Pacific Coast Shellfish Growers Association (PCSGA)

2023 RESEARCH PRIORITIES

CONTACT:

Kim Thompson, executive director, PCSGA
kimthompson@pcsga.org

About PCSGA

The Pacific Coast Shellfish Growers Association (PCSGA) was founded in 1930 and represents bivalve shellfish growers in Alaska, Washington, Oregon, California and Hawaii.

PCSGA is dedicated to ensuring a healthy social, regulatory, and natural environment for shellfish farming on the West Coast. Our members strive to develop and use science-based methods of safe, sustainable shellfish production that supports healthy people, communities, and ecosystems.

The PCSGA Research Committee has updated the research priorities document to reflect current Board of Directors' research priorities for membership. The purpose of the document is to enable the PCSGA membership, funders and agencies to have up to date understanding of what researchable issues the PCGA finds most important for funding for the current year.

Document Purpose:

- Encapsulate current priorities for the PCSGA and membership.
- Identify funding opportunities that best match up with industry needs.
- Assist PCSGA staff to align letters and other kinds of support to best represent PCSGA interests.

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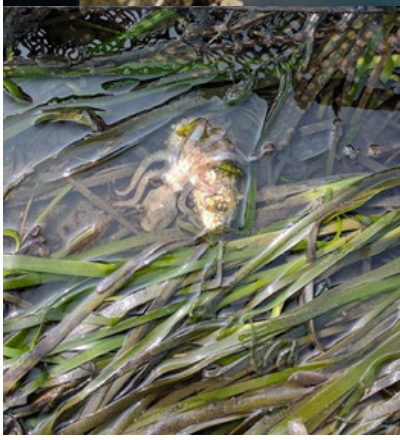

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1. Ecosystem Services Provided by Shellfish Farms

A number of RFP's address this topic annually with new interest in quantifying ecosystem services expressed by large ENGO's including The Nature Conservancy and the World Wildlife Fund along with NOAA Federal and State grants (Saltonstall-Kennedy, FFAR, National Sea Grant, State Sea Grant offices).

This research topic remains important under the current farm permitting climate coupled with the necessity for shellfish industry to provide justification for aquaculture to deserve increased social license to operate. Emphasis for research under this topic should focus on the variety of ecosystem services afforded by cultivating shellfish.

RESEARCH PRIORITIES:

- Demonstration of provision of habitat on intertidal or suspended farms. Research utilizing time lapse video and sonic tagging that can better quantify habitat use by fishes and mobile invertebrates is urgently needed.
- Ecological research including food web dynamics is needed that can discern between use of habitat that simply concentrates other organisms (aggregation) from use of habitat that provides increased resources (food and prey) for population enhancement.
- Carbon and nitrogen credit programs. There is continued interest among growers especially as this relates to opportunities for capitalizing on nutrients removed from nearshore waters by shellfish at harvest. The case for how important the cultivation of shellfish (oysters and clams) for carbon credits remains uncertain, however due to the complexity associated with accounting for the formation of calcium carbonate (where CO_2 is released on formation of shell materials) and during respiration in cultivated bivalves. It will be critical for companies to accurately assess production to take advantage of emerging nutrient credit programs.
- Nutrient benefits associated with harvested shellfish in terms of carbon and nitrogen removed from growing waters (sequestered in the meat and shells of harvested shellfish) remains important to quantify, especially if these data can reflect a drawdown of ambient nutrients.
- Nitrification and denitrification in sediments utilized for shellfish aquaculture remain under researched on the Pacific coast and offer opportunities to better describe the case for shellfish aquaculture to contribute to the removal of elemental nitrogen from surface waters through natural deposition and biogeochemical processes in the sediments.

***Top image**: Salmon smolt foraging among mussel lines. **Bottom image:** Anemones, tunicates, sponges, hydroid jellyfish, skeleton shrimps, and sea stars are part of the community of life that is living in tandem with farmed mussels.*

RESEARCH PRIORITIES CONTINUED:

- Co-culture of seaweeds with shellfish and other invertebrates offer opportunities to capitalize on integrated multi trophic relationships between plants and animals and remain under researched on the Pacific coast.
- Shellfish gear modifications that increase habitat potential for other organisms to use as refuge while submerged is needed. Quantifying the ecosystem services associated with the use of shellfish gear by fish, invertebrates, birds and marine mammals is needed.

2. Increased Sustainability of Shellfish Gear

Alternatives to plastics use in aquaculture is important to address industry wide. Initial work should target the plastic cages and other gear used to grow shellfish. This includes grow out bags, geoduck mesh tubes and the variety of floating cages in use today. Limited research to date suggests that the UV treated manufactured gear in use today, however, contributes little plastic degradation into microplastics (particles < than 5mm) polluting the world's oceans and beaches. The vast majority of plastics associated with microplastic pollution are associated with fibers and plastics that are not UV treated. The shellfish industry is vulnerable, however, to pollution based on plastics associated with ropes and twines and represent an important problem for the industry to resolve.

Alternatives to the use of yellow polypropylene rope in longline oyster culture is a critical need, for example. A second need is to eliminate plastic (nylon) cable or zip ties from one-use applications in shellfish aquaculture.

RESEARCH PRIORITIES:

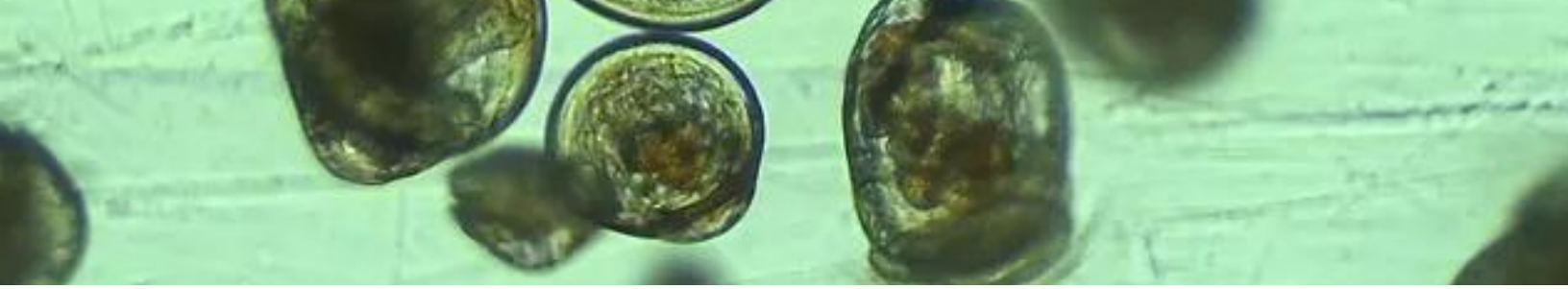
- Alternatives to plastic-based ropes and twines. Alternatives to plastics include natural fibers (e.g., bamboo and coir based twines) and carbon-fiber based gear that have outstanding longevity and strength to weight characteristics.
- Support of research that identifies the source and fate of microplastic generation in the marine environment, including gear associated with the shellfish industry.

3. Quantify Effects of Macro Algae Removal from Shellfish Ground

Macroalgal mats (Ulva, Enteromorpha and others) grow on and in shellfish gear associated with oyster and geoduck culture and nets used for Manila clam aquaculture. Excess macroalgae cover can result in significant reductions of dissolved oxygen in seawater, especially at night when the plants are respiring, increased hydrogen sulfide concentrations as the material decomposes and reduced flows of fresh seawater around the shellfish. Recent funding is supporting initial research on this topic, mainly in Puget Sound.

RESEARCH PRIORITIES:

- Quantify the effect of macroalgae removal on water column dissolved oxygen, water flow and transport, substrate dissolved oxygen, substrate H2S concentration substrate biology including infaunal and epifaunal invertebrate abundance and diversity in plots maintained free of excess macroalgae compared to control plots with macroalgal cover.
- Quantify macroalgal production on per square meter basis on a seasonal and geographic basis.
- Quantify the carbon, nitrogen and phosphorus in seaweeds that are removed as excess nutrients.
- Investigate means of automating macroalgae removal – including the relative costs and benefits to the health of shellfish. Macroalgal removal methods should be investigated, specifically the means for individual farms to design raft-based Venturi dredge based methods to remove macroalgae from farm beds.
- Research on macroalgal use following harvest is a priority. Uses include soil amendments, compost and fertilizers, among other uses.



4. Shellfish Breeding for Increased Production, Sustainability and Resilience to Climate Change

The PCSGA and shellfish industry continues to express strong interest to retain and enhance the capacity to sustainably and profitably farm oysters and other shellfish into the future. Disease threats have emerged 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.

The USDA ARS Pacific Shellfish Research Unit, in partnership with the Oregon State University Coastal Oregon Marine Experiment Station (OSU/COMES) has reorganized with renewed focus on grower's needs. Of specific interest to the PCSGA is the Pacific Oyster Genomic Selection project (POGS) breeding program. This program will focus on traits of interest to growers including growth, survivorship and other production traits though the current research priority will focus on better understanding the genetic underpinnings of resistance to Ostreid herpesvirus, also known as OsHV-1.Other private shellfish breeding efforts are focused on crossbreeding in combination with selection, coupled with polyploid development.

RESEARCH PRIORITIES:

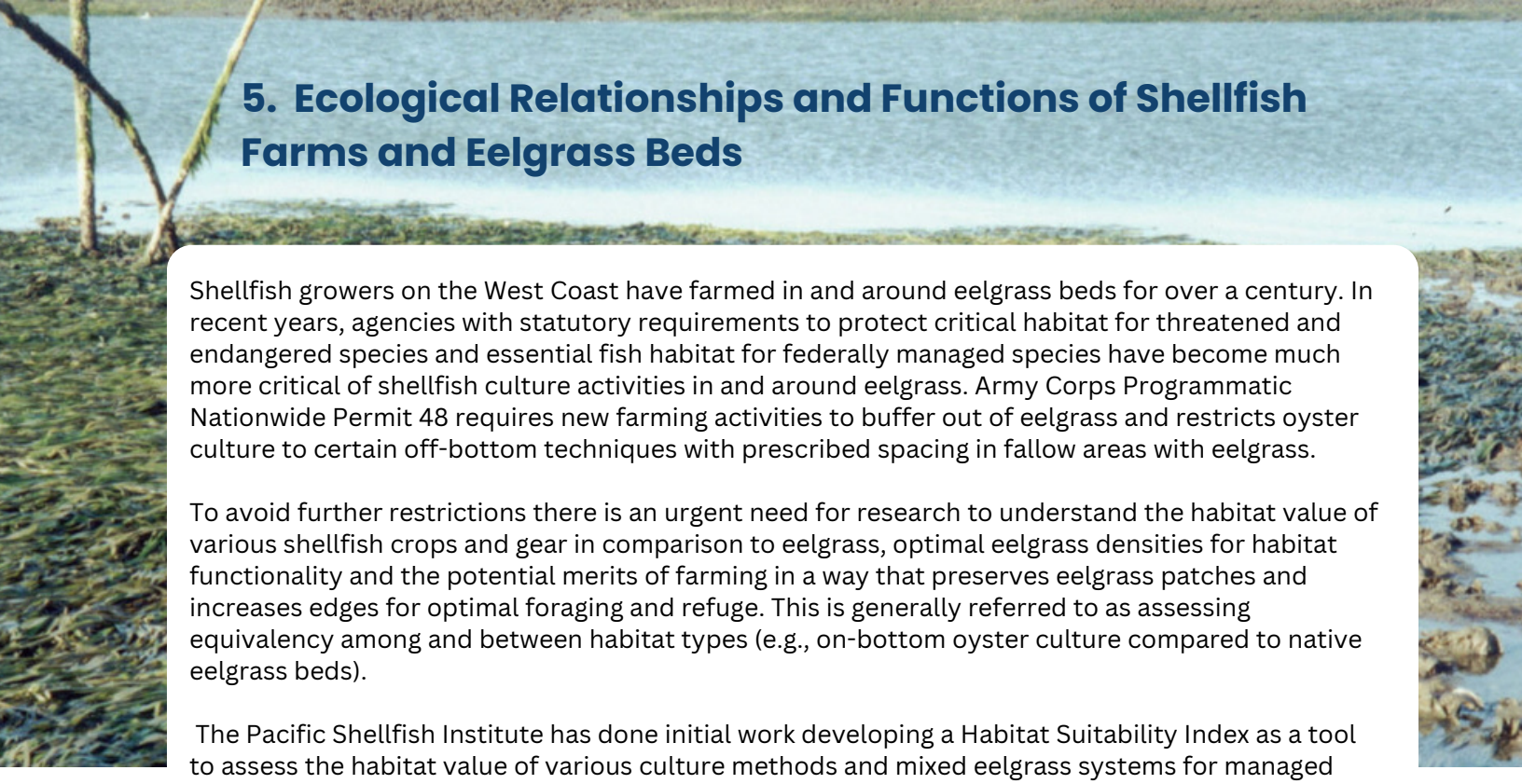
- Ostreid herpesvirus 1 (OsHV-1 var), or Pacific Oyster Mortality Syndrome (POMS) in the United States remains an existential threat to the shellfish industry and there is critical interest to conduct primary research on
    - Genetic mechanisms in oysters associated with resistance.
    - Application of breeding approaches to provide genetically based resistance to POMS in broodstock for subsequent seed production.
    - Means to build the industry's capacity for disease surveillance and breeding for resistance to herpes microvars.
    - Potential for Ostreid herpesvirus 1 (OsHV-1 var) to impact other species including commercially important clams and Kumamoto oysters.
    - Means to utilize a suite of coast-wide growers to assist in POMS research.
- 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.

RESEARCH PRIORITIES CONTINUED:

- Utilizing breeding approaches to decrease mortalities in both diploid and triploid oysters grown on intertidal beds exposed to multiple stressors including 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 U.S. 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.
- Support safe and sustainable alternatives to producing sterile shellfish outside of traditional triploid and tetraploid production technologies. This specifically includes research on identifying and silencing early sex-determining genes during embryogenesis.
- Explore opportunities to secure genuinely wild or naturalized pacific oyster broodstock for the US West Coast breeding programs.



5. Ecological Relationships and Functions of Shellfish Farms and Eelgrass Beds

Shellfish growers on the West Coast have farmed in and around eelgrass beds for over a century. In recent years, 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.

RESEARCH PRIORITIES:

- Understand equivalency of eelgrass to mature oyster habitat in terms of the ecosystem benefits. Emphasis on fish use of oyster beds (esp. salmonids), mobile invertebrates (e.g., Dungeness crab) and the capacity for oyster beds to support prey organisms associated with salmonids (e.g., harpacticoid copepods). How equivalent are oyster beds to eelgrass beds based on a suite of measurable metrics?

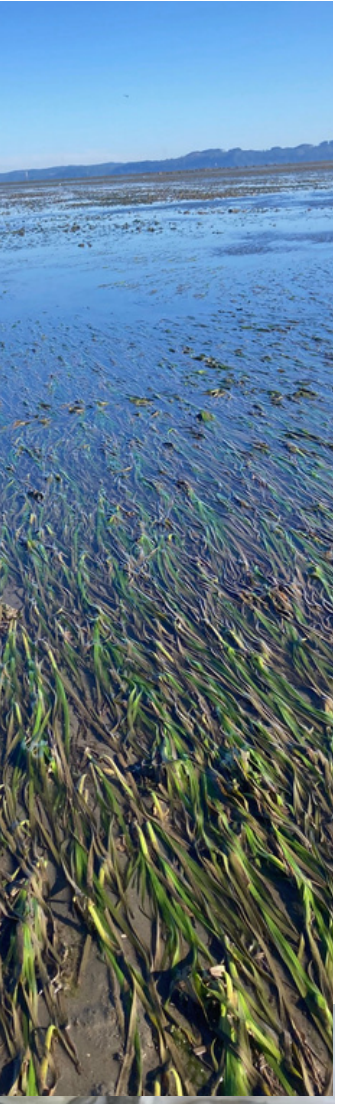
- Track the behavior of fish for meaningful periods of time over seasonal cycles to assess habitat use in different geographical habitats along the West coast.

    - 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 urgently required to inform regulators of equivalencies between oyster and eelgrass habitat in order to ease regulatory restraints related to farming shellfish in eelgrass.

- Follow up on prior research on benthic zooplankton populations, including harpacticoids and amphipods important to juvenile out-migrating salmonids, across the range of West Coast habitats and considers different oyster culture techniques and practices (on bottom, bag on bottom, off-bottom longline, flip bag, etc.) is needed.

    - 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 PRIORITIES CONTINUED:

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

- Relationship between aquaculture and perennial vs. annual eelgrass beds. Some eelgrass beds are now recognized to be annual eelgrass beds and the response of annual vs. perennial eelgrass beds are likely quite different to natural and aquaculture sourced disturbances. Annual beds may be more likely to 'blink out' if the bed is disturbed prior to seed sets preventing or limiting seed sets. Also, seedlings are particularly sensitive to disturbances at certain timings (shortly after germination) and may be more tolerant of winter disturbances than perennial eelgrass. Understanding that relationship could lead to time shifts in the management of activities towards time of year and certain activities being prioritized in say Sept-March and others in the April-August peak growing period.

- Studies that evaluate the function of eelgrass beds for salmon, forage fish and birds are warranted. Specifically, are the ecological functions of eelgrass beds higher near chinook salmon natal streams (within 5 miles) and areas actively used for herring spawn compared to other areas. If scientific support continues to affirm that some eelgrass beds have more ecological importance and value for these resources that could guide the future configuration of shellfish farms and use of habitats.

6. Public Health and the Shellfish Industry

Maintaining and improving the quality of growing waters remains the highest priority for the shellfish industry. However, primarily a task for State and Federal regulatory agencies, the maintenance of certifications of growing waters for shellfish production remains an urgent need. Research on the public perception of the shellfish industry and its reliance on excellent water quality is needed relative to threats associated with Vibrio parahaemolyticus and V. vulnificus, HAB's and Norovirus relative to public health.

RESEARCH PRIORITIES:

- Increase capacity to forecast emergence of virulent Vibrios in shellfish growing waters that impact shellfish.

- Increase capacity to forecast emergence of Harmful Algal Blooms (HABs) impacting growing waters including the capacity to model emergence of HABs at a finer (bay-scale) resolution than currently available.

- Increase capacity to forecast emergence of Norovirus threats.

- Public perceptions of shellfish relative to urgent necessity to maintain certified growing waters on the US west coast

7. Increasing Social License to Operate

The shellfish industry operates in a social environment without significant governmental support, unlike other forms of agriculture. Examples abound associated with the difficulty and expense associated with permitting shellfish farms for continued operations. This is ultimately due to a lack of public support to operate, and it is incumbent for the industry to work to increase their collective social license to operate in a social environment that often does not understand nor appreciate the values shellfish farming bring to communities.

RESEARCH PRIORITIES:

- Quantify the economic value of industry and contributions to communities in terms of direct and indirect employment. This metric needs development and should be developed and marketed as a published, annual contribution of shellfish farming to the economic and social health of communities.
- Identify key messages, images, and other content that have the most efficacy in terms of changing opinions about shellfish farming with various stakeholder audiences (e.g., local communities, NGOs, policy makers, etc.).
- Identify key stakeholders and strategies to address concerns or amplify support at community, state, and national levels.
- Increase social license for shellfish farming by providing unbiased research on ecosystem benefits and services shellfish farms provide. Public trust in shellfish farming can increase if benefits and services shellfish farms provide can be effectively demonstrated and communicated to the public.
- Environmental education with emphasis on how shellfish can enhance the health of the marine environment is needed to increase public acceptance of shellfish farming and combat inaccurate information provided to the public by NGO's averse to shellfish farming. The research community must play a role in engaging and educating NGOs, Aquariums, and others who regularly engage the public.

A few items that will be useful:

- Updated annotated bibliographies with a list of independent peer-reviewed research for relevant topics (e.g., ecosystem services, plastic use, human health implications, etc.)
- Sharing research results in a more publicly palatable format so organizations can easily translate for their public audiences.

8. Workforce Development and Retention

Workforce development and retention tools are urgently needed to address labor shortages in the shellfish industry.

RESEARCH PRIORITIES:

- Conduct a workforce needs assessment of the industry which includes current workforce needs, challenges, and hiring experiences of the west coast shellfish industry, including service providers and ancillary businesses

- Develop a coast wide strategy to establish a comprehensive workforce training system which includes employee retention and diversity. Such a strategy should be informed by:

    - Identifying the current status of diversity in shellfish industry workforce and opportunities for advancement which reflect community-level interests and needs.

    - Identifying gaps and areas where small adjustments can help address gaps (e.g., more Spanish-language training materials). Some of this will be helpful with a broader scope but understanding community-level challenges and benefits of shellfish employment will be critical.

    - Best practices the shellfish industry, service providers and ancillary businesses can use to improve employee recruitment and retention in a manner that best serves the communities in which they operate.