PCSGA

PACIFIC COAST SHELLFISH GROWERS ASSOCIATION

SUMMARY

Based on input received at the January 2018 Board meeting in Portland, OR follow-up conference calls in summer 2018 and early 2019, the PCSGA's ad hoc Research Committee has focused on developing research topics PCSGA identified as priorities for membership and the shellfish industry generally. The research topics described below represent the current PCSGA's highest priorities and will likely change with time. Other research needs exist and address other critical, more regional priorities that are not described here, including IPM strategies for controlling burrowing shrimp, research to increase hatchery production and efficiency among others.

The ongoing purpose of this document is three-fold; to encapsulate current priorities for the PCSGA and membership, assist both the research community and funders of PSCGA's research priorities and identify funding opportunities that best match up with industry needs. Together, it is hoped that this document will help the PCSGA and staff to align letters and other kinds of support to best represent PCSGA research interests.

Strategies and Tactics

Research priorities will always need to be refined to specifically fit grant opportunities as they arise. This is the role of researchers making the efforts to secure grant funding for projects that benefit the shellfish industry. Over a calendar year there is a generous handful of requests for proposals (RFP's) from public grant-making agencies. An important role of the PCSGA should be to enunciate research needs to both grant makers and researchers in the region through ongoing communications. The 2015 Goals document, developed by the Pacific Shellfish Institute, describes the large breadth of shellfish related research needs in the region for industry and more broadly (restoration, public health, education, etc.) and is updated every five years. It is advised that the 2015 Goals document be updated regularly to reflect PCSGA membership (industry) concerns over the long term and serves the important purpose of integrating the wide breadth of shellfish related research needs and opportunities to a wide audience.

This document seeks to focus on emerging and critical PCSGA research priorities. As times change and new issues emerge or are resolved, this document will hopefully be updated (at least annually) in order to focus on the critical issues facing the industry that both basic and applied research can help resolve. This document can also help serve to inform Federal and state grantors and researchers in the near term about how to best frame research RFP's and solutions that best assist the West coast shellfish industry.

Current PCSGA Research Priorities

1. Shellfish Breeding for Increased Production and Sustainability

The PCSGA and shellfish industry expressed strong interest to retain and enhance the capacity to sustainably and profitably farm oysters and other shellfish into the future. Disease threats are emerging on the West coast at a time that growers are already grappling with ocean acidification and other environmental changes associated with rapid climate change. The use of genetics and breeding that helps to increase the sustainable production of oysters has been long recognized as an important tool to assist the industry in adapting to emerging threats. University led oyster breeding programs at Oregon State University and the University of Washington predated the establishment of The Molluscan Broodstock Program in 1996. The MBP (now iMBP) has focused mainly on increased yield in Pacific oysters and maintaining stocks of Kumamoto oysters among other priorities. Other emerging shellfish breeding efforts are focused on crossbreeding in combination with selection, coupled with polyploid development.

PCSGA Priorities:

- With the recent detection of ***Ostreid herpesvirus 1 (***OsHV-1 μvar), or Pacific Oyster Mortality Syndrome (POMS) in the United States, there is critical interest to conduct primary research on 1. genetic mechanisms in oysters associated with resistance, 2. the application of breeding approaches to provide genetically based resistance to POMS in broodstock for subsequent seed production, 3. the means to build the industry's capacity for disease surveillance and breeding for resistance to herpes microvars., 4. the potential for ***Ostreid herpesvirus 1 (***OsHV-1 μvar) to impact other species including commercially important clams and Kumamoto oysters, and, 5. the means to utilize a suite of coast-wide growers to assist in POMS research, including, for example Alaskan growers to maintain genetic lines potentially resistant to POMS in the cold waters there.

- There is strong Interest in developing oyster lines resilient to OA as growers recognize that OA impacts will increase in the years ahead making it increasingly difficult to maintain larval and seed supplies in the face of increasingly corrosive seawater.

- There is strong interest to utilize breeding approaches to decrease mortalities in both diploid and triploid oysters grown on intertidal beds exposed to high summer temperatures and warmer mean seawater temperatures.

PCSGA priorities related to breeding for increased production traits in shellfish other than Pacific oysters on the US west coast include:

- Breeding in Manila clams is a priority with the development of clams with unique shell patterns (e.g. designer clams). The production of triploid clams is desired by a number of companies on the US West coast where Manila clams are farmed.

- Breeding in Kumamoto oysters combined with more widely available seed is an important need expressed by a number of companies.

2. Quantifying Ecological Equivalency Between Shellfish Farms and Eelgrass Beds including Ecosystem Services Provided by Shellfish Farms

Shellfish growers on the west coast have farmed in and around eelgrass beds for over a century. In recent years, resource management agencies with statutory requirements to protect critical habitat for threatened and endangered species and essential fish habitat for federally managed species have become much more critical of shellfish culture activities in and around eelgrass. Army Corps Programmatic Nationwide Permit 48 requires new farming activities to buffer out of eelgrass and restricts oyster culture to certain off-bottom techniques with prescribed spacing in fallow areas with eelgrass. *To avoid further restrictions there is an urgent need for research to understand the habitat value of various shellfish crops and gear in comparison to eelgrass, optimal eelgrass densities for habitat functionality and the potential merits of farming in a way that preserves eelgrass patches and increases edges for optimal foraging and refuge.* This is generally referred to as assessing equivalency among and between habitat types (e.g. on-bottom oyster culture compared to native eelgrass beds). The Pacific Shellfish Institute has done initial work developing a Habitat Suitability Index as a tool to assess the habitat value of various culture methods and mixed eelgrass systems for managed species of interest. There is a need to refine this and/or other tools that allow for a comparative analysis of the relative habitat value of shellfish crops and gear and varying densities of eelgrass for various species.

PCSGA Priorities:

- Quantify equivalencies between oyster habitat and native eelgrass and assess the extent that migratory fish, including salmonids and/or their prey, use oyster beds for refuge and foraging compared to adjacent seagrass beds.

While difficult to research because it requires the means to track the behavior of fish for meaningful periods of time over seasonal cycles to assess habitat use in different geographical habitats along the West coast, this work is urgently needed. Video analysis, pop and Fyke net studies, electronic tagging, eDNA approaches have all been used in past studies, mainly led by Brett Dumbauld, ARS Ecologist and his co-researchers. Food web analyses have also been an excellent approach to assess what habitats migratory fish or their prey utilize. Continued work in this area is required to inform regulators of equivalencies between oyster and eelgrass habitat in order to ease regulatory restraints related to farming shellfish in eelgrass.

- Quantify equivalencies between oyster habitat and eelgrass habitat for salmonid prey populations.

Following up on Jeff Cordell's (UW SAFS) work with the Pacific Shellfish Institute and others on benthic zooplankton populations, including harpacticoids and amphipods important to juvenile out-migrating salmonids, is an important priority. Research quantifying the abundance and diversity of salmonid prey items within and adjacent to oyster beds and eelgrass meadows is needed to assess the level of habitat equivalency. Research that evaluates this question across the range of West coast habitats and also considers different oyster culture techniques and practices (on bottom, bag on bottom, off-bottom longline, flipbag, etc.) is urgently needed.

- Quantify equivalencies of oyster habitat to eelgrass habitat for migratory birds, fish and other commercially important species that utilize eelgrass for food.

As an example, original research done by Dave Armstrong and students at the UW-SAFS in the 1980's on the effects of both added oyster cultch and live oysters on cultch in Grays Harbor to provide emergent habitat for settling young of the year Dungeness crab when compared to un-cultched burrowing shrimp habitat should be followed up with research assessing the suitability of oyster bed habitat to commercial species of interest such as Dungeness crab.

- Quantify ecosystem services associated with growing shellfish in both eelgrass and other intertidal habitats. Ecosystem benefits associated with denitrification processes associated with shellfish biodeposit production, general provision of habitat for other organisms, filtration activities and nutrient sequestration and removal at harvest provided by shellfish are undervalued by the public and need to be better quantified.

- Research is needed to establish shellfish habitat equivalency to unfarmed habitats to assess resident and migratory bird use of tidal flats compared to cultivated shellfish beds.

3. Next-generation Automation/Robotics Applications to Shellfish Farming

Shellfish farmers face a number of production challenges spread across the four primary phases of recurring farm activities: Planting, Crop Tending and Maintenance, Harvest, and Packing/Shipment. All these activities are labor intensive. Given the variability of all these activities, it is no wonder that human labor is the primary resource in oyster farm activities. Skilled humans are very adaptable. They are also expensive, sometimes scarce, and bring with them administrative burdens that can be onerous. However, as hard as finding skilled laborers can be, finding automation/robotics substitutes in shellfish farming is even harder. There are few viable choices and affordability is often an insurmountable barrier.

That may be about to change with a convergence of advancing technologies and improved economics. Robotics technologies in several other industries are advancing rapidly in terms of both function and affordability. At the same time, sea-based robotics are likewise advancing and bringing along with them the designs and materials appropriate to the marine environment. There are also significant advancements in the processes needed to *build* robotics, such as additive manufacturing, which may have special, enabling value for shellfish farming applications in marine environments.

The next few years may be a perfect time to apply shellfish industry attention and resources, as well as other grant-based resources, to develop robotics applications for farming operations. At the same time that labor availability may become even more challenging than normal, robotics technologies and costs are becoming more appropriate as practical labor substitutes in shellfish farming. This is particularly true if we segment the potential application of robotics to the four primary phases of recurring farm activity mentioned above. For instance, it would not be much of a stretch from common production or packaging robotics in several industries today to high-speed packaging of oysters, in proper orientation, into specially designed boxes for air shipment to overseas customers. Likewise, it may not be as far as it seems from today's land based agricultural robots to intertidal machines capable of tending or harvesting crops while also accomplishing other routine functions such as water quality testing or algae removal. Across many critical enabling factors, technology and affordability trends support near-term advances in this domain.

Given the above, a sequence of candidate research topics related to shellfish farming supporting this topic can be (preliminarily) defined as:

1. Document the value chain of the major shellfish farming species/method combinations with special emphasis on labor requirements and quality
2. Develop a high-level cost model for the major shellfish farming species/method combinations with special emphasis on labor requirements and critical quality factors. Extend this model include industry level estimates of the impact of labor shortages, escalating labor rates, and the potential value of labor substitution
3. Combine the results of 1 and 2 above into a prioritized target list for the development of labor substitution robotics in shellfish farming. Keep in mind during this activity the potential for synergistic applications of technology such as in-water crop tending or harvest operations with routine water quality sampling and testing
4. Conduct a survey of the marine science and robotics industries to identify new and converging technologies, and related industrial entities, which would be candidates for participation in applied research projects focused on new, cost-effective robotic technology labor substitutes in shellfish farming. From this survey identify a short list of potential robotics industry partners for research projects
5. Define a research/development process to keep robotics application projects from collapsing too early to short-term, low creativity outcomes; given the unique nature of the opportunity for robotics in shellfish farming, ample time must be allowed for the wide ranging, highly creative phase of development
6. Define one to three high priority targets, based on the results of tasks 3 and 4 above, and begin development of specific robotic technologies for shellfish farming with the greatest potential for positive economic impact in the shellfish industry