Near Term Priorities for Mariculture in Alaska
(DRAFT)

Prepared for the Research, Development and Environmental Information Advisory Committee of the Alaska Mariculture Task Force. May-June 2017.

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.

I. Near term research priorities for shellfish farming in Alaska

Oysters, Pacific

1. Research focused on oyster spawning in Alaska
   a. Develop capacity to spawn oysters in Alaska
      i. 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 $CaCO_3$).
      i. Buffering seawater into culture tanks with sodium carbonate is current practice at OA. 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.
      i. 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.
      i. This is currently underway at OceansAlaska, and there is recently some interest in additional private setting facilities
      ii. 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.
    i. 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.
    i. 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.
        i. 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.
        i. 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.
        i. Private efforts have been underway, but nothing seems definitive.
4. Research focused on oyster farms
    a. Develop improvements in production technology.
        i. Identify strategies and best practices to reduce the cost of labor and time to produce aquatic farm product.
        ii. 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
        i. 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).

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. 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 a Alaska's labor poor environment.

II. Near term research priorities for shellfish <u>enhancement</u> in Alaska

<u>King crab (Paralithodes camtschaticus; Paralithodes platypus)</u> (priorities 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.
        i. 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 in order to minimize potential competitive interactions with future outplanting.
        i. 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.
        i. 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.
        i. Initial habitat suitability index models done but more refined studies needed to assess requirements at outstocking densities.
        ii. 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.
        i. 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.
    i. 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.
    i. 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.
        i. 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.
        i. 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.

III. Near term research priorities for seaweed mariculture in Alaska

Saccharina latissima (sugar kelp) and Alaria marginata (ribbon kelp)

1. Research the population genetics of seaweeds of current and future commercial importance in order 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.
        i. 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.
    a. Currently this can only be done as non-commercial research with limitations on outplanting select strains.
        i. 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.

IV. Near term research priorities for new species mariculture in Alaska

General

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.

V. Near term research priorities for environmental data collection to support mariculture in Alaska

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.
    a. 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 (_____
    _____

d. APSH Seward is currently monitoring carbonate chemistry including alkalinity, CO_2, TCO_2, 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, CO_2, TCO_2, Aragonite saturation, pH, salinity, and temperature.

VI. Near term research priorities for economic data collection to support mariculture in Alaska

General

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.

VII. Near term research priorities for education to promote regional scale mariculture opportunities in Alaska

1. Identify educational opportunities in coastal communities
2. Identify and develop workshops on particular 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
    a. Assist with business plan development.
    b. Develop demonstration farms for seaweed and shellfish mariculture.
4. Identify mechanisms for technology transfer to interested entities.
    a. e.g. red king crab
    b. kelp
5. Integrate mariculture into STEM education.

6. Investigate possibility of personal use oyster mariculture (gardening), including regulatory issues.