Restoring Southern California Estuaries through Public-Private Partnerships: Developing Sustainable Aquaculture for an Ecosystem Engineer, the Native California Oyster, *Ostreola conchaphila*

Group Project Proposal 2007

Proposer: Josh Madeira **Faculty Sponsor:** Hunter Lenihan

Clients:
Jennifer Boyce, NOAA Southwest Fisheries Restoration Center
Lisa Stratton, Cheadle Center for Biodiversity and Ecological Restoration
Andy Brooks, Carpinteria Salt Marsh Reserve

Statement

California's coastal marine ecosystems have been degraded by anthropogenic perturbations including overfishing, eutrophication, sedimentation, and point/ nonpoint source pollution. As a result, coastal marine ecosystems have suffered large-scale losses of critical marine habitat and a more than 90% reduction of native coastal wetlands (California Ocean Protection Council 2006). While marine reserves and mitigation banking for coastal development projects protect tracts of coastal habitat from fishing effort and development, they do not address the impaired quality of the ecosystems they protect. As such, these conservation measures do not solve the problem of impaired ecological function and critical habitat loss. NOAA Southwest Fisheries Division, the EPA, and California's Coastal Commission recognized that large-scale habitat restoration of oyster beds, seagrasses, and kelp forests represent the primary means of improving degraded marine ecosystems.

Oysters are ecosystem engineers in estuaries worldwide as they create reef habitat, stabilize benthic substrata, biofilter the water, recycle nutrients, and occupy important positions in coastal marine food webs (Lotze, Lenihan et al. 2006). Various species of oysters also support thriving aquaculture industries in the Pacific Northwest of the US, Japan, Korea, China, and several countries in Europe. Such an aquaculture industry exists for the endemic West Coast oyster, *Ostreola conchaphila* (also known as the native California oyster and the Olympia Oyster), in Puget Sound, Washington. The ecosystem functions of *O. conchaphila* are less understood than other species but appear to include the provision of reef habitat and the capacity to filter and therefore "clean" huge volumes of water. There were once large populations of *O. conchaphila* throughout estuaries and marine wetlands of California. However, populations have been decimated by overfishing, introduced species, habitat loss, and disease. Recent unpublished research indicates that remnant populations exist throughout California, but the largest populations are in the Southern California Bight (Lenihan, pers. comm., 2007). Restoration of this species throughout California is hypothesized to have major positive effects on the resilience, biodiversity, and function of estuarine ecosystems.

This group project will explore the potential for public-private investments in *O. conchaphila* aquaculture along the Southern California coast as an economically sustainable means to restore this cornerstone species and improve the function and quality of coastal marine ecosystems. This project will construct a business model business for public-private partnerships in aquaculture of *O. conchaphila* in the California Bight. The model will make recommendations about how municipalities and private investors could grow native California oyster "seed" and also produce a marketable delicacy (adult oysters) while donating excess harvests to oyster habitat restoration sites. With inherent incentives to maximize aquaculture productivity, all of the stakeholders would be working toward the same goal: sustainable improvements to water quality and native marine habitat in the California Bight.

Objectives

This project will construct a business model for public-private partnerships in aquaculture of *O. conchaphila* in Southern California and quantify the restoration potential for local marine ecosystems as well as the economic gains of the public-private partnership. Initially, the project must analyze existing oyster aquaculture technology. Once the appropriate technology is chosen, a complete business plan will be developed to balance profit margins with restoration goals. The business plan will be a model that can be used by municipalities and private investors to form sustainable public-private partnerships with NOAA, the EPA, and other restoration organizations. With a viable business plan in place, the focus of the project will shift to analysis of different outplanting techniques to maximize *O. conchaphila* recruitment in estuary restoration.

Significance

Developing *O. conchaphila* aquaculture along the Southern California coast could be an economically sustainable means to restore this cornerstone species and consequently restore the function, structure, and quality of coastal ecosystems. Unlike all other forms of marine aquaculture, commercially-grown bivalves, especially oysters, have been identified as the only sustainable form of aquaculture that has no negative impact on the environment (Naylor, Goldburg et al. 2000; Shumway, Davis et al. 2003). Rather, bivalve aquaculture operations actually improve the local water quality by filtering out pollutants, sediments, and phytoplankton from the water column (Naylor, Goldburg et al. 2000; Shumway, Davis et al. 2003). Field experiments have proven that oysters grow well and resist oyster disease, even in the face of moderate eutrophication and pollution (Jackson, Kirby et al. 2001). Thus, aquaculture operations in marginally polluted areas of the California Bight are likely to be viable.

In order to meet aquaculture and restoration goals, a portion of the oysters that are grown to maturity in aquaculture operations will be transplanted to restoration sites. As population densities of *O. conchaphila* are restored, NOAA scientists estimate that their "top-down" control will return. As a reef engineer, *O. conchaphila* solidifies the sediments and constructs large oyster reefs. The stabilization of the benthic substrata provides ideal habitat for eelgrass and other native seagrasses, while reducing turbidity that improves kelp regeneration (NOAA). Efforts to recolonize *O. conchaphila* in Washington and Oregon have met with resounding success, including greater than expected recolonization rates in areas that have been extirpated for decades (NOAA). Given NOAA's recent finding that the California Bight is the best remaining natural habitat for the *O. conchaphila*, there is significant anticipation that restoration efforts in Southern California will be met with great success.

Considerable political momentum to restore native California oyster populations surfaced in 2006. Governor Arnold Schwarzenegger's Ocean Protection Council identified habitat restoration of native oyster habitat, wetlands, eelgrass, and kelp as the number one priority for improving the physical processes of California's coast (California Ocean Protection Council 2006). With NOAA support and growing public concern over identifying solutions to degraded water quality in Southern California's estuarine systems, the political climate is ideal for the formation of public-private aquaculture partnerships.

Background

The historical range of the native California oyster stretches from Southeast Alaska to Baja California, Mexico (Couch and Hassler 1989). Existing in dense populations in estuaries, tidal creeks, bays, and protected outer-coast reaches, the native oyster is the only endemic species along the West Coast (Couch and Hassler 1989). In response to heavy fishing effort that began during the Gold Rush, the population of native oysters in California declined from more than 130,000 bushels per year in the 1890's to only 16,000 bushels per year in 1910 (Couch and Hassler 1989). With the decline, most fishing effort shifted to importation of native oyster seed from Washington (Conte and Moore 2001). However, these efforts largely failed due to the slow transportation network, which led to the importation of two exotic species of oyster, most notably the Pacific oyster (*Crassostrea gigas*) and the Eastern oyster (*Crassostrea virginica*) (Barrett 1963). As commercial activity shifted from the harvest of endemic species to exotic species, industry effort went into plantations of exotics in San Francisco Bay, Morro Bay, and the Elkhorn Slough (Conte and Moore 2001).

With decimated populations, continued fishing pressure, and large new inputs of pollution into California's coastal bays and estuaries, natural populations of the native oyster remained very low and showed no signs of recovery. Without the oyster to solidify the benthic structure of the ecosystem, cascading impacts on benthic and pelagic food webs caused large-scale transformations of oyster reef habitats into broad expanses of (unproductive) shifting soft bottoms (NOAA). This habitat transformation had a catastrophic impact on the fish and invertebrates dependent on oyster reef structure and function, resulting in significant changes in diversity and abundance of endemic marine species (NOAA; Kirby 2004).

With the enactment of the Clean Water Act and the shift in commercial harvest to the Pacific oyster, the suppressed populations of *O. conchaphila* are poised for a comeback in the California Bight (NOAA). Improved water quality conditions, reduced heavy metals and toxics, and tighter controls on effluents have improved the likelihood of recolonization, even in urban coastal zones. Successful oyster restoration efforts in Washington, Oregon, and Chesapeake Bay (*C. virginica*) have shown striking success in oyster recruitment programs, including increased richness and diversity in native fish populations in the vicinity of reef structures (NOAA). NOAA Southwest Fisheries Division, in coordination with municipalities, local stakeholders, and non-profit organizations initiated three native oyster restoration projects in Northern California (San Francisco, Tiburon, and Tomales Bay) from 2000- 2004. Given the political climate, the potential for profits under a public-private aquaculture enterprise, and NOAA's assessment of the suitability of the California Bight for restoration, successful recolonization through restoration has a high probability for success.

Stakeholders

Stakeholders include aquaculture operators, the California Aquaculture Association, seafood suppliers, restaurants, restoration scientists, recreational users of the California Bight, NOAA, and municipalities with coastline on the California Bight.

Approach

The business model for potential public-private partnerships in *O. conchaphila* aquaculture will focus on three critical questions:

- **How could *O. conchaphila* aquaculture technology currently in use in Puget Sound, Washington, Oregon, and Northern California be adapted to maximize production of *O. conchaphila* in estuaries of the California Bight?** Aquaculture operations in of the different regions feature different goals, scopes, and technologies, so appropriate selection and adaptation of current practices must be selected for Southern California. In addition, we will examine the two commercial *O. conchaphila* aquaculture operations in Puget Sound, Washington (Olympia Oyster Company and Taylor Shellfish). We will then compare the technology and methodology from Puget Sound operators with aquaculture operations in Humboldt Bay, Tomales Bay, Morro Bay, the Santa Barbara Channel, and the Agua Hedionda Lagoon (San Diego).
- **Can the development of an aquaculture industry in Southern California provide the economic and logistical framework for restoring *O. conchaphila* throughout Southern California estuaries?** Is aquaculture of *O. conchaphila* economically viable in Southern California? Where is the balance between profitability and restoration effort that would maximize the benefits of the aquaculture operation? The project will create a business model that will provide the framework for a public-private native oyster aquaculture partnership. The business plan will include a complete vision statement, market analysis, competitive analysis, strategy, marketing/sales estimates, and an operational budget.
- **What outplanting techniques and restoration strategies should be used to re-establish *O. conchaphila* in Southern California's estuaries?** By combining current *O. conchaphila* research at UC Davis, the University of Washington, and NOAA Southwest Fisheries Division, this project will analyze *O. conchaphila* data and identify potential estuary restoration strategies. Using ecological modeling software and/or GIS technology identify the best outplanting techniques for *O. conchaphila* in Southern California's estuaries.

Available Data

- Grosholz Lab, UC Davis: data on population dynamics and restoration of *O. conchaphila*
- Ruesink Lab, University of Washington: data on *O. conchaphila* substrate modification, competition, and settlement sinks
- FAO Fisheries Department: Fishery and aquaculture production data and statistics via web
- Pacific Shellfish Growers Association and the California Aquaculture Association: harvest data

- Aquaculture technology information available on the web and through individual companies
- George C. Matthiessen: expert in oyster aquaculture, including details of *O. conchaphila* aquaculture
- National Marine Fisheries Service: Fisheries Statistics & Economics Division: trade data available online.
- NOAA Southwest Fisheries Division Restoration Program: data on *O. conchaphila* restoration efforts in Northern California

Funding

Seeking funding through two summer internships with NOAA Southwest Fisheries Division's Restoration Program

Deliverables

This group project will produce a business model for a public-private aquaculture partnership in Southern California. The model will include an aquaculture technology assessment, a complete business plan for a public-private partnership, and analysis of restoration strategies for *O. conchaphila*.

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