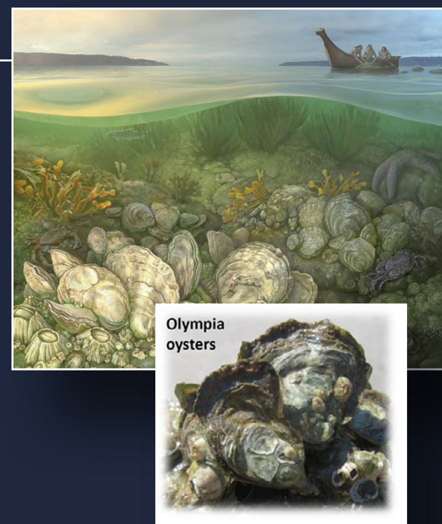
Native Oysters in the Coos Estuary



Summary:

- *Olympia oyster populations appear to be stable and even increasing. A 2006 survey shows native oysters present in multiple Coos estuary subsystems including particularly dense patches in the Upper Bay.*
- *However, native oysters are present in much smaller numbers today than in the early 20th century.*
- *Researchers are re-introducing adult oysters in the Coos estuary and investigating the biology and ecology of naturally occurring Olympia oysters.*

(Source: Groth and Rumrill 2009)

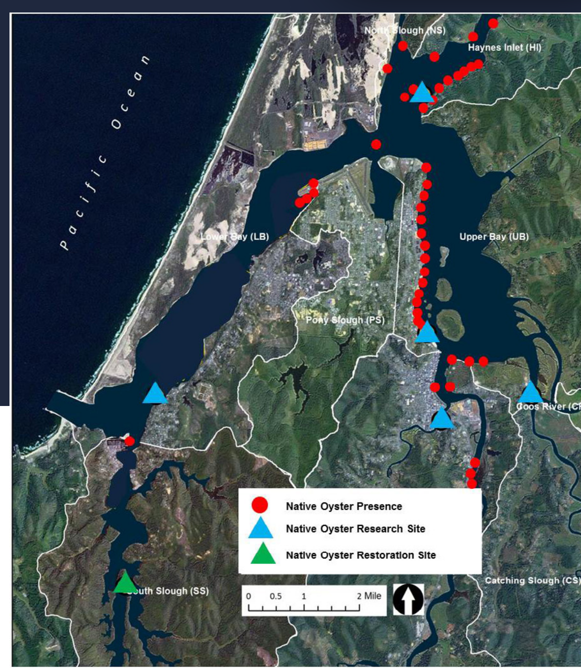


Figure 1. Status of native oysters in the Coos estuary in the South Slough, Lower Bay, North Slough, Haynes Inlet, Upper Bay and Isthmus Slough subsystems.

Evaluation

Status of Native Oysters is stable and improving and should continue to be monitored.

What's happening?

The Olympia oyster (*Ostrea lurida*) is the only oyster native to the U.S. West Coast, and was once abundant in estuaries from Baja California to Sitka, Alaska. Interestingly, the oyster was not present in Coos Bay at the time Europeans settled in the area, but shells found in dredge spoils and shell middens indicate that they were present in the area historically and were harvested by Native Americans. One hypothesis is that a tsunami and/or fire caused a huge input of sediment into the bay, smothering the oyster population.

In the 1980s, Olympia oysters were discovered growing in Coos Bay once again. Genetic similarities between Olympia oysters in Coos Bay and those in Willapa Bay, WA suggest that the local reappearance of this species was likely the result of an introduction event from Willapa (Stick 2011). It is likely that they arrived as juveniles attached to the shells of (non-native) Pacific oysters grown commercially in Willapa Bay and transported to Coos Bay. These juvenile Olympia oysters may have then spawned and their larvae settled elsewhere in the bay, setting up a new population.

Presently, the Olympia oyster population here appears to be stable and even increasing. A 2006 survey shows the oyster to be present mainly in the upper part of the bay, with particularly dense patches along the waterfront of Coos Bay, North Bend, and Eastside (Figures 1 and 2). An increasing number of researchers have become interested in restoring Olympia oyster populations (Figure 3). Researchers at the South Slough Reserve are attempting to recreate an oyster population in the South Slough estuary. They are also partnering with the Oregon Institute of Marine Biology (OIMB) to conduct research into the biology and ecology of the oysters in Coos Bay (see below).

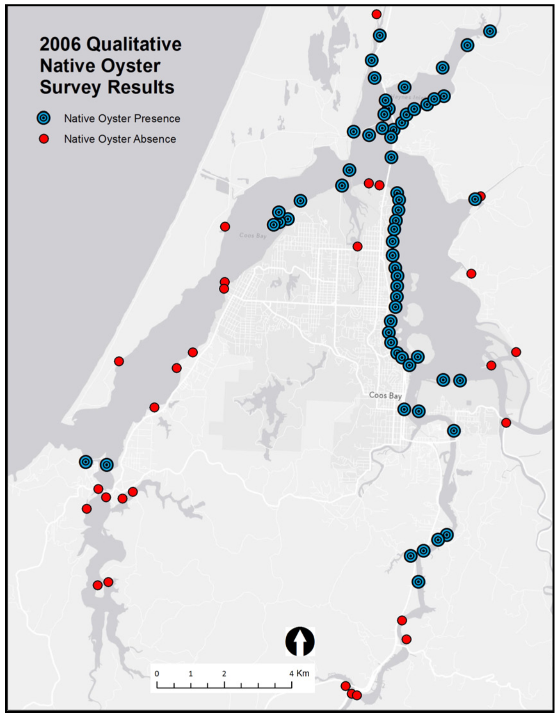


Figure 2. 2006 qualitative native oyster survey results Data: Groth and Rumrill (2009)

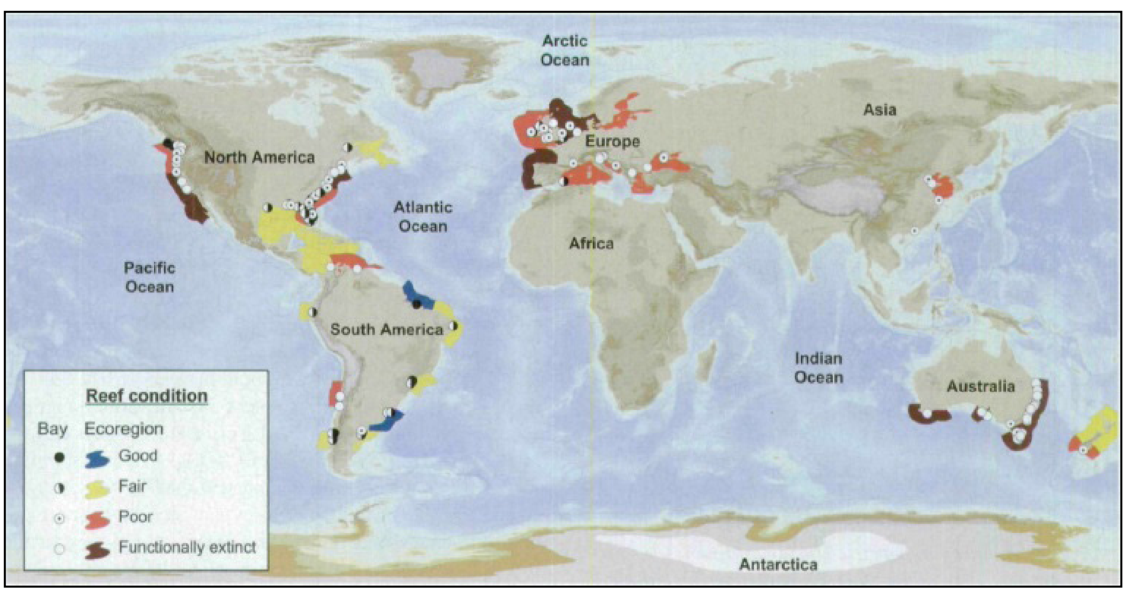
Figure 3. Volunteers aid in the restoration of native populations of Olympia oysters (*O. lurida*) in Coos Bay

Why is it happening?

The disappearance of Olympia oysters in Coos Bay is most likely the result of a natural disaster. One hypothesis is that a tsunami and/or fire caused a huge input of sediment into the bay, smothering the local oyster population. In recent history, populations of Olympia oysters outside the Coos Bay area have also experienced a pattern of decline. Around the turn of the 20th century, Olympia oysters were heavily harvested along the West Coast, mainly for the San Francisco market. This overharvesting, as well as the increased development of estuarine areas, loss of hard substrate, sedimentation, and pollution caused the Olympia oyster population to decline dramatically.

The decline of oyster populations on the West Coast in the 20th century is indicative of a larger global trend (Figure 4). Several factors have contributed to the decline of oyster reefs across the globe. The extensive harvest of wild oyster populations has commonly led to the loss of reef structure, which exacerbates the impact of additional stresses such as anoxia, sedimentation, disease, and non-native species (Beck et al. 2011). Other anthropogenic influences including the modification of coastlines, changes to freshwater inflow regimes, sedimentation, nutrient loading, and pollution have further contributed to the decline of oysters across the globe (Beck et al. 2011; NRC 2004). A loss of 85 percent of the world's oyster reefs relative to historic abundance levels is estimated, and over a third (37 percent) of existing oyster reefs in bays across the globe are considered functionally extinct (Beck et. al. 2011).
The conservation of oysters on a global as well as local scale is important, because oysters provide many ecosystem services, including water filtration, shoreline stabilization, and habitat for many animals (e.g., fish, crabs, and birds)(Beck et al. 2011). There

Figure 4. Condition of the world's oyster reefs. < 50% lost = Good; 50% to 89% lost = Fair; 90% to 99% lost = Poor; > 99% lost = functionally extinct. GRAPHIC: Beck et al. (2011)



are also beneficial secondary effects that are associated with these ecosystem services. For example, water filtration can serve to remove excess nutrients, thereby reducing likelihood of harmful algal blooms that have many ecological as well as economic consequences (Beck et al. 2011). In order to protect these valuable ecosystem services and promote biodiversity in the Coos estuary, two main oyster restoration projects have been spearheaded. These projects are supported by NOAA's Community-based Restoration Program (CRP) and the National Estuarine Research Reserve System (NERRS) Science Collaborative program.

What's being done?

The CRP has supported several research projects investigating the biology and ecology of native oysters, many of which were led or assisted by community members and college student interns. One project involved collecting oyster juveniles, or spat, on shell bags in Coos Bay and then transferring these bags to South Slough (see Figure 3). Researchers then monitored the growth and survival of these juveniles for about a year. The juveniles survived well and grew, on average, about 10 mm between January and July.

Although the CRP projects were completed in 2009, South Slough Reserve science staff members continue to monitor these shell bags, and are currently in the process of moving them from their current location at Younker Point to a more suitable area near Long Island Point. Monitoring living adults in South Slough will provide data on the feasibility of restoring oysters to this area; the adults may also serve as local sources of natural occurring Olympia oyster larvae for use in future restoration efforts, if needed.

A thorough understanding of the reproductive development of Olympia oysters in Coos Bay is a critical component of the advancement of local restoration efforts. As a means towards that end, the South Slough Reserve and OIMB are partners in several Olympia oyster research projects supported by the NERRS Science Collaborative program. Graduate students at OIMB are currently investigating sexual development and timing of oyster larval brooding and release; mechanisms of oyster larval retention in the bay; oyster larval abundance vs. settlement throughout Coos Bay; and oyster growth and survival throughout the bay.

The results of this research have provided important insights into the life history of native oysters in the Bay. Oates (2013) found that intertidal oysters in Coos Bay have a reproductive period of approximately three to four months, and reproduction corresponds to water temperatures of approximately 15-19° C (59-66° F). These findings corroborate previously conducted research (Hori 1933; Hopkins 1937; Imai et al. 1954). In addition to temperature, brooding closely corresponds to high chlorophyll-a concentrations, suggesting a positive relationship between food availability and reproductive output of oysters (Oates 2013).

Temperature and chlorophyll-a concentrations alone, however, fail to completely explain the timing of reproductive events of native oysters in Coos Bay. Oysters exposed to low salinity regimes in Coalbank Slough experienced repressed levels of gametogenesis, suggesting that the reproductive success of native oysters in Coos Bay may be critically dependent on salinity parameters (Oates 2013). Further research suggests that other abiotic factors such as tidal mixing and changes in precipitation regimes may also affect recruitment patterns and larval distribution in juvenile Olympia oysters (Prichard 2013). More research is required in order to fully understand the effects of salinity and other ambient parameters (e.g., dissolved oxygen or pH) on the reproductive success of native oysters in Coos Bay.

Additional research provides restoration practitioners with guidelines concerning the settlement preferences of native juvenile oysters in Coos Bay. Sawyer (2011) found that juvenile Olympic oysters were generally non-selective in their settlement preference when provided with a variety of hard substrata, including both live and dead species of native Olympic oysters and non-native Pacific oysters (*Crassostrea giggas*). However, juveniles did demonstrate a clear preference for settlement on the bottom of shells.

These findings indicate that the type of substrate provided for settlement is unlikely to limit the success of local restoration efforts. They further indicate that restoration efforts may benefit by suspending settlement substrata in the water column in order to allow for easy access to bottom of shells. Interestingly, the non-selective settlement tendencies of Olympic oysters implies that the commercial harvest of Pacific oysters represents a potential “recruitment sink” in that juvenile Olympic oysters that have settled on mature Pacific oysters become, in effect, bycatch upon the harvest of these individuals (Sawyer 2011).

Restoration decisions involving the placement of settlement substrata relative to the location of existing adults will benefit from a further understanding of the spatial preferences of juvenile Olympia oysters. As a means to this end, Prichard (2013) has studied recruitment patterns and larval distributions in Coos Bay. Her research suggests that juvenile Olympia oysters tend to settle in close proximity to previously established populations of adults, suggesting that these oysters have relatively limited larval distributions. Research investigating the timing of settlement of Olympia oysters in Coos Bay is on-going, and restoration efforts will also benefit from a well-developed understanding of the temporal settlement preferences of these oysters (R. Rimler, pers. comm., Nov. 2013).

The genetic practices of restoration projects are likely to directly affect the degree to which native oysters may successfully reestablish themselves in Coos Bay. The genetic distance between populations of Olympia oysters is a function of the geographic distance between those populations; that is to say that Olympia oysters in California, for example, are genetically distinct from oysters of the same species in Coos Bay (Stick 2011). The marked exception to this finding is the population of Olympia oysters in Willapa Bay, WA, which is genetically very similar to the population of oysters in Coos Bay despite the geographic distance between these two sites (Stick 2011). As previously mentioned, this is likely the result of a previously occurring introduction event from Willapa Bay to Coos Bay. In order to assure the long-term viability of restoration efforts in Coos Bay, the implications of collecting broodstock from geographically distant sources should be carefully considered until it can be determined whether these populations are locally adapted (Stick 2011).

Work to further understand the status of contaminants in the Bay that may be harmful to native oyster stocks has also been undertaken by the Oregon Department of Environmental Quality (ODEQ). Butyltins, which are chemicals found in anti-fouling boat bottom paints, are of particular concern because they have been shown to cause shell deformities and decreased reproductive capacity in oysters (Wolniakowski et al. 1987). In the late 1980s, ODEQ documented high concentrations of Butyltins in the waters of Coos Bay as well as in the tissues of locally produced Pacific oysters (Wolniakowski et al. 1987). Research has documented steady declines in local Butyltin levels since the late 1980s, suggesting that the on-going management and regulation has been relatively effective in abating this pollutant in Coos Bay (Elgethun et al. 1999). The local distribution of detected Butyltins did not closely correspond to the locations of their origin, suggesting that concentration of Butyltins may be more a function of estuary bathymetry and tidal flushing patterns than proximity to point sources (Elgethun et al. 1999).

Peteiro and Shanks (2014) have studied migratory patterns in larval Olympia oysters. Their findings suggest that larval oysters in Coos Bay have some capacity to perform tidal-timed migrations, but their swimming ability is usually overcome by current speeds. These results indicate that the effectiveness of tidal-timed migrations in the estuary may be limited by local hydrology, and strategies for maximizing larval retention may benefit from detailed studies on local hydrodynamics.

Background

Oysters are bivalves, a type of mollusk characterized by two opposing shells, or valves. They are related to clams, mussels, and other commonly known and often edible mollusks. They feed by filtering small particles from seawater. Many oysters, like other bivalves, release sperm and eggs separately in the water, where they meet and fertilize to form

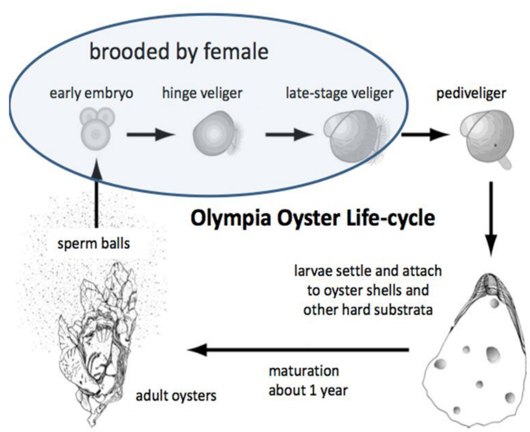


Figure 5. Life history of the Olympia oyster. GRAPHIC: Swanson n.d.

embryos outside the body of the mother. But Olympia oysters retain eggs within the mother's shell. They "brood" their embryos for several weeks before releasing the young, now called larvae, into the water column (see Figure 5).

All oysters and most bivalves produce larvae, which are generally less than a millimeter in length. The larvae swim, eat, and develop in the water for several weeks to several months. They then search for a hard surface on which to settle and metamorphose into a juvenile oyster.

Young oysters tend to settle near other oysters, forming large aggregations, or beds. These beds help stabilize the muddy bottom of the estuary and may improve habitat conditions for eelgrass, an important estuarine plant. Once settled, oysters are cemented to the substrate and remain attached to the substrate for the rest of their lives. The hard, complex surfaces provided by groups of oysters provide a unique habitat in which other estuarine animals can hide, settle, or lay eggs. In this way, a substantial oyster population could increase species diversity.

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