

Chapter 2: Alaska Mariculture Development

The state of Alaska, with over 34,000 miles of predominantly undeveloped coastline, an established seafood industry, and culture of sustainable fisheries resource management is in many respects an ideal location for development of a robust mariculture industry. In turn, new mariculture operations offer Alaska's coastal communities a chance for jobs and economic activity that is often compatible with current seafood industry-related knowledge and infrastructure.

While potential for growth is high, as reported in Chapter 1 of this report, total mariculture commercial sales (almost exclusively oysters, clams, and mussels) remain below \$1 million per year with little sustained growth over the past few decades. Most mariculture activity in Alaska beyond oysters and mussels is in the research and development stage, with no other species in commercial production. The first material commercial harvest of kelp production in 2017 may mark an important mariculture milestone in an industry that has otherwise struggled to achieve its potential.

This chapter provides insight into barriers to mariculture development in Alaska, and opportunities to break down those barriers so the potential for a thriving mariculture industry in Alaska may be realized. These include barriers and opportunities related to:

- Initial entry into the Alaska mariculture industry
 - Knowledge Transfer and Information Resources
 - Access to Capital
 - Site Selection, Availability, and Access
- Operating factors
 - Seed Security
 - Infrastructure
 - Environmental Factors
 - Workforce Development
 - Access to Markets and Market Development
 - Regulatory Framework
- Research and development

The Alaska Governor's Mariculture Task Force advisory committees analyzed specific aspects of the mariculture industry to develop recommendations and priorities for the industry moving forward. The committee work is summarized and incorporated into this chapter, with complete lists of committee recommendations and priorities included in Appendix A.

Entry into the Alaska Mariculture Industry

Looking ahead, Alaska's mariculture industry may include a range of new entrants as production grows, from small and mid-sized independent businesses, to existing seafood processing companies, to industry participants from other areas, such as the Pacific Northwest, who may expand operations into Alaska. Each type of entrant may need to overcome a variety of barriers to operate in Alaska. This might include need for information on the biology, growing conditions, and factors impacting production of species; financing, site selection, and permitting; transportation and infrastructure; operating regulations; and markets.

Knowledge Transfer and Information Resources

Alaska mariculture industry participants, researchers, and policymakers have endeavored for decades to bridge barriers to successful mariculture business operation in the state. Such work has led to a wide-ranging, and still expanding, body of knowledge about species, operating models, and systems influencing mariculture operation outcomes. Such knowledge is extremely valuable for new entrants into the industry, particularly during business planning and permitting and loan application processes.

Information of interest to new entrants may include financing options, financial planning strategies, site selection parameters, gear and equipment choices and farm layout, logistics, growing and harvesting practices, labor requirements and training, marketing options, and other industry best practices. Consolidation of such information into documents accessible to new entrants and into training and professional development programs will assist with knowledge transfer important to growth of the industry.

ADVISORY COMMITTEE RECOMMENDATIONS

1. Mariculture Industry Literature

Publicly available manuals that document existing information useful to starting a mariculture business in Alaska will provide a means for researchers and experienced industry professionals to share information with new entrants. Such “how-to” manuals may be species specific and some may focus on more industry-wide issues, such as the logistics of business operations in remote locations.

2. Mariculture Professional and Business Development

An Alaska mariculture business development training program could help new producers apply for loans and develop business plans. The program, as currently envisioned, would include a set of training modules to develop skill sets and teach best practices to prospective operators and employees, and to enhance knowledge for those already in the industry. Such modules will build on current knowledge and materials developed by mariculture specialists in Alaska. A demonstration farm may be an effective part of this effort.

A certificate or credential for completing such a program may be useful for farmers in attracting loans and securing leases, and when recruiting and training employees. As many mariculture operations in Alaska are located in remote areas, an online distance-learning component to the training will be necessary. Additionally, from a workforce development standpoint, such a program would support and train existing participants in the mariculture industry as well as act as a tool for recruitment of new entrants.

3. Seafood Industry Outreach Program

Mariculture presents potential business diversification opportunities for Alaska seafood industry participants, including processors and hatcheries. While synergies between fishing and mariculture operations exist, information on compatible and conflicting operating conditions need to be better understood. Outreach to the seafood industry may help kindle interest in mariculture. Such outreach could be augmented by an informative map of mariculture sites and specifications as discussed below in the *Site Selection, Availability, and Access* section of this chapter.

4. Mariculture Business Planning Tools

A web-based tool, or series of tools, to provide information on the existing mariculture industry, including number of farms, years of operation, species grown, farm size, region, etc. For specific farm site available to new entrants, the tool would include capability for break-even analysis planning that can be used to explore the effects of farm scale, production intensity, scope, and location on financial viability of operations. A concurrent tool could provide risk management analysis to integrate consideration of production risk (survival, growth, etc.) and financial risk (input costs, price volatility, etc.).

Access to Capital

For some species, such as mussels, capital costs associated with specialized equipment may be prohibitive for small growers. Others find it hard to secure loans for species with long grow-out periods. There is a need for realistic loan programs that offer consistent and stable funding sources suited to mariculture operations.

ADVISORY COMMITTEE RECOMMENDATIONS

1. Investment Information

An information manual that may be helpful to new entrants into mariculture, as discussed above in the Knowledge Transfer section of this report, would be one that focuses on securing investment. The manual could include basic statistics, information on the regulatory process, identification and evaluation of potential funding sources, and other relevant information.

2. Analyze and Plan for Industry Capital Needs

Several public sources of funding currently assist mariculture operations. These include the State of Alaska Mariculture Revolving Loan Fund, Alaska Industrial Development and Export Authority (AIDEA) programs, and U.S. Department of Agriculture (USDA) loans.

The State revolving loan fund is currently not fully utilized, though additional, and perhaps more flexible sources of capital may also be needed as the industry grows. A first step toward understanding capital needs for a growing mariculture industry may be a closer analysis of existing programs to understand how they meet the needs of industry participants and potential entrants. Once industry needs are better understood, a combination of private and public sources of capital may be explored. Two options identified during the MTF advisory committee are private/public revolving loan funds and cooperative investment structures (see the following two recommendations for details).

3. Private/Public Revolving Loan Funds

A private/public revolving loan fund program to assist with mariculture business planning and start-up costs may provide revenue needed to help new entrants access the industry at a feasible scale. Such a fund may provide a flexible source of capital that can be used in combination with more conventional sources and help borrowers leverage additional funding from private sources.

4. Cooperative Investment Structures

Cooperative structures may enhance individual mariculture operations and the overall industry. This structure involves shared benefits and risks and may provide participants access to industry information and advancements, infrastructure, and markets that would otherwise be more difficult to acquire. Identified during the MTF committee process as a potential means of building financial resiliency in an emerging Alaska mariculture industry, a cooperative structure may also help counter barriers involving economies of scales, equipment needs, and selling product.¹

Site Selection, Availability, and Access

Availability and access to suitable sites for operations is a key factor in the success of a mariculture industry. Alaska's geography and limited infrastructure present significant challenges to often remote mariculture operations, especially related to transportation, high energy costs, and access to labor and markets. Additionally, environmental conditions for product growth and harvest are important, and often site-specific, factors for operators to consider when choosing a location for operations.

When choosing a site, operators need accurate and accessible information about the site, as well as a means of analyzing site specifications relative to their operation. A clear and accessible method to secure permits and comply with regulations for the site is also necessary.

¹ The Intertribal Agriculture Council may serve as a good source for development of a mariculture cooperative in Alaska.

ADVISORY COMMITTEE RECOMMENDATIONS

Information Resources

1. Interactive Information Map

The Alaska Department of Fish and Game provides resources for mariculture industry participants, including a handout on selecting a site for shellfish growers and maps with the location of existing operations. This information may be enhanced through development of an interactive map tool designed to inform site and species selection. Such a product, as currently proposed by Sea Grant, could provide information on ocean conditions, bathymetry, existing support infrastructure for processing and shipping, and other factors important to site selection. A comprehensive map of mariculture sites could also help identify research needs.

2. Access to Data

Whether part of the interactive map described above, or separately, public access to an active list of environmental data currently collected at mariculture sites will be useful to mariculture industry participants and researchers. A lack of open access to environmental data hinders the ability of mariculture operators to plan, select appropriate sites, and problem-solve. DEC has been developing an open data exchange/viewing site since April 2016. If completion of this site is not feasible within DEC resources, industry may be able to establish an authorized industry-wide database or assist DEC with creating one that can provide this service.

3. Expand Data Collection

Collection of physical and biological data that is currently not available may enhance site selection and mariculture operation success. Data necessary for site selection by species or production method of interest could include information to avoid areas with PSP, large wildlife populations, anadromous streams, higher freshwater influx, and other important factors for the industry. Such information could be included in online information and mapping tools as previously described in this section.

4. Research on Biophysical Factors

Further research may help define and refine what data is especially important for mariculture operations. Oceanography studies of existing growing areas, in cooperation with the farmers, may help increase understanding of biophysical factors contributing to operations, such as shellfish growth rates and meat yields, as an example.

Statutes and Regulations

Aquatic farming is the only legal form of mariculture in Alaska. In addition, small scale research and ADFG projects are currently underway on stock restoration, rehabilitation, and enhancement. Legislation introduced and considered in the State legislature in 2017, though not yet passed, would have allowed for shellfish rehabilitation and enhancement. See Appendix A for a discussion of the constitutional, legal, and administrative framework for mariculture in Alaska.

Regulatory and legal hurdles create barriers for mariculture in a number of ways, as identified by the MTF advisory committees, and summarized below with recommendation for addressing the barriers.

1. Support Commercial Shellfish Enhancement and Restoration and Continue Research

Mariculture enhancement and restoration projects are currently in the research phase in Alaska, as described in Chapter 1 of this report, for species such as king crab and abalone. Legislation that allows for research to progress to commercial application in the state could provide important opportunities for common property fisheries and potentially help mitigate impacts of climate change on commercially valuable crab fisheries.

2. Account for Varied Species Grow Out Periods in Regulation

In current Alaska regulation, farmers must demonstrate commercial viability by year five of a lease. As some species grow to marketable size after five years, amendment of this benchmark to reflect a realistic timeline for slower growing species would make such operations more feasible.

3. Expand Possibilities for Importation of Seed from Outside of Alaska

Currently, seed importation from outside of Alaska is limited to only Pacific oysters from the Pacific Northwest and weathervane scallops produced from parents taken from SE Alaska and Yakutat areas. Amendments to State regulations prohibiting importation and release of live fish could allow for seed importation for other species.²

4. Adopt Regulations to Allow for Use of Sterile Stock or Other Species that Will Not Reproduce

At this point, State regulations limit the distance from the donor stock acquisition location that progeny may be grown out. Large minimum donor stock numbers to ensure genetic diversity in progeny are also required. Such genetic requirements limit wide distribution of indigenous organisms for farm stock.

- a) While indigenous stock used on farms that can reproduce naturally in those same waters may potentially impact natural production of that species locally, if triploid (sterile) stock is used, or if the species does not occur or reproduce naturally in an area, there are no genetic concerns. Adoption of regulation to clearly state that sterile stock, and species that do not occur or reproduce naturally within a significant distance of a farm growing area, are not subject to the ADF&G genetic policy would allow for use of these stocks.
- b) At times, a lack of genetic stock structure data for a species forces precautionary restrictions on transport of indigenous organisms used as mariculture seed. If a timeline for action to gain information is required in regulation when such a situation occurs, such restrictions may at times be safely lifted.

5. Amend Regulations to Assist with Start-Up Bonding, Insurance, and Lease Fees

Bonding, insurance, and annual land use fees present a hurdle for mariculture operations, particularly for farms that are not yet at a stage to sell product.

- a) A mechanism or funding source to offset lease costs could be tied into aquatic farm loan programs and provide start up financing for new farmers. An amended regulation to allow for deferring a portion of fees, or for a graduated increase in lease fees, could be instituted until a site is producing.
- b) Maintenance of a consistent lease fee during a farm lease period, only changing it if necessary when the lease is renewed or transferred, would provide a more consistent business environment for operators.
- c) Farmers with demonstrated training or experience, or new farmers that locate near an established farm, might be considered for a reduced bond amount since they will be lower risk.
- d) Commercial Liability Insurance and Worker's Compensation Insurance requirements are expensive for mariculture operators. Legislation to create insurance coverage for commercial farmers or encourage broad insurance policies to be adopted by industry-sponsored groups or organizations that cover members could help provide a more cost-effective option.

² The MTF Regulatory Issues Advisory Committee recommends following the weathervane scallop model.

Permitting and Fees

1. Amend Aquaculture Permit Applications to Simplify and Allow for Operations Flexibility

The current aquaculture permit application process is viewed as requiring excessive detail and speculative information in applications and plans. This issue, in turn, results in inflexibility for species and gear diversification during operations. A simplified application process that adheres to language in statute and regulation and requests only information with an identified purpose and need could ease this burden for operators and new applicants.

2. Incorporate Allowances for Mariculture Training in Permit Applications

One reason for the oversight and stringent requirements imposed upon mariculture permit applicants is the challenge of determining if a potential operator has the knowledge and/or experience to run a mariculture operation. Agency regulations could be amended to accept industry-driven training, that includes a standardized set of skills and knowledge, as qualification.

3. Amend the Lease Fee Structure to Account for Surface Acreage

In regulation, mariculture farm lease size includes the entire foot print of the farm site, including anchors and scope of lines. Such a calculation method expands lease sizes, particularly for larger farms, which increases cost per surface acre farmed and ties up additional surface area not actually being farmed. Regulations that separate actively farmed lease acreage, such as surface water footprints, from on bottom acreage needed to secure infrastructure may improve this situation.

Mariculture Operating Factors

Operating costs and logistics, environmental factors, infrastructure, workforce development, access to markets, and regulations can all present challenges to mariculture operations. Though Alaska's mariculture industry is in its early stages of development, successful operations in the state provide valuable information to help break through some barriers and grow the industry. In addition, the MTF and others have gathered industry knowledge from around the world to help inform Alaska's efforts.

Seed Security

Seed security and quality is a factor many Alaska mariculture operations struggle with due to historical fluctuations in both availability and quality, limited sources for seed, and research and development needs.

ADVISORY COMMITTEE RECOMMENDATIONS

1. Develop Alaska-Grown Seed Capacity for the Oyster Industry

Systems to spawn oysters do exist in Alaska, at Alutiiq Pride Shellfish Hatchery (APSH) and OceansAlaska (OA). Funding to develop capacity to set sufficient quantities of oyster seed to satisfy Alaska demand and to provide for sales outside of Alaska, with the immediate goal being to have an in-state source of larvae, will be an important step in oyster seed security for Alaska operators.

Also, future ability for nurseries and operators to raise smaller seed than is currently standard is of interest to the industry.

2. Continue Research and Development of Seaweed Seed Production

Research is ongoing in Alaska on seed production, some next steps include determination of best practices for obtaining parent plants for seed production and researching strain selection.

3. Develop a Source for Geoduck Seed

While there is currently no source for geoduck seed in Alaska, and quality of seed available in the state has reportedly varied, OceansAlaska is currently working with APSH to acquire seed and grow them to plantable size. Continued development of a source for seed will be essential to development of this industry.

Infrastructure

ADVISORY COMMITTEE RECOMMENDATIONS

Location/Partnerships

1. Explore Efficiencies in Location of Operations

The concepts of cluster farms and regional processing centers may be implemented to provide methods to efficiently transport and process product.

2. Explore Synergies with Existing Seafood Industry Infrastructure

Many aspects of the seafood industry, including equipment, knowledge, location, and skills, overlap with mariculture needs. As the seafood industry is well established in the state, there may be opportunities to share infrastructure for mariculture during the off-season for other seafood operations.

Nurseries

1. Develop more efficient and low-cost oyster nursery options

Expansion of existing research and development efforts to establish methods and equipment to increase efficiencies in oyster nursery systems will help provide lower-cost options for mariculture operators.

Production Technology

1. Publish and Disseminate Current Production Techniques and Technologies

Production technology specific to each mariculture species continues to be improved and refined, while further research and development needs continue. Dissemination of current information and continuation of research on production technology are both important factors for new entrants and existing operators in the Alaska mariculture industry.

2. Support Production Technology Research Priorities

Identified production technology research includes:

- a) Strategies and best practices to reduce labor and time necessary to produce product.
- b) Improvements in production and processing methods to increase throughput.
- c) Value-added product forms, including freezing techniques to extend shelf life.
- d) Hatchery production of mussel seed.
- e) Predator control methods (see discussion below in Environmental Factors).

Environmental Factors

Environmental influences can significantly affect mariculture operations by impacting human health and/or growth conditions for product. Such impacts may translate to significant financial implications for operators.

ADVISORY COMMITTEE RECOMMENDATIONS

Paralytic Shellfish Poisoning (PSP)

PSP issues continue to cause concern in the Alaska shellfish industry. Testing for PSP is often slow and expensive, causing significant production delays as samples are sent to the DEC lab, located in Anchorage. Additionally, it is challenging for remote operators to transport water samples to the laboratory within required time and temperature constraints.

1. Improve PSP Testing

A new PSP field test under development may help remedy current logistical issues with PSP testing, with research in Sitka on development of an in-field test particularly promising. Recommended improvements to the PSP testing situation include:

- a) Support certification of additional private labs and testing methods in the state to facilitate ease of transport, faster results, and more cost-effective testing.
- b) Support research into holding samples for depuration and certification of process.
- c) Identify appropriate regions to increase spatial extent of PSP testing (e.g. Kodiak Island) to address potential for underdeveloped opportunities for shellfish farms.
- d) Identify and support research to assess mechanism of PSP loading (cyst density) in mariculture species.

2. Collect and Distribute Data on PSP in Alaska

Aside from testing improvements, a wider understanding of PSP occurrence and causation will assist mariculture operators. Such understanding may be accomplished through further data collection on where and when PSP occurs and research into causes. Also, establishment of a public platform to access Paralytic Shellfish Poisoning (PSP) data will provide wider understanding of this issue.

Vibrio Bacteria

Alaskan oysters can host a form of bacteria which causes gastroenteritis, and in rare cases can be fatal. The bacteria can also be carried by marine organisms such as shrimp and crabs.

1. Research and Communicate Vibrio Bacteria Findings

Development of methods to monitor and mitigate Vibrio bacteria occurrences are important for human health and marketing. While methods are being developed, distribution of DEC's Vibrio plan for farmers may be useful.³

Other Genetic and Disease Issues

1. Blue Mussel Research

Genetic and disease issues that prohibit/inhibit blue mussel growth to market size in Southeast Alaska needs to be investigated.

2. Fecal Coliform

Research and develop methods to mitigate harvest disruptions due to wild animal fecal coliform in remote areas will be useful to mariculture operators.

Predation

1. Improve Predation Protection Techniques and Technologies

Natural predators, including otters, sea ducks, and sea stars prey on unprotected some forms of mariculture product. Physical protections and regular monitoring are used to abate predation. However, predator protection technology may be improved and refined for situations specific to Alaska's marine environment.

Ocean Acidification

Research into the impacts of ocean acidification on shellfish spat and on ocean conditions is ongoing.⁴

1. Monitor Ocean Conditions

³ http://dec.alaska.gov/eh/fss/seafood/Shellfish_Home.html.

⁴ <https://seagrant.uaf.edu/map/aquaculture/shellfish/techtraining/2016/ocean-acidification-foy.pdf>.

Continuation or initiation of ocean condition monitoring in all Alaska coastal regions with feasible mariculture opportunities that may be affected by ocean acidification will provide more information about this issue and help understand impacts on mariculture.

Workforce Development

Remoteness, seasonality, and lack of resources for training and professional development present difficulties for mariculture operations in attracting and maintaining high-quality labor. An increase in the number and size of mariculture operations in Alaska will require development of a cohort of skilled owners and laborers who are available for work at these often-remote sites. In addition, to grow the industry, new operators must be attracted through raising awareness about mariculture careers, without compromising existing businesses. To develop a workforce with the skills and knowledge necessary to run mariculture operations, investment in training opportunities will be important. Such workforce development may be accomplished through the following recommendations.

ADVISORY COMMITTEE RECOMMENDATIONS

1. Establish an Alaska Mariculture Specialist Position

A Mariculture Specialist position could function as a point person for industry training, research, recruitment, and support of new farmers in the state. The position will require understanding needs of the industry and help direct industry-driven research to meet workforce objectives.

2. Institute a Mariculture Workforce Development Training Program

This program, as described above the professional development discussion in the Knowledge Transfer section of this chapter, will help grow and educate the mariculture workforce. Additionally, a long-term apprenticeship program could provide a more in-depth understanding of the industry for potential participants and serve as a labor source for existing operations.

3. Track and Evaluate Workforce Training Efforts

To improve and refine effectiveness of workforce development efforts, it will be important to track participation in training programs. Subsequent placement into mariculture-related positions and careers should also be tracked. Evaluation of programs by participants, mariculture industry owners and operators who hire trained employees, can also provide useful feedback.

4. Raise Awareness about Mariculture Careers

Targeted industry career awareness efforts, including to high schools and universities, may be incorporated into mariculture public education efforts. Also, mariculture may be incorporated in STEM education.

Access to Markets and Market Development

McDowell Group research has confirmed that Alaska's unique "wild" mystique, coupled with the image of pristine Alaska waters, provides an important marketing platform for tapping a potentially large market for high-quality Alaska products. However, consistent production and reliable delivery of a high-quality product are essential in sustained market development. Reliable and efficient distribution with competitive pricing will be the biggest challenges for Alaska's mariculture industry as it seeks to profitably expand into new and larger markets.

Market development will occur at wholesale and retail levels. Wholesale markets offer the potential to sell large volumes of product, reducing the unit cost of marketing, harvesting, testing, packaging, handling, and shipping. These wholesale markets require that growers be willing to settle for lower prices than direct sales to retail buyers.

Competitive pricing will depend on efficient, cost-effective, and reliable transportation of product to buyers. The cost of shipping can represent a significant constraint on the net unit price earned by operators. For

Alaska producers, freight costs might represent one-third of the delivered cost in some out-of-state markets.

Investment in cooperative marketing programs may be required to build on Alaska's inherent brand value and generate the price premiums necessary to overcome higher costs of operating in Alaska and moving product to distant markets.

MARKET INTELLIGENCE

It is important to recognize that no single marketing strategy or market development plan can serve all the varied mariculture species or products potentially produced in Alaska. Nevertheless, further development of markets for Alaska's mariculture products must begin with a detailed understanding of potential markets, including:

- Current local, regional, domestic buyers/consumers and their specific needs
- Competing producers and competitive advantages/disadvantages
- Consumption and production trends
- Current prices and price trends
- Cost barriers associated with serving various markets

Gathering this kind of market intelligence is often beyond the resources of start-up operators. Cooperative or publicly-supported research can serve to inform new entrants and established operators alike.

ADVISORY COMMITTEE RECOMMENDATIONS

1. Develop Downstream Market Support

Continued engagement with ASMI will be very important in evaluating new products/species marketing strategies to fit within the broader Alaska seafood market.

2. Conduct Market and Product Research

Outlook and trends for product prices and demand for Alaskan mariculture products will help inform marketing plans.

Regulatory Framework

Many mariculture operators report the Alaska regulatory environment has improved over recent years, though the process can still be laborious and has reportedly significantly impacted profits margins for some operations, particularly small ones.

1. Ensure Sufficient Bonding to Adequately Clean Up Abandoned Sites

State statutes require bonds to pay for potential defaulted lease fees on mariculture sites and cleanup for sites if abandoned by a leaseholder. The current minimum bond amount is not adequate surety to clean up sites.

- a) Legislation that would create a bond pool to be utilized for cleanup of abandoned site and pay default fees could, if adequately funded, provide adequate coverage for site clean-up and potentially reduce individual bond requirements.
- b) Create legal authority for agreements with other operators to clean up a defaulted site. Incentives for successful site restoration could include site security bonds from the defaulted site, and the site gear and inventory.

2. Establish Representation for the Mariculture Industry

Currently, no entity is authorized to represent mariculture operators and the industry. An entity established, through legislation, to represent the industry could coordinate outreach within the industry and interaction with regulatory agencies and marketing bodies.

Research and Development

The MTF Research, Development, and Environmental Information Advisory Committee developed a list of near-term priorities for mariculture in Alaska. Many of these priorities are discussed throughout this chapter, and they are provided in detail in Appendix A. The committee's work is summarized in this section as well.

Current Species

OYSTERS, PACIFIC

1. Research focused on oyster spawning in Alaska

- a) Develop capacity to spawn oysters in Alaska.
- b) Research and develop methods and ability to buffer incoming seawater with calcium aragonite (a form of CaCO₃).
- c) Develop region specific broodstock breeding program.

2. Research focused on oyster larvae setting and growth to nursery size in Alaska.

- a) Develop capacity to set sufficient quantities of oyster seed to satisfy Alaska growers' demand and to provide for sales outside of Alaska.

Alaska Sea Grant submitted a grant proposal to NOAA to support further development of oyster larvae setting capacity and best practices and researching b, c, d, and e below.

- b) Research efficacy of seed fluidizers.
- c) Research live feed vs. commercially available algae concentrate.
- d) Research and develop methods to combat colonial ciliates in the hatchery.
- e) Research comparison of differing sea water filtering systems.
- f) Compare growth rates and survival of over wintered oyster seed to farm market size vs. newly set oysters.
- g) Determine economic viability of shellfish hatcheries.

3. Research focused on oyster nursery stage

- a) Research and develop low cost nursery options for farmers.
- b) Research and develop methods and equipment to increase efficiencies of nursery systems.
- c) Develop and disseminate ability for nurseries and farmers to successfully raise smaller seed than is currently standard.

4. Research focused on oyster farms

- a) Develop improvements in production technology.
- b) Research and develop value added products aimed at export markets.

MUSSELS, BLUE

1. Identify genetic and disease issues that prohibit/inhibit the growing of blue mussels to market size in Southeast Alaska.

2. Continue research on production technology.

- a) Publish and disseminate current production techniques already researched in Alaska.
- b) Develop hatchery production of mussel seed.
- c) Develop predator control methods.

3. Develop frozen product form and other value-added products and methods.

4. Develop improvements in production and processing methods to increase throughput.

SEAWEED

- 1. Research the population genetics of seaweeds of current and future commercial importance to better understand how seaweed farms might affect the natural populations.**
 - a) Priorities should be the population genetics of *Saccharina latissima* and *Alaria marginata* especially in the areas along the Gulf of Alaska.
- 2. Research to determine the best practices for obtaining parent plants for seed production.**
 - a) Research on collecting parent seed stock from natural populations.
 - b) Research on using parent seed stock from maricultured outplants.
 - c) ADF&G ongoing genetic research will partly address some of these issues.
- 3. Research on strain selection.**
 - a) Currently this can only be done as non-commercial research with limitations on outplanting select strains.
- 4. Market and product research for sugar and ribbon kelp**
- 5. Research on hatchery optimization for large scale production of seeded string**
- 6. Research needed on optimal timing of outplanting and harvest (at different sites in Alaska).**
- 7. Research on the optimal conditions for growth (depth of outplant, nutrients, temperature, light, salinity, current).**
- 8. Site selection research.**
- 9. Oceanographic monitoring at existing growing sites, including nitrogen, phosphate, salinity, temperature, turbidity and currents.**

KING CRAB

While legislative changes are attempted to allow for commercial application of shellfish enhancement and restoration, research may proceed. In part, such research may occur through the priorities developed by the Alaska King Crab Research Rehabilitation and Biology Program (see Appendix A for detailed priorities).

- 1. Refine rearing protocols for red and blue king crab.**
 - a) Optimize rearing conditions and hatchery techniques to both improve survival rates and reduce production costs.
 - b) Optimize rearing conditions and hatchery techniques to reduce behavioral, morphological, and physiological differences between hatchery and wild crabs to minimize potential competitive interactions with future outplanting.
- 2. Understand the behavioral, morphological, and physiological differences between hatchery-reared and wild juvenile king crab and potential competitive interactions.**
 - a) Determine if morphological and behavioral differences are present between hatchery-reared and wild king crab juveniles and identify any potential competitive interactions or advantages.
 - b) Continue to compare bioenergetics of hatchery-reared and wild king crab juveniles to understand health and energy allocation and identify any potential competitive interactions or advantages.
- 3. Determine optimal nursery habitats to maximize growth and survival of juvenile king crab in both the hatchery and once outplanted.**

- a) Identify the habitat requirements of juvenile king crab through their first year of life, including foraging, structural, and biological habitat attributes, as well as ontogenetic shifts, with continued laboratory and field studies.
 - b) Develop best practices for transporting large numbers of juvenile king crab to remote sites without incurring high mortalities or harming their health.
- 4. Assess likelihood of outplanting success based on biological and environmental interactions. Transport to and successfully maintain live juveniles in a shore-based facility in the Pribilof Islands.**
- a) Conduct tethering experiments in the Pribilof Islands to assess optimal habitats, crab size, relative predation and seasonal conditions for outplanting success.
 - b) Quantify predation pressure at potential release sites in the Pribilof Islands and during experimental releases in Kodiak.
 - c) Survey habitat, environment, and juvenile red and blue king crab density at potential release sites in the Pribilof Islands.
 - d) Monitor predation, prey availability, and competitive interactions before and after controlled release events and evaluate predator control devices.
- 5. Investigate fate of hatchery-produced juvenile king crab during release experiments.**
- a) Design and test in the lab, nursery structures that may provide an artificial habitat to reduce initial mortality upon release for hatchery-produced juvenile king crab in the marine environment.
 - b) Continue to assess the behavior and marine survival of hatchery-produced juvenile king crab released into the wild at sites with appropriate habitat near Kodiak Island.
 - c) Investigate larger controlled releases (~100,000 juveniles per site) to evaluate if crabs can be rehabilitated on an embayment scale in Kodiak.
 - d) Assess the behavior and marine survival of hatchery-produced juvenile king crab released into the wild at sites with appropriate habitat near the Pribilof Islands.
- 6. Project operational costs for producing juvenile red and blue king crab for enhancing depressed wild crab stocks, including hatchery, nursery, and stocking phases.**
- a) Continue to document hatchery operational costs from acquiring broodstock through production of C3 juveniles.
 - b) Develop and publish cost projections for the culture of C3 juveniles for different survival rates and levels of production.
 - c) Develop and publish projected costs of operating various stocking and nursery projects.
- 7. Determine funding mechanisms and identify any potential changes in state law and regulations necessary to allow crab harvesters and/or coastal communities to conduct king crab rehabilitation activities.**
- a) Work with legislators and state agencies to research the potential legal framework for crab harvesters or coastal communities to form an association, such as a private-nonprofit corporation, to conduct rehabilitation activities.
 - b) Work with legislators and state agencies to research the following: Who will pay? What changes to state law are necessary to provide for a voluntary assessment similar to the salmon rehabilitation program? Is it possible to have cost recovery harvests of enhanced king crab to offset costs? If so, what changes in statutes are necessary?
 - c) Begin implementation of any necessary changes in law and policy.
 - d) Legislation defining enhancement management processes was introduced but not passed in 2016 and 2017.
- 8. Work with potential user groups to develop preliminary collaborations with community and/or industry groups interested in forming rehabilitation associations.**

New Species

The industry may benefit from identification of new species that present potential economic opportunity in Alaska based on previous studies or successful mariculture in other regions and encouragement of private and public research and development.

Industry-Wide Research and Development

In addition to research to address specific barriers or take advantage of opportunities in Alaska mariculture, there is also an identified need for industry-wide research to inform and grow the industry in the state.⁵

ENVIRONMENTAL DATA COLLECTION

Bivalves and Public Health Issues

- 1. Research and develop methods to monitor and mitigate *Vibrio P.* and harvest disruptions due to wild animal fecal coliform.**
- 2. Develop low-cost PSP testing methods and a public platform to access Paralytic Shellfish Poisoning (PSP) data, including occurrence of PSP and causation in Alaskan waters.**
- 3. Identify appropriate regions to increase spatial extent of PSP testing (e.g. Kodiak Island) to address potential for underdeveloped opportunities for shellfish farms.**

Site selection and site-specific measurements

- 1. Develop prioritized physical and biological data collection necessary for site selection and operation by species or method of interest.**
- 2. Conduct basic oceanography studies of existing growing areas in cooperation with farmers to understand biophysical factors contributing to shellfish growth rates and meat yields.**
- 3. Identify and support research to assess mechanism of PSP loading in different species.**

Regional Measurements

- 1. Develop prioritized physical and biological data collection necessary to provide regional and seasonal information to assist with farm or enhancement operations.**
 - a) Include an active list of data currently being monitored at each site and work with regional groups (e.g. AOOS) to host a database and website for public data access.
- 2. Develop or maintain carbonate chemistry monitoring in all coastal regions with feasible mariculture opportunities that may be affected by ocean acidification.**

ECONOMIC DATA AND PARTNERSHIPS

- 1. Develop mariculture business planning tools.**

Development of a web-based break-even analysis and risk management planning tools can assist operators and those considering entry into the industry.
- 2. Create regional and social impact models.**

Development of regional and social impact models to highlight the role of mariculture operations in local and regional economies, including employment and income impacts, will help identify the importance of mariculture and to increase awareness of the industry.
- 3. Identify management strategies.**

⁵ Recommendations in this section come from both the Investment and Infrastructure and the Research Advisory Committees.

A need for research to identify strategies for production and price risk has been identified.

4. Explore horizontal and vertical integration.

Horizontal and vertical integration or coordination studies may illuminate these strategies as mechanisms for developing stronger markets, reducing input factor costs, and mitigating risk in the mariculture industry.

5. Encourage industry partnerships.

Partnerships with state and local governments, industry, Alaska Native tribes, Community Development Quota organizations, NGOs, and communities can help leverage local expertise, knowledge, and funding sources for growing the mariculture industry. Following examples of other countries that have developed a successful mariculture industry, an appointed lead organization tasked with coordinating private, public, and governmental relationships can be critical in carrying industry strategies forward. Such strategies would likely include the comprehensive plan developed by the Mariculture Task Force.

6. Continue to learn from mariculture industries around the world.

Alaska mariculture industry participant and policymaker tours to other areas around the world may help provide lessons learned from mariculture businesses that may be applied in Alaska. Information sharing in the early stages of mariculture development between existing growers and potential investors, both in-state and externally, may also play an important role in the efficient growth of the industry.

EDUCATION TO PROMOTION OF REGIONAL SCALE OPPORTUNITIES

1. Identify educational opportunities in coastal communities.

2. Identify and develop workshops on mariculture opportunities and provide training opportunities in multiple aspects of farms or enhancement operations.

3. Develop demonstration farms for seaweed and shellfish mariculture.

4. Identify mechanisms for technology transfer to interested entities.

5. Integrate mariculture into STEM education.

This appendix contains notes and recommendations by each of the MTF advisory committees. The following documents are included in this section.

- Regulatory and Legal Framework of Mariculture in Alaska (authored by Regulatory Advisory Committee)
- Regulatory Issues Advisory Committee Recommendations
- Investment and Infrastructure Advisory Committee Recommendations
- Research, Development and Environmental Information Committee Recommendations
- Workforce Development Advisory Committee Recommendations

Regulatory Legal Framework of Mariculture in Alaska

Constitution

Alaska is a common property resource state and the Alaska Constitution includes provisions relating to common use. Most tide and submerged lands within Alaska's 40,000 miles of coastline are a common property resource managed upon multiple use principals and sustained yield requirements. The State of Alaska Constitution requires resource decisions to be vetted thru a public process and noticed for public input to balance resource management decisions with the best interests of the State of Alaska. Management of replenishable resources for sustained yield is enshrined in Article 8, Section 4, of the constitution. Article 8, Section 15, specifically prohibits exclusive right of fishery; however, this section was amended in 1972 to provide exemptions for the state to both limit entry into fisheries for conservation and economic reasons, and to provide for the efficient development of aquaculture in Alaska. Article 8 also provides for the use of state lands and waters, with certain assurances, in Sections 8 and 14. Article 7 requires that the legislature provide for the promotion and protection of the public's health.

Statute

Several statutes have been approved by the Alaska Legislature that provide for mariculture activities in the State. The fisheries rehabilitation, enhancement and development statute (AS 16.05.092) went into effect in 1971, directing the Alaska Department of Fish and Game (ADFG), in part, to encourage private investment in the development and economic utilization of fisheries resources, and through rehabilitation, enhancement and development programs, do all things necessary to ensure perpetual and increasing production and use of the aquatic resources of the state.

The Aquatic Farm Act (Section 19, Chapter 145, SLA 1988) was signed into law on June 8, 1988, authorizing the Commissioner of ADFG to issue permits for the construction or operation of aquatic farms, and hatcheries to supply aquatic plants or shellfish to aquatic farms (AS 16.40.100 - 199). The intent was to create an industry that would contribute to the state's economy and strengthen the competitiveness of Alaska seafood in the world marketplace, broadening the diversity of products and providing year-round supplies of premium quality seafood. The law limited aquatic farming to shellfish and aquatic plants and in 1990 CSHB 432 became law, prohibiting farming of finfish in the state (AS 16.40.210).

Statute also authorizes Alaska Department of Natural Resources (DNR) to make land and water available through lease for aquatic farming subject to bonding or other security (AS 38.05.083). All lease applications and proposed decisions are required to be noticed for public comment per AS 38.05.945 before a final decision is rendered by DNR.

Statutes that direct the Alaska Department of Environmental Conservation (DEC) to provide for food safety are found in the Alaska Food, Drug, and Cosmetic Act in AS 17.20.

There is currently no statutory authorization to issue permits for shellfish rehabilitation and enhancement projects, however, bills were introduced in 2016 and again in 2017 to achieve this.

Administration of the Alaska Aquatic Farm Program

Three State agencies jointly administered the Alaska Aquatic Farm Program: the Department of Natural Resources (DNR), the Alaska Department of Fish and Game (ADFG), and the Department of Environmental Conservation (DEC). Each of these state agencies has a specific role in authorizing and managing aquatic farm activities within Alaska.

The DNR authorizes the use of tide and submerged land and seeks to balance use of the land for the development of aquatic farming with traditional uses of the area, upland owner access, public access, and navigation of public waters as required under Article VIII of the Alaska State Constitution. The department is required to balance disposal of interest (lease) decisions with traditional and existing uses within a given area to ensure proposed farm sites are compatible. If approved, leases authorize a specific footprint and infrastructure to remain on state land to support aquatic farming activities. DNR is required to charge no less than appraised fair market value for lease fees which require annual land use fees. Lease holders are also required to post a bond to cover the costs to the department of restoring leased sites in the event the site is abandoned. Other requirements include providing proof of commercial liability insurance and meeting the commercial use requirements outlined within 11 AAC 63.030(b) within five years of lease issuance. DNR aquatic farm regulatory guidance is contained in 11 AAC 63.010 – 050.

The ADFG issues permits for the operation of aquatic farms and aquatic farm hatcheries, acquisition of stock, and transport of seed and aquatic farm products; certifies and permits seed coming into the state and transported within state for aquatic farming, ensures aquatic farming does not significantly alter established fishery or other existing uses of resources, does not significantly affect fisheries, wildlife or their habitats in an adverse manner, and determines wild stock populations prior to permitting aquatic farm species. ADFG employs the “precautionary principle” when authorizing use of resources to ensure sustained natural productivity of common property resources. Specific ADFG aquatic farm regulatory guidance is contained in 5 AAC 41.001 – 400.

To protect human health, the DEC classifies growing areas, issues permits, conducts inspections, investigates complaints, conducts outreach and training, and monitors bacteria and toxins in shellfish harvest areas (growing waters) and shellfish products. Primarily, two programs within DEC are involved: the Food Safety and Sanitation program (FSS), the state’s Shellfish Sanitation Authority, and the Environmental Health Laboratory (EHL), which provides the FSS program analytical support to carry out its responsibilities. DEC regulates the shellfish industry through adoption by reference at 18 AAC 34 of a document called the National Shellfish Sanitation Program Model Ordinance (NSSP MO). The NSSP MO specifies sanitation requirements for harvesters, dealers, and shucker/packers and outlines State regulatory program requirements so that shellfish grown and harvested in Alaska may be sold interstate.

Regulatory Issues Advisory Committee Recommendations

The table below presents the Regulatory Issues Advisory Committee's recommendations to address regulatory challenges to mariculture in Alaska. These recommendations were identified through broad participation with farmers, industry representatives and state agencies, and are organized by priority groupings of 1) Near Term needs; 2) Intermediate Term needs; and 3) Long Term needs. Many of these suggestions require legislation, funding, or both. These nonbinding recommendations are offered to the Mariculture Task Force for consideration and do not commit any industry representative or agency to additional action beyond these recommendations.

Agency	Regulatory Issue	Recommendation	Priority
ADFG	Shellfish stock restoration, rehabilitation, and enhancement projects are not legal in Alaska, other than for small scale research or for ADF&G projects.	Pass legislation creating authority to issue permits for this type of activity (2016 HB300/SB172; 2017 HB128/SB89)	1
ADFG	Importation of seed from outside of Alaska is limited to only Pacific Oysters from the pacific Northwest, and to Weathervane Scallops produced from parents taken from SE Alaska and Yakutat areas.	Amend regulation (5 AAC 41.070 Prohibitions on importation and release of live fish) to allow for other species using the weathervane scallop model.	2
ADFG	Genetic requirements are restrictive and limit wide distribution of indigenous organisms for farm stock. These requirements include limitations on the distance from the donor stock acquisition location that progeny may be grown out at, and large minimum donor stock numbers to ensure genetic diversity in progeny.	A) Indigenous stock used on farms that can reproduce naturally in those same waters may potentially impact natural production of that species locally. However, if triploid (sterile) stock is used, or if the species does not occur or reproduce naturally in an area, there are no genetic concerns. Adopt regulation to clearly state that sterile stock, and species that do not occur or reproduce naturally within some significant distance of the farm growing area, are not subject to the ADF&G genetic policy.	2
		B) Adopt regulation to require a timeline for action to gain information when a lack of genetic stock structure data for a species forces precautionary restrictions on transport of indigenous organisms used as mariculture seed.	2
ADFG	Aquatic (wild) stock acquisition is limited to only <i>initial needs</i> in Statute (AS 16.40.120(f)(1)) and regulation (5 AAC 41.290(b) and (d)).	Donor stock of indigenous species may need to be collected on a continual basis to propagate and produce seedstock for aquatic farms and nurseries and for growout of natural set on farmsites. Amend the statute and regulations to remove the word "initial".	3
ADFG	Requiring excessive detail and speculative information on applications and plans, and inflexibility to species and gear diversification in real time.	Adhere to the actual language in statute and regulation to avoid "over reach". Any information requested should have an identified purpose and need. Additional requirements or restrictions should be promulgated through statutory and regulatory change processes rather than personal interpretations.	1
DNR	Bonding, insurance, and annual land use fees are challenging for farmers to pay, especially new farmers not selling product yet.	Establish a mechanism or funding source to offset lease costs. This could be tied into aquatic farm loan programs and provide start up financing for new farmers. Amend regulation to allow for deferring a portion of fees, or for a graduated increase in lease fees, until farm site is producing.	1

Agency	Regulatory Issue	Recommendation	Priority
DNR		B) Farmers with demonstrated training or experience working a farm, or new farmers that locate near an established farm, should be considered for a reduced bond amount since they will be lower risk.	2
		C) Adopt industry sponsored training or best practice standards to ensure new farmers understand aquatic farm site selection, husbandry practices, marketing and financial planning requirements. This may increase success of the new farmer but may not remove bonding requirements.	3
DNR	DNR statute AS 38.05.083(e) & regulation 11 AAC 63.080 require bonds to pay any defaulted lease fees and cleanup a site if abandoned by the leaseholder. The minimum bond amount of \$2500 is not adequate surety to clean up sites.	A) Pass legislation to create a bond pool which could be utilized to cleanup abandoned farms and pay default fees. A bond pool could reduce individual bond requirements if it were adequately funded.	2
		B) Obtain legal authority to enter into agreement with another farmer(s) to clean up a defaulted farmsite, incentivized by offering the defaulted farms security bond, gear and inventory as compensation upon successful restoration of the defaulted farmsite.	2
DNR	Commercial Liability Insurance and Worker's Compensation Insurance requirements are expensive for farmers.	Pass legislation to create insurance coverage for commercial farmers or encourage broad insurance policies to be adopted by industry sponsored groups or organizations that cover its members.	2
DNR	The commercial use requirement (11 AAC 63.030(b) is a low benchmark for farmers to demonstrate their farms commercial viability by year 5 of a lease. This benchmark does not work for all species.	Amend 11 AAC 63.030(b) to consider a longer term for farms producing only slow growing species such as geoduck and a shorter term for farms producing only fast-growing species such as seaweed.	1
DNR	Lease size is required to encompass the entire foot print of the farm site including anchors and scope of lines. This expands lease size substantially for larger farmers which increases cost per surface acre farmed and ties up additional surface area not actually being farmed.	Amend regulations to separate actively farmed lease acreage, such as surface water footprints, from the on-bottom acreage needed to secure infrastructure such as the anchors, lines and scope for purposes of calculating the lease fee.	2
DNR	Escalating lease fees during the lease period makes it difficult to plan the operations/expenses of the farm.	Only change the lease fee when the lease is renewed or transferred. Do not change the lease fee during the effective period of the lease.	1
DEC	There is a lack of open access to collected and reported environmental data. Farmers, and others, need open access to this data to conduct individual analysis and to assist DEC and others conducting problem-solving efforts.	Make the data visible, or if it is not utilized and stored, do not require that it be collected and submitted. DEC has been working towards providing for an open data exchange/viewing site since April of 2016. If this is not feasible within DEC's resources, allow industry to establish an authorized industry-wide database or assist DEC with creating one that can provide this service.	1
DEC	Growing water sampling and PSP testing is slow and expensive. It is extremely challenging for many farmers to transport water samples to the DEC laboratory in Anchorage within the time and temperature constraints required.	Support certification of additional private labs and testing methods to facilitate ease of transport, faster results and more cost-effective testing.	1

Agency	Regulatory Issue	Recommendation	Priority
DEC		Support research into holding for depuration and certification of process.	2
All	Communication is not organized to reach all farmers and industry representatives. There is no authorized body representative of farmers and industry to work with agencies in drafting and implementing rules and regulations.	Pass legislation to establish a comprehensive board or group to represent farmers and industry in interactions with regulatory agencies.	2
All	There is a seemingly adversarial role by some regulators towards mariculture. Recognizing that departments operate within many strict guidelines, regulations, statutes, and manpower and fiscal constraints, and that many of those are necessary to protect the public, there is an impression that some individual regulators tend to interpret guidance more stringently than is required or was intended, or that enforcement of a flawed rule or regulation is easier than seeking a beneficial solution.	Direct regulatory agencies to adopt an advocacy approach to the mariculture industry for the benefit of the State. Regulators should seek to make improvements to bureaucratic rules and regulations that needlessly impede the growth of the industry while still fulfilling their responsibilities to protect the people and resources of the state.	1
All	There is no assurance to the State that an aquatic farmer is qualified or capable. Regulatory agencies have a responsibility to the people of the State to ensure that resources are used wisely. One reason for the oversight and stringent requirements imposed upon aquatic farmers by the State is that there is no way to determine if a farmer has the knowledge and/or experience to operate a farm.	Amend agency regulations to provide for acceptance of industry-driven training as qualification. Aquatic farmers are currently developing a series of training and accreditation efforts that will provide a better trained workforce and better, more knowledgeable, farmers/operators who will have standardized skills and knowledge, as a minimum. When this program is fully developed and implemented, this accreditation/certification should be accepted and used by state agencies to demonstrate an applicant has the knowledge and skill sets required to work on, or operate, a successful farm. This should be considered an endorsement for favorable consideration of the farmers aquatic farm permit application, lower bonds, initially smaller lease rates, loan guarantees, etc.	3

Investment & Infrastructure Committee Recommendations

Infrastructure

RECOMMENDATION 1

Develop an interactive map tool and/or fact sheet to help inform site and species selection. (Near-term)

The I/I AC understands that there is a Sea Grant proposal to begin a regional mapping project and that the first phase of the project may begin in 2017. The AC committee supports this project and has discussed that the lack of a cohesive and accessible site containing information on issues such as; ocean conditions, bathymetry and existing support infrastructure for processing and shipping has created significant barriers for potential investors to adequately select sites and formulate business plans. A mapping tool will alleviate some of these limitations, while highlighting remaining research gaps and potential future inputs as they become available.

RECOMMENDATION 2

Develop a seafood processor/salmon hatchery outreach program to inform existing infrastructure owners of potential mariculture and business diversification opportunities. (Mid-term)

Alaska's seafood operators have had to surpass significant challenges with remoteness, transportation, high energy costs and labor. An emerging mariculture industry will face similar challenges and will benefit from extracting lessons learned and building partnerships with existing operators. Numerous seafood processors throughout the state have expressed interest in exploring diversification opportunities through mariculture development. Many potential synergies exist, but information on compatible and potential conflicting conditions need to be better understood. This outreach program would likely follow the completion of the mapping project. The existing expertise of salmon hatcheries could lend well to mariculture seed production and operations.

RECOMMENDATION 3

Explore potential frameworks and regulatory mechanisms for funding hatchery operations.

These could include voluntary assessments, marketing tax, value-added tax, fish tax, etc. Reference to the language in HB 128 (allowing a mechanism for self -assessment), as well as HB 76 (allowing non-profits to assess) should be included in the plan.

Investment

RECOMMENDATION 1

Support amendments to the Mariculture Revolving Loan fund to include hatchery eligibility. Encourage opportunities for increased support and funding of hatchery development. (Near-term)

Under the leadership of AFDF, AC and MTF members have advocated for advancing legislation to amend the mariculture revolving loan fund during the 2017/8 legislative session. The I/I AC believes that legislation is needed to allow for fuller utilization of the existing mariculture revolving loan fund and to fill an important funding gap for hatcheries. The committee also believes that there should be a continued effort to align industry needs with private and public funding opportunities.

RECOMMENDATION 2

Support shellfish enhancement enabling legislation. (Near-term)

As with the revolving loan fund legislation, AC and MTF members have been advocating for legislation that would provide a regulatory framework for shellfish enhancement and restoration efforts. This legislation is critical in advancing the AKCRRAB program out of research phase and into implementation. Future enhancement projects could provide important opportunities for common property fisheries and potentially help mitigate impacts of climate change on commercially valuable crab fisheries. The I/I AC believes this legislation will be key to advancing a successful mariculture industry.

RECOMMENDATION 3

Develop an investment package that includes -basic statistics, information on the regulatory process, funding sources etc. (Near-term)

The I/I AC has evaluated various public and private programs applicable to mariculture development in Alaska. The committee feels it would be helpful to create a tool for potential investors that identifies these sources, along with other information that would be pertinent to the development of a business plan.

RECOMMENDATION 4

Promote cooperative investment structures (Long-term)

Cooperative structures are designed to provide member level benefits that may be reflected on a social, cultural and/or economic level. Coops typically offer their members a wide variety of benefits such as access to markets, shared information on technological advancements and efficiencies, shared risk, innovation, common facilities, etc. This type of structure could help build the financial resiliency of an emerging mariculture industry and may be an important component to consider in establishing economies of scales, collective purchasing and in developing selling strength. The committee discussed that the Intertribal Agriculture Council may be a good resource to assist in developing a model for Alaska.

The work product coming out of this recommendation should be a compilation of information related the logistical formation of a coop, available resources and an assessment of relevant existing models. Items specifically mentioned for inclusion:

- Legal entity required for membership
- Antitrust issues

RECOMMENDATION 5

Explore the potential to seed a private/public revolving loan fund program for mariculture planning purposes and start-up costs. Prioritize options to seed additional funding into existing funds. (Mid-term)

Revolving loan funds provide access to a flexible source of capital that can be used in combination with more conventional sources. While the state's revolving loan fund is not presently being fully utilized, the anticipated growth of the industry may quickly surpass the amount of support that the fund provides. A complimentary revolving fund could provide an important bridge for new borrowers trying to leverage private sources. The fund could be initially capitalized through economic development organizations, federal grant programs or local governments.

The committee believes it important to note that prior to the creation of a new loan program, existing programs should be analyzed for their ability to meet the needs of industry participants and evaluated for potential expansion.

RECOMMENDATION 6

Develop a business development training program, which dovetails with workforce development, to help new producers successfully apply for loans and develop business plans. (Mid-term)

The I/I AC discussed the challenges that new entrants faced in developing the business plans required of most lending agencies. The group discussed the value of training opportunities catered specifically to producing and understanding financial projections.

The committee noted that it is important to integrate any new program with technical workforce training and that business and accounting training needs to be catered specifically to mariculture as opposed to a more general farming training which may have limited applicability to the unique circumstances of the industry. Committee members mentioned a specific challenge regarding mariculture related accounting for capitalizing labor on balance sheets.

RECOMMENDATION 7

Facilitate partnerships with state and local governments, industry, Alaska Native tribes, Community Development Quota organizations, NGOs and communities. Identify a dedicated lead organization. (Mid-term)

Developing strategic partnerships will help leverage local expertise, knowledge and funding sources.

The committee discussed that other countries that have developed a successful mariculture industry have identified a lead organization that is tasked with coordinating private, public and governmental relationships. These organizations have been critical in carrying strategy forward. At this point, it is unclear who will be charged with implementing the MTF's recommendations. The committee discussed that if this entity was a government agency, it should be one not conflicted with trying to manage as well as advocate. The group also discussed that a logical choice would be AFDF.

RECOMMENDATION 8

Include in the comprehensive plan, a statement of commitment from the State of Alaska expressing support for sustainable mariculture growth and defining its role in helping industry to development and invest. (Near-term)

The AC discussed how the success of the industry is dependent on the state's continued commitment to provide sufficient funding to agencies that are critical to regulating and supporting mariculture efforts. The AC also discussed that that it may be important for the state to reinforce its position on mariculture as a form of agriculture for the purposes of leveraging USDA funds. The committee discussed the value in trying to define an appropriate role for government in the development of the industry.

RECOMMENDATION 9

Support Alaska delegation tours to share and extract lessons learned from mariculture operations and businesses from around the globe. (Mid-term)

Information sharing in the early stages of mariculture development between existing growers and potential investors, both in-state and externally, will play an important role in the efficient growth of the industry.

RECOMMENDATION 10

Develop a fact sheet on survival and growth rates of various mariculture species. (Long-term)

AC members from out of state discussed that the general lack of information on growth rates, survival and predation presented a significant impediment to their ability to develop business plans for investing in Alaska. The committee discussed how some information on growth rates may be available from ADFG and that a comprehensive product may necessitate a willingness from existing operators to share their experience and knowledge base. These types of inputs may be appropriate for a subsequent phase of the interactive mapping project. Region specific information is critical.

RECOMMENDATION 11

Develop downstream market support.

The committee discussed the unknowns of future marketing components, particularly for aquatic plants, and that continued engagement with ASMI will be very important.

RECOMMENDATION 12

Following the development of the comprehensive plan, coordinate conversations with federal representatives to ensure alignment of state and federal priorities.

For example, the new NOAA administrator publicly expressed interest in reducing the US' seafood trade deficit. The committee discussed the importance of aligning federal initiatives with Alaska's mariculture opportunities.

Research, Development and Environmental Information Committee Recommendations

Near term priorities are defined as priorities for species of immediate interest (1-2 years) for mariculture in Alaska along with specific issues that need to be addressed to create a viable commercial enterprise for each species. For an overview of the near, intermediate, and long-term priorities for mariculture in Alaska see the document entitled Existing Research and Future Needs for Alaska Mariculture.

Pacific Oysters

1. Research focused on oyster spawning in Alaska
 - a. Develop capacity to spawn oysters in Alaska
Physical systems to spawn exist at Alutiiq Pride Shellfish Hatchery (APSH) and OceansAlaska (OA); access to certified broodstock; currently conditioning broodstock at OceansAlaska; proposed partnership with Alaska Sea Grant (ASG) for funding to initiate spawning on more than a test basis. Note: Seed from certified broodstock that is permitted to be imported into Washington and California has much larger demand than seed only permitted for planting in state. Some farms in Pacific Northwest value a completely independent source of oyster seed.
 - b. Research and develop methods and ability to buffer incoming seawater with calcium aragonite (a form of CaCO_3).
Buffering seawater into culture tanks with sodium carbonate is current practice at OceansAlaska. However, drip concentration is adjusted by measuring pH. Direct measurement of calcium aragonite concentration will lead to more accurate buffering data and practice.
 - c. Develop region specific broodstock breeding program.
Spawning of Alaska broodstock can lead in small steps toward a simple breeding program. The immediate goal is to have an in-state source of larvae and to start discussion of breeding program genetic.
2. Research focused on oyster larvae setting and growth to nursery size in Alaska.
 - a. Develop capacity to set sufficient quantities of oyster seed to satisfy Alaska growers demand and to provide for sales outside of Alaska.
 - This is currently underway at OceansAlaska and there is recently some interest in additional private setting facilities.
 - Alaska Sea Grant has submitted a grant proposal to NOAA to support further development of oyster larvae setting capacity and best practices and researching b, c, d and e below.
 - b. Research efficacy of seed fluidizers.
 - c. Research live feed vs. commercially available algae concentrate.
 - d. Research and develop methods to combat colonial ciliates in the hatchery.
Basic experimentation with chlorine and ascorbic acid to combat ciliates at OceansAlaska.

- e. Research comparison of differing sea water filtering systems.
 - f. Compare growth rates and survival of over wintered oyster seed to farm market size vs. newly set oysters.
 - g. Determine economic viability of shellfish hatcheries.
British Columbia Shellfish Aquaculture Industry did a hatchery feasibility report on this topic: https://www2.viu.ca/csr/documents/HatcheryFeasibilityReport080606CSR_002.pdf.
3. Research focused on oyster nursery stage
 - a. Research and develop low cost nursery options for farmers.
Some work on this has already been developed at OceansAlaska with fish tote based upwellers.
 - b. Research and develop methods and equipment to increase efficiencies of nursery systems.
Successful private efforts (namely Jim Aguiar) in the past centered around floating upweller systems (FLUPSYs) and collaboration with Alaska Sea Grant to some degree on this.
 - c. Develop and disseminate ability for nurseries and farmers to successfully raise smaller seed than is currently standard.
Private efforts have been underway, but nothing seems definitive.
 4. Research focused on oyster farms
 - a. Develop improvements in production technology.
 - Identify strategies and best practices to reduce the cost of labor and time to produce aquatic farm product.
 - Alaska Sea Grant efforts in the past; mostly private efforts with info sometimes shared at Alaska Shellfish Growers Association annual meeting.
 - b. Research and develop value added products aimed at export markets.
Some work on TVO (top valve off) frozen oysters done by Alaska Sea Grant/Fishery Industrial Technology Center (renamed as the Kodiak Seafood and Marine Science Center).

Blue Mussels

1. Identify genetic and disease issues that prohibit/inhibit the growing of blue mussels to market size in Southeast Alaska.
2. Continue research on production technology.
 - a. Publish and disseminate current production techniques already researched in Alaska.
 - b. Develop hatchery production of mussel seed.
 - c. Develop predator control methods.
3. Develop frozen product form and other value-added products and methods. Frozen product form is widely accepted as mussels are traditionally cooked for eating and frozen product has acceptable quality

parameters; freezing technology is widely known/practiced in Alaska; theoretically Alaska frozen mussels could compete with Irish mussels in the world market.

- a. Research other ways to create value added products with mussels.
4. Develop improvements in production and processing methods to increase throughput.
 - a. Mussel farming (internationally) lends itself to a degree of mechanization more so than oyster production; which may lead to better competitive advantage in an Alaska's labor poor environment.

Shellfish Enhancement

KING CRAB (*PARALITHODES CAMTSCHATICUS*; *PARALITHODES PLATYPUS*)

The following king crab research priorities were developed by the Alaska King Crab Research Rehabilitation and Biology Program.

1. Refine rearing protocols for red and blue king crab by:
 - a. Optimizing rearing conditions and hatchery techniques to both improve survival rates and reduce production costs.
Has been done for red king crab but needs to be refined for blue king crab at the Alutiiq Pride Shellfish Hatchery.
 - b. Optimize rearing conditions and hatchery techniques to reduce behavioral, morphological, and physiological differences between hatchery and wild crabs to minimize potential competitive interactions with future outplanting.
Work has started at UAF and NOAA but additional work needed.
2. Understand the behavioral, morphological, and physiological differences between hatchery-reared and wild juvenile king crab and potential competitive interactions.
 - a. Determine if morphological and behavioral differences are present between hatchery-reared and wild king crab juveniles and identify any potential competitive interactions or advantages.
 - b. Continue to compare bioenergetics of hatchery-reared and wild king crab juveniles to understand health and energy allocation and identify any potential competitive interactions or advantages.
Early work done by NOAA and University of Oregon but additional work needed in collaboration with outstocking experiments.
3. Determine optimal nursery habitats to maximize growth and survival of juvenile king crab in both the hatchery and once outplanted.
 - a. Identify the habitat requirements of juvenile king crab through their first year of life, including foraging, structural, and biological habitat attributes, as well as ontogenetic shifts, with continued laboratory and field studies.

- Initial habitat suitability index models done but more refined studies needed to assess requirements at outstocking densities.
 - Further develop king crab habitat suitability models for red king crab and begin development of models for blue king crab based upon laboratory and field studies for research use, as a guide to selecting potential release sites.
- b. Develop best practices for transporting large numbers of juvenile king crab to remote sites without incurring high mortalities or harming their health.
4. Assess likelihood of outplanting success based on biological and environmental interactions.
 - a. Transport to and successfully maintain live juveniles in a shore-based facility in the Pribilof Islands. Facilities are being developed with tribal government collaborations.
 - b. Conduct tethering experiments in the Pribilof Islands to assess optimal habitats, crab size, relative predation and seasonal conditions for outplanting success.
 - c. Quantify predation pressure at potential release sites in the Pribilof Islands and during experimental releases in Kodiak. This work is currently ongoing by NOAA in Kodiak. A joint UAF-NOAA research project is underway in St. Paul.
 - d. Survey habitat, environment, and juvenile red and blue king crab density at potential release sites in the Pribilof Islands. A joint UAF-NOAA research project is underway in St. Paul.
 - e. Monitor predation, prey availability, and competitive interactions before and after controlled release events and evaluate predator control devices.
 5. Investigate fate of hatchery-produced juvenile king crab during release experiments.
 - a. Design and test in the lab, nursery structures that may provide an artificial habitat to reduce initial mortality upon release for hatchery-produced juvenile king crab in the marine environment. Initial studies underway by NOAA in summer 2017.
 - b. Continue to assess the behavior and marine survival of hatchery-produced juvenile king crab released into the wild at sites with appropriate habitat near Kodiak Island.
 - c. Investigate larger controlled releases (~100,000 juveniles per site) to evaluate if crabs can be rehabilitated on an embayment scale in Kodiak.
 - d. Assess the behavior and marine survival of hatchery-produced juvenile king crab released into the wild at sites with appropriate habitat near the Pribilof Islands.
 6. Project operational costs for producing juvenile red and blue king crab for enhancing depressed wild crab stocks, including hatchery, nursery, and stocking phases.
 - a. Continue to document hatchery operational costs from acquiring broodstock through production of C3 juveniles.
 - b. Develop and publish cost projections for the culture of C3 juveniles for different survival rates and levels of production.
 - c. Develop and publish projected costs of operating various stocking and nursery projects.

7. Determine funding mechanisms and identify any potential changes in state law and regulations necessary to allow crab harvesters and/or coastal communities to conduct king crab rehabilitation activities.
 - a. Work with legislators and state agencies to research the potential legal framework for crab harvesters or coastal communities to form an association, such as a private-nonprofit corporation, to conduct rehabilitation activities.
 - b. Work with legislators and state agencies to research the following: Who will pay? What changes to state law are necessary to provide for a voluntary assessment similar to the salmon rehabilitation program? Is it possible to have cost recovery harvests of enhanced king crab to offset costs? If so, what changes in statutes are necessary?
 - c. Begin implementation of any necessary changes in law and policy.
Legislation defining enhancement management processes was introduced but not passed in 2016 and 2017.

8. Work with potential user groups to develop preliminary collaborations with community and/or industry groups interested in forming rehabilitation associations.

Seaweed

SACCHARINA LATISSIMA (SUGAR KELP) AND ALARIA MARGINATA (RIBBON KELP)

1. Research the population genetics of seaweeds of current and future commercial importance to better understand how seaweed farms might affect the natural populations.
 - a. Priorities should be the population genetics of *Saccharina latissima* and *Alaria marginata* especially in the areas along the Gulf of Alaska. Some of this research is currently being done by ADF&G genetics group.

2. Research to determine the best practices for obtaining parent plants for seed production
 - a. Research on collecting parent seed stock from natural populations
 - b. Research on using parent seed stock from maricultured outplants.
 - c. ADF&G ongoing genetic research will partly address some of these issues

3. Research on strain selection.
 - b. Currently this can only be done as non-commercial research with limitations on outplanting select strains. Some of this research is being done at University of Alaska Southeast (UAS) with ASG and Blue Evolution (BE) funding.

4. Market and product research for sugar and ribbon kelp
 - a. Unknown if anyone is doing this.

5. Research on hatchery optimization for large scale production of seeded string
 - a. BE and UAS are involved in this.
6. Research needed on optimal timing of outplanting and harvest (at different sites in Alaska).
 - a. Some of this is being done by UAS and BE.
7. Research on the optimal conditions for growth (depth of outplant, nutrients, temperature, light, salinity, current).
 - a. Some of this is being done by UAS, but other sites need to be outplanted and monitored.
8. Site selection research.
9. Oceanographic monitoring at existing growing sites, including nitrogen, phosphate, salinity, temperature, turbidity and currents.
 - a. Some of this being done by UAS and may be part of an ARPA-E grant in the near future.

New Species Mariculture

1. Begin the process to identify new species that present potential economic opportunity in Alaska based on previous studies or successful mariculture in other regions.

Environmental Data Collection to Support Mariculture

BIVALVES AND PUBLIC HEALTH ISSUES

1. Rigorously research and develop methods to monitor and mitigate *Vibrio P.* occurrences.
 - a. DEC has developed *Vibrio P.* plan for farmers when this occurs (http://dec.alaska.gov/eh/fss/seafood/Shellfish_Home.html).
2. Research and develop methods to mitigate harvest disruptions due to wild animal fecal coliform in remote areas. Grant funding proposal Alaska Sea Grant/Pacific Shellfish Institute in WA.
3. Develop public platform to access Paralytic Shellfish Poisoning (PSP) data.
 - a. Proposed action on this by Alaska Sea Grant. AOOS and SEATOR may be helpful with this.
4. Research and develop low cost PSP testing methods.
 - a. SEATOR (<http://www.seator.org/>) in Sitka is pursuing certification to conduct certified PSP testing which would reduce the testing burden on the State Environmental Health Lab and could lead to further R&D opportunities.

- 5 Identify appropriate regions to increase spatial extent of PSP testing (e.g. Kodiak Island) to address potential for underdeveloped opportunities for shellfish farms.
- 6 Develop a data base of the occurrence of PSP and causation in Alaskan waters.

SITE SELECTION

1. Develop prioritized physical and biological data collection necessary for site selection by species (bivalve, crab, seaweed) or method (farm, enhancement) of interest. This would include information to avoid areas with PSP, large wildlife populations, anadromous streams, higher freshwater influx etc.
2. Do basic oceanography studies of existing growing areas in cooperation with the farmers to understand biophysical factors contributing to shellfish growth rates and meat yields.
3. Identify and support research to assess mechanism of PSP loading (cyst density) in different species (e.g. oysters, geoducks).

SITE SPECIFIC MEASUREMENTS

1. Develop prioritized physical and biological data collection necessary for site operation by species (bivalve, crab, seaweed) or method (farm, enhancement) of interest.
2. Develop an active list of what is currently being monitored at each site and work with regional groups (e.g. AOOS) to host the database and website for public data access.

REGIONAL MEASUREMENTS

1. Develop prioritized physical and biological data collection necessary to provide regional and seasonal information to assist with farm or enhancement operations.
2. Identify regional groups (e.g. AOOS) to host a mariculture database and website for access by the farmers and the public.
3. In addition to other physical measurements, develop or maintain carbonate chemistry monitoring in all coastal regions with feasible mariculture opportunities that may be affected by ocean acidification. Locations include:
 - a. OceansAlaska Ketchikan (<http://www.ipacoa.org/>; <http://nvs.nanoos.org/ShellfishGrowers>) is currently monitoring carbonate chemistry including alkalinity, CO₂, TCO₂, Aragonite saturation, pH, salinity, and temperature.

- b. AMHS M/V Columbia has been outfitted with an underway CO₂ system on the passenger ferry Columbia that services SE Alaska communities (Haines, Skagway, Juneau, Sitka, Petersburg, Wrangell, and Ketchikan).
- c. SEATOR Sitka (www.seator.org) is currently monitoring carbonate chemistry including alkalinity, CO₂, TCO₂, Aragonite saturation, pH, salinity, and temperature.
- d. APSH Seward is currently monitoring carbonate chemistry including alkalinity, CO₂, TCO₂, Aragonite saturation, pH, salinity, and temperature. APSH also processes discrete samples and has reached climate data ratings.
- e. Kasitsna Bay Laboratory has a discrete carbonate chemistry monitoring program.
- f. Prince William Sound Science Center is routinely monitoring oxygen but should expand to match capacity at other regions.
- g. NOAA Kodiak Laboratory will be monitoring carbonate chemistry in FY18 and should include additional monitoring including alkalinity, CO₂, TCO₂, Aragonite saturation, pH, salinity, and temperature.

Economic Data Collection to Support Mariculture

1. Development of a web-based break-even analysis planning tool that can be used to explore the effects of farm scale, production intensity, scope, and location on financial viability of shellfish mariculture operations. Includes an analysis of production efficiency related to farm operation and technology.
2. Development of regional and social impact models to highlight the role of aquatic farms in local and regional economies including employment and income impacts.
3. Development of risk management tools to integrate consideration of production risk (survival, growth, etc.) and financial risk (input costs, price volatility, etc.).
4. There is need for research designed to identify strategies for management of production and price risk.
5. Studies to explore role of horizontal and vertical integration or coordination as mechanisms for developing stronger markets, reducing input factor costs, and mitigating risk.
6. Outlook and trends for product prices and demand for Alaskan mariculture products.
7. Economic profile of the existing mariculture industry, including the number of farms, the years of operation, the species grown, farm size, region, etc.
8. Establish goals for industry growth.
9. Investigate existing fisheries infrastructure for possible use in mariculture.

Education to Promote Regional Scale Mariculture Opportunities

1. Identify educational opportunities in coastal communities.
2. Identify and develop workshops on mariculture opportunities.
 - a. Conduct a workshop on seaweed identification and opportunities in southeast Alaska, Seward and Kodiak.
3. Provide training opportunities in multiple aspects of farms or enhancement operations.
4. Assist with business plan development.
5. Develop demonstration farms for seaweed and shellfish mariculture.
6. Identify mechanisms for technology transfer to interested entities. e.g. red king crab
7. Integrate mariculture into STEM education.
8. Investigate possibility of personal use oyster mariculture (gardening), including regulatory issues.

Workforce Development Committee Recommendations

RECOMMENDATION 1

Encourage the hire of an Aquaculture Specialist to finalize training materials, develop and coordinate training opportunities to meet workforce objectives. Paula asked, do we want to designate the Aquaculture Specialist a Sea Grant specialist versus a state agency employee or traditional academic faculty member? General consensus is yes, that Sea Grant is the best fit because we are looking for someone who understands the needs of industry and can help direct industry-driven research. Eric noted that linking the specialist with Sea Grant will help enable ongoing Sea Grant aquaculture funding. Reid mentioned that Sea Grant's link to industry and science is the model and is a better approach than making the position academic. Jim mentioned that a Sea Grant person could focus on helping new farmers getting certified and approved. Eric encouraged a new aquaculture specialist visit all farms and projects right off the bat to get a sense of what is going on and understand lessons learned. Consensus to keep Sea Grant in the recommendation and to include an aquaculture specialist in the current proposal being developed to National Sea Grant.

RECOMMENDATION 2

Finalize modules and skill sets needed for individuals to work on shellfish/seaweed farms using best practices. Paula noted that the aquaculture specialist would be tasked with developing these modules and skill sets for training and developing training and professional development program. She also recognized that a lot of materials are available and have been developed by John Kiser, Ray RaLonde already that are available. Reid noted that, as with salmon enhancement training, credit is not useful. Maybe recommend non-credit. However, John noted that some form of University credential is important. Jim agreed that some type of credential linked to training may help with ease of getting loans and leases. Eric noted that certification without credit is possible, i.e. a credential in how to operate a flupsy could be useful. Jim discussed the usefulness of online training and the need to make sure classes are compatible with the shellfish farming lifestyle. Tomi talked about the value of remote training classes for professional development while on the farm. Maybe an Introduction to Shellfish Farming for workers. Reid then talked about the use of iPads by the UAS Fisheries Technology Program, allowing for a suite of classes to be taken on an iPad without the need for internet connection. Consensus to add remote access to coursework to the recommendation as both a professional development and recruitment/retention tool.

RECOMMENDATION 3

Develop a hands-on "Introduction to Shellfish/Seaweed Farming" workforce development training program in partnership with Central Council of Tlingit and Haida, Alaska Sea Grant, growers and other partners. Objective is to develop a cohort of skilled farmers who could either work on a farm or eventually start their own farm. Call it an "intensive". Reid said that they are starting to do intensive training as well with salmon enhancement program. Myrna, divide the intensive into discrete training modules with a set curriculum so that it is compatible with a workforce training program. Include basic skill building such as safety, boat operation, etc.

Make sure it takes advantage of the earlier training. Make sure this leads into the next step. Maybe develop a letter of attendance or certificate or something to give people access to programs such as a certification course.