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# Development Pathways in Aquaculture: Factors that Influence Consolidation of Ownership and Inhibit Success of Small-Scale Producers

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# Development Pathways in Aquaculture: Factors that Influence Consolidation of Ownership and Inhibit Success of Small-Scale Producers

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## Abstract

Aquaculture is now the fastest-growing sector of food production worldwide, with marine aquaculture accounting for 38% of global aquaculture supply. In the development of agricultural industries in the United States and internationally, environmental, economic, and governmental factors have allowed for significant consolidation of ownership structure and market share. As aquaculture industries continue to expand, governance structures will need to be put in place to reflect the values and development goals for the aquaculture industry of a given area. While finfish aquaculture has already experienced significant consolidation, shellfish aquaculture remains relatively unconsolidated in most areas, with room for expansion that could follow one of two possible development pathways. One pathway may be the proliferation and success of many small-scale shellfish farm operations, and the alternative may be to follow the lead of salmon aquaculture into a highly consolidated, monopolized industry. This study examined shellfish aquaculture industries in four New England and Mid-Atlantic states to determine factors that have inhibited and/or led to consolidation within the industry, with the goal of making recommendations for burgeoning shellfish and kelp aquaculture within the Gulf of Maine. Results show that governance policies play a major role in limiting or allowing for consolidation. Specifically, limits on lease size and leaseholder eligibility, the prohibition on transferability of leases, and the requirement to prove production on a lease all inhibited the potential for consolidation. In addition to policy, federal and state agency grant and loan programs and University-led aquaculture training programs helped to support the viability of small growers and limit opportunities for consolidation. Additionally, resource-sharing structures such as cooperatives and informal partnerships have the potential to offer small-scale growers the

economic benefits associated with consolidation while still maintaining their autonomy. These findings demonstrate the importance of states and municipalities in being proactive to determine development goals for their aquaculture industries, and creating strategic plans to meet these goals accordingly.

## Introduction

Aquaculture, the farming of aquatic organisms such as finfish, shellfish, and plants, is the fastest-growing sector of food production worldwide, with marine aquaculture accounting for 38% of global aquaculture supply (FAO, 2018)**.** Since 1970, coastal communities worldwide have undergone what is referred to as the Blue revolution, entailing the rapid expansion of aquaculture and a transformation of the world's food system (Campbell et al., 2021; Hanes, 2018). In 2016, global aquaculture operations produced a cumulative 80 million metric tons of food fish, 30.1 million metric tons of aquatic plants, and 37,900 metric tons of non-food products, worth $243.5 billion USD (FAO, 2018). Globally, reducing food security, ending hunger, and increasing employment are the motivating factors for aquaculture expansion, particularly in developing nations (Béné et al., 2016; Dewey et al., 2011; FAO, 2018). Worldwide, coastal marine ecosystems that support popular finfish and shellfish species are threatened by anthropogenic pollution, habitat degradation, and overharvesting, all of which are exacerbated by the impacts of climate change (Dewey et al., 2011). In addition to adding to the global food supply, aquaculture is also viewed as a more sustainable method of meeting increasing demand for seafood, as opposed to industrial wild fishing practices and the overexploitation of wild fisheries, some of which are now depleted past the point of return (Hanes, 2018; Stoll et al., 2019).

Maine's coastal waters have been home to aquaculture since the 1800s, with the first laws governing finfish and shellfish culture established in 1905. Formal leasing of aquaculture sites was first established in the state in 1973, with a law that gave jurisdiction over leasing to the Maine Department of Marine Resources (DMR) (DMR, 2021c). The legal system for aquaculture leasing allows for three types of permits; Standard Leases, Experimental Leases, and Limited Purpose Aquaculture licenses (LPAs). Standard Leases allow for commercial aquaculture leases of up to 100 acres for 20 years, and are transferable, meaning they can be bought, sold, or traded with the approval of DMR. Experimental Leases are much smaller, with a maximum four-acre limit, and are non-renewable after three years except for scientific purposes. The smallest permit, LPAs, may not exceed 400 square feet and must be renewed annually. Differing from Standard and Experimental Leases, LPAs cannot be issued to corporations, and leaseholders are required to participate in annual trainings on aquaculture production and public health requirements (Stoll et al., 2019). The Damariscotta River has always been ideal for growing shellfish, and the first aquaculture leases in Maine occurred in this river growing oysters and mussels. Shellfish aquaculture expanded throughout the 1980s to Penobscot Bay, and continued to expand into Casco Bay and the Jonesport area, where it persists today. Culture of finfish species including salmon and rainbow trout began in Maine in the early 1970s, raised in floating pens in the Wiscasset River and on Vinalhaven Island. Today, finfish leases exist in Cobscook May, Machias Bay, Eastern Bay, and Toothacker Bay (DMR, 2021c). Species cultured in Maine in 2020 include atlantic salmon, american/eastern oyster, blue mussel, european oyster, northern quahog, sea scallop, hen/surf clam, strap/skinny kelp, sugar kelp, and winged kelp. There are currently 168 active and pending aquaculture leases in the state, totaling to 1649.92 acres. 24 of those

leases grow finfish, 41 grow aquatic plants, and 131 grow shellfish (many leaseholders are licensed to grow multiple species in the same area). In 2019, total aquaculture harvest value within the state was $88,408,714 (DMR, 2021b).

Salmon aquaculture in Maine has developed quickly and with massive consolidation of ownership and market share (Hanes, 2018; Stoll et al., 2019). Disease outbreaks in the 1990s drove most salmon farmers out of business, which left all the leases available to one Canadian company, Cooke Aquaculture, which leased all newly vacated sites in Cobscook Bay (Hanes, 2018). Today, Cooke has become a multinational corporation, and is the only company in Maine farming salmon, with over 614 acres in lease sites (DMR, 2021b). Consolidation has also been documented in other finfish aquaculture industries in New Brunswick, Canada and Ireland, and is largely attributed to both governance and disease outbreaks, similar to what occurred in Maine in the 1990s (Chang et al., 2014; Evers, 2010; Knott & Neis, 2017; Renwick, 2018). Oyster aquaculture has experienced a small amount of consolidation, however there are still many successful, small-scale operations that exist as well. In total, there are 98 leases licensed to grow oysters, and 67 total leaseholders (both individual people and corporations). The six largest leaseholders control 39% of the total acreage leased to grow oysters, and the 20 largest leaseholders control 77% of the total acreage. The largest oyster leaseholder in Maine has 49.81 acres, with the average acreage controlled by a single oyster leaseholder being 9.05 acres (DMR, 2021b).

Oysters are the most common shellfish species grown in Maine waters, but the number of leases for other species is continuing to increase each year as shellfish aquaculture gains popularity. Currently, there are 42 blue mussel leases, 30 sea scallop leases, 21 northern quahog leases, 19 surf clam leases, 15 soft-shell clam leases, and 3 razor clam leases

(DMR, 2021b). The industries for these species are continuing to develop, and have great potential for expansion in the coming decade. This is especially true given the context of declining landings for wild fisheries of popular shellfish species, including the soft-shell clam. Since its peak in 1977 at approximately 37 million pounds in annual landings, soft-shell clam harvest has declined to approximately 7 million pounds in 2020. Despite this, the industry's value has increased in the same time period from $9 million annually to over $15 million, indicating that the market for soft-shells exists and is growing (DMR, 2021a). The decline in wild landings is largely attributed to the increase in predation from invasive European green crabs, and milky ribbon worms. As predation has intensified, there has been growing interest in clam aquaculture from both wild harvesters and others, as a means of livelihood diversification and the generation of additional income (McMahan, n.d.)**.** Some growers have also begun culturing northern quahogs on existing oyster leases as a means of diversifying their product with a secondary crop species (Mayer, 2020; Moon et al., 2020). Maine DMR prohibits the wild harvest of northern quahogs greater than one inch in thickness, but that restriction does not apply to farmed quahogs. Due to this distinction, quahog aquaculture may be able to capture a local market where smaller, cultured quahogs fetch higher prices than their larger, wild-caught counterparts (Mayer, 2020)**.**

Interestingly, despite the potential and likelihood for significant shellfish aquaculture expansion in Maine in the near future, key governance provisions present in other commercial fisheries in the state do not exist for aquaculture. For example, the regulations that have preserved the small-scale operator structure of the iconic Maine lobster industry have no similar counterparts in aquaculture legislation. While this is not necessarily problematic, it is important to note that a lack of goal-oriented policies may lead shellfish

aquaculture down the same path as salmon aquaculture in Maine. Despite the potential for aquaculture expansion to support coastal communities, there have been instances in which aquaculture growth has had negative local impacts by triggering consolidation, destabilizing traditional land tenure through privatization of the commons, and therefore displacing small-scale resource users (Stoll et al., 2019). As shellfish aquaculture industries develop further in the state, there is a pressing need to determine a strategic plan for the industries' development in order to create an industry structure that meets the needs and goals of affected communities to support their wellbeing.

In this study, I researched the development of shellfish aquaculture industries in four New England and Mid-Atlantic states. Specifically, I sought to determine the factors and conditions that enabled industry development without significant consolidation of ownership and market share, and the structures that support the financial viability and success of small-scale growers. To achieve this, I asked the question: what environmental, economic, and governmental factors encourage development of aquaculture without consolidation of ownership and market share? There is currently a lack of extensive research on trajectories of consolidation in aquaculture, particularly in the United States. With the goal of informing future aquaculture policy in Maine, I present findings from interviews conducted with shellfish aquaculture managers from state and federal management agencies, Sea Grant staff members, and oyster business owners. I begin with a literature review on the pressures leading to a rise in aquaculture both globally and locally in Maine, trajectories of consolidation in comparable agricultural industries, consolidation in aquaculture, and the role of grower cooperatives in mitigation of and adaptation to the impacts of consolidation on small growers. Next, I present relevant results from interviews on factors that both inhibit

and lead to consolidation. Following the results, I discuss my findings in comparison to existing literature. Finally, I offer recommendations for aquaculture policy in Maine based on qualitative interview data and analysis of existing literature.

## Methods

The data for this research come from semi-structured interviews with aquaculture experts, managers, Sea Grant affiliates, and business owners from Massachusetts, Rhode Island, Maryland, and Virginia. This study area was chosen due to the existence of established shellfish aquaculture industries and proximity to Maine. Fifteen interviews—nine shellfish aquaculture managers from state and federal management agencies, four Sea Grant staff members, one aquaculture business owner, and one former aquaculture business owner and current expert and advocate in the field—were conducted between March and April 2021, over the phone and via Zoom. Initial manager interviewees were identified from state agency websites, and snowball sampling was used with initial interviewees to identify more participants with diverse perspectives. Interviews ranged from 30 to 90 minutes and were structured around the major themes of history of the given aquaculture industry, governance, amount of consolidation, and power structures and influence over the industry (Full interview guide in Appendix A). Interviews were conducted until the point at which additional interviews were no longer uncovering new information. Interviews were recorded via Zoom or an iPhone app, and were then transcribed by hand from the recording to ensure accuracy. Later, I reread transcriptions multiple times, making note of major thematic factors that either inhibited or led to consolidation of ownership within the state's aquaculture industry. Through this rereading process, a coding scheme was created to assist in qualitative analysis

(Figure 1). As I read through more transcriptions, I created new codes along the way to capture relevant information. All interview data under each code was highlighted in a unique color, and copied into another document under the appropriate heading or sub-heading. This process allowed me to keep track of relevant quotations to later be used in writing my results section. While drafting the results, interview participants' identities were reduced to the state they are from and a general description of their position, in order to preserve their anonymity. Two participants requested not to be quoted, and therefore are paraphrased accordingly. The results of this study are shared in the section following the literature review.

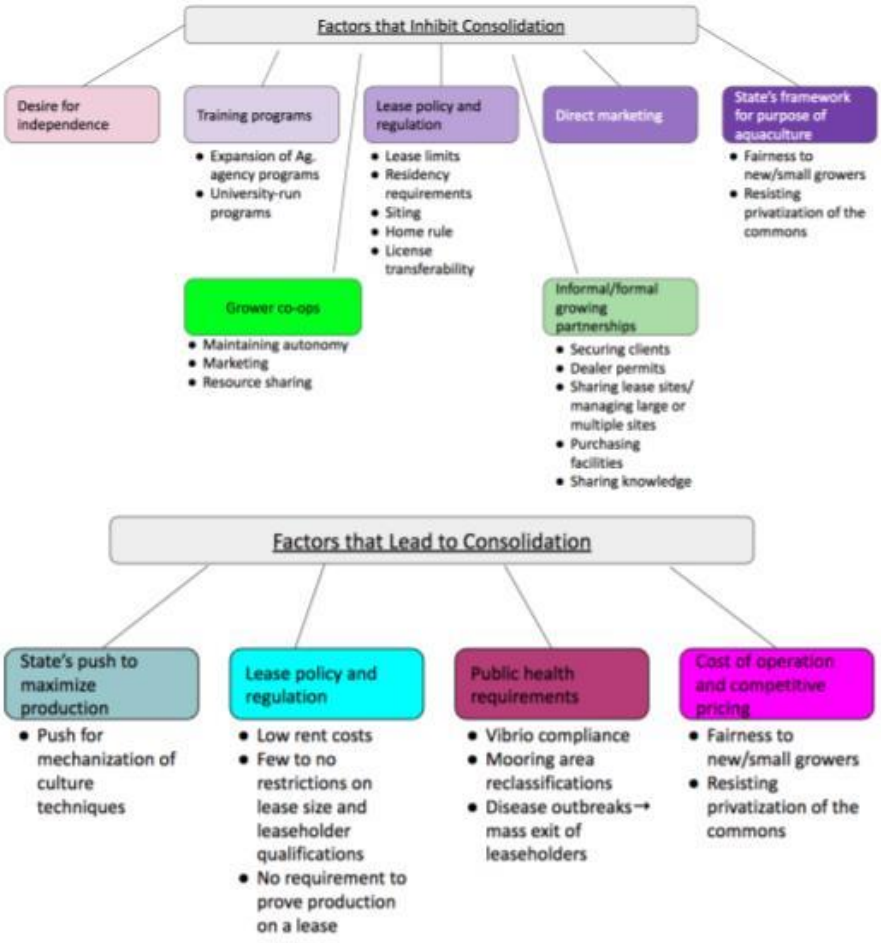


Figure 1. Code structures used in qualitative data analysis.

## Literature Review

Pressures leading to the rise of aquaculture

Aquaculture is the fastest-growing sector of food production worldwide, with marine aquaculture accounting for 38% of global aquaculture supply. With seafood demand projected to continue growing, many UN sustainable development goals are directly relevant to fisheries and aquaculture. In particular, sustainable development goal 14, to "conserve and sustainably use the oceans, seas, and marine resources for sustainable development," is tied closely to the factors motivating growth of aquaculture across the globe (FAO, 2018). Since 1970, coastal communities worldwide have undergone what is referred to as the Blue revolution, entailing the rapid expansion of aquaculture and a transformation of the world's food system (Hanes, 2018). In 2016, global aquaculture operations produced a cumulative 80 million metric tons of food fish, 30.1 million metric tons of aquatic plants, and 37,900 metric tons of non-food products, worth $243.5 billion USD (FAO, 2018). Globally, reducing food security, ending hunger, and increasing employment are the motivating factors for aquaculture expansion, particularly in developing nations (Béné et al., 2016; Dewey et al., 2011; FAO, 2018). Worldwide, coastal marine ecosystems that support popular finfish and shellfish species are threatened by anthropogenic pollution, habitat degradation, and overharvesting, all of which are exacerbated by the impacts of climate change (Dewey et al., 2011). In addition to adding to the global food supply, aquaculture is also viewed as a more sustainable method of meeting increasing demand for seafood, opposed to industrial fishing practices and the overexploitation of wild fisheries, some of which are now depleted past the point of return (Hanes, 2018; Stoll et al., 2019).

Sustainability is a major motivating factor for aquaculture expansion, with shellfish aquaculture being pointed to as having the most potential for ecological benefits over time (van der Schatte Olivier et al., 2020). Bivalve species cultivated in shellfish aquaculture such as oysters, clams, mussels, and scallops, can provide valuable ecosystem services that support the integrity of human and non-human communities surrounding farm locations. These include provisioning, regulating, supporting, and cultural services (Alleway et al., 2019; Gentry et al., 2020; van der Schatte Olivier et al., 2020). Provisioning services include the production of seafood for human consumption, medicinal uses, live products for aquarium trade, and raw materials such as pearls, shells, and agar created from algal aquaculture. Regulating services are unique to shellfish aquaculture, as bivalve species are naturally filter feeders. These species filter water and particulates therefore improving water quality, and aid in nutrient cycling and removal of nitrogen and phosphorus (Alleway et al., 2019; van der Schatte Olivier et al., 2020). Natural and cultured oyster reefs are also able stabilize wave energy and sediments to create a buffer against shoreline erosion (Alleway et al., 2019), an ecosystem service of particular importance to coastal communities facing increased flooding due to erosion and sea level rise. The creation of habitat through the increased substrate area provided by aquaculture supports other wild species, and has been known to act as a nursery ground for juvenile fish and invertebrates (Alleway et al., 2019; van der Schatte Olivier et al., 2020). In fact, oyster farmers in Maryland are now eligible for monetary compensation for the service they provide in improving water quality and controlling nutrient levels (Parker & Bricker, 2020). Finally, the farming of marine species also results in cultural services, including the preservation of spiritual and physical

connections with the marine environment, food tourism for particular species, and livelihood diversification for commercial fishers (Alleway et al., 2019; Gentry et al., 2020).

In the United States, seafood imports have greatly exceeded seafood exports, leading to a $16 billion deficit that the U.S. Department of Commerce and states are attempting to lessen through policies that encourage domestic aquaculture expansion (Campbell et al., 2021; Hanes, 2018; Parker & Bricker, 2020). One such policy came through the form of an executive order, issued by former President Donald Trump in May of 2020. The order, *Promoting American Seafood Competitiveness and Economic Growth*, is meant to encourage aquaculture expansion to reduce the national seafood trade deficit, increase seafood security, create jobs, and enhance rural prosperity (Campbell et al., 2021). Growth has come both from the public and private sector, with investments being made in science, technology, and infrastructure aimed at improving husbandry practices to aid in expansion (Stoll et al., 2019). Researchers agree that marine aquaculture has a high potential to support coastal communities and enhance overall wellbeing through the creation of jobs. It is also viewed as a method of livelihood diversification for rural fishers faced with decreased landings or fishery closures, which is of particular interest in Maine. However, rural communities do not necessarily experience the trickle-down economic effects from growth and expansion of rurally-based industries that is used to justify such expansion in dominant expansionist discourse. Limiting barriers to entry and streamlining permitting processes to attract capital investment may encourage growth, but that growth has the potential to come at the expense of rural coastal communities if policies are not oriented with their wellbeing in mind (Campbell et al., 2021; Stoll et al., 2019).

While aquaculture began in Maine in the Damariscotta river in 1975, the industry has seen rapid growth and expansion in recent years (Hanes, 2018; Stoll et al., 2019)**.** Despite significant public and private investment into aquaculture of both finfish and shellfish, researchers have found that the majority of those entering the aquaculture sector in Maine are not commercial fishermen, suggesting that there is more work to be done for fishermen to reap the benefits of livelihood diversification through aquaculture (Stoll et al., 2019). As of 2019, Maine did not have a comprehensive management plan to guide the growth of aquaculture, though some reports have been drafted through state agencies and nonprofits. Field experts suggest that more attention should be given to aquaculture governance systems, as they play a major role in shaping the trajectory of the industry's long-term development. Currently, key governance provisions that have shaped Maine's commercial fishing sector are not in place in aquaculture governance. Maine's lobster industry is touted as a success story in maintaining many small-scale, family run operations, with no consolidation into corporate ownership. This system has been maintained by key governance provisions, including owner-operator requirements and the prohibition on license transferability, which are currently not present in aquaculture governance in the state (Stoll et al., 2019). Salmon aquaculture in Maine has developed quickly and with massive consolidation of ownership and market share (Hanes, 2018; Stoll et al., 2019). While this consolidation is not necessarily problematic, governance systems must consider their desired outcome for industry development and regulate accordingly. As aquaculture is designated to help coastal communities diversify their livelihoods, there is a need for governance systems that promote this outcome.

Trajectories of consolidation

Consolidation is defined in the literature as the shift in industry structure to fewer and larger firms. Its counterpart, concentration, is defined as the extent to which a small number of firms control most of the sales. While not always the case, it is common for these two processes to happen concurrently as an industry develops into fewer larger firms with greater market share (Shields, 2010). Agricultural industries in the United States have experienced consolidation to varying extents, with the dairy and poultry industries being notable examples of significant consolidation and high exit rates for small-scale farmers (Bruckner, 2016; McDonald et al., 2020; Ollinger et al., 2005; Shields, 2010). While aquaculture varies greatly from other agricultural industries, it is important to understand the trajectories of consolidation to compare across sectors. Regarding consolidation of agribusinesses in general, Bruckner (2016) argues that agricultural subsidies in the New Deal legislation have had the net effect of raising the price of farmland, resulting in smaller owner-operated farms exiting the industry, leaving mostly large-scale operations with more control. Bruckner speaks heavily to the role that government policy plays in influencing the structure and development of an industry, also highlighting the impact of the 2014 farm bill. The bill removed limits of subsidies to large farms and increased subsidies for insurance against crop losses and income risk. By offering unlimited subsidies, the bill effectively provided the largest farms the financial resources to bid up land prices and drive smaller farms out of business (Bruckner, 2016). In Brazil, the government's deregulation of the dairy industry between 1989-993, freeing retail and farm prices to be determined by market forces. This policy change resulted in a rapid increase in competition as firms began competing in price and cost cutting, with multinational corporations seeing the most success and small farms being forced to exit (Farina, 2002). Policies such as these allow companies to build up

financial resources and enjoy economies of scale, another factor that researchers point to in encouraging consolidation.

The dairy industry, in particular, has experienced consolidation at a pace greater than most other agricultural industries in the United States (McDonald et al., 2020). In the period 1987-2007, the number of commercial dairy farms decreased from 202,000 to 70,000, with a concurrent increase in milk production, demonstrating the ability for fewer, larger firms to increase production (Gould, 2010). Researchers argue that small and mid-sized commercial dairy farms face significantly more financial challenges, and consolidation comes largely at their expense (Gould, 2010; McDonald et al., 2020). Expanding in size helps firms to lower their per-unit costs of production, providing a financial incentive for firms to consolidate when possible (McDonald et al., 2020; Shields, 2010). Larger dairy farms enjoy economies of scale, due to their ability to invest in highly automated milking processes and feed delivery systems, resulting in a more effective use of labor and more milk produced per cow. With increasing demand for value-added products, companies were incentivized to undergo vertical integration to obtain processing and distribution plants, further encouraging consolidation. In addition to efficiency and profitability motivating consolidation within the dairy industry, significant advancements in milk marketing and the ability to transport milk more efficiently over longer distances have reduced the need for a greater number of small, local dairy farms (Shields, 2010).

Similar to the dairy industry, the poultry industry has undergone significant consolidation, as well as vertical and horizontal integration (Hendrickson et al., 2001; Ollinger et al., 2005). Large firms that were able to acquire slaughter plants, feed mills, and processing plants drove others out of business, and now contract with individual poultry

growers. In this model, the corporation provides growers with chicks, feed, and other inputs, and the grower provides housing and labor services to raise birds to finished size. Growers are typically compensated based on performance relative to peers, with higher payments going to growers with lower mortality rates and a more efficient conversion of feed to meat. Researchers suggest this structural change was due to a rapid growth in consumption of poultry meat, incentivizing firms to expand and sell a greater variety of value-added products (Ollinger et al., 2005).

Trends of consolidation in aquaculture

The majority of literature on consolidation in aquaculture industries is focused on New Brunswick and Ireland, both of which have salmon and shellfish operations. In New Brunswick, the salmon aquaculture industry has become highly consolidated (Chang et al., 2014; Knott & Neis, 2017). When the industry began, there were no policies, legislation, or guidelines for aquaculture development. Sites that had previously been used for the herring weir wild fishery were deemed to be very suitable to salmon aquaculture, and a market was created for fishers to lease their weir locations to aquaculturists with the highest bid. This market started the initial consolidation process, with aquaculture sites being leased to companies that could afford to bid generously (Knott & Neis, 2017). In order to promote development, the government began a financial assistance program in 1984 and constructed private hatcheries. As the industry grew, the government issued a moratorium on new applications from 1986-1991 to slow growth and give them time to develop policies. In 1988, the New Brunswick Aquaculture Act was passed, which included a site allocation policy aimed to promote industry growth and encourage new entrants, with priority given to local commercial fishermen (Chang et al., 2014). In the 1990s, outbreaks of infectious salmon

anemia and sea lice triggered bankruptcy and buyouts of smaller companies by larger ones. These outbreaks made it clear to farmers that companies with only one grow-out site would no longer be viable (Knott & Neis, 2017), and the state's guidelines were revised to encourage a 3-year crop rotation system, which only accepted new applications from existing companies (Chang et al., 2014). These buyouts resulted in massive consolidation of ownership, and by 2012 the 45 active salmon farms in New Brunswick were controlled by just three companies, with Multinational Fish Farm operating 60% of the lease sites. Knott and Neis (2017) argue that Multinational Fish Farm was able to consolidate due to the disease outbreaks leading to large amounts of acreage for sale, and the corporate strategy of vertical and horizontal integration in all aspects of the industry; from a hatchery and processing plant to marketing, environmental monitoring, and research. In addition, the state's policies laid the foundation for monopoly control over the industry, by showing support for new development and expansion by entrepreneurs from off-island companies (Knott & Neis, 2017; Marshall, 2001).

In Ireland, the salmon aquaculture industry has become highly consolidated with a relatively small number of highly capitalized producers, while the shellfish aquaculture industry has remained made up of single owner-operated units (Cush & Varley, 2013; Evers, 2010). Cush and Varley (2013) identified four survival conditions for small-scale natural resource enterprises, all of which they argue have helped maintain the owner-operator structure of the Irish mussel farming industry. The first condition is economic; the low-profit margins in mussel farming have restricted external capital investment, allowing local people with access to small amounts of capital to become farmers. The second condition is the deployment of household labor, and the willingness of household members to work with very

little to no pay, at least in the initial start-up phase of the operation. The third condition is the importance of the state regulations. The state must regulate the industry by stimulating small-scale enterprises and buffering local aquaculture regions from neoliberal forces and the concentration of capital at the expense of small-scale producers. Finally, the fourth condition is cooperation; small-scale operators are able to survive and thrive with the help of formal, organized cooperation through co-ops, and informal cooperation by pooling resources (Cush & Varley, 2013). The oyster aquaculture industry in Ireland has also remained unconsolidated, though for different reasons. Due to a dysfunctional licensing system and regulatory challenges, it is difficult for new entrants to obtain licenses, and for experienced farmers to gain licenses to expand their operations. In addition, licenses are not transferable, and therefore are not commodified in a way that encourages small operators to sell to larger corporations (Renwick, 2018). The salmon aquaculture industry in Maine has followed a similar trend in development. Disease outbreaks in the 1990s drove most salmon farmers out of business, which left all the leases available to be obtained by a Canadian company with access to capital, Cooke Aquaculture, which now controls all the leases in Cobscook Bay (Hanes, 2018). Today, Cooke is the only company in Maine farming salmon, with over 614 acres in lease sites (DMR, 2021).

The role of the cooperative

As mentioned earlier, cooperation is one of four sets of conditions that enable small-scale growers to succeed, and researchers have found formalized grower cooperatives can do much to offset the market disadvantages that come from being small. A cooperative (co-op) can be defined as a business jointly owned and controlled by its members who also directly benefit from its services. The purpose of a co-op is generally to provide shared economic,

social, and cultural resources that members would not have access to individually (Frederick et al., 2016; Walsh, 2020). In a successful co-op, servicing the needs of members takes precedence over profit maximization (Cush & Varley, 2013) In aquaculture industries, co-ops can help small-scale growers succeed by reaping the benefits of economies of scale typically only enjoyed by larger or more consolidated corporations (Cush & Varley, 2013; Hasan et al., 2020; Walsh, 2020). In Ireland, a state-run training program prepares coastal community members to become mussel growers, and sets up the structure of a co-op, enabling small producers to succeed. The program includes grant assistance and expert advice relating to mussel biology, business and marketing principles, and co-op structures and operating practices. Cush and Varley (2013) argue that without the cooperative, small-scale mussel growers likely would not have succeeded on their own, leaving the industry vulnerable to consolidation from outside investors buying out the farms. Notable benefits of aquaculture cooperatives are widespread and multifaceted. On the business side, co-ops enable growers to access the economy of scale necessary effectively manage production, increase leverage for transactions with input suppliers and product buyers, provide access for small farmers to the wider value chain, assist with low or interest free loans and insurance, provide dividends, and reduce competition while acting as a guaranteed buyer for growers. Regarding resource sharing, co-ops may allow growers access to equipment, hatcheries, processing and distribution facilities, additional labor, and the shared industry knowledge from older to younger members (Hasan et al., 2020; Walsh, 2020)**.** Politically and socially, co-ops may offer growers representation in government policy making and program planning, be a platform for discussing industry issues, support compliance with legislation and public health standards, offer capacity building programs, and assist with community

relations such as lease hearing support and resolving 'not in my backyard' (NIMBY) issues (Hasan et al., 2020; Walsh, 2020).

## Results

*1. Factors that limit consolidation*

Through interviews with aquaculture managers, regulators, and industry members, the following subsections were identified as factors that either directly or indirectly limit consolidation of ownership and market share in the shellfish aquaculture industry.

*1.1 Lease policy and regulation*

A state or municipality's policies and regulations on eligibility, transferability, and siting of aquaculture leases were identified as influencing whether or not the state's aquaculture industry has experienced consolidation. These policies dictate whether or not a single individual or corporation can accumulate significant acreage in aquaculture lease sites, determining the potential for consolidation in the given state's industry.

*1.1.1 Lease limits*

Acreage limits on individual lease sites, as well as limits on the percentage of water bodies that could be sited for aquaculture, were designed in some states to maintain small-town character and reflect a biological and social carrying capacity. Towns in Cape Cod, MA have the authority to designate size limits for leases, and many choose to limit new leases to two to three acres. In a town on Cape Cod, MA with a two-acre limit in lease size, a shellfish manager mentioned, *"[we] determined that the best way to keep it fair with the amount of people that had interest would be to limit the amount of acreage per person so that you wouldn't have a system like out on the West Coast where you just have one or two big*

*companies."* In Rhode Island, initial lease applications in coastal salt ponds are capped at 3 acres, and the ponds themselves may not have aquaculture on more than 5% of their surface area. A staff member of the Department of Environmental Management of Rhode Island explained the motivation for capping acreage, *"they're not big ponds, you know, they have limitations to them, and given some of the user conflict that started to occur, we put a hard cap on the ponds that said, 'no more than 5% of the ponds will be taken over by aquaculture.'"* In Virginia, however, leases are capped at 250 acres, much larger than in New England states. While participants did not identify this as a factor causing consolidation, it is important to note that the aquaculture industry in Virginia has experienced significantly more consolidation than in New England states with much stricter acreage caps.

While managers feel that an acreage cap limits entrance for larger companies and mitigates user conflict by leaving lots of space open for other uses, some growers feel that the limit is too restrictive on growth and profitability. This issue arose as a major theme in interviews with industry members, who explained the difficulty of making a profit when limited to a two or three-acre lease. Expressing this, a retired oyster farmer and current policy advocate said, *"restricting the industry out in Wellfleet and some of these towns to 3 acre maximums is like committing the farm to a lifetime of backbreaking manual labor."* Going further into detail, an oyster company owner in Massachusetts explained how the Covid-19 pandemic differentially impacted growers with smaller leases and fewer resources, *"this last year is pretty typical of what can happen if you're a small producer. You're just out of business, you can't sell it, you don't have a salesperson, you're relying on distributors, or you're relying on people that are picking it up at the launch place. It's impossible."*

*1.1.2 Residency requirements*

In Massachusetts, some municipalities require a lease applicant to be a resident of the town the lease is sited in. This requirement can make it much more complicated for a larger company to be approved for a lease. Expressing this, a staff member at NOAA explained, *"when you have a state process, kind of the lowest common denominator for eligibility would be a resident of a state. And in a municipal process, it could be a resident of the municipality. And that certainly limits opportunity for a big company like Cooke, or another company in that state that's larger but not based in that municipality to consolidate and purchase that farm."*

*1.1.3 Specifications for lease siting*

States' requirements for where aquaculture leases can be sited vary greatly, and play a large role in determining how much area within a state's waters can be used for expansion of aquaculture. In Massachusetts, no area can be sited for aquaculture if it has a productive bottom for wild shellfish. Before a lease site is approved, a state biologist will conduct a shellfish survey to determine if the bottom is productive for wild shellfish. If there are more than three quahogs, three soft-shell clams, or one oyster per square foot, then they consider the ground productive and it cannot be used for private aquaculture. This policy limits the amount of area aquaculture can expand into, therefore limiting the opportunity for economies of scale that motivate consolidation in the first place. Speaking to this, a shellfish manager from Cape Cod, MA explained, *"it really limits the amount of growth that you can have in any given area, and even though we have a little over 100 miles of shoreline in this town, we have very small pockets in which aquaculture growth could exist."* In Virginia, 240,000 acres of state waters, known as Baylor grounds in the namesake of James Baylor who originally proposed this policy in the 1890s, are designated entirely for their public fishery that is open

to any commercial shellfishermen. The Baylor survey, conducted in the 1890s, surveyed Virginia's waters for productive oyster reefs, and resulted in the designation of productive grounds for indefinite public use, protecting them from being privatized. A staff member from the Virginia Marine Resources Commission speculated that the Baylor grounds may limit the amount of consolidation in the state because the public fishery creates opportunities for independent watermen to make a living without facing the high costs of purchasing their own seed and grow-out equipment.

*1.1.4 Municipality jurisdiction over aquaculture*

In Massachusetts, each individual municipality has jurisdiction over the shellfish resources, including leasing of shellfish aquaculture sites. Stakeholders agreed that this policy greatly inhibits the potential for consolidation, as many towns choose to prioritize small farms and equal opportunity for residents to pursue aquaculture over the efficiency and profitability associated with fewer, larger corporations. A staff member of the National Oceanographic and Atmospheric Administration (NOAA) explained that, *"in Massachusetts and other states where there's municipal rule, where they limit eligibility to residents or to state-permitted or licensed corporations, it makes it a little bit more difficult to consolidate formally."* Giving jurisdiction over shellfish resources to municipalities inhibits consolidation by allowing towns to create regulations that fit their priorities, such as residency and eligibility requirements.

*1.1.5 Transferability and absentee leaseholders*

States and municipalities set policies for how shellfish aquaculture licenses can be transferred from one grower to another. Stakeholders emphasized that the nature of the policy can either allow for or inhibit consolidation of ownership, depending on how easy it is to

transfer a license. In Massachusetts, licenses can easily be transferred, but one person's name cannot be on multiple leases greater than 2 acres (with the exception of growers who leased larger acreage prior to the adoption of this policy in the late 1990s). Explaining how this allows for consolidation of ownership, a shellfish manager on Cape Cod, MA stated, *"it always starts off as the one person has the one parcel, and then they see who's interested in the business, who's not interested in the business anymore, and through a transfer are allowed to expand, just to people who have different names."*

Consolidation of lease ownership can also occur on a small scale through more informal practices, if regulations allow. A NOAA staff member explained, *"a lot of growers will find an absentee lease holder, and they'll say, 'hey I'll send my farm manager, I'll run that farm, I will basically do it all under your permit, and I'll give you ten cents on the dollar, because I'm doing all the work.' That's consolidation, and it's also a concern to a lot of people who want to get into the industry, because if you have a waiting list, or limited opportunities, it never really changes hands, and it doesn't provide that opportunity for someone new to come in, because I can just keep that lease in my name and have someone else run the company for me."* Policies that limit these kinds of transfers may in turn limit the amount of consolidation in a state's aquaculture industry. In Virginia, the Marine Resources Commission (VMRC) recently attempted to address consolidation by changing a law that allowed for easy transfer of leases. Leases in Virginia last for ten years, and used to be easily transferable between parties. A VMRC staff member explained that some corporations of growers would hold onto lease ground without growing any shellfish, transfer it to someone else they work with at the end of the ten years, and continue to hold onto that acreage without using it in order to keep that land from being leased by anyone else. The agency addressed

this issue by changing guidelines to require "significant production" on leases in order to legally meet the lease agreement terms. This policy therefore limits corporations from accumulating excess acreage that they are not currently using to grow shellfish.

*1.2 State's conceptual framework of purpose of aquaculture*

The way a state views the purpose of aquaculture within its borders influences the nature of its policies that create and regulate the industry. A state that prioritizes fairness to new and small growers may tend to choose policies that ensure owner operators and limit expansion, while a state that prioritizes production and economic value may choose policies that allow for expansion and consolidation.

*1.2.1 Fairness to new and small growers*

Some municipalities in Massachusetts form their aquaculture regulations around the idea that all residents should be able to participate if they so choose, and prioritize taking new growers off the waitlist rather than allowing existing sites to expand. This sentiment is also present in Rhode Island with acreage limits, and in Virginia with the exclusive use of certain grounds for public harvest. In Massachusetts, a bill known as the Cutler bill was proposed in 2019 in order to transfer some authority over shellfish resources and aquaculture from municipalities to the state. The proposed bill would have allowed shellfish licenses to be transferred to corporate entities rather than individual people, and would have eliminated the 15-year time limit on licenses, allowing larger corporations to bid on farms. While some of the larger aquaculture companies in the state approved of the bill, smaller growers felt their livelihoods were threatened, and organized and collaborated with state representatives to stop the bill. Describing the ethos of Cape Cod aquaculture, a staff member of NOAA explained, *"the idea is they can grow aquaculture that's consistent with the character of*

*their community, and what their community wants to see."* A shellfish manager on Cape Cod described the question managers face when determining policies, *"do we then change regulations to allow for growth, or do we address the people who have been waiting, some of them for well over a decade, to try to get into the business? So, it's a really complicated question in terms of growth here."*

*1.2.2 Resisting privatization of the commons*

Because aquaculture policy is essentially a question of how to manage the commons, states and municipalities' regulations may be largely based on their philosophy of how the commons should be used and who has the right to access its resources. Particularly in Massachusetts, many municipalities believe firmly in resisting privatization, and therefore limit the acreage available for each individual lease, which inhibits consolidation as there are few opportunities to expand, especially for new entrants. Expressing this, a shellfish manager on Cape Cod, MA explained, *"we have a number of large companies in town, but we also have oodles of small companies existing at the same time. And I think that the people of [town name] wanted to preserve that because… you're taking that land out of public domain and letting somebody use it for private benefit. And when you only let one or two people do that, is that really fair to all of your constituency?"* Towns with this mindset therefore choose regulations that limit the potential for consolidation, in order to create the opportunity for anyone interested to grow shellfish on a small-scale. The Baylor grounds' public fishery in Virginia is another example of a state prioritizing public use of the commons. Governed differently from the rest of the state's waters, the Baylor grounds are protected for use by licensed commercial wild harvesters only, and not to be leased for private ownership or rentership. Expressing this sentiment, a VMRC staff member explained that the public

grounds were created to avoid individuals privately profiting off of resources that should be accessible to every resident. Another staff member stated that they believe the Baylor grounds keep smaller growers economically afloat in the industry, reducing the opportunity for consolidation. Similarly, in Maryland, the Haman Act was passed in 1906 which called for a survey of naturally productive oyster bars, in order to identify other areas suitable for aquaculture leasing. Charles Yates carried out this survey and determined 100,000 acres that would be kept in the private fishery, and 200,000-300,000 acres that would be designated for potential leaseholders.

*1.3 Viability of alternatives to consolidation: grower cooperatives*

As discussed earlier, regulations designed to be fair to new and small growers, such as limits on lease size, may prevent consolidation within the aquaculture industry. However, they also can create potential inefficiencies for growers who are unable to scale up their operations to capture efficiencies of scale. A staff member of the Virginia MRC explained that aquaculturists can remain small and be successful while making a modest profit, or they can expand their operations and vertically integrate to capture efficiencies of scale and increase their profits. He highlighted that the most financially precarious situation occurs when growers are in the process of trying to scale up their operations, and may be in a great amount of debt from purchasing refrigerated trucks, or building a hatchery or wholesale facility. Aquaculture cooperatives are designed to assist growers in avoiding this issue by pooling resources together to vertically integrate in a cooperative manner. Aquaculture cooperatives help growers market their product, and provide advantages that bolster their profitability. While cooperatives may not directly inhibit consolidation, by giving small

growers the tools they need to be successful, they limit the number of growers that would be looking to sell their farms to larger companies.

*1.3.1 Market share and marketing assistance*

Aquaculture cooperatives, whether they are strictly marketing cooperatives or more inclusive of the entire seed to table process, aid small growers with the difficult aspects of marketing, allowing them to maintain consistent contracts with restaurants. Discussing the difficulty of maintaining restaurant contracts as an individual grower, a NOAA staff member explained, *"A small grower can often find it difficult to maintain contracts with restaurants… because one thing might impact their ability to make their orders. So, if you have a co-op, where if your product isn't available… you can have a consistent supply of a comparable, you know from the same growing area or embankment, product and grow in a way that you ensure the supply's there. Cause as soon as you can't meet the demand, they'll go somewhere else, and it's really hard to get that customer back."* Explaining how a cooperative allows growers to focus only on farm operations, a former marketing cooperative director said, *"the sales and marketing piece of this is really important, and not everybody's good at it… So, you know, it allows the guys who are really good at farming and being on the water to stay on the water and do what they do best, and not have to come home and deal with the marketing, and the chasing of the checks, and the permits, and the hassles of running the shop."*

In Maryland and Virginia, aquaculture managers explained a common occurrence of larger, more well-established shellfish companies co-oping with smaller, newer growers. In these types of cooperatives, the larger companies give small growers seed and agree to buy their product back at a fixed price, similar to a traditional shellfish aquaculture cooperatives.

A staff member at VMRC expressed that this business structure acted as an alternative to consolidation, in which larger companies were guaranteed a greater amount of product without expanding their lease, and without having to manage multiple farms as the farm operations are the responsibility of each individual grower. By allowing small growers to maintain their autonomy, the larger company can master the public health, shipping, and marketing side of the business. An aquaculture business specialist in Maryland explained that in order for an aquaculture cooperative to be successful, the way they market their product is essential. Explaining this, he said, *"The number one thing… is 100% of your production has to be sold through the cooperative. That is the number one thing that you have to start up, from the start. You can't sell what you can for a higher price and then dump what you can't sell on the cooperative, or your cooperative just won't work. It's got to be 100% of your production goes through the cooperative, or you're booted out of the cooperative."* In addition to all members selling 100% of their product through the cooperative, this interview participant also identified the need for successful cooperatives to expand to new markets. Describing this, he said, *"I think that if you're relying on the traditional shellfish markets, you might be in trouble, you need to start looking elsewhere. A lot of people are like, 'oh I'm going to sell to New York,' or 'I'm going to sell to Philadelphia.' They hit those traditional, along the coast, oyster markets, but there's a lot of people in the rest of the country that like to eat oysters that don't live in those areas. And we've heard that some of those more traditional markets are starting to get a bit saturated, at least when it comes to half shell product. If you can find other areas that aren't your traditional Northeast oyster market, then I think that you have a good shot. So, if you had a dedicated marketing person that could go out and look for those things, I think that it would help."*

*1.3.2 Consistent price and income*

Membership in a cooperative also allows growers a predictable price for their oysters, regardless of current market demand, and improves resiliency when the market is poor. Explaining how membership in a cooperative benefits growers economically, a staff member at NOAA said, *"there are times when the dealers are at the disadvantage in the market, when there's not a lot of supply, winter's a good example, and dealers will pay anything for an oyster. Whereas in the fall, there's so much product on the market, growers would be lucky to get 20 cents. In [the co-op] model, the grower can say, 'I'm always going to get 40 cents for my oyster, even if the market's at 60. I know in the fall, when it's at 20, I'll still get 40 cents.' And there's a lot of predictability that comes with that, you know it's very advantageous to growers and dealers."* In Rhode Island, one cooperative also purchases oysters from non-members, providing marketing services without the other benefits. When the Covid-19 pandemic hit and restaurants closed, the demand for oysters plummeted and growers were impacted financially. However, growers that were members of a cooperative in Rhode Island fared better than those that were independent or new to aquaculture. Explaining this, a Rhode Island Sea Grant staff member said, *"I think for Covid, the new growers really suffered because, well one, they couldn't prove sales from the previous year to get some of the relief fund, so that's a bummer. And two, they just didn't have the market channels set up, so they didn't have those strong relationships with the Co-op."*

*1.3.3 Access to Resources*

Membership to an aquaculture cooperative can help growers to save money by splitting costs on seed and equipment, and give them access to resources they may not have otherwise been able to afford. Explaining how his marketing cooperative benefited its

original six members, a former cooperative director in Rhode Island said, *"what we find is that the costs of running the shop are vastly larger than any of the members really anticipated. And it took them a couple years to really come around to the fact that this is just the cost of doing business. Now you can do 6 different dealer shops, and each have a dealer's permit at $500/ year and all these associated costs and inspections and everything else, or we could all team up together."* Specifically, members of a cooperative can pool money to purchase large seed orders at discounted prices, refrigerated trucks for storage and transport, and a wholesale facility. A staff member of the VMRC also added that many small growers do not have the upfront infrastructure in place to meet health department sanitation requirements or to meet the demand quotas of larger contracts. He explained that working cooperatively either in an organized aquaculture co-op, or growing for already established oyster companies on their individually-owned lease can provide access to expensive refrigerated trucks and on-land refrigeration facilities for small individual growers. In Maryland, the philanthropic Ratcliffe Foundation is currently constructing an oyster hatchery to support the Maryland Seafood Cooperative, as well as other growers. A staff member of the University of Maryland Extension Office explained, *"that's largely where a lot of that production is going to go, into the Co-op. And the idea there is those oysters would come back through the Co-op and be marketed, probably branding and marketed."*

*1.3.4 Maintaining autonomy*

Another important benefit of aquaculture cooperatives identified by participants is the ability for small, independent growers to reap the benefits of vertical integration while still maintaining their autonomy over their farm. A staff member of the Maryland Sea Grant described this benefit in the context of the Maryland Seafood Co-op. Explaining how the

strategic advisor of the Co-op views the role and purpose of the Co-op, she explained, *"he's very much thinking along these lines of continuing to empower the growers to be their own boss, have their own schedule, have their own operations, and yet kind of using this co-op to share resources, gain additional buying power, and kind of leverage some of those resources, and leverage their collective impact as opposed to just acting as disparate actors."* Demonstrated here, the co-op model offers growers the benefits associated with consolidation and vertical integration without the loss of autonomy or increased debt to corporations, as has been seen in other agricultural industries as a result of consolidation.

### *1.4 Informal and Formal Growing Partnerships*

Many growers may choose to form partnerships with others in order to improve efficiency and reach economies of scale. These partnerships may take the form of an informal handshake agreement, or a more formalized, legal partnership. Similar to aquaculture cooperatives, growing partnerships do not directly inhibit consolidation, but instead provide the tools and resources to support small growers and allow them to maintain autonomy over their farms.

#### *1.4.1 Securing clients*

Newer growers with a limited amount of product and fewer industry contacts may initially struggle to find clients. However, working collaboratively with other growers may allow them to produce quantities great enough to appeal to larger clients. Expressing this, a staff member from the Maryland Department of Natural Resources explained, *"some smaller operators, or newer ones, they're not able right away to find a really good market for their product, maybe because they don't have the quantity yet to get a big client, or a steady client. But when they work with other nearby growers, maybe in the same river system or county,*

*together they can provide enough of that volume where they could, between the two of them, secure a more reliable client."*

*1.4.2 Dealer permits*

In states where not all leaseholders are also certified shellfish dealers, partnering with another grower who is certified can open up more opportunities for marketing and distribution. A staff member from Maryland Department of Natural Resources explained, *"not all of our leaseholders are also dealers, seafood dealers, so unless they're selling to certified dealers, they have limitations in the ways that they can market and distribute their product. So, because of that, some of our folks found themselves in a situation where, if they couldn't sell to a dealer, they couldn't just go to a farmer's market or a direct ship, or some of those other ways that people started being able to reach out during Covid that kept them alive. So, they had to partner up with folks who did not have those limitations, and move product that way."*

*1.4.3 Purchasing facilities*

Participants in Rhode Island highlighted a partnership of three small growers who purchased a marina facility on the banks of the coastal salt pond where their leases are. Explaining the benefits of this arrangement, a staff member of Rhode Island Sea Grant said, *"they ended up buying a marina that's on the banks of the pond… And they co-manage it, and run it, and it's a benefit to their business because then they can decide when and how they have access, and they get the additional fees from the recreational boats."* In addition to purchasing a marina, those same growers also built a hatchery to produce seed for themselves and to provide additional income from seed sales. A staff member of the Rhode Island CRMC explained, *"well there's two growers that came together and bought a marina*

*facility, and also worked together to establish a hatchery there. So, they, in a way, have kind of come together to share the costs and burden of seed production. And also to sell some of their seed."*

*1.4.4 Sharing lease sites to take advantage of best growing waters*

While informal partnerships may assist new growers in securing clients and marketing their product, a formalized legal partnership may open up even more opportunities for small growers. A Maryland DNR staff member offered an example of two growers forming a legal partnership with a business name while still retaining their individual leases as separate entities. The staff member expressed the benefits of this arrangement, *"so the one party has two leases in one river system that tends to be fresher, and the other group has about five or six leases that are further down into more saltier water and kind of spread around a couple of different places. So, they're operating under one broader company name, but they're individually still responsible for all the reporting and different things that leaseholders do, but they're moving product between leases cooperatively from nursery to grow-out to take advantage of the best growing waters. So that ends up that the oysters are going between leaseholders to these different leases, but they're being sold under that one broader business name now. And it so far had ended up being quite a successful endeavor for those groups to do it that way."*

*1.4.5 Improving recognition and quality of state's unique oysters*

While it may first seem that working cooperatively with other small growers may be counterproductive because each grower is competing for market share with a similar product, a staff member of the Maryland DNR expressed that these partnerships actually benefit all involved and help to increase recognition of the state's unique oysters, therefore increasing

demand. Explaining this, they said, *"there's competition obviously because you want to sell your product, but there's also a really strong sense of 'we're all in this together sometimes.' And if we can all boost the recognition of Maryland oysters and the quality, and help each other cut into that market share for Maryland as a whole, the better that we all do. So, while it's counterintuitive to think that you help your neighbor leaseholder because they're competing with you, it really doesn't seem to play out that way in real life."*

*1.4.6 Managing large/multiple leases*

Both formal and informal partnerships between growers and commercial harvesters can be essential in improving the viability of large lease sites that are privately owned and operated by a single grower. Expanding to larger leases helps growers to be more profitable, but also leads to additional challenges such as a lack of sufficient time and labor. To combat these challenges, some growers in Maryland have formed partnerships with commercial harvesters who assist leaseholders while the wild harvest season is closed. Explaining these mutually beneficial relationships, a staff member of the University of Maryland Extension Office said, *"we have one grower who, he's got like 600 and some acres of bottom culture, and he's only got his one boat, he can't do it himself. So, he hires commercial watermen when the wild season's closed, and pays them a flat rate per bushel that they harvest off of his leases, to help him."* Partnerships such as this allow growers to increase production and be profitable without risking bankruptcy or needing to sell their business.

*1.4.7 Sharing knowledge*

In addition to sharing resources and labor, partnerships between growers can facilitate the sharing of practical knowledge between those familiar with the industry and those that are new to it. A staff member of Maryland Sea Grant explained a mentorship program that pairs

new and veteran growers together, *"they have a program where they pair veteran growers that have been doing this for five, ten years, they pair them with new growers, and it's kind of like a mentorship program. And so, through that, some of these guys have really gotten to share a lot of information, and then also… it also helps the growers to not have to reinvent the wheel every time… And so, through that they just mentor the new growers, teach them everything about, you know, what you have to think about before a big winter Nor'easter comes through, to thinking about how you're engaging with restaurants or wholesalers on the marketing side. So, it seems to have been really helpful for those who have engaged in it."* This type of mentorship program increases the likelihood that new and small growers will be successful, as they can learn from seasoned growers how to navigate all aspects of the shellfish aquaculture industry.

*1.5 Aquaculture Training and Assistance Programs*

Programs that assist new and smaller aquaculturists may also indirectly inhibit opportunities for consolidation by increasing the viability of small, owner-operator aquaculturists. Programs may instruct growers about new gear types, facilitate networking and partnerships, and reduce excess costs through crop insurance and biotoxin monitoring programs.

*1.5.1 Expanding agricultural agency programs to aquaculture*

A staff member at NOAA explained that federal agricultural agencies have expanded programs to include aquaculture, including grants for food safety and crop insurance to help with the unpredictability of growing shellfish. Explaining the connection between these programs and consolidation, he said that without these assistance programs, *"…those costs would likely go onto the aquaculturists, and that would certainly push for consolidation,*

*because most folks couldn't afford it. A big company would end up buying them out."* In Rhode Island, an example of a United States Department of Agriculture (USDA) program expanded to support aquaculturists is the Natural Resources Conservation Service (NRCS) Rhode Island Oyster Restoration Initiative. Looking to restore natural oyster reefs, the program purchased oysters that had grown too large from participating growers. Explaining how this program helped growers get through the early stages of the pandemic, a staff member from the Rhode Island Coastal Resources Management Council said, *"it was a tough year for a lot of folks. One of the things that really saved a lot of farmers was the NRCS program, restoration initiatives. They actually paid farmers for their oysters if they were too big, if they were large enough they would use them in reef restoration projects. So, they're able to actually get some money for product they couldn't sell, that had actually grown beyond its prime, but was now reproductively mature and suitable for restoration. So that was a big deal. They planted like three quarters of a million oysters."*

In Maryland, the Maryland Agriculture and Resource-Based Industries Development Corporation (MARBIDCO) is a state agency with programs to support many livelihoods, including oyster aquaculture. MARBIDCO runs a low-interest loan program, allowing growers to borrow up to $300,000 to get a lease and equipment to start their oyster farm, which interview participants from Maryland identified as being essential in helping new and small growers start farms and remain in business. Explaining how the program keeps small and new growers in business, a staff member of the University of Maryland Extension Office said, *"we've had growers say they wouldn't be in business without it. We've had growers that have taken advantage of it multiple times, and maxxed out the amount they could borrow from it. And they went back just because, and they couldn't get the debt forgiveness, but they*

*could get the no interest portion that helps them out a lot. Because with oysters, it's not like I can make an oyster today if I plant it today, you know? It takes a couple years. But if you look at the paper that we published, if you utilized the MARBIDCO funding over the ten-year simulations that we had, your net present value and rate of return were better with MARBIDCO funding than if you borrowed from a traditional bank, or if you used all your own money, and that's because of the debt forgiveness portion of it. It's part loan, part grant. So, it's been very useful, I believe, for our growers."*

*1.5.2 University-run programs*

Universities and Sea Grant extension offices were highlighted by shellfish managers and regulators as running training and assistance programs that support small and new growers, giving them additional resources to be successful and profitable. In Maryland, the University of Maryland and Maryland Sea Grant extension office have held aquaculture training programs for decades, according to a staff member of the Maryland DNR. These programs teach growers how to do remote setting (settling of hatchery larvae to produce spat on shell for planting oyster grounds) and provide access to setting tanks for up to 2 weeks at a time per grower. Explaining this, she said, *"you bring your own shell, and they teach you how to do it, with the idea being then you can reserve that in future weeks on your own and just do it. And that has really, really boosted people's ability to not rely on purchasing material from out of state, but it also has fostered a lot of cooperative work."* In addition to providing access to remote setting tanks, Maryland Sea Grant offers free consultations for prospective and current leaseholders, with specialists to offer guidance on gear types, business planning, and sanitation and safety protocols.

Another support program exists at the University of Maryland Horn Point hatchery, where they maintain a demonstration lease in which they utilize various types of aquaculture gear and provide opportunities for growers to learn about gear types and practice using them, which helps new growers choose what gear would work best on their own lease. In addition to providing access to resources, a Maryland DNR staff member explained that training programs also provide networking opportunities for growers to meet each other, and have led to successful partnerships.

*1.6 Direct marketing*

Participants interviewed explained that small growers that have been able to maintain their independence and be financially successful have formed loyal relationships with restaurants, and a select few have created their own farm to table restaurants to sell their own product directly. Explaining this, a staff member of the Rhode Island Department of Environmental Management said, *"So I think they've started off at an early stage by making connections with certain restaurants, and those restaurants kind of become loyal to them, and stick with them, and so they've just been able to move a lot of their product that way. Some of them participate in farmers' markets, and are able to make some profit that way."* Participants explained that a grower having their own dealer permit helps to speed up the process of selling product to restaurants, rather than having to work with a separate dealer. Expressing this, a NOAA staff member said, *"There's a massive advantage if I am also a dealer and basically purchase my product from myself as a grower and then sell it wholesale or retail. I can control the prices, I can decide the market's low, I'm not going to harvest. You have a lot of flexibility. You don't have to basically take what the dealer will offer you."* In a few cases, participants mentioned that the most successful small growers they knew

owned and operated their own small restaurants, meeting a niche market demand of farm to table oysters. Specifically, the Matunuck Oyster Bar in Rhode Island was highlighted multiple times for its owner's success in growing seed, bottom planting oysters, running a land-based organic greenhouse, and selling his product in his own restaurant. A staff member of the Rhode Island DEM explained, "*you might have heard of the Matunuck Oyster Bar here in Rhode Island. Yeah, so he has a restaurant where he pretty much is able to just move all his product to his restaurant, he sells it elsewhere too. So that makes it a much easier, so because of that they haven't really had to consolidate their operations at all."*

*1.7 Desire for independence*

Growers expressed a big factor limiting consolidation is their desire for independence and their willingness to endure financial hardship in order to keep their farms and maintain their autonomy. Explaining how this limits opportunities for consolidation, a former grower and current aquaculture advocate said, *"when I think of consolidation, it's one farm buying another. And that means that somebody wants to sell. And what we're seeing is that these highly independent people, and I'm not saying that these are traits that are good or bad, but I see them in myself, you know, stubborn, pig-headed, absolutely refuse to die, under any circumstances will not cave in and admit failure, despite years of… you know, I had an oil spill where I couldn't sell any product, I had 9/11, my first year in the black I lost everything. Any rational person would have given up, but in many cases, especially for some of these small, new growers, I suspect that they're cash negative and it's a lifestyle choice. And they just are committed, and really enjoying it."* Going further, he explained that growers who want to maintain their independence must plan to endure financial hardship often, and stated that many are comfortable doing so, *"the thing about this industry is that any farmer,*

*especially a shellfish farmer, has to be really able to weather losing everything every ten years, whether it's a disease, a hurricane, or some calamity. If you aren't building that into your business model, then you're planning on failing."*

*2. Factors that enable consolidation*

Through interviews with aquaculture managers, regulators, and industry members, the following subsections were identified as factors that either directly or indirectly create opportunities for consolidation of ownership and market share in the shellfish aquaculture industry. These factors reduce the ability of individual growers to be economically viable on their own, increasing the likelihood that they would sell their farms to a larger corporation more equipped to take on the following additional costs.

*2.1 Lease policy and regulations*

The oyster industry in Virginia has experienced the most consolidation of ownership and market share in comparison to the industries of other states with participants in this study. Staff members of the Virginia MRC identified the regulations that shape the industry as having the greatest influence over the level of consolidation they have experienced thus far. In addition, Maryland legislators overhauled their lease laws between 2008 and 2010 in order to remove restrictive barriers to entry and encourage growth. While growth is not necessarily synonymous with consolidation, and Maryland's industry does still have a large number of independently owned and operated oyster leases, the new laws put in place prioritized ease of entry into the industry and the ability to expand operations. These are the characteristics of lease laws that create opportunities for future consolidation, similar to what has occurred thus far in Virginia.

*2.1.1 Low rent costs for leases*

Until 2019 when the governor and state agencies overhauled aquaculture lease requirements and regulations, the cost to apply for a lease in Virginia was $25, and annual rent was $1.50. These virtually nonexistent costs allowed companies to quickly accumulate extensive lease ground, regardless of whether or not they were actually growing shellfish on every acre. The low costs of acquiring acreage allowed companies to limit their competition by effectively boxing others out of viable grounds.

*2.1.2 Lease size and leaseholder qualifications*

In 2008 in Maryland, the state was interested in changing their aquaculture leasing laws in order to encourage growth and expansion within their aquaculture industry, which had been limited in the decades prior due to outbreaks of oyster diseases such as MSX and Dermo, and political resistance from commercial watermen who felt threatened by aquaculture. Explaining the motivation to change the laws, a staff member of the University of Maryland Extension Office explained, *"we basically went through [the lease laws] and looked at where all the problems were, and tried to wipe them all out. You could only have, in previous lease laws, you could only have one lease. Well leaseholders had figured out how to get around that generations previously. That went. There were minimum and maximum size acreage you could have. That went. There were bans on leasing in most of the Eastern shore counties, the watermen had gotten through the legislature one by one. Those went out. There was a ban on corporations holding leases, as the attorney general who worked with us said, that's illegal under MD law. That went."* In addition to removing limits on lease size and restrictions against corporations, Maryland also chose to begin allowing non-residents to hold leases as well. A staff member of the University of Maryland Extension Office explained, *"The interesting discussion was when we got into should we allow non-residents*

*to lease in Maryland? And the gut reaction from everybody is 'hell no, Maryland for Marylanders, let them go somewhere else'… And the discussion became one of, 'oh what if someone from Philadelphia wants to have a lease in MD?' And I looked at it and said, 'well, it would be legal for someone in Garrett County, Maryland to have a lease, they're four hours away. Philadelphia's only about an hour and a half up the road. Yeah okay, that's gone too.'"* Another staff member of the University of Maryland Extension Office explained how these policies make consolidation easier, *"if there's smaller farmers that might decide they want to get out of it, it might help because you don't have to worry about, 'oh I'm going to get that 20 acres and I'm going to be over my cap now'. Somebody could come in and then purchase it, or purchase the business, so to say, if they wanted to. I think that they've done a pretty good job of making it easy."*

*2.1.3 No requirement to prove production on a lease*

Until 2019 when the governor and state agencies overhauled aquaculture lease requirements and regulations, leaseholders in Virginia were not required to prove shellfish production on a lease, and could hold onto massive amounts of acreage without farming shellfish. A staff member of the Virginia MRC explained her belief that this policy loophole allowed for the level of consolidation of ownership and market share that Virginia's oyster aquaculture industry has experienced. In order to limit the potential for lease grabbing and consolidation, laws were put in place that required growers to prove they were actively using their lease. Similar laws exist in Maryland, a staff member of the University of Maryland Extension office explained, *"we created an active use program, so it's a public resource and it belongs to all the people in the state of Maryland… So, if you're going to lease it, you have to use it. And we have criteria for that. You have to file a monthly harvest report, whether or*

*not you harvested from that lease in that period. Annually, when DNR sends out the bills for the next year's lease, they're very low rates, they have a whole form that goes with that, you have to, what have you done with it, how many days have you worked it, have you put any shell on the bottom, what seed and other things have you put out there."*

*2.2 Public health requirements*

The public health regulations from the National Shellfish Sanitation Program (NSSP) in regard to vibrio and proximity to mooring areas can be financially and physically taxing on small growers, stakeholders report. Vibrio, a bacterium naturally occurring in marine coastal waters that can contaminate shellfish and cause Vibriosis, an intestinal disease, when consumed by humans. In order to limit the chance of contamination, strict regulations are put in place by the NSSP, including keeping shellfish on ice shortly after harvesting them, and properly refrigerating them until they reach the consumer. While these regulations are important for public health, they can be economically and temporally costly for growers, and may indirectly create opportunities for consolidation due to the difficulty for an individual grower to meet requirements. Expressing this, a shellfish constable from Massachusetts explained, *"We have two areas in the state, the Plymouth Duxbury Kingston area, and Edgartown on Martha's Vineyard, that have more stringent vibrio controls. Like they have to have their product on ice within an hour of exposure, whether that exposure is harvest from a subtidal site, or the tidal exposure in an intertidal site. So, an hour goes by fast, especially depending on how long it takes for you to, how offshore your site is. We do have some pretty vast tidal mudflats, so to have people have the ice with them at their site, sometimes the logistics can be very burdensome."* In order to keep up with increasingly stringent public health regulations, growers may seek assistance from larger corporations that are better

equipped to handle the logistics, potentially increasing opportunities for consolidation. One oyster company owner explained how the scale of his company allows him to meet requirements, and how a smaller grower may struggle, *"You know, when our guys go out in the boat, they've gotta have their life jackets on, it's much more, like the vibrio issues, you've gotta pay attention to that because it's very important. A lot of these little guys, they absolutely don't pay attention. I'm shocked that we don't have more problems, quite frankly."*

In addition to vibrio compliance, the NSSP has reclassified areas approved for shellfish harvesting in Massachusetts to conditionally approved due to proximity to mooring areas, which significantly limits the harvesting and growing season that is allowed by law. A staff member from the Massachusetts Division of Marine Fisheries (DMF) explained, *"we have some growers in some sites that are going to be impacted by mooring area reclassification. And so, in some of those cases that classification to conditionally approved is going to mean that they're going to get closed down during the summer when the boats are in the water. And so, speaking with some of those, they're not happy about it. You know, there's water quality sampling done there, and the water quality sampling suggests that there's nothing wrong with the water quality, but you know, the NSSP, is concerned about the threat."* Losing the ability to grow in those summer months may severely impact the amount of product a grower is able to produce, thereby lowering profits significantly and creating opportunities for consolidation when a grower is no longer able to operate their farm.

*2.3 Cost of operation and competitive pricing*

Stakeholders reported that the cost of scaling up farm operations to the point at which growers become significantly more profitable may be too high for small growers to successfully scale up without consolidation. A staff member of the Virginia MRC explained that small growers may be successful working alone and making a marginal profit, but when they attempt to expand their farms to increase profits by investing in more gear, refrigeration, and marketing, they may struggle to meet those upfront costs. Also expressing this, an oyster company owner in Massachusetts explained, *"You'll see someone that has four acres, you know, he's got his wife and himself. And what happens is they get six acres or eight acres, and then they realize they can't really take care of it… Because, it's not easy work, first of all, and as you expand, it's just more gear, more work, more sales, you know, just more, more, more, more, more. And pretty soon you get overwhelmed. So, you can either be small, like I know a couple of guys. They're retired, they like the business, they have their little grant, they sell their oysters, they're very happy. Cause they're retired, they've already got a pension, so they keep it small. You can either be small, or big, there's no in between. You've gotta have a facility, if you have a facility now you gotta have a truck, refrigerated truck. Refrigerated van is $75,000, it just becomes, it's a different business."*

An interesting example of the benefit of the connection between having the resources to remain profitable and consolidation was reported by staff members from the Virginia MRC. In the 1990s, the oyster industry on the east coast was hit hard by parasitic diseases including Multinucleated Sphere Unknown (MSX) and Perkinsus marinus (commonly referred to as Dermo). During that time, many farms in Virginia let go of their leases, as the mortality rate of their oysters was so high they could not make a profit. Seeing an opportunity, a few corporations took up many of the formerly productive leases that had been

let go, consolidating ownership of lease grounds, and eventually market share of the oyster industry as the industry recovered in the early 2000s. A similar phenomenon occurred in Maryland, a staff member of the University of Maryland Extension office explained, *"Once the industry died, a lot of those leases were vacated. But we had people who'd come back and taken those over, and have renovated the shell base that was in there, and now they're planting with hatchery seed… It was very interesting to me that the ones who basically came in and got involved in the water column leases were entrepreneurs from other businesses. They got interested and they came in, they had a strong business background, and learned the techniques for producing oysters."*

*2.4 Push to maximize production*

A staff member of the University of Maryland Extension office described how new and advanced technology and the mechanization of culture techniques could allow for a great expansion of oyster aquaculture. Explaining this, he said, *"I mean what I would like to see, quite honestly, is a return to highly expanded bottom culture. I'd like to see us parallel the poultry industry, quite honestly, have tens of thousands if not hundreds of thousands of acres in cultivation, using hatchery technology, advanced breeding and selection for oysters. One of the projects that we got funded last year by USDA, it's a five year $10 million project, to bring advanced technology in robotics into bottom culture of oysters. Better planting, better harvesting, better monitoring of the crop, to kind of parallel where agriculture is, move us from the 19th century to the 21st. And if you can get to that point where you're doing very high volume production of oysters, then you get into, then we can go into mechanized, and how do you get them out of the shell cheaply, how do you process those products. I keep telling our growers, I want to see Wendy's and Popeye's and Burger King fighting over*

*who's got the best oyster sandwich."* While this quote reflects only one person's goals for an oyster industry in which production is maximized, this sentiment may be held by others at any level within the industry. The push to maximize production to the extent given by the quote would likely also call for vertical integration and consolidation of businesses in order to achieve such a large scale. In other industries, such as the poultry and dairy industries, these kinds of production maximizing efforts have put individual small farmers at great disadvantages, in which they take on all the risk of going into debt to raise the product, while the consolidated companies that handle processing and distribution reap the financial benefits.

## Discussion

While the literature on trajectories of consolidation in agricultural industries does not explicitly connect to similar developments in aquaculture industries, the factors influencing consolidation remain relevant and of interest across sectors. Researchers explained that governance and policy have a major impact over which actors are successful in agricultural industries (Bruckner, 2016; Farina, 2002), which was also reflected in my own results from interviews. States that experienced the most consolidation in their oyster aquaculture industries were those with historically less restrictive leasing policies, and policies that in particular allowed for large corporations to acquire greater amounts of acreage. Additionally, states that allow leases to be transferable have experienced consolidation due to the ability for highly capitalized corporations to offer higher bids on available lease sites than small-scale growers. The impact of policies allowing the transfer of leases has also been documented in the New Brunswick, Canada salmon aquaculture industry, in which sites

previously used for the herring weir wild fishery were effectively auctioned to the highest bidder to be used to grow salmon, leading to mass consolidation of site ownership (Knott & Neis, 2017). In New Brunswick, governing policies laid the foundation for monopoly control over the industry by showing support for expansion by entrepreneurs from off-island companies. This process disrupted traditional land tenure regimes and displaced small-scale resource users previously utilizing lease sites for wild capture fisheries (Knott & Neis, 2017; Marshall, 2001). Though occurring at a different scale, my research determined that similar policy choices in Virginia have also allowed for some consolidation of the state's oyster aquaculture industry. Prior to a change in legislation in 2009, leases in Virginia were easily transferable. Additionally, leaseholders were not required to prove production on their leases, allowing them to acquire large amounts of acreage and hold onto them without growing shellfish. This process blocked others from entering the industry, effectively committing the marine equivalent of land grabbing.

Literature documenting consolidation in salmon aquaculture in both Maine and New Brunswick, Canada also highlighted the impact major parasitic disease outbreaks can have on resulting industry structure and amount of consolidation. Sea lice and salmon anemia outbreaks in both locations led to mass exit from the industry by growers who could not withstand the financial hardship caused by fish mortality rates near 100%. Consequently, a small number of larger, highly capitalized corporations were able to acquire and stockpile leases, waiting until disease outbreaks had been controlled before starting to grow salmon again (Hanes, 2018; Knott & Neis, 2017; Stoll et al., 2020). Similarly, outbreaks of Multinucleated Sphere Unknown (MSX) and Perkinsus marinus (commonly referred to as Dermo) in the coastal waters of Virginia and Maryland in the 1990s were highlighted by

interview participants from both states as contributing to consolidation of ownership in their oyster aquaculture industries. As growers let go of their leases, a few corporations saw the opportunity to take up formerly productive leases with the hope of eventually capitalizing on them after disease outbreaks were controlled. Due to policies that allowed for the easy transfer of leases and no limits on the amount of acreage an individual or corporation could lease, the disease outbreak gave way to consolidation of ownership that both states are continuing to reckon with today.

Regarding the literature on factors that contribute to the success of small-scale producers, Cush and Varley (2013) describe low-profit margins that do not attract capital investment, the deployment of free household labor, state regulations that stimulate small-scale enterprises and buffer aquaculture from neoliberal forces at their expense, and cooperation as being the most important contributing factors. While low-profit margins were not explicitly identified in my interviews as inhibiting consolidation, stakeholders from Massachusetts and Rhode Island did mention the small-scale structure of their industries as limiting the potential for investment from larger corporations, as stricter lease limits reduce the ease of reaching economies of scale and widening profit margins. The deployment of household labor and willingness to endure financial hardship were thematic in interviews in relation to growers' desire for independence inhibiting the potential for consolidation. As mentioned in section 1.7 of my results, growers that highly value their autonomy are typically willing to withstand little to no profit for at least one or two years in order to remain viable in the future and resist being bought out or going bankrupt. Regarding the third factor of state regulations, policies that support small-scale growers and protect them from consolidation and the concentration of capital greatly influence their ability to be successful.

Influential regulations identified in my results include residency requirements, acreage limits, and the prohibition of lease and license transfers. While the impact of residency requirements and acreage limits on consolidation was implied in the existing literature, the allowance of license transfers was explicitly described by Renwick (2018) as contributing to consolidation in the Irish salmon aquaculture industry. In addition to state regulations, my results show the value of state agency-backed low-interest loan programs in improving the viability of small-scale growers as well. As described in section 1.5.1, the MARBIDCO low-interest loan program allows growers to borrow up to $300,000 with a below-market interest rate. Research on the loan program has shown that growers who utilize it had significantly higher net present value and internal rates of return compared to self-financed and conventionally financed farm operations (Parker et al., 2020). The fourth and final success factor identified by Cush and Varley (2013), cooperation, was also present in my results. Cooperation through formalized grower co-ops, and informal growing partnerships between leaseholders contributed greatly to the ability of small-scale growers to be successful in all four states.

In the literature on aquaculture co-ops, major benefits received by members include greater profit margins reached by collectively obtaining economies of scale by pooling harvests, resource sharing, and joint acquisition of technology and infrastructure (including hatcheries, refrigerated trucks, wholesale facilities, etc.) (Cush & Varley, 2013; Hasan et al., 2020; Walsh, 2020). Aside from these benefits, my results identified the additional advantage from co-op membership of growers maintaining their autonomy over their own lease site. Maintaining autonomy and independence from corporate control is very important to small-scale growers, according to interviewees. Because of this, co-ops have the potential to become a viable alternative to consolidation, allowing growers to collectively reach

economies of scale while simultaneously retaining personal control over their individual farm operations. By joining a co-op, growers have access to a reliable income, steady clients, marketing, and expensive resources at all stages of the supply chain, which are also the typical benefits associated with consolidation. The cooperative structure of grower co-ops, however, distributes these benefits to many small-scale producers, rather than to the select few individuals in power of a small number of corporations. Informal partnerships between leaseholders also cannot be discounted, as the benefits from this form of cooperation have been documented in both my results and existing literature (Cush & Varley, 2013). As mentioned in results section 1.4, informal partnerships offer small-scale growers the tools to better secure clients, sell their product if their partner has a dealer license, pool resources to purchase facilities, share lease sites to rotate product, improve consumer recognition of product from a particular area, manage large or multiple leases, and share industry knowledge. Similar to a formalized co-op but on a different scale, informal partnerships between growers provide them the benefits from scaling up production while preserving their autonomy and independence.

Another unique factor inhibiting consolidation identified in my research is the importance of university and non-profit-run training programs in supporting and enhancing the financial viability of small-scale growers, which was not previously mentioned in existing literature. These programs, mainly run by Sea Grant extension offices through universities, offer growers expert advice on shellfish biology, gear and grow-out techniques, public health compliance, and business/marketing strategies. These programs are free to growers and allow them access to seasoned industry knowledge and advice that would otherwise be unavailable to most. Extension of similar programs to new areas would likely

assist in the expansion of shellfish aquaculture, while also indirectly inhibiting the potential for consolidation by decreasing the likelihood of small growers being bought out by larger corporations. Additionally, small growers directly marketing to restaurants or consumers themselves was uniquely identified by my results as lessening opportunities for consolidation. In order to market directly, growers must purchase a dealer permit, which costs around $500 annually, and may require additional training and/or inspections. By acquiring a dealer permit and establishing relationships with clients, small growers can reach a higher level of self-sufficiency and become less reliant on outside sources to purchase and market their product. This option may function as an alternative to joining a co-op, as co-op membership does not require a dealer permit because all products are, in most cases, marketed exclusively through the co-op.

It is important to note that in dominant discourse on aquaculture expansion, it is touted as a manner of increasing employment and improving livelihoods in rural, coastal communities (Campbell et al., 2021; Stoll et al., 2019). However, this has not always been the case, as has been documented in my literature review and results section. Expansion that is not guided by development goals and corresponding policies to ensure that economic benefits and overall wellbeing enhancement are directed to coastal communities will likely result in consolidation at the expense of small-scale producers. Interviews with state management agency staff members revealed that policies and programs that support the proliferation and success of small-scale growers do exist and are utilized in some aquaculture industries. However, they are rarely aligned with a strategic development plan complete with goals for industry structure and the metrics to measure attainment of those goals. These findings demonstrate the importance of states and municipalities in being proactive to

determine development goals for their aquaculture industries, and creating strategic plans to meet these goals accordingly.

## Conclusion

While I believe the results of my research to be significant, gaps in our understanding of trajectories of consolidation in aquaculture still exist. My findings reveal the many complicated factors at play in influencing the amount of consolidation occurring in aquaculture industries. However, they also introduce complexities and new questions regarding the costs and benefits of policies that restrict industry growth to only small-scale producers. For example, two and three-acre lease limits in oyster aquaculture on Cape Cod were highlighted as heavily inhibiting the potential for consolidation. On the other hand, even small-scale producers expressed disdain for the policies and argued that the physical costs of labor associated with trying to make a living on such a small lease have great consequences for growers. This raises the question of how to determine the ideal lease size, as well as other governing policies, to allow small growers to thrive while still inhibiting the potential for consolidation and monopolization of the industry. While my results do not answer that question, I believe that they lay the foundation for further scholarship and discussion amongst researchers, managers, and growers themselves to find solutions. At the very least, it is my hope that my work highlights the reality that unguided aquaculture expansion does not necessarily benefit the people living in rural, coastal communities as it is often promised to. While the economic benefits of consolidation are real, they are typically not distributed to the communities supporting the industry themselves. An argument can be made that consolidation creates jobs for growers that solely want to grow shellfish without

business or management responsibilities. However, evidence from my results demonstrates that growers highly value their independence and ability to make decisions about their farm operations themselves, revealing that benefits of consolidation that come at the expense of small growers' autonomy are outweighed.

While I recognize that I do not have management experience and am informed solely by the results of my research and literature review, the aim of this study is to provide recommendations to guide development of emerging shellfish aquaculture industries in Maine. Based on my findings alone, I offer the following ideas moving forward:

1. Prohibit the easy transfer of aquaculture leases and licenses among parties. This measure would help to inhibit the potential for consolidation by eradicating a potential market for leases and licenses resulting in the highest bidders controlling all acreage sited for aquaculture.
2. Require all leaseholders to prove they are using their leases to grow product on at least an annual basis. This policy would prevent leaseholders from holding onto and accumulating acreage without actually using it to grow shellfish. This type of "land" grabbing has been documented to result in consolidation of industry share in Virginia's oyster aquaculture industry, and should be proactively prevented through policy.
3. Create a working group of various stakeholders to discuss the current acreage limit a single individual or corporation may lease (100 acres). Pose questions surrounding reducing this maximum acreage limit in order to decrease the potential for consolidation in the future. Allow stakeholders to share views and come to

conclusions together, even if the ultimate decision is to continue with the 100-acre limit.

4. Offer support for both existing co-ops and encourage the establishment of new ones. This support should come through DMR, Maine Sea Grant, and/or other fisheries-related non-profits to support small growers collaborating together. Important programs to consider include shellfish biology, gear and grow-out techniques, public health compliance, business/marketing, and low-interest loans or grants. In particular, assisting co-ops with innovative marketing techniques to reach new customers may greatly enhance profitability and success of small growers with limited knowledge or resources to market their product alone.

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## Appendix A: Interview Questions

Semi-structured interview questions adapted as needed for participant roles.

1. Can you describe the structure of the aquaculture industry? Individual growers, small companies, cooperatives, larger corporations? Has that changed over time?
2. Which players have the most influence over the industry, and how has that happened?
3. Can you describe to me how the aquaculture industry in your state has developed over time?
4. How consolidated is the aquaculture industry in your state? (Consolidation: small growers being bought out by larger existing companies, small growers merging together to form their own companies)
5. What factors had the most influence in your industry's consolidation, or not?
6. How has your state government or DMR/DMF equivalent influenced the development of the existing aquaculture industry?
7. In what ways, if any, have federal policies (such as Trump's Promoting American Seafood Competitiveness and Economic Growth executive order) influenced the development of the aquaculture industry?
8. How have the growers themselves influenced the development of the existing aquaculture industry?
9. What are the most pressing challenges facing the aquaculture industry now and in the next decade?
10. Where do you see the industry going in the next 5-10 years, and where would you like to see it go?

11. From your perspective, what conditions or resources would need to change for the industry to go where you'd like it to?
12. How has the greater community (general public) responded to the growth of aquaculture in your state?
13. Is there anything else you'd like to add?
14. Is there anyone else you recommend for me to talk to?