the major factor limiting growth of industry.…It is estimated that establishing a water column lease requires between $20,000 and $60,000 per acre…..commercial lenders have been hesitant to lend money to growers given the inherent risk associated with the trade. The few existing programs require high collateral and the participation of commercial creditors that are often unwilling to take the actuarial risk for any unsecured portion of a loan.…Terrestrial based agriculture is afforded with financial incentives encouraging the entry into this industry by new (and often inexperienced) farmers, but these same incentive programs are closed to shellfish aquaculture*[20]. " The next year the North Carolina General Assembly approved the proposal to set aside $1 million to establish a low interest loan program. Loans are offered to new and existing growers in amounts up to $50,000.

The State of Louisiana initiated a grant program to subsidize development of Alternative Oyster Culture—their term for cultchless oyster culture. In 2021, there were nine such farms on 51.5 acres, but all lessees dropped out following Hurricane Ida. To re-start the industry, Louisiana offered the grant program from funds the state provided in anticipation of salinity changes expected to occur from Mississippi River diversions[21]. Over a three year period, $1.8 million in grants will be available to intensive aquaculture lessees to buy equipment and supplies. These grants are available to both new and existing businesses[22].

Finding investment and capital support for Delaware Inland Bays shellfish growers is a better strategy for enticing new shellfish lessees and supporting current lessees in growing their businesses than reducing the amount of shellfish grown.

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[19] North Carolina Strategic Plan for Shellfish Mariculture: A Vision to 2030. 2018. North Carolina Strategic Plan for Shellfish Mariculture: A Vision to 2030 (unc.edu)

[20] North Carolina Coastal Federation. 2020. Low Interest Loan Program for Shellfish Aquaculture Study. Low interest loan Legislative Study - 3-18-20-v2 (nccoast.org)

[21] Petrolia, D.R. 2023. Economic Analysis of Alternative Oyster Culture (AOC) in Louisiana. AOC Economics Study Finds Scale and Marketing Challenges - Louisiana Sea Grant (laseagrant.org)

[22] Louisiana Sea Grant. Alternative Oyster Culture Grant Program — LA Seafood Future

Planting Minimum

Comments:

- *The amount of equipment and manpower to keep up with 100,000 oysters when the waters are warm and the oysters are in their peak growing phase is extremely difficult to keep up with. We should be allowed to manage our own business models to our specific needs.*
- *Reduce the minimum annual planting requirement from 100,000 to 10,000 per year or totally eliminate the planting requirement at all….Oysters harvest cycle is between 6 months to 2 years, some oysters just grow faster then [sic] others. Only 50% of the first year's planting is harvested when it is time to plant again. Durning [sic] the growth time of the year, oyster cages should be culled to separate the fast growers from the slow growers. During the summer months the farmer must process every bag on their farm once a month. The seed that we plant is smaller than a kernal of pop corn and market size 3". This requires lots of poles, lines, anchors and cages above the original planting point. Current perception with the active farmers is that 100,000 oyster planting requires $30,000 to $50,000 of equipment. As the number of cages on your farm increases the amount of labor increases. Creating another barrier to entry. If the planting requirement were 10,000 that is $3,000 to $5,000 in gear plus boats, trailers, corner markers and other gear. This is still a very large commitment for a recent graduate or part time farmer and will clearly prevent some folks from entering this industry. I request reduction or elimination of the minimum annual planting requirement from 100,000 to at least 10,000 per year or totally eliminate a planting requirement and allow the farm sizes to grow organically. We just need more farmers. 8 active acres * 100,000=800,000 Oysters. This requirement is a huge barrier to entry. 298 active acres*10,000=2,980,000 oysters. Lower planting per acres can still get us to a New Aquaculture industry if we get more farmers started.*
- *It is now required to plant 100,000 oysters every year to maintain leases. This and other requirements drive the cost up and keep farmers and oysters out of our watershed.*
- *While we applaud DNREC for including an active use clause in the Inland Bays shellfish aquaculture regulations, we request that the planting requirements be changed from 100,000 oysters per acre per year, to 50,000 oysters per acre per year. Reducing the planting requirement will cut the initial capital expenses of cages in half and help new farmers grow into an operation, while hopefully enticing more farmers to get involved, and continuing to avoid individuals interested in leasing acres without engaging in aquaculture activities. Further, reducing the minimum planting requirements will allow for present farmers to modify growing practices between years and maintain business solvency.*
- *I had hoped to settle full time into my Bethany Beach home and secure a lease to raise oysters while educating students about this valuable commodity. The requirement of planting 100,000 oysters to maintain a lease coupled with the other expenses that one would incur to enter this industry have placed this dream out of reach.*
- *In addition to purchasing enough gear to grow 100,000 oysters per acre, these new growers are learning, through trial and error, how to properly manage their farms, and also trying to develop markets for their product. Lowering the planting requirement to 50,000 oysters per acre per year will still ensure active commercial use*

of leased acres, but will also not over tax new growers while they are building their businesses. A reduced planting requirement will decrease business start-up costs significantly and encourage more individuals to get involved. in this industry. Further, this will allow individual growers to expand their production at a pace that is manageable for them given available labor, markets, and capital, helping them be more financially solvent as they grow.

- *Please consider modifying the aquaculture regulations to reduce the initial minimum number of oysters (SPATS) required for the oyster farmers. This will hep reduce their cost of entry and ongoing operation to support oyster farming in the Rehobeth [sic] and Indian River bays* [sic].
- *I strongly support a use-it-or-[lose]-it clause because other states that don't have this, like, or are not enforcing it, like Virginia and Connecticut, have thousands of acres that are not being productively leased, and that is not the objective of your lease program. So I support a lease minimum harvest or at least other means of showing that the lease is actively being used….strongly support lease requirements for some use of every lease because people will lease areas defensively to prevent others if you don't have that.*
- *August of 2013, the legislators passed…HB 160 and gave DNREC responsibility to give farms identified and create regulation to utilize this subaqueous land to remove nutrients and create an oyster industry. DNREC translates industry as many large farmers. To ensure that we get—have large farmers, they have created the planting minimum. I think that has not worked. We have continuously asked to decrease or eliminate planting requirements and find an organic path to oyster industry through small or part-time farmers….As demonstrated, a very small fraction of our population can quit their jobs, invest $50,000, and work without pay for one or more years…..redo these regulations to lower the cost of business and welcome all farmers no matter how small or long it takes to ramp up production.*

Response

When legislation was passed in Delaware allowing shellfish aquaculture in the Inland Bays, the Department of Natural Resources and Environmental Control was directed to write regulation to support a shellfish aquaculture industry that was compatible with existing uses of the Inland Bays. Active use lease requirements (minimum planting and minimum harvest) for Inland Bays shellfish aquaculture are protection for that industry. Delaware's Inland Bays are densely populated and heavily used—the bays support commercial and recreational fishing and shellfishing, commercial boating enterprises, recreational boating, bird watching, kayaking, paddleboarding, sightseeing, beach and nature tourism and other uses. While the Inland Bays do not have a natural oyster population, Delaware is one of the few East Coast states with a natural healthy hard clam population, and this hard clam population is concentrated in the Inland Bays. Balancing all of the uses and users and natural biota in the bays is important.

Other states and even shellfish growers have documented that there is a tendency to lease more area than is actually used for shellfish growing. When leasing first started in Delaware, the majority of leases were for 5 acres, the maximum amount allowed. Within the first years, many lessees reduced the acreage on their lease without a reduction of oysters produced on the lease.

A lessee remarked to DNREC that a lot more oysters can be grown on a single acre than they originally thought.

As for leasing area that is not used to grow shellfish—there are a few possible explanations for this. A lessee may lease acreage to try to prevent shellfish aquaculture--an exclusionary lease. The cost of the subaqueous land lease is low and not a deterrent to those who would lease to prevent actual shellfish aquaculture around their homes and viewsheds. Protection of future interests--a speculative lease—is another potential. These lessees presumably want to protect their ability to start or expand their shellfish aquaculture business in the future, or they think that a child may want to get into shellfish aquaculture in the future, and they want to 'claim' the option now in case all of the land is leased by the time that they/their child may be ready for that venture. Some shellfish growers may want to expand their lease acreage so that they reserve more space around themselves and their operations. This low production in expanded shellfish aquaculture acreage has been demonstrated to be a problem in other states and to be detrimental for the shellfish aquaculture industry. Virginia and New Jersey, for example, have experienced low oyster productivity for the amount of subaqueous land leased. A decade-long study of Virginia aquaculture leases found that, with the state's low requirement for 'active use,' only 33% of leases were ever used (even a single year out of the entire decade) for producing oysters[23]. The study also found that the non-used leases were more likely to be found in populated, high-income regions. The authors pointed out that there are increased pressures and conflicting uses in coastal areas and one conclusion of the study was that Virginia would benefit from annual quantitative production or investment requirements for shellfish leases. Virginia's lack of minimum planting requirements and enforcement have allowed an average of only 309 oysters harvested per leased acre[23].

One comment said that lessees should be allowed to manage their own business models to their specific needs. But these shellfish leases are taking place on state-owned public land. Shellfish aquaculture gear is exclusionary to most other users in the state's water, especially in the shallow Inland Bays. The gear can fill up most of the water column, and there are often ropes, anchors, support poles, baskets, bags, cages and lines in an acre that limit fishing, boating, or other uses. The number of conflicts between shellfish aquaculture growers and other water users has increased in other states. In recognition of this, the East Coast Shellfish Growers Association has made recommendations for efficiency in shellfish growing. "*As this industry matures, the efficient use of space will play an increasingly important role. An efficient footprint is good for farmers, good for the neighbors and good for the industry as a whole*[24]." Other states in our immediate area are experiencing the friction of public ground leased for shellfish growing that is not being used or being used very minimally. New Jersey has a significant number of inactive shellfish leases and the state recognized that this needed to be addressed in their Aquaculture Development Plan Update 2021-2026. The Plan states, "*Responsible use of public waters must*

[23] Beckensteiner, J., D.M. Kaplan, and A.M. Scheld. 2020. Barriers to Eastern Oyster aquaculture expansion in Virginia. Frontiers in Marine Science, 7

[24] Terry, C., Oyster Tracker Team, Castine, Rhealt. 2018. "Space, Neighbors, and Shellfish" article in East Coast Shellfish Growers Association newsletter. ECSGA_NL_v3-18.pdf

consider the needs of the industry as well as those of other coastal users and natural resources[25]." Dr. Joel Fodrie, associate professor at the University of North Carolina Institute of Marine Sciences testified before his state's General Assembly, "*We've been asked to in some ways model our growth after Virginia. However, one thing we found is that they produce this shellfish using a huge amount of leased habitat, and this infringes on public trust resources. They produce at an incredibly low rate per unit-acre*[26]." In the six years that there's been leasing in Delaware's Inland Bays, there have been multiple lessees who each leased more than one acre and maintained all of those acres for the life of the lease, but did not plant any oysters in year one, two, or even three years of the lease. Delaware has seen it realized that some lessees have a business model that never gets any oysters into the water. This problem was highlighted in the North Carolina Strategic Shellfish Plan, "*Occurring on public trust bottom, unproductive leases represent an impediment to other public trust uses without delivering the economic and ecological benefits used to justify their conveyance for private uses*[27]." Minimum planting and harvest requirements help ensure that space leased and set aside for shellfish aquaculture is being used for shellfish aquaculture and that the industry is carried out in an efficient way.

A comment supposes that lowering the planting requirement will ensure active commercial use of leased acres, but not overtax new growers while building their businesses. Another comment asked that the regulation be modified to reduce the initial minimum number of oysters. This and the other comments received on lowering planting minimums all fail to recognize that Delaware currently has in the shellfish aquaculture regulation, that lessees are given the first two years of the lease without the minimum planting requirement applying. Lessees may plant 10,000 shellfish or 50,000 shellfish during those first two years while they learn to manage business, build equipment, and start having returns on investment from shellfish sales. The planting and harvest requirements currently do not take effect until the third and fourth calendar years, respectively, of the lease. It is from the third year forward that the minimum planting requirement requires the lessees to start to operate at the small-scale lease level of 100,000 shellfish planted per year. While the Division of Fish and Wildlife believes that the current regulation giving a lessee until the third year of the lease to meet the planting minimum is an appropriate timeline to scale a business, the Division does recognize that there were multiple comments stating that lessees need more time to learn, develop markets, and build their aquaculture leases. Therefore, the Division of Fish and Wildlife proposes changing 7 DE Admin. C. 3801 §16.3.1 to read: *By December 31st of the calendar year in which the lease reaches 60 months from the date of lease issuance or transfer, leaseholders must provide evidence to the Department's satisfaction that they annually plant at least 100,000 shellfish per acre leased*. The proposed change to 60 months means that lessees will have until the fifth year of the lease before the minimum planting requirement is in effect. To the best of our knowledge, this five year timeline would equal that of the State of Georgia as the longest lease start-to-full minimum planting allowed in East Coast state aquaculture programs. However, Georgia requires

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[25] New Jersey Aquaculture Development Plan Update 2021-2026: Molluscan Bivalve Shellfish. New Jersey Department of Agriculture AquacultureDevoPlanUpateFinalOnline.pdf (nj.gov)

[26] Ross, K. 2019. Session Ahead: Oysters, Storm Damage, PFAS. Session Ahead: Oysters, Storm Damage, PFAS | Coastal Review

[27] North Carolina Strategic Plan for Shellfish Mariculture: A Vision to 2030. 2018. North Carolina Strategic Plan for Shellfish Mariculture: A Vision to 2030 (unc.edu)

that lessees meet a threshold level building to the full minimum planting in each of the first five years[28] (20% of the minimum planting in year 1, 40% in year 2, 60% in year 3, etc.), while Delaware's regulation does not stipulate any specific planting level prior to the fifth year. Five years is one third of a full Delaware lease term specified in Delaware Code and should provide lessees with time and experience to be able to meet the minimum planting requirement. In order to remain consistent with the timeline currently set between the planting and harvest minimums coming into effect on a lease, the Division of Fish and Wildlife also proposes a modification to 7 DE Admin. C. 3801 §16.3.2 to state that the harvest minimum will begin in the calendar year that the lease reaches 72 months. And, given these prospective changes to §16.3.1 and §16.3.2, the Division of Fish and Wildlife proposes modification to clarify criteria for planting and harvest minimum exemption in 7 DE Admin. C. 3801 §16.5.

Allowing recreational or hobby producers in Delaware's Inland Bays would not be good for the industry as a whole. Aquaculture economist Carole Engle advises, "*A common pitfall for aquaculture entrepreneurs is the confusion that stems from believing that an aquaponics or aquaculture project, that is in effect a hobby, can function as a real business that supports the household's income. A business is not a hobby, and to be successful, must be designed, managed, and operated on sound business and marketing principles*[29]." Recreational or hobbyist aquaculture costs substantially more per oyster produced, so growers would already be behind in what they have to invest proportional to what they might harvest, as they'd pay a premium for seed or supplies, or be at the bottom of the hatchery/supply house seed or supply list because the business focuses on larger sales or the supply warehouse doesn't find it worth their while to package small orders. Several of the larger oyster seed retailers in the area have a minimum seed order that is above recreational limits. Ward Oyster Company, one of the larger suppliers to the Inland Bays, has a minimum order of $1,000 for seed. This year, quarter inch seed, a size many Inland Bays lessees order, was $22.50/thousand. An order of 45,000 is required to make the minimum order. Ferry Cove Shellfish has on their order form that a minimum seed order of 50,000 is required unless special prior arrangement can be made. Mook Sea Farm lists on their seed order form that the minimum order is 200,000 oysters. Downeast Mariculture has a note on their price list that seed orders less than 10,000 are $0.10 per oyster. This is a significant increase in price—ordering over 10,000 of the quarter inch seed makes them $0.0224 per oyster.

If recreational or hobby aquaculture production were allowed in Delaware's Inland Bays, the footprint of shellfish aquaculture and exclusion of other uses/users would be extended without a significant amount of oysters grown, and there would be a larger possibility for the leases to be used as exclusionary or speculative leases. The added economic burden of operating at a hobby-level scale and accepting that there will likely be financial loss in growing oysters makes it difficult to put aside money toward growing into a financially sound and productive shellfish aquaculture business. One comment says "*8 active acres * 100,000=800,000 Oysters. This requirement is a huge barrier to entry*." It is unclear where these numbers are coming from, the

[28] Georgia Department of Natural Resources. Coastal Resources Division. Shellfish Policy Manual. PolicyManual_v1.1_FINAL.pdf (coastalgadnr.org)

[29] Engle, C. 2020. Aquaculture Businesses: A Practical Guide to Economics and Marketing. 5m Books Ltd.

Inland Bays have more than 8 lessees and more than 8 acres leased. In 2022, there were 1,600,000 oysters commercially planted in the Inland Bays. The commenter goes on to say "*298 active acres * 10,000=2,980,000 oysters.*" Again, it is unclear where these numbers come from. There are 300 Shellfish Aquaculture Development Area (SADA) acres in Rehoboth and Indian River Bays. As marked on the public-facing map[30] that DNREC maintains and, in accordance with the shellfish aquaculture regulation, 7 of those acres are not currently eligible for lease because of having a high natural hard clam density. If there were 298, as the commenter suggests, or even 293 (300-7, the maximum number of SADA acres in Rehoboth and Indian River Bays that could be leased) separate lessees each planting only 10,000 oysters, or less if no minimum planting were entertained, this would be extremely difficult for the industry. Expanding the footprint of shellfish aquaculture while actually producing few oysters would lead to greater conflict with other uses and users of the bay. As is pointed out in the comment, cultchless oysters require care, with sorting, keeping gear clean, and tumbling—according to the comment, at least monthly. Shellfish aquaculture is a green industry, but it is not without an environmental footprint. If there were actually 293 acres leased in Rehoboth and Indian River Bays, that would mean a minimum of 58 lessees because of maximum lease limits set in Code, and there could be more lessees if not everyone leased the maximum. This would mean that in this scenario, there would be at least 58 separate trips made with truck and trailer each visit to a lease. There would be at least 58 separate trips made by boat to these leases. The trucks and boats have engines. There would probably be gas-powered power washing of equipment on many different leases, and some gas generators powering tumblers. Gasoline engines contribute to air pollution with carbon monoxide, nitrogen oxides, particulate matter, and unburned hydrocarbons. Atmospheric deposition is a source of pollution for Delaware's Inland Bays. The commentor suggests that lowering the planting minimum to 10,000 might result in 2,930,000 oysters planted per year—this would mean at least 6 times the current number of commercial lessees, 13 times the current amount of public subaqueous land leased, for not even twice the number of oysters planted in 2022. An increase of documented polluting activities by a factor of at least 6, spread out over 13 times the amount of public land, in order to result in less than twice the number of oysters currently planted is a poor environmental trade off.

Other comments suggested 50,000 oysters per acre as a minimum planting requirement stating that this level would entice new lessees and allow existing growers to modify their business practices to stay solvent. Planting 100,000 oysters is considered small scale by most aquaculture business planners and to further reduce the number planted to 50,000 would result in fewer oysters harvested and sold—a very, very small scale indeed. When Virginia Sea Grant developed their cultchless budget based on information provided by oyster growers, they defined small-scale production as selling 50,000 to 250,000 market oysters per year[31]. Planting 50,000 oysters is going to result in harvest well below that mark, even with high survival. Assuming only 25% mortality on 50,000 oysters planted, a lessee might have 37,500 survive. Assume 90% marketability—as some oysters will not be fit for sale, and the lessee has 33,750 oysters to harvest and sell. Using the same assumptions of mortality and marketability, a lessee would

[30] Shellfish Aquaculture (arcgis.com)

[31] Hudson, K., D. Kauffman, T.J. Murray, and A. Soloman. Cultchless (single-seed) oyster crop budgets for Virginia: 2013 user manual. Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2013

need to plant 75,000 oysters and need everything to go right in terms of oyster survival to harvest 50,000 oysters.

At a hobby or very low-level scale, shellfish aquaculture is costly. Shellfish aquaculture is a time- and resource-intensive endeavor, even at a very small scale. The cages still have to be visited and cleaned just as often as larger growers. It is difficult to make money as a very small producer in the oyster business. There are economies of scale in oyster farming from buying seed in bulk, buying gear, time spent on the lease, all the way through to marketing/packing/delivering oysters. In a Maryland study modeling the effect of source of financing on Maryland oyster aquaculture profitability, it was noted that as production increased for self-financed water column oyster leases, the breakeven price per oyster decreased[32]. The figure below is from the study.

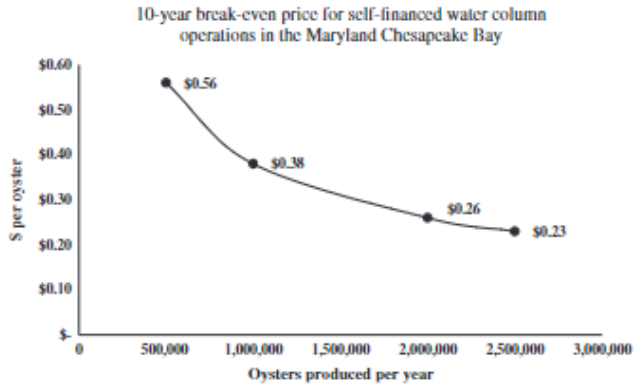

FIGURE 3 Breakeven price per oyster harvested for self-financed water-column culture operations with original model assumptions for labor and survival in Chesapeake Bay, Maryland. [Correction added on 18 June, after first online publication: The scale values in Figure 3 have been corrected.]

Another study documented the investment capital efficiency by production scale for oyster farms in Maine. It recorded investment cost per oyster harvested had was substantially greater on smaller farms. The figure shows a sharp decline in investment cost per oyster when the production scale passes the 100,000 oyster[33] threshold. The figure below is from that study.

[32] Parker, M., D. Lipton, R.M. Harrell. 2020. Impact financing and aquaculture: Maryland oyster aquaculture profitability. Journal of the World Aquaculture Society, 51: 874-895

[33] Engle, C.R., J. van Senten, M.H. Schwarz, C. Brayden, and S. Belle. 2023. Developing production and financial benchmarks for marine aquaculture farm data. Aquaculture Economics & Management, 27:3, 352-381

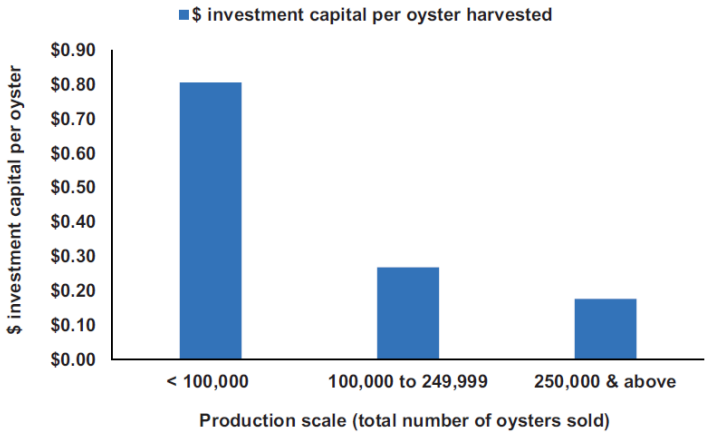

Figure 7. Investment capital efficiency ($ of investment capital per oyster harvested) by production scale, oyster farms.

Delaware Inland Bays lessees will see benefit from economies of scale. If the required oyster seed amount is reduced by half, only a few of the expenses are reduced by half as well. The initial seed cost and the number of cages would be reduced, but because of the scale of the order, the price may not be half. There are expenses that would be unaltered. Fixed costs like boat, trailer, truck, and insurance for same remain static whether the number of oysters grown is large or small. The time and gas involved in trailering and launching a boat and driving to the lease is the same whether the person is tending 10,000 oysters or 1,000,000 oysters—but the per oyster breakdown is significant. There are other expenses that might be reduced, but not nearly in half. In one economic model of oyster farming, a threefold output of market-ready oysters required only a 6.6% increase in total labor costs[34]. Labor is a significant cost to oyster lessees—whether the lessees count hours they put in themselves or hire outside labor. A recent publication based on a survey of Maryland oyster growers found that for container culture oyster farms, both large and small (and the cutoff in this study between large and small was under or over 600,000 oysters produced) the greatest cost was labor. Small farms averaged 37% labor and large farms 33% labor[35]. But if part of the cost of labor is getting to the lease and returning from the lease, handling shellfish, sorting shellfish, etc., the cost of labor is not halved when the planting is halved. When the seed planted is reduced by half, gross income potential will be reduced by at least half.

In the Virginia cultchless oyster budget [36](produced the figure below) that was based on years of grower data gathered by the Virginia Sea Grant Marine Extension Program, labor was the costliest item.

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[34] Chen, J.Q., M.C. Haws, Q.S.W. Fong, and P. Leung. 2017. Economic feasibility of producing oysters using a small-scale Hawaiian fishpond model. Aquaculture Reports, 5: 41-51

[35] Engle, C.R., J. van Senten, M. Parker, D. Webster, and C. Clark. 2021. Economic tradeoffs and risk between traditional bottom and container culture of oysters on Maryland farms. Aquaculture Economics & Management. 25: 472-503

[36] Hudson, K., D. Kauffman, T.J. Murray, and A. Soloman. 2013. Cultchless (single-seed) oyster crop budgets for Virginia: 2013 user manual. Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2013

Table 1. Estimated labor hours required to grow varying quantities of oyster.*

No. oysters planted	No. F-T hours	No. P-T hours	Total hours
1 to 100,000	0	960	960
100,000 to 200,000	2,080	0	2,080
200,001 to 300,000	2,080	960	3,040
300,001 to 400,000	2,080	1,920	4,000
400,001 to 700,000	4,160	960	5,120
700,001 to 800,000	4,160	2,000	6,160
800,001 to 1,000,000	6,240	960	7,200
1,000,001 to 1,500,000	6,240	3,840	10,080
1,500,001 to 2,000,000	6,240	5,760	12,000

*From 2011 Virginia Shellfish Grower Situation and Outlook Survey.

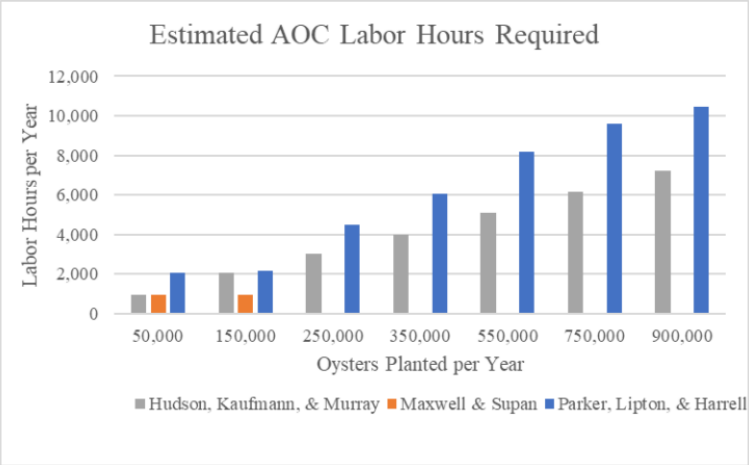
In that estimate, the labor block for 1-100,000 oysters planted remained the same even though the steps in production are varied sizes in the table; until 800,000, the steps are in 100,000 oyster increments, at 800,001 the step increases to a 200K step, and at over 1,000,000 oysters the step increases to 500K. An economic study[37] conducted via survey in Maine comparing start up oyster farms on bottom and suspended culture vs. established oyster farms on bottom and suspended culture found that labor efficiency (measured as the number of oysters harvested per hour of labor) was the greatest for established suspended culture oyster farms. Another conclusion was that, both on bottom and suspended culture, labor efficiency increased with scale of production.

In fact, pulling together labor hour estimates for oyster farms of different production levels from multiple studies, a report commissioned by Louisiana Sea Grant[38] showed that two of three aquaculture economic studies documented nearly the same level of labor required for producing 50,000 oysters as was estimated for producing 150,000 oysters. Please see below for a figure from that report.

[37] Engle, C.R., J. van Senten, M.H. Schwarz, C. Brayden, and S. Belle. 2023. Developing production and financial benchmarks for marine aquaculture from farm data. Aquaculture Economics & Management, 27:3, 352-381

[38] Louisiana Sea Grant. 2023. AOC Economics Study Finds Scale and Marketing Challenges. AOC Economics Study Finds Scale and Marketing Challenges - Louisiana Sea Grant (laseagrant.org)

Figure 9. Comparison of Estimated Labor Hours Required by Production Scale, as Reported in Other Sources.



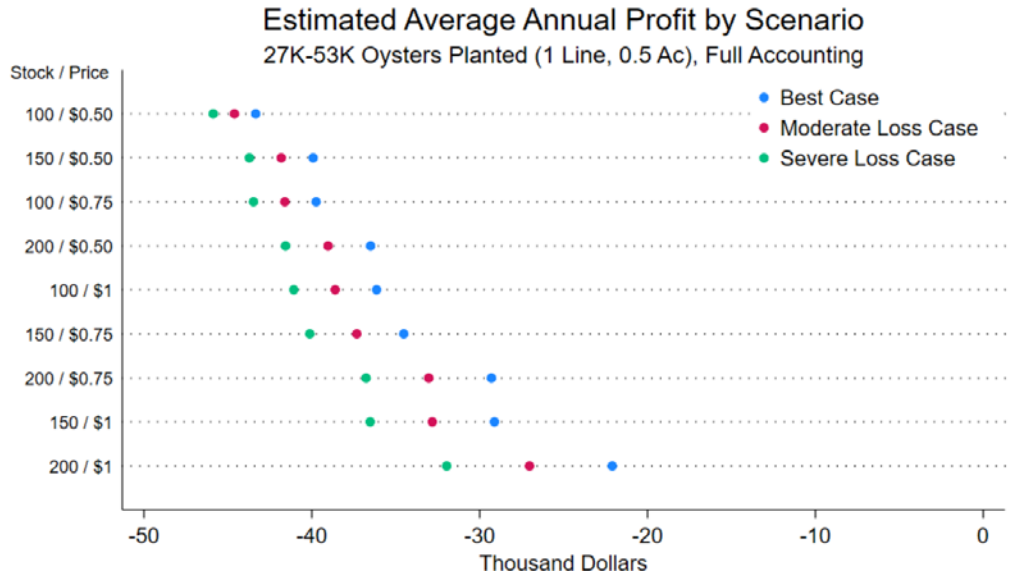
Source: Hudson, Kaufmann, and Murray (2013), Maxwell and Supan (2010), and Parker, Lipton, and Harrell (2020).

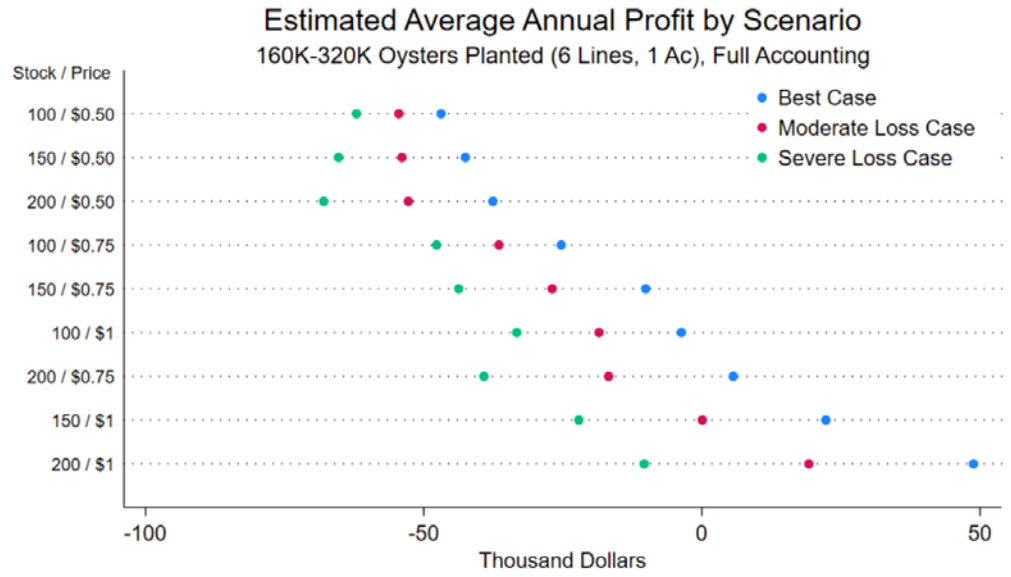
In January 2023, Louisiana Sea Grant commissioned an economic analysis of the cultchless oyster. The report was published in August 2023. The author, a professor of agricultural economics at Mississippi State University and a Louisiana Sea Grant chair, concluded "*Total cost, including loan payments, labor, fuel and oyster seed, is estimated to range from $50,000 a year to operate a small, half-acre farm* [40,000 oysters/year in this study] *to $250,000 a year to operate a large, four-acre farm* [960,000 oysters/year in this study]." The report concluded that a small farm would lose the grower money. "*Under full accounting, estimated profit for the lowest two production levels was negative under 53 of 54 scenarios…..Consistent with the findings of previous analyses in the literature, I find that small-scale operations are not expected to be profitable. In my analysis, I estimate that it is generally necessary to operate at or above levels of 720,000 oysters planted on three acres to realize positive average annual profit. The other analyses in the literature estimate the threshold to be in the same range or higher*[39]." In this analysis, farms raising 40,000 oysters would need to sell all of those oysters for more than $2 each to break even. The break even point for 480,000 oysters dropped to $0.71 apiece, and the 960,000 annual planting had a break even a little over $0.50 each. The economist, after analyzing data from Virginia, Maryland, Louisiana, Alabama, Florida, and North Carolina concluded, "*Based on what I was seeing in other states, it appeared that farms need to go big to be profitable over the long-haul. My findings confirm that*[40]." In the figures below, from that Louisiana analysis, different loss scenarios were modeled. Aquaculture relies on environmental conditions that are beyond the control of the grower. Based on years of experience from multiple states, there is a high likelihood that some type of adverse environmental event (storm/hurricane, unexplained mortality, disease, predation, etc.) will occur in at least one year of operation out of five. In this modeling, the adverse event was applied in the form of 75% loss in one year out of five for "Moderate Loss Case." In the "Best Case," no adverse mortality events

[39] Petrolia, D.R. 2023. Economic analysis of alternative oyster culture (AOC) in Louisiana. Louisiana Sea Grant. Economic Analysis of Alternative Oyster Culture (AOC) in Louisiana (laseagrant.org)

[40] Louisiana Sea Grant. 2023. AOC Economics Study Finds Scale and Marketing Challenges. AOC Economics Study Finds Scale and Marketing Challenges - Louisiana Sea Grant (laseagrant.org)

were modeled. And the "Severe Loss Case" models 100% loss of one year's crop and lingering effects (partial gear loss/damage, seed scarcity, water quality issues, etc.) resulting in a loss of 50% of the following year's harvest. The first figure, for 27,000 to 53,000 oysters planted, there is net loss to the grower, even in the best case scenario. The second figure, for 160,000 to 320,000 oyster planted, shows that, at prices between $0.75 and $1.00 each, there are scenarios where the grower might realize some profit.





In a Florida study, which modeled risk and revenue at theoretical oyster farms at multiple sites, all models created new farms with 10,000 oyster seed planted in the first year. There were baseline statistics input to the model from interviews with oyster growers and the University of Florida experimental lease for oyster mortality, labor, and capital costs. For all iterations of the model, in all sites, there was a 100% probability of negative net returns at the end of year 1.

When those same farms were projected to increase each year, 50,000 oysters planted in year 2, 150,000 in year 3, culminating with 250,000 oysters planted in year 5, there was a greater than 98% chance that farms were profitable in year 5[41]. These economics do not just exist in economic models, oyster growers themselves recognize them—Chris Matteo, president of the North Carolina Shellfish Growers Association was quoted, "*Obviously there are upfront costs, but once you have a barge or docking, the average oyster farmer is going to spend $25,000 to $50,000 per acre to set up, and these costs go down when you scale up*[42]." In a specific warning for small scale oyster growers, the Agricultural Marketing Resource Center makes the only underlined statement on their page when they caution "*a smaller operation will have higher per-oyster costs and will require a number of small-volume, local markets that are willing and able to pay higher prices."* They further state: *"When a small oyster operation loses a customer, alternatives may be limited or nonexistent. Your input suppliers (seed and equipment) must be reliable and trustworthy, even when larger customers are competing with you*[43]."

Even oyster purchasers can see the economic pinch that small scale oyster growing puts on lessees. In a survey of buyers on the economic sustainability of oyster aquaculture in Maine, this was noted: "*Oyster farms in Maine, particularly small farms, are associated with small profit margins and exhaustive labor. This labor is time consuming to the point where operations do not increase in efficiency quickly. One buyer described this by saying 'economically…they're going to have to figure out how to make themselves more efficient to sustain the volume that's going to be coming down the road.' Small farms often have a difficult time offsetting this through hired labor due to cost, 'That's really one of the most expensive things in farming is the labor. So that makes sense as especially your baseline, your minimum wage is always increasing.' With labor costs cutting into small profit margins on many farms, one buyer expressed concern regarding efficiencies of scale, 'The farms I'm working with, right, that want to scale outside of Maine, you know, need to get bigger and get more efficient*[44]."

It is understandable that marketing of oysters is a concern some commenters expressed. However, reducing the planting minimum to very, very small or hobby level could potentially hurt Inland Bays lessees on that front as well. If there were a sudden influx of new lessees enticed by lower planting limits, then there would be a corresponding inrush of competition saturating the local market. There could be dozens of new local oyster brands competing for the sales. If these new local oyster brands were planting and harvesting at a very small scale, they would not be able to look outside of the local region for sales. "*You can't just ship a single case of oysters. It is not economically feasible. Volume goes with scale, and it starts with making it*

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[41] Dame, R., L.N. Sturmer, C.M. Adams, R. Weldon, and K.A. Grogan. 2019. Financial risk in off-bottom oyster culture along Florida's West Coast. Food and Resource Economics Department, University of Florida Extension

[42] Rakestraw, E. 2023. "Shell shock: North Carolina oyster farmers face pushback from critical beach property owners" Business North Carolina Shell shock: North Carolina oyster farmers face pushback from critical beach property owners - Business North Carolina (businessnc.com)

[43] Agricultural Marketing Resource Center. Revised March 2022. Oysters | Agricultural Marketing Resource Center (agmrc.org)

[44] Feldman, S. 2021. Adding value through sustainability: Incentivizing an ecosystem approach to oyster aquaculture in Maine. Thesis submitted to the University of New England.

worthwhile for transportation companies to establish services[45]" a professor at the University of Florida was quoted talking about increasing the market for local oysters. The very small inventory planted and harvested could make marketing at any level difficult. Part of building a market is proving consistency to buyers, which is hard to do if a lessee's oyster inventory is limited. In the Maine survey of buyers, "*Consistent supply of high-quality oysters was a barrier brought up by buyers with local, regional, and national distribution.…many smaller Maine farms do not yet have the capability to consistently supply those oysters year-round. According to one buyer with national distribution, 'It's not just having good product, you've got to keep it on the menu long enough to get customers used to it'…Once distribution chains are stopped or put on hold, it is difficult to get them going once oysters are available again.*" This survey of buyers showed that their priorities were quality of product and reliability of supply[46]. And very small part-time or hobby farms, while it will keep the individual grower very busy cleaning gear, sorting and tumbling oysters, will not produce jobs, a primary goal of aquaculture in the Inland Bays. A Maryland oyster grower of over a decade gave his thoughts on very small shellfish farms to Aquaculture North America, "*While McClarren is happy to see the industry grow, he has reservations about hailing the industry as the region's 'savior.' 'It's not the silver bullet that some people are trying to portray it as,' says McClarren. 'The state wants to say, 'this is a great thing, this is creating jobs!' But, these are very small, little farms and you're not employing that many people. I don't know that it really has that big of an impact here on the shore. And I don't know that it will.' McClarren has concerns about the local markets becoming saturated given the industry's rapid expansion. As he sees it, distributors now have an overabundance of boutique-style oysters to choose from the local market, which could touch off a price war amongst the producers. 'There's not enough space in the local market to handle all the boutique oysters*[47]*."*

In the same vein, the East Coast Shellfish Growers Association webpage offers this anecdote, "*Local competition only drives down price. I cannot emphasize this enough. If growers have flooded the local markets, then make a little extra effort and get your product out to New York, Boston, Chicago or St. Louis. Having too many people selling directly to the same limited number of local restaurants will result in price wars and nobody will be making any money. This happened on Cape Cod, where a few dozen clam growers saturated the local restaurants and the price fell from 25-30 cents down to 18 cents. Because no one was big enough to get their product to Boston or New York, they all suffered the consequences*[48]*."*

One of the written comments offered, "*I was told by an Aquaculture professor at a Florida university that Delaware was 10 years behind every other state on the eastern seaboard in Aquaculture science*." It is true that Delaware started shellfish aquaculture after other east coast states; however, that is an advantage for Delaware as Delaware was able to learn from the other states about where their programs had been and where they were going, especially with planting

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[45] How can US oyster growers increase their profits? 2022. https://thefishsite.com/articles/how-can-us-oyster-growers-increase-their-profits

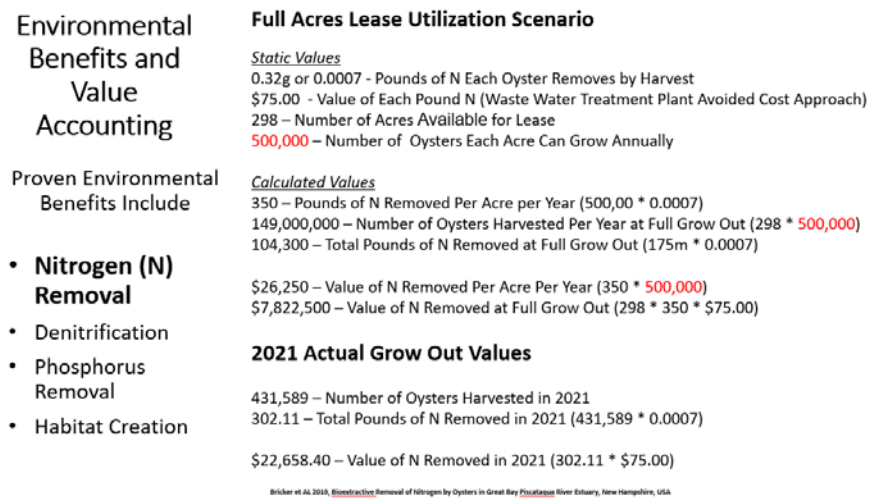
[46] Feldman, S. 2021. Adding value through sustainability: Incentivizing an ecosystem approach to oyster aquaculture in Maine. Thesis submitted to the University of New England.

[47] Jones, M. 2017. Maryland's oyster industry overcomes growing pains. Aquaculture North America. Maryland's oyster industry overcomes growing pains - Aquaculture North America

[48] East Coast Shellfish Growers Association. Consumers – East Coast Shellfish Growers Association (ecsga.org)

minimums on aquaculture leases. Florida, for example, must plant 100,000 clams/acre or 70,000 oyster seed/acre, but most of Florida's water column lease sites for oysters are pre-divided into 1.5 acre blocks. The planting requirement for the block is 105,000 oysters/year. In Texas, for off-bottom use, the lessee must plant at least 100,000 oyster seed per acre annually. Maryland's law, MD. Natural Resources Code § 4-11 A-09, requires "Annually planting at least one-fourth of the leased area at a minimum density of 1,000,000 shellfish seed per acre; or complying with any other requirements established by the Department." North Carolina recently increased their planting minimum and the state's commitment to enforcing it. Georgia had a recent increase in planting minimums, and Virginia and New Jersey's resource management departments have proposed doing the same.

The Delaware Aquaculture Association has made projections about how many oysters can be grown on an Inland Bays leased acre. In 2023, the Delaware Aquaculture Association presented information publicly to the Delaware Dept. of Agriculture Nutrient Management Commission. During this presentation, the Delaware Aquaculture Association projected 500,000 oysters/acre/year for all of the available to lease SADA acres (slide from the Delaware Aquaculture Association public presentation February 2023 below).



If planting minimums are reduced to 50,000 or 10,000 or lower, it is difficult to see how growers would be able to afford scaling up to meet the Delaware Aquaculture Association's predictions.

Gear Marking Requirements
Comments: • *Modify the need for floats based on cage type. Submerged bottom cages are the only type that need marking….I request that no floats be required on Australian longline systems. These systems hang growing cages or bags to a cable that is suspended on poles 6 feet apart that are well above high tide and very visible. I have heard that these poles could be submerged in an extreme weather event. The 6" corner markers still warn of navigational hazards. I have been on my acre in extreme conditions and never saw my poles go under. If the water ever got this high the islands and grass areas adjacent to these farms would be submerged and boaters should not be out there, designing for these conditions is cost prohibitive. I request that no floats be required on floating cages, as these cages come with black floating containers installed from the factory or farmer. Having to add white supplemental floats to these cages provides additional expenses (cost of float and labor to handle). The additional 3" white float does not make the cage easier to see.* • *We request the no floats be required on floating cases, as these cages come with black floating containers installed from the factory. Having to add supplemental floats to these cages provides an additional expense, that is unnecessary given the other marking requirements (4" PVC poles at each corner of each acre of the lease, and signs). We further request that no floats be required on Australian longline style growing cages, that are suspended from a cable in the water. Having to add floats, is unnecessary given the other marking requirements noted above, and for this style of gear, the poles needed to support the lines. The addition of these floats increases operation complexity and expense, as these floats get in the way during cage cleaning and harvest.* *Where floats are necessary, as for bottom cages, we request that we be allowed to use floats of any color that meet the specified size requirements. Mandating the use of white floats unnecessarily increases the cost associated with meeting this regulatory requirement, as opposed to the use of other colored floats like yellow or orange floats. Again, with each lease acres having corners marked with a 4" PVC pole and signs, individual boaters should recognize that this area is in commercial use.* • *Floating cages, by design, already have floats attached to one or both sides to provide buoyancy, and Australian long line cages are suspended on a cable between two or more posts to maintain their position in the water column. Adding supplemental floats to these cages increases farmer expense and they get in the way during cage cleaning and harvest, while only providing neglible benefit given the other marking requirements.* *Where floats are necessary, as for bottom cages, current regulations specify the use white floats. White floats are more expensive than orange or yellow floats of the same shape and size, and provide no tangible benefit in terms of safety or utility. Float color therefore should not be mandated, as white floats unnecessarily increases the cost associated with meeting this regulatory requirement.*

Response

The uniform marking of each piece of gear was highly recommended by the DNREC Fish & Wildlife Natural Resource Police (NRP). The Inland Bays are densely populated and highly used waterways. There are many users, including many visitors unfamiliar with the area. The

requirement of marking each cage and bag (not requiring multiple buoys for those cages, trays, or bags stacked vertically) was an effort to protect both boaters and the aquaculture lessees' investment in gear and oysters.

Safety of boaters in Delaware waters is a large concern. The US Coast Guard statistics show that nationwide in the last five years, collision with a floating object was identified at the primary event in 315 boating accidents. In the same time frame, collision with a submerged object has been the primary event in 846 boating accidents[49]. There are even more accidents that occur than are reported to the Coast Guard, the 2022 report cautions "*Non-fatal accidents are severely under-reported because boaters are unaware of reporting requirements or are unwilling to report*." The Coast Guard cites a study that found "*upwards of 93% of non-fatal, non-hospital admitted injuries were not captured in the data collection*." The report also states that recent data suggests that 12-21 accidents actually occur for every property damage accident in Coast Guard records[49]. We have not been immune to shellfish aquaculture gear and boater interaction in Delaware. There have been reports of boat and shellfish gear damaged [50] in the Inland Bays and in annual surveys completed by the shellfish lessees.

The comment submitted by the Inland Bays shellfish grower said that his longline poles are well above high tide and very visible and further stated that he has never seen his poles go under the water. This may be the case for his poles; however, there is not a minimum height requirement for longline poles in the Inland Bays. DNREC staff have observed, during normal weather conditions, the poles and lines on longline acres be completely submerged.

In these pictures of an Inland Bays lease, there are lines extending north from the wooden posts and there are PVC posts that are submerged holding the lines up. To the left of the wooden posts, you can see a parallel line of floating oyster bags, each with a white PVC float. The posts holding the lines that these bags are attached to are submerged as well.

[49] 2022 Recreational Boating Statistics. U.S. Department of Homeland Security. U.S. Coast Guard. Office of Auxiliary and Boating Safety. 2022 Recreational Boating Statistics (uscgboating.org)

[50] Delaware-Surf-Fishing.com "Inland Bay Oyster Farms are Being Damaged by Boats" Inland Bay Oyster Farms Are Being Damaged By Boats - delaware-surf-fishing.com

Picture of an Inland Bays lease with bags suspended on lines at low tide. The posts holding the lines are highly visible.

Picture of the same lease at high tide when many of the poles are submerged. The white floats that mark the suspended bags are, however, still visible.

Additionally, there is floating gear used in the Inland Bays that is not attached to poles, the gear is strung up between two anchor points, or may be hung between buoys. In such cases, the floats themselves tend to be small and dark against the water. Such gear doesn't have the benefit of poles to act as a visual cue that gear and lines are in the area.

Even on a calm and clear day, the low profile of these black floating bags in Inland Bays' water is a boating hazard due to their low visibility. These bags were not marked with the required white buoy.

Another comment says that floating gear comes with factory installed floats. The attached picture on this comment is a floating cage with pontoons. While the comment is correct that these pontoons come factory installed with floats, these pontoons are designed with caps, so that they can also be filled with water and lowered in the water column or completely submerged. These cages are not exempt from biofouling. The addition of silt, seaweed and algal growth on the cages and bags can make them sit significantly lower in the water—sometimes under wave height.

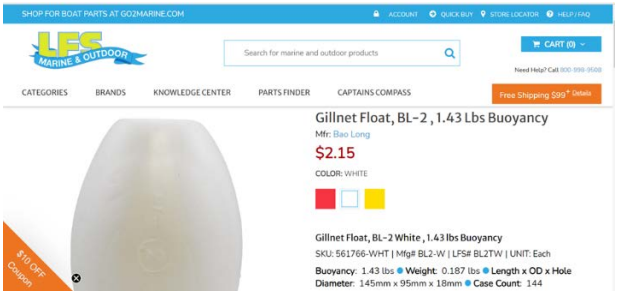
There can be quite a difference in visibility in these pontoon floating cages when they're clean and freshly deployed vs. when they have significant biofouling.

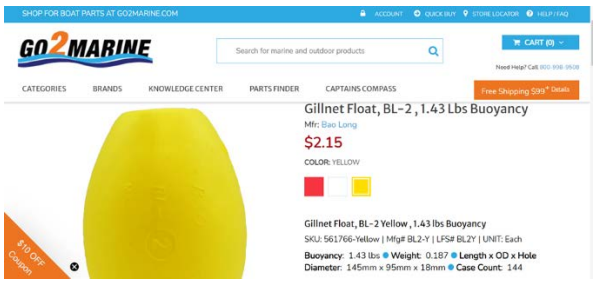
These are three pictures of the floating pontoon cages, the same types as in the submitted comment, and all pictured on the same Inland Bays lease. DNREC staff have observed one or both pontoons of a cage under the water on multiple occasions. When the cages are fouled, perhaps the pontoons have let in water or been pulled down by the weight of oysters and extensive biofouling, then the cages along with the pontoons are largely submerged. These are 3'x4'x2' wire cages. If filled with oysters, these cages can weigh over a hundred pounds. When the cages are biofouled, the majority or all of the cage can sit below the water's surface, like an iceberg. They represent a hazard to boaters.

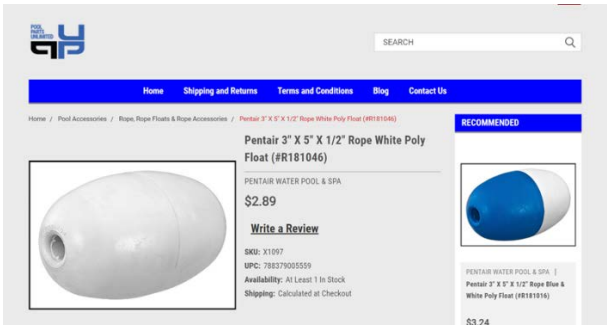
The commenters do point out that the corners of the leases are marked with PVC poles and placards and suggest that this should provide sufficient warning to boaters. Please note that corner poles or pole buoys need to be 6" in diameter, as listed in regulation, rather than the

comment's claim of 4". The corner markers are part of the uniform marking system that NRP suggested to help with visual recognition of a shellfish aquaculture area. However, shellfish gear does not always stay within the marked lease borders. DNREC staff have had to retrieve lost shellfish gear on multiple occasions, and alert lessees to lost gear reports many additional times. There are weather events that can move gear outside of the lease. When gear is adrift outside of the lease boundaries, boaters may need all of the warning that they can get in order to avoid an accident. The long line and floating gear does often come with factory- or grower-installed floats, as the commenters point out, but the default floats are most often black. The shellfish bags and cages are most often black. Black blends in with the water. The requirement of a white buoy provides a visual pop of contrast outside of a lease. There are also times when a corner pole on a lease may come down. Without the benefit of a corner pole and placard warning, boaters may find themselves into gear before they know it. The marking of gear provides an additional safeguard if the poles have come down on the lease.

One comment suggests that mandating the use of white floats unnecessarily increases the costs, as opposed to the use of other colored floats like yellow or orange. In DNREC's research, the costs of white and other color buoys are comparable. Comparing floats of the same size and different colors at the same vendor, DNREC has not been supplied any evidence that white buoys add more cost than buoys of another color. Examples found in DNREC's searches (performed September 2023) below.



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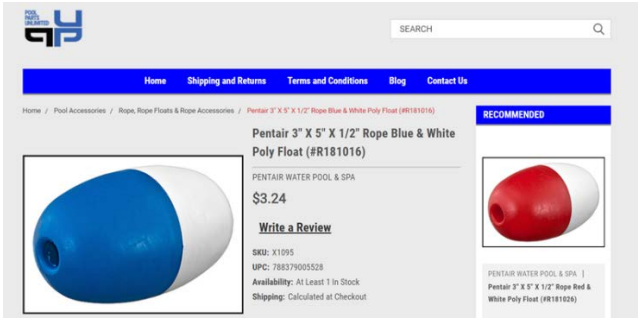
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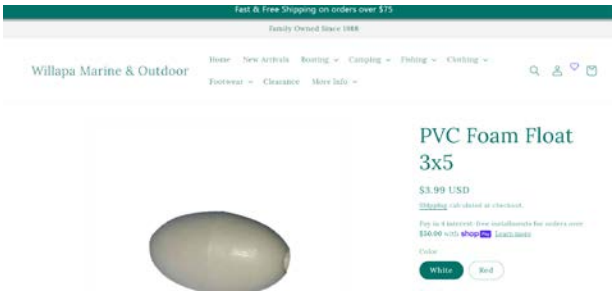
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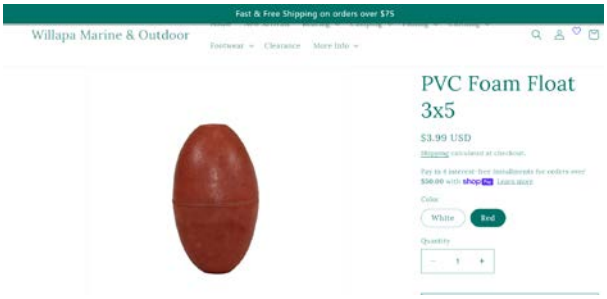
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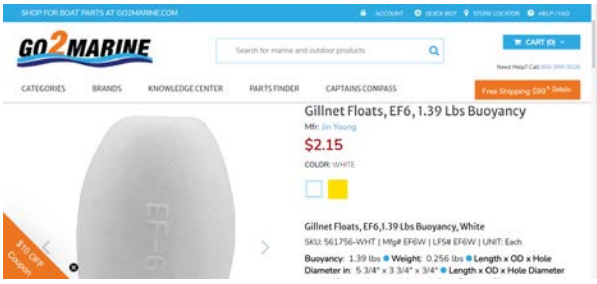
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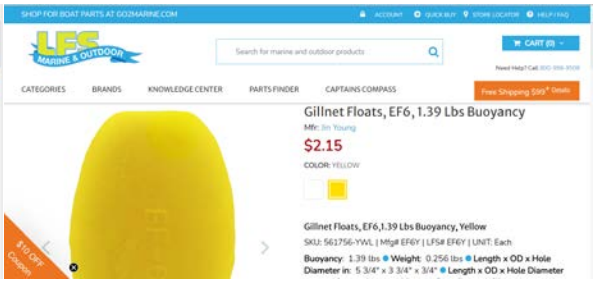
Gillnet Floats, EF6,1.39 Lbs Buoyancy, White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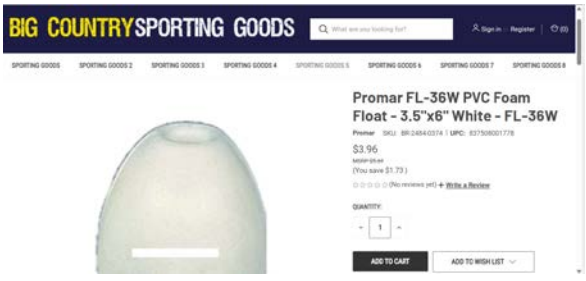
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Other Comments
Comments: • *Pertaining to the changes that you are proposing now, I would offer strong objection to the sublease prohibition. I don't think that there is an economic justification or a practical justification for such a prohibition.* • *As far as the corner markers, this six-inch PVC poles should be adequate. Honestly, putting a strip of highly reflective buoy tape around that post is probably adequate.* • *You forbidding mechanical harvest. I have a whole section on my website at ecsga.org that addresses the pros and cons of mechnical harvest and the ecological risks and benefits, and I think it would be quite illustrative for you to look there*

Response

Respectfully, DNREC does not understand what the commenter is referring to with "*pertaining to the changes that you are proposing now….objection to the sublease prohibition*." The prohibition on subletting is not one of the proposed changes. The subletting of shellfish aquaculture subaqueous land leases has been prohibited via 7 DE Admin. C. §3801 (20.6) since the regulation was first published. While minimum and maximum lease sizes are set by Code, and leases must be in whole acre increments, Delaware allows leasing by individuals, partnerships, and corporations. If people wanted to each work only a portion of a an acre, combining efforts to constitute minimum lease size and minimum planting requirements, that would be possible via a partnership. Lessees in other states may be motivated to sublet because of the length of time to obtain a new lease. The process of obtaining a lease may take several months to years in other states, by comparison, the lease process itself is fairly streamlined and relatively quick for Delaware's Inland Bays (weeks to months). Additionally, subletting may be occurring because some other states have limited area left to offer a new lessee, while Delaware does have space available for new leases.

As far as the proposed changes to the corner marker requirement of six-inch PVC poles or pole buoys, except for leases in the Little Assawoman Bay, this proposed change comes as a result of changes to Delaware Code since the first publication of the regulation. In the case of Little Assawoman Bay, legislation was changed in 2017 to require different corner markings. As Code supercedes regulation, the change to the Little Assawoman corner marking requirement has been in effect since 2017, and the amendment to the regulation is proposed to make the regulation consistent with Code. There is no proposed change from DNREC to make the corner markings different than what has been required from 2017-present, only to make the regulation consistent with Delaware Code.

A comment recommends perusal of ecsga.org on mechanical harvest. The East Coast Shellfish Growers Association webpage offers much information to shellfish growers up and down the East Coast. There is a section titled "Environmental Impacts of Dredging on Shellfish Aquaculture" with citations. This page provides general information about shellfish growing and dredging, including some objections that have been raised to the impacts of commercial fisheries trawling and dredging. The page answers those objections with "*in reality, the situation is more nuanced and requires an understanding of the various environments and different types of gear,*

and how they interact[51]." This is an important statement. The East Coast Shellfish Growers Association has a wide membership encompassing many different environments in multiple states. The Delaware Inland Bays are a distinct local environment with a unique history of dredging and shellfish aquaculture leases. Rehoboth and Indian River Bays have a sustainable population of hard clam[52], and this sustainable natural population of hard clam is rare among East Coast states. More than 99.9% of Delaware's recreational and commercial hard clam fishing occurs in the Inland Bays, and DNREC is invested in protecting both the natural resource and commercial and recreational clamming. Other states have recognized that dredging was deleterious to their hard clam populations; Maryland's 2015 Coastal Bays Fisheries Management Plan report on hard clams stated that six years after their dredging ban, hard clam surveys in the coastal bays were stable or increasing—although still far below historic benchmarks[53]. Moreover, Delaware's Inland Bays have a nuanced history between shellfish aquaculture leasing and mechanical harvest. This history is evident in Delaware Code still-- 7 Del. C. §2405 (a) *It shall be unlawful to dredge for hard clams with a commercial dredge clam license on leased shellfish grounds, except that a person may dredge hard clams from his or her own leased shellfish grounds as long as those grounds are not within Delaware's Inland Bays.* (c) *It shall be unlawful for any person to use any hydraulic dredge or mechanical device which employs a vacuum or suction method for the taking or catching or harvesting of clams from any of the waters under the jurisdiction of this State without the prior written consent of the Department.* Mechanical means of harvest have been deleterious to Delaware Inland Bays natural hard clam populations in past iterations of shellfish leasing. Even from the beginning of this iteration of shellfish aquaculture, the Center for the Inland Bay's Tiger Team final report makes the clear and unanimous recommendation, "*It shall be unlawful to use mechanized harvesting gear on leased shellfish grounds other than power winches to raise aquaculture gear*[54]."

Conclusion:

We appreciate the thoughtful comments submitted on the proposed amendments and we believe the proposed amendments published in the Register and those explained in this TRM are the only revisions necessary to Delaware's shellfish aquaculture regulation at this time and should be adopted as written.

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[51] Dredging – East Coast Shellfish Growers Association (ecsga.org)

[52] Bott, M. and R. Wong. 2012. Hard clam (Mercenaria mercenaria) population density and distribution in Rehoboth Bay and Indian River Bay, Delaware. DNREC report

[53] 2015 Maryland FMP Report (August 2016) Section 11. Maryland Coastal Bays Hard Clam (Mercenaria mercenaria) Hard Clam (Mercenaria mercenaria) (maryland.gov)

[54] Delaware Center for the Inland Bays. 2013. Final report of the shellfish aquaculture Tiger Team. Tiger_Team_Report_Full.pdf (inlandbays.org)