Executive Summary
Burrowing Shrimp Management Report

Willapa Bay and Grays Harbor – two coastal estuaries in the southwest corner of Washington State – provide a substantial percentage of the nation's oysters, and the shellfish industry is central to the local economies of Pacific and Grays Harbor counties. In recent years, shellfish growers have contended with many ecological stressors that threaten the future viability of the industry, including ocean acidification, mortality events caused by harmful algal blooms and summer heat waves, and invasive species. The increased uncertainty generated by these large-scale environmental changes has also contributed to conflicts between shellfish growers and regulators about aquaculture practices and their impacts on protected species and habitats.

The Washington Coast Shellfish Aquaculture Study

To make progress on the most pressing of these regulatory conflicts in the bays, the Washington Coast Shellfish Aquaculture Study (WCSAS) – a three-year program of integrated engagement and research guided by stakeholders and scientists, coordinated by Washington Sea Grant (WSG), and funded by the Washington State Legislature and other grants – was initiated in 2018. ***The goal of WCSAS was to sustain shellfish aquaculture in the region under changing environmental conditions by establishing a collaborative, ecosystem-based management framework that addresses two key challenges: perceived conflicts between shellfish farming and eelgrass habitat conservation, and the lack of effective burrowing shrimp pest management on shellfish farms.*** Central to this endeavor is a shared foundation of information for developing and evaluating management and adaptation strategies. To that end, WSG commissioned a series of reports synthesizing the scientific and management literature related to system-scale environmental challenges in Willapa Bay and Grays Harbor.

This report focuses on burrowing shrimp management in the bays, highlighting the history of strategies employed and their impacts, as well as the long-standing and continuing effort to develop an effective integrated pest management (IPM) plan.

Main Findings

Chapter 1 describes the history of burrowing shrimp management in Willapa Bay and Grays Harbor. The insecticide carbaryl was applied to shellfish beds in the area to manage burrowing shrimp from 1963 until 2013, when its use was discontinued as part of a legal settlement and a formal IPM approach was adopted. Various tactics to manage burrowing shrimp and integrate them into an IPM program have been attempted since the 1990s, including a multi-year, multi-million dollar effort to permit the use of the pesticide imidacloprid on shellfish beds, which was ultimately denied. ***The development of an effective, economically feasible and socially and environmentally acceptable IPM plan is an ongoing challenge.*** Alternative management tactics continue to be investigated as part of a settlement agreement between the Washington State Department of Ecology (ECY) and the Willapa-Grays Harbor Oyster Growers Association (WGHOGA). In the meantime, shellfish growers have been struggling to manage burrowing shrimp on shellfish beds for several years , threatening the survival of the local shellfish industry.

Chapter 2 provides an overview of IPM and its application to shellfish aquaculture. The scientific and regulatory challenges of managing pests that are well adapted native ecosystem engineers living in a subterranean estuarine environment, combined with the logistical constraints and variability of shellfish aquaculture, generates fundamental incompatibilities with traditional IPM strategies. ***Dozens of studies of potential physical, biological and chemical management methods identified only a few tactics that could suppress shrimp densities for longer than a single growing season***, but considering economic and logistical factors, only the pesticide imidacloprid showed potential for full scale implementation.

Chapters 3 and 4 review the risk assessments and impact analyses of two pesticides: carbaryl, which was applied for 50 years to control burrowing shrimp; and imidacloprid, which underwent several years of trials and testing but was ultimately not approved for use. Carbaryl is a broad-spectrum carbamate insecticide that blocks nerve transmission by inactivating the enzyme acetylcholinesterase. Imidacloprid is a more selective neonicotinoid insecticide that blocks the neurotransmitter acetylcholine by disrupting nicotine receptors. ***Risk assessments determined that neither carbaryl nor imidacloprid posed substantial risk to a wide variety of non-target organisms when applied to manage burrowing shrimp on commercial shellfish beds***, and according to the EPA's registered label. Four field trials conducted from 2010 – 2014 featuring 10 large plots (5 –20 acres) included measures of imidacloprid concentrations on-plot and off-plot following application. Examinations of potential impacts to Dungeness crab, sturgeon and benthic invertebrates showed potential impacts to crustaceans at one of the sites. Based on that finding, only one of five risk assessments conducted in Willapa Bay showed potential localized and seasonal effects for a few genera of benthic invertebrates. The low frequency of negative effects on benthic invertebrates at the time of testing was likely due to brief and low-concentration exposures, natural resilience to disturbance and extreme environmental events and – in the case of imidacloprid – low toxicological susceptibility.

Next Steps and Recommendations

IPM is ultimately a decision-making process that depends on the monitoring of pest populations to determine when a threshold of economic injury has been reached and when pest management interventions become necessary. Despite many years of research efforts, each of these steps is constrained by ***persistent data and information gaps that have ultimately hindered successful IPM plan development.*** As such, several areas of research should be prioritized as burrowing shrimp IPM efforts continue. These include standardized methods for determining burrowing shrimp population density, dynamic models that can be used to hindcast and forecast burrowing shrimp populations and action thresholds linking burrowing shrimp distribution to ecological and economic impacts. Finally, ***research that expands the suite of effective management options is essential.***

The focus on pesticides in the media and by the broader public is easily misperceived as simply replacing one pesticide with another without looking at more sustainable management interventions. However, several years of research and millions of dollars in funding have been dedicated to finding a wider arsenal of effective management tactics to include in the burrowing shrimp IPM toolkit. Unfortunately, suggested management interventions have thus far been ecological and/or economically infeasible. The importance of the local shellfish industry to the communities surrounding Willapa Bay and Grays Harbor, to Washington State, and to the entire nation compels persistence, and the search for additional management tactics continues under the coordination of the IPM Working Group co-led by ECY and WGHOGA.

Future Research Priorities for Burrowing Shrimp IPM

- Standardized methods for determining burrowing shrimp population density, distribution and range.
- Dynamic models using past and present population trends, ocean and estuarine conditions, climate data, etc. to hindcast and forecast burrowing shrimp populations.
- A monitoring framework liking burrowing shrimp distribution to negative impacts on shellfish beds and other tidelands.
- Reliable methods for estimating economic injury to shellfish growers with different farm sizes, markets, culture methods and site conditions.
- A diverse toolkit of effective management strategies that are environmentally safe and socially acceptable.
- Rigorous science-based evaluation of the efficacy, feasibility, and non-target impacts of proposed alternatives to chemical management methods.

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