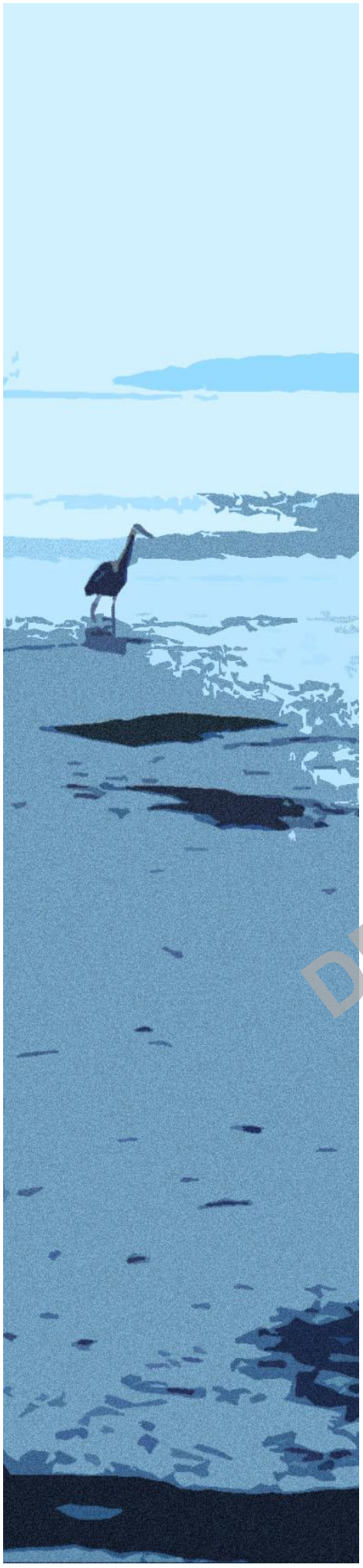

West Coast Shellfish Research Goals 2015 Priorities

Pacific Shellfish Institute
120 State Ave NE #1056
Olympia, WA 98501
Tel: 360.754.2741
www.pacshell.org

West Coast Shellfish Research Goals -- *2015 Priorities*

Table of Contents

Note: Each goal includes strategies, which are prioritized as High (H), Medium (M) or Low (L).

Topic 1: Protection and Enhancement of Water Quality in Shellfish Growing Areas

Goal 1.1. Respond to water quality problems in a coordinated and constructive manner.

Rationale

With coastal populations on the rise, shellfish growing areas are threatened with degrading water quality from failing on-site sewage systems, storm water runoff, domestic and commercial animal waste, and increased recreational use without adequate facilities. Responding in a coordinated, cooperative fashion could prevent future growing area classification downgrades, and reduce the time necessary to upgrade polluted growing areas.

Strategies

1.1.1 (H) Establish a water quality standing committee within PCSGA to respond to water quality problems in West Coast shellfish growing areas. This committee should:

- Draw on the collective experiences of growers in areas.
- Be familiar with water quality law [Clean Water Act (Total Maximum Daily Load's (TMDL's), 303d list), Shellfish Protection Districts (Revised Code of Washington 90.72) etc.].
- Consider revisiting the shellfish protection district legislation to make it more sustainable, enforceable, and responsive to emerging problems.
- Be involved in local and regional watershed plan development and implementation.

1.1.2 (M) Form alliances between growers and marine resources committees (MRCs), watershed groups and tribes to provide a stronger focus on shellfish growing water quality.

1.1.3 (H) Develop a public communication strategy surrounding water quality issues.

Goal 1.2. Develop a strategy for engaging the community in the health of local waters and galvanizing broader community support for pollution control projects.

Rationale

State statutes that require creation of shellfish protection districts provides a valuable structure for local governments to address water quality problems. Similarly valuable are state laws requiring local governments to create operation and maintenance programs for on-site septic systems. However, these statutes do not guarantee that local elected officials act on these recommendations to fund infrastructure improvements and pollution control projects. Community support for water quality improvements can be fostered through community shellfish farms and backyard shellfish gardens. Citizens involved in these activities not only improve their own habits related to near shore water quality, but many also become advocates for local water quality improvements.

Strategies

1.2.1 (H) Encourage community shellfish farms and backyard shellfish gardening through outreach, education and hands-on instruction.

Topic 2: Shellfish Health, Disease Prevention and Management

Goal 2.1. Develop disease prevention, surveillance and treatment strategies to ensure the production of high health shellfish which meet domestic and international health standards and maximize production efficiencies.

Rationale

The ability to grow healthy, disease-free shellfish is of basic importance to any successful shellfish operation. However, many tasks remain to be completed in order to better identify, understand, and control the disease processes affecting shellfish in hatcheries, nurseries, and grow-out beds, and to ensure that healthy shellfish can be transported freely to meet market demand.

Strategies

2.1.1 (H) Define water quality standards for shellfish hatchery and nursery operations. Determine the key parameters to measure, and feasible methods for measurement, in hatchery and nursery environments. Establish a protocol for hatchery water quality and bacteriological monitoring.

2.1.2 (H) Determine prevention and management methods for hatchery and nursery bacterial pathogens that cause morbidity and mortality in shellfish larvae and seed.

2.1.3 (H) Continue water quality testing in shellfish seed collection areas such as Willapa Bay. Develop predictive ability for natural seed setting and growth conditions based on knowledge of optimal timing and conditions of natural setting.

2.1.4 (H) Continue efforts to improve interstate coordination for shellfish movements in order to promote the sale of disease-free larval, seed and brood stock shellfish. Expand this effort to include shellfish grower outreach, including information and education on interstate health and certification requirements.

2.1.5 (H) Determine the role of algal toxins related to mortality and poor performance of shellfish in hatcheries and production areas.

2.1.6 (H) Continue and expand the monitoring of adult and seed shellfish diseases in growing areas. Continue and expand oyster monitoring program to sites in all West Coast states. Develop similar programs for other species, specifically clams and mussels.

2.1.7 (H) Develop risk management procedures for shellfish transfers and disease assessment. Encourage regulatory authority acceptance and application of established procedures.

Goal 2.2. Conduct research to enhance understanding of the extent and impact of ocean acidification on shellfish and identify and develop potential response and management strategies.

Strategies

2.2.1 (H) Continue research into larvae mortalities and remote setting problems, including monitoring of pH levels and aragonite saturation state of seawater at remote setting sites.

2.2.2 (H) Conduct research on ocean acidification adaptation tools and techniques. Examine and develop strategies to determine effective water treatments at the hatchery scale.

2.2.3 (H) Determine which species are most vulnerable/resilient in an acidifying environment (native and non-native species in upwelling environments).

2.2.4 (H) Conduct research into the buffering benefits of shell.

Topic 3: Shellfish Ecology

Goal 3.1. Promote the industry Environmental Management System (EMS). Establish and maintain a reputation as responsible stewards of the estuarine environment with the public, resource management agencies, tribes and the environmental community.

Rationale

The West Coast shellfish industry is under ever increasing regulatory scrutiny as a result of salmon listings under the Endangered Species Act, the Sustainable Fisheries Act and associated identification and protection of essential fish habitat (EFH). The general population is increasingly demanding that forests, riparian areas, beaches and other wildlife habitats be preserved and enhanced. The animals that are cultured by the shellfish industry are an integral part of the marine ecosystem, and commercial shellfish growers are clearly dependent upon a healthy ecosystem. The Environmental Management System (EMS) consisting of an Environmental Policy (EP) and an Environmental Code of Practice (ECOP = Best Management Practices) prepared by PCSGA in 2002 will be crucial to the prosperity of the industry.

Strategies

3.1.1 (H) Promote and maintain the shellfish industry Environmental Policy (EP).

3.1.2 (H) Promote and implement the shellfish industry Environmental Code of Practice (ECOP) which implements the EP to support sustainable aquaculture and address regulatory, environmental and tribal concerns. Provide training opportunities for growers, possibly through services of PSI, using a variety of tools and hands-on workshops.

3.1.3 (H) Promote waste reduction and recycling procedures for the shellfish industry that are linked to current production methods and proactive public/NGO organization education. Expand outreach and participation with marine-focused organizations (such as tribes, environmental groups, and marine resource committees) in beach clean-ups throughout Puget Sound, most notably to retrieve and recycle or properly dispose of all derelict or lost shellfish aquaculture equipment and materials. Initiate additional industry beach clean-up events similar to the twice annual south Puget Sound events.

3.1.5 (M) Establish a process to monitor implementation and evaluate effectiveness of the ECOP. Train growers to implement the ECOP and ensure that new PCSGA members are provided a copy and briefed on the PCSGA ECOP.

3.1.6 (M) Establish a process to periodically update the ECOP as science and technology find new economical and environmentally sensitive practices.

Goal 3.2. Ecological impacts (positive and negative) associated with shellfish growing and harvesting need to be documented and incorporated into the Environmental Management System (EMS).

Rationale

Cultured shellfish are an integral part of estuarine ecology. It is crucial to the development of an effective EMS that industry and resource managers have a clear understanding of the role cultured shellfish play in the ecosystem.

Strategies

3.2.1. (H) Establish a research database related to shellfish ecology. Collect relevant data associated with different growing practices using best available science. Publish the data in scientific journals, and make the information available on PSI and PCSGA's websites. Seek opportunities to inform resource managers and elected officials at venues such as research conferences, public meetings, grower conferences and agency work sessions.

Goal 3.3. Quantitatively document environmental and economic impact and contribution of shellfish aquaculture.

Strategies

3.3.1 (H) Develop bioeconomic models that incorporate data on production, costs of production, crop value, and spatially explicit environmental and oceanographic data to predict long term trends and inform adaptive management in the face of changing ocean conditions.

3.3.2 (H) Calculate filtration services, including carbon sequestration and nitrogen removal, provided by shellfish culture.

3.3.3 (H) Quantify biodiversity benefits of shellfish culture.

3.3.4 (H) Determine economic value of the ecosystem services provided by shellfish culture.

3.3.5 (H) Support efforts to ensure that ecosystem services provided by shellfish are factored into the Department of Ecology's DO model.

Topic 4: Domestication of Established Shellfish Species on the West Coast

Goal 4.1. Establish and maintain an industry-supported Pacific oyster breeding program.

Rationale

Two oyster breeding programs previously funded by USDA are either ongoing or have been transferred to industry. Both breeding programs have shown excellent results, one focused on selection, the Molluscan Broodstock Program (MBP), and the other on crossbreeding of inbred lines. Due to reduced federal funding, parts of these programs will continue to need financial support from industry and other stakeholders to ensure long-term genetic improvement of oyster brood stock. The programs are currently based at the Hatfield Marine Science Center of Oregon State University (OSU), which is currently underfunded. Adoption of a breeding program by industry may entail enhanced funding for facilities at the Hatfield Marine Science Center and/or the Ken Chew Center for Shellfish Research and Restoration in Manchester, Washington.

Industry facilities are also placing greater emphasis on triploid oysters. Triploids produced from tetraploids have demonstrated increased growth and are an established part of commercial production. Continued development of lines of tetraploid oysters is needed.

Strategies

4.1.1 (H) Support breeding programs to enhance resistance to disease and summer mortalities, yields, shellstock characteristics and marketability of Pacific oysters.

4.1.2 (H) Support genomic research, QTL-mapping, development of markers for selection and purging of deleterious mutations, development of BAC libraries and micro-arrays, sequencing the Pacific oyster genome and other biotechnology research on improving oyster broodstock.

4.1.3 (H) Support research on improvement of tetraploid oysters to develop genetic lines, enhance performance and stability of chromosome number (3N), and use for producing all triploid oysters.

4.1.4 (H) Expand outreach programs via state Sea Grants, PSI, PCSGA and other organizations to enable determination of the performance of genetic lines as they pass through the hatchery, nursery and grow-out to market, including improvements in line testing technologies.

Goal 4.2. Establish techniques for increasing the level of domestication for other cultivated shellfish.

Rationale

Improvement of currently cultivated shellfish is desired. Species include Kumamoto oysters (*Crassostrea sikamea*), Eastern oysters (*C. virginica*), Suminoe oysters (*C. ariakenesis*) and European flat oysters (*Ostrea edulis*), Manila clams (*Venerupis philippinarum*) and Mediterranean mussels (*Mytilus galloprovincialis*). Long grow-out periods, losses due to disease and other mortality factors, and seasonal problems with marketability of product contribute to high costs of production, product loss and reduced market share on an annual basis.

Strategies

4.2.1. (H) Maintain the genetic integrity and diversity of commercially important species that comprise small populations. These include Eastern, European flat, Kumamoto and Suminoe oysters.

4.2.2. (H) Develop an industry-based breeding program, focusing on selection and/or crossbreeding and polyploidy, for developing lines of higher yielding Manila clams.

4.2.3. (H) Develop an industry-based breeding program focusing on selection and/or crossbreeding and polyploidy for developing lines of higher yielding Kumamoto oysters.

Topic 5: Aquaculture and Enhancement of Native Shellfish

Goal 5.1. Establish hatchery, nursery and grow-out techniques for shellfish species with current or emerging potential for aquaculture, enhancement and restoration.

Rationale

Hatchery techniques need to be developed and refined to rear native species of shellfish for purposes of aquaculture, enhancement and restoration. Development of maturation and conditioning techniques, spawning and larval rearing, nursery techniques and planting/distribution methods are critical to establish prior to large-scale production. For stocks intended for ecological restoration, genetic integrity of native stocks should be investigated and preserved, and strategies developed to minimize any negative impacts on wild populations. More work is needed to determine the effectiveness and feasibility of using hatchery produced shellfish in restoration and mitigation projects.

Strategies

5.1.1 (H) Conduct studies to evaluate the genetic structure, distribution and temporal changes in populations of Olympia oysters, native clams (butter, native littleneck, horse, razor and geoduck), cockles, scallops and abalone, in order to evaluate the risk of using hatchery-propagated seed for aquaculture, enhancement and restoration purposes.

5.1.2 (H) Develop culture techniques for producing native species that minimize the risk of genetic interactions between hatchery propagated and wild populations. The development of triploids and other means for sterilizing adults are important to pursue.

5.1.3 (H) Develop hatchery, nursery and grow-out techniques for the large-scale enhancement of public and tribally controlled tidal and near-shore habitats, including the development of methods for mass marketing of shellfish produced for enhancement purposes.

5.1.4 (H) Investigate use of hatchery-cultured shellfish as a means of contributing to the effectiveness and efficiency of mitigation and restoration efforts in tidal and near-shore habitats.

5.1.5 (M) Determine key factors affecting native oyster recruitment/survival in Willapa Bay.

Topic 6: Management and Research of Pests and Invasive Flora and Fauna

Goal 6.1. Develop enhanced management techniques for burrowing shrimp on shellfish tidelands.

Rationale

A comprehensive Integrated Pest Management (IPM) plan was designed to enable the shellfish industry to manage burrowing shrimp in an effective, ecologically sound and economically feasible manner. A framework for an IPM plan for burrowing shrimp was developed in 2003 and has been updated several times to reflect changing conditions. Maintaining a current IPM plan is critical to sustainable shellfish cultivation in areas affected by burrowing shrimp.

Strategies

6.1.1 (H) Evaluate alternative (biological, physical and chemical) tactics and their impacts to manage burrowing shrimp under a controlled experimental regime.

6.1.2 (M) Increase accuracy and precision of monitoring techniques. Expand monitoring program to better assess and forecast shrimp densities on all commercial beds.

6.1.3 (H) Investigate burrowing shrimp development, life-history, and ecology to increase the potential of discovering novel mechanisms of control.

6.1.4 (L) Determine the economic thresholds and action levels associated with differing burrowing shrimp densities, sediment types, control techniques, and oyster culture methods.

6.1.5 (L) Conduct cost/benefit analysis for oyster cultural techniques, such as bottom culture, long-lines, and stake under different scenarios of wild vs. hatchery seed, growth rates, and end-market

Goal 6.2. Develop a strategy to study and manage Japanese eelgrass.

Rationale

Japanese eelgrass (*Zostera japonica*) is a non-native eelgrass that has spread to most intertidal areas in Willapa Bay and Grays Harbor, and has also been observed throughout Puget Sound and Hood Canal. Japanese eelgrass forms thick blankets in the intertidal environment, affecting water drainage, sediment temperature, and likely nutrient composition. For these reasons, the eelgrass hinders both burrowing shrimp control and shellfish harvest.

Strategies

6.2.1 (H) Measure and better describe the impact of Japanese eelgrass on intertidal ecology and shellfish production.

6.2.2 (H) Monitor the spread of Japanese eelgrass.

6.2.3 (H) Investigate biological, physical and chemical control methods.

Goal 6.3. Expand the research program for exotic oyster drills and develop a management program.

Rationale

Japanese and Eastern oyster drill (*Ocinebrellus inornatus* and *Urosalpinx cinerea*) are well established in all Washington state shellfish growing areas. Oyster drills perforate the shell of oysters and eat the meat, with preference for smaller, younger oysters. Their impact has not been precisely measured. Control is by labor intensive hand removal during low tide events.

Strategies

6.3.1 (H) Work with growers, local and state government agencies, and scientists to expand the research of oyster drill ecology and management.

6.3.2 (H) Incorporate the results into a management plan that can be implemented to growers via PCSGA and PSI communications.

Goal 6.4. Incorporate monitoring and management of shellfish pests, both native and non-native, into an all-encompassing Integrated Pest Management Plan (IPM).

Rationale

Research is needed to develop better methods of managing the colonization and effects of native and exotic shellfish pests. Predaceous pests to shellfish aquaculture include various species of crab, oyster drills, slipper shells, starfish, moon snails, perch, and waterfowl. Both native eelgrass (*Zostera marina*) and non-native eelgrass (*Zostera japonica*) beds are dynamic colonizers and respond to a variety of physical and environmental variables. While some farming practices can impact eelgrass, others promote its establishment to new areas and can impact shellfish farming activities.

Strategies

6.4.1 (H) Investigate and implement methods to identify and quantify the impacts of native and non-native species on wild and farmed shellfish.

6.4.2 (H) Evaluate environmentally sensitive and relevant management tactics, beginning with the establishment of a comprehensive database of current investigations.

6.4.3 (H) Work with federal, state, local, and tribal resource management agencies to establish a seagrass policy which recognizes both the positive and negative aspects of grower activities. The policy should provide for the management of beds based on the conservation and protection of estuarine habitat, rather than the traditional policy based on no net loss of eelgrass. Educate public

and resource agencies regarding the differences between native (*Z. marina*) and non-native (*Z. japonica*) eelgrass and assure policies do not require protection of non-native plants.

Topic 7: Aquaculture Training, Education and Outreach

Goal 7.1. Enhanced aquaculture training for industry and tribal employees.

Rationale

Staff training is a critical requirement for new and existing employees. New employees often little understanding of shellfish culture, safe food handling practices, or other skills required by the industry and tribes.

Strategies

7.1.1 (H) Develop and provide information on the availability, type and cost of aquaculture training on the West Coast and at other locations.

7.1.2 (H) Establish a short-term training program to include on-the-job training (i.e. algae culture methods, BMP outreach, restoration methods, business management and personnel issues) with links to professional organizations, meetings or workshops.

7.1.3 (L) Evaluate and promote longer-term continuing education offerings, similar to the Washington Agriculture-Forestry program or specific course-work at local colleges, to provide more extensive aquaculture training.

Goal 7.2. Continue support for formal undergraduate and graduate training in aquaculture centers and laboratories at community colleges, universities, tribal and other research facilities.

Rationale

Continued advances in shellfish cultivation requires a commitment by research institutions. The industry and the private sector research and consulting community will need students with training in shellfish biology, marine ecology, culture techniques for commercial and restoration applications, aquaculture business and management, and related disciplines.

Strategies

7.2.1 (H) Promote the continued development of aquaculture research and training programs at the high school, technical school, and college levels.

7.2.2 (H) Establish community college-based certification programs for farm managers to include both aquaculture and business management skills.

7.2.3 (H) Promote recruitment to bring new students and faculty into these programs.

Goal 7.3. Promote shellfish education in schools, clubs and marine interpretive centers.

Rationale

Schools, clubs and marine interpretive centers provide an opportunity to educate a wide range of students in classroom, laboratory and field settings. Students gain entrepreneurial skills and an understanding of the biological and water quality requirements of shellfish culture and restoration.

Strategies

7.3.1 (H) Develop shellfish science program curriculum aligned with state learning standards for K-12 educators.

7.3.2 (M) Work with PCSGA, non-government organizations (NGOs), foundations and individual growers to develop opportunities for high-school students.

7.3.3 (M) Encourage shellfish clubs at high schools and colleges, such as the Evergreen State College Shellfish Club in Olympia.

7.3.4 (L) Work with an existing marine interpretive centers to create working shellfish culture exhibits.

Goal 7.4. Aquaculture information and outreach should be made available to the shellfish industry, tribes, and regulatory agencies.

Rationale
Many growers have requested creation of a library dedicated to the shellfish industry. Information resources could be made available on the PCSGA or PSI websites, or other accessible location.

Strategies

7.4.1 (M) Develop a readily available "tool box" of information for people interested in shellfish farming or restoration.

7.4.2 (H) Continue to encourage tribal and agency personnel to attend the annual Pacific Coast Shellfish Growers Association (PCSGA) conference and tradeshow, as well as the annual Washington Sea Grant Shellfish Grower's Conference.

Goal 7.5. Enhance efforts to effectively communicate research findings to a general audience.

Rationale
Results of ongoing and completed shellfish research should be made available to a general audience. Effective communication must include non-technical summaries of research findings.

Strategies

7.5.1 (H) Produce web and social media based sound bites related to shellfish ecology, aquaculture research and current issues facing shellfish cultivation and restoration.

7.5.2 (H) Utilize the PSI and PCSGA websites and social media platforms to disseminate shellfish-related information to the public.

7.5.3 (H) Identify appropriate venues, and utilize effective science communicators, to disseminate shellfish-related information to the public.

Topic 8: Farming, Harvesting and Processing: New Methods and New Products

Goal 8.1. Establish a library of processing, seafood handling, and value added developments.

Rationale
A centralized library of information pertinent to commercial shellfish culture would be of great value to researchers and commercial growers.

Strategies

8.1.1 (M) Investigate feasibility of establishing and maintaining a library focused upon the production and processing of shellfish under the auspices of PCSGA or PSI.

8.1.2 (M) Maintain current information regarding alternative food processing/sterilization from other food industry literature. Evaluate applicability of these alternatives to shellfish production, particularly as they apply to the live shellfish market.

Goal 8.2. Identify optimal design and materials of shellfish farming implements.

Rationale
The shellfish industry must continue to test innovative products and materials to facilitate economically and environmentally sustainable shellfish production.

Strategies

8.3.1 (H) Alternative materials – continue research on alternative predator control methods and

materials for all cultivated species. Focus on economically and environmentally sustainable materials minimize waste through reuse or are biodegradable.

Goal 8.3. Continue development trials of High Hydrostatic Pressure processing for oysters and other shellfish species.

Rationale

High Hydrostatic Pressure (HHP) is effective at releasing the adductor muscle from both shells without changing the texture or other characteristics of the meats. The process also appears to effectively kill bacteria (*Vibrio* spp.). Promising commercial results indicate further exploration of this technique is merited.

Strategies

8.3.1 (H) Continue to investigate the effects that HHP processing has on product shelf life, *Vibrio* bacteria, various toxic phytoplankton (PSP, domoic acid, DSP), viral pathogens (human) and spoilage microbes.

8.3.2 (H) Develop National Shellfish Sanitation Program guidelines for HHP treatment for the control of *Vibrio parahaemolyticus*.

Goal 8.4. Evaluate other value-added processing methods for use by the West Coast industry.

Rationale

The oyster industry should continue product development for improved safety and new markets. Understanding consumer needs in domestic and the international markets is critical for developing successful products.

Strategies

8.4.1 (M) E-beam radiation was approved by FDA in 2005 as a process for bacteria removal for oysters, but more research is needed to determine the tradeoffs between *Vibrio* inactivation and sensory changes.

8.4.2 (M) Thermal pasteurization of value-added products will eliminate potential pathogens and expand opportunities for new product niches. Research should include time/temperature parameters and measurement of sensory, chemical and microbial indicators.

8.4.3 (H) New packaging options for fresh and processed products should be researched for new and value added products.

8.4.4 (H) Conduct a market survey to identify amongst other things, market potential for new and existing product forms, new packaging and new species.

Topic 9: Human Health and Shellfish

Goal 9.1. Improve public and food handlers' understanding of shellfish pathogens and good shellfish handling practices.

Rationale

The National Shellfish Sanitation Program (NSSP), which governs the activities of commercial shellfish operators, ensures that commercial growers possess a reasonable understanding of good shellfish handling practices. Retail marketers and restaurant workers often do not have this same level of understanding, and as a result, shellfish-borne illnesses are often associated with mishandling in shellfish distribution systems.

Strategies

9.1.1 (H) Improve food handlers understanding of shellfish pathogens and good shellfish handling practices. Work through local health departments to disseminate this information.

9.1.2 (H) Transporters, retailers and consumers need to be educated on means to reduce time temperature abuse of shellfish.

9.1.3 (H) Develop a public education campaign to reduce the number of illnesses associated with mishandled product.

Goal 9.2. Improve indicators of contamination and tools to identify specific pollution sources.

Rationale

Fecal coliform bacteria, the current indicator organism used to classify shellfish growing waters, is present in the feces of all warm blooded animals. When growing areas are impacted by fecal coliform bacteria, it has historically been very difficult to both determine and quantify the source. The result is a non-targeted assault on all non-point source pollution (birds, waterfowl, livestock, failing septic systems, storm water runoff etc.). Microbial source tracking methods are being used to trace fecal coliform bacteria, but there is not yet a technique available to quantify the contribution or assess the associated human health risk.

Strategies

9.2.1 (H) Support on-going and new research to identify specific bacterial pollution sources in shellfish growing areas.

9.2.2 (H) Support research that determines the human health risk associated with various sources of bacterial pollution.

9.2.3 (H) Promote and monitor progress of fecal coliform indicator studies. Monitor state protocols to determine value of enterococcus for shellfish growing areas.

Goal 9.3. Improve understanding of dynamics of Paralytic Shellfish Poisoning (PSP) accumulation in geoducks and other bivalve shellfish species.

Rationale

A clearer understanding of PSP dynamics in geoducks and other bivalve shellfish species is essential to adequately protect public health and minimize economic impact to the industry.

Strategies

9.3.1 (H) Encourage further research on PSP in geoduck, looking at variables such as depth, harvesting effects, seasonality, water column, intertidal vs. subtidal, cultured vs. wild, and age variability.

9.3.2 (H) Encourage further evaluation of the risk assessment associated with PSP and other toxins levels currently established in the National Shellfish Sanitation Program and current methods of testing.

9.3.3 (H) Conduct ecosystem based studies to provide insight into increased PSP toxin levels in all bivalve species, as a tool to identify mitigation methods.

9.3.4 (H) Encourage further research on PSP retention and depuration for geoduck clams and other bivalve species.

9.3.5. (H) Conduct research on the viability of cysts in inter-tidal vs. sub-tidal zones. Examine environmental reservoirs in different geographical areas in Puget Sound.

Goal 9.4. Develop an ability to predict changes in toxic phytoplankton and bacterial levels in water and sediments.

Rationale

Toxic phytoplankton and excessive bacteria levels can close shellfish growing waters very quickly.

Occasionally toxin or bacteria levels increase so rapidly that contaminated product escapes detection and enters the market place, causing illnesses and subsequent recalls. The illnesses and recall process both erodes consumer confidence and generates considerable expense for the shellfish grower. Inexpensive tools for early and rapid detection or prediction of developing blooms or increasing bacteria levels would prevent unnecessary illnesses and recall situations. It would also allow growers the opportunity to manage shellfish supplies by shifting to i harvest areas or by supplying alternative product.

Strategies

9.4.1 (H) Communicate economic impacts of marine biotoxins to funding sources to encourage additional research funding.

9.4.2. (H) Develop rapid identification tools for toxins such as PSP, including field kits.

9.4.3 (M) Collect information about virulent species, abundance and prevalence. Build comprehensive database for phytoplankton occurrences.

9.4.4 (M) Assure that the harmful algae bloom (HAB) relationships in newly cultivated and/or harvested species are understood. Identify HAB effects and how absolute levels of toxins differ among shellfish species.

Goal 9.5. Support research directed at developing effective methodologies to control the impacts of marine biotoxins, bacteria, viruses, and heavy metals in live shellfish.

Rationale

Toxic marine algae, *Vibrio* spp. and other marine bacteria, and viruses are public health risks associated with West Coast shellfish. Monitoring of shellfish meats and growing areas is expensive and growers are economically impacted by closures, product recalls and lost consumer confidence. While depuration is a proven technology for eliminating harmful bacteria from shellfish, it is not effective at eliminating viruses or marine biotoxins. Depuration techniques for heavy metals remains inadequately tested. Further development of post-harvest treatments for live shellfish would improve public health protection and reduce the associated economic impacts to the industry.

Strategies

9.5.1 (H) Conduct research to identify possible inactivation or removal (depuration) of marine biotoxins from live shellfish.

9.5.2 (H) Conduct research to develop an effective process for removal of viruses from live shellfish.

9.5.3 (H) Encourage further research on domoic acid accumulation, retention, and depuration for all commercial bivalve species.

9.5.4 (H) Conduct comparisons of heavy metal accumulation in bivalve species and processes to reduce concentrations.

9.5.5 (H) Investigate the cause of sporadic cases of *Vibrio parahaemolyticus* (Vp) associated with low tdh+ and tlh numbers. Determine the role and significance of different strains, and need or potential for a different pathogenicity indicator.

Topic 10: Marketing and Promotion of Shellfish Culture

Goal 10.1. Develop a marketing strategy for current species and identify opportunities for new species.

Rationale

Marketing of West Coast shellfish products has relied largely on the efforts of individual companies. Substantial increases in East Coast hard clam production and eastern Canadian blue mussel production have dampened demand and price for West Coast clams and mussels in the traditional “steaming”

market. Similarly, frozen product from Asian markets consistently competes with fresh West Coast product. However, shellfish products remain poised to take advantage of the growing "localvore" eating movement, where people are increasingly seeking sustainably produced food from within close proximity to their community.

Strategies

10.1.1 (H) Investigate examples of organized marketing efforts similar to programs developed by the Alaska Seafood Marketing Institute and various agricultural commodity commissions.

10.1.2 (H) Continue to identify funding options to support the development and implementation of a marketing program.

10.1.4 (H) Continue to participate in promotional activities such as seafood shows and the Shellfish Lovers Ultimate Rejuvenation Party (SLURP).

10.1.5 (M) Continue to update and produce promotional information regarding environmentally sound culture techniques, shellfish quality, handling, nutritional and product safety for distribution (brochures, flyers, table tents, recipe cards) in retail outlets, trade shows, county fairs, farmers markets, press releases and on the PCSGA/PSI/SG/Cooperative Extension websites and social media platforms.

10.1.6 (H) Promote shellfish as a unique locally grown, sustainable protein source that exemplifies the "localvore" movement in the Pacific Northwest.

10.1.7. (H) Develop marketing effort toward ecosystem services. Focus on outreach to policy makers and how ecosystem changes can impact income tax revenues.

Goal 10.2. Conduct studies or analyses to assess marketing opportunities and constraints in shellfish aquaculture.

Rationale

The West Coast shellfish industry must be well-informed of marketing trends and consumer demands to help guide farming activities.

Strategies

10.2.2 (H) Collect and report on data emerging markets and the impact of global opportunities and competition with respect to the West Coast region.

10.2.4 (H) Investigate the feasibility of marketing partnerships and/or cooperatives (local and regional) among producers, wholesalers and retailers to expand marketing opportunities.

10.2.8 (H) Perform a consumer preference survey to include questions on: preferred package size (ounces of shucked meat, lbs. or dozens of live shellfish); opened on ½ shell vs. live in shell, frozen vs. fresh; alternative shucked meat containers ("dyno" pack, square jars); tamper evidence; shelf life (shelf stable); safety; value added (smoked, marinated, ½ shell with toppings); ease of cooking and handling; sustainable and/or organic labels; and perceptions regarding shellfish "farming."

Goal 10.3. Educate the general public, consumers, waterfront owners, resource managers, boaters, and others regarding the benefits of shellfish, shellfish culture and the industry's need for a clean healthy environment.

Rationale

Shellfish processors share a common need to educate a wide array of people on a variety of topics. Some of these needs include educating the general public, consumers and resource managers on topics ranging from proper handling and preparation of their products, to culture practices and the industry's need for a healthy environment.

Strategies

10.3.1 (H) Expand educational efforts regarding the ecosystem services provided by shellfish cultivation.

10.3.2 (M) Develop educational information for inclusion in printed materials, informational kiosks, interpretive center displays, and on the PCSGA/PSI/SG/Cooperative Extension webpages.

10.3.3 (M) Encourage and promote public education and water quality awareness through activities such as shellfish gardening, community shellfish farms and retail seed sales.

10.3.4 (L) Promote opportunities for the public to tour shellfish farms, especially in conjunction with meals that showcase shellfish in combination with other locally-produced food.

10.3.5 (H) Support opportunities to demonstrate sustainability and local nature of shellfish aquaculture through social marketing, farmers markets, culinary tours, and outreach to restaurants and retail stores.

Topic 11: Policy and Regulation

Goal 11.1. Promote the Washington Shellfish Initiative and other state's shellfish initiatives.

Rationale

The Washington Shellfish Initiative (WSI) was launched in 2011, following NOAA's National Shellfish Initiative**.** The WSI goals are ambitious and vital to the sustained health of shellfish resources. The shellfish industry, resource management agencies and the research community must participate in continued advancement of the WSI goals.

Strategies

11.1.1 (H) Representatives from PSI and PCSGA should continue to serve on the WSI stakeholder committee to ensure advancement of WSI goals.

11.1.2 (H) Support other state's shellfish initiatives, such as the Oregon and California Shellfish Initiatives and the Alaska Mariculture Initiative.

Goal 11.2. Foster a positive regulatory and social environment which supports environmentally sound shellfish culture.

Rationale

International, national and state policies exist which support the development of environmentally sound aquaculture. Unfortunately some coastal zone management plans have limited aquaculture development, and competing user groups and waterfront homeowners have dominated planning processes and aquaculture siting hearings. To reverse this trend the Department of Commerce and its affiliated agencies (NOAA, NMFS, Sea Grant, etc.), the United States Department of Agriculture, the Joint Subcommittee on Aquaculture, state resource management agencies and growers associations need to coordinate an advocacy program that communicates to citizens and governments the merits of environmentally sound shellfish culture.

Strategies

11.2.1 (H) Streamline state and local permitting processes for siting of environmentally sound shellfish culture projects.

11.2.2 (H) Advocate state and local laws, codes and policies that support and promote environmentally sound shellfish culture.

11.2.3 (H) Ensure that legislators and decision-makers receive the results of peer-reviewed studies and that forums are organized for discussing the results.

Goal 11.3. Maintain cooperative relationships between industry and regulatory agencies, ensure regulations reflect best available science and that growers understand and implement appropriate conservation measures.

Rationale

The rules and regulations being applied to commercial shellfish growers can change frequently. There is a need for regulatory stability and predictable futures for this predominantly small business industry.

Strategies

11.3.1 (H) Coordinate with the Army Corps of Engineers, NOAA Fisheries and the US Fish & Wildlife Service on the Nationwide Permit 48 (NWP48) to ensure measures are appropriate and based on best available science. Educate growers on conservation measures included in the NWP48 and acceptable culture practices. Consider options and funding for PSI to host periodic training sessions that would be targeted at growers and their employees.

11.3.2 (M) Establish connections to the regulatory community through a "regulatory" committee within PCSGA. Efforts by this committee should include but not be limited to:

- Contacting Washington Department of Ecology's Permit Assistance Center (PAC). Encourage grower members to be trained or informed of new guidelines and regulations at workshops or the annual PCSGA meeting, and through PSI and/or PCSGA webpages.
- Seek a streamlined process for local, state and federal permits and request PSI to provide best available science to inform this objective.
- Seek policy solutions to land-use conflicts with shoreline property owners.