

## REBUILDING OLYMPIA OYSTERS, *OSTREA LURIDA* CARPENTER 1864, IN FIDALGO BAY, WASHINGTON

PAUL A. DINNEL,<sup>1\*</sup> BETSY PEABODY<sup>2</sup> AND TRISTAN PETER-CONTESSÉ<sup>2</sup>

<sup>1</sup>Western Washington University, Shannon Point Marine Center, 1900 Shannon Point Road, Anacortes, Washington 98221; <sup>2</sup>Puget Sound Restoration Fund, 590 Madison Ave. N, Bainbridge Island, Washington.

**ABSTRACT** The Olympia oyster, *Ostrea lurida*,<sup>†</sup> is native to the Pacific Coast of North America and was common in Puget Sound prior to the arrival of European settlers. Over harvest in the late 1800s, combined with severe pollution in the first half of the 20th century from pulp mills, drove many Puget Sound beds to near extinction. Olympia oysters can still be found throughout most of their historic range, but current populations are mostly limited to remnant aggregations where habitat characteristics remain favorable. Whereas Olympia oysters are still present in Puget Sound, their numbers do not compare with the expanses of Olympia oysters that supported a thriving oyster industry in the mid-1800s. One reason for rebuilding Olympia oyster populations is to regain the ecosystem benefits associated with larger assemblages. Skagit County Marine Resources Committee, working in cooperation with shellfish industry, tribal, and community partners initiated a project to establish self-sustaining Olympia oyster beds in Fidalgo Bay near Anacortes, WA. Thus, oysters on these beds must survive, grow, spawn, and produce larvae that recruit to the new beds and surrounding areas. Olympia oyster seed on Pacific oyster cultch were planted in Fidalgo Bay during 2002, 2003, 2004, and 2006. Survival and growth of planted seed has been excellent at the first enhancement site. With the addition of seed on cultch during four years and augmentation of the enhancement site with five cubic yards of Pacific oyster shell in 2006, a structured oyster bed is gradually emerging. Deployment of temperature sensors in 2006 showed that water temperatures easily reached the minimum temperature for gameteogenesis and spawning. Examples of larval spawning (veligers in the mantle cavity) and natural postlarval recruitment to the enhancement site were documented in 2006. Several new sites within and around Fidalgo Bay are being evaluated for future rebuilding efforts.

**KEY WORDS:** Olympia oyster, *Ostrea lurida*, restoration, Puget Sound, enhancement, survival, growth, reproduction

### INTRODUCTION

The native or Olympia oyster (*Ostrea lurida* Carpenter 1864) is native to the Pacific coast of North America and occurs in marine waters from Baja California, Mexico to Sitka, AK (Dall 1914). The Olympia oyster was an important food resource for native tribes, which often based settlement locations on its harvest (Steele 1957). With colonization, the Olympia oyster supported a large commercial industry. Beginning in the 1850s, Olympia oyster beds from Puget Sound, Hood Canal, and Willapa Bay were harvested extensively, and later cultivated with an elaborate system of dikes (Steele 1957). Over harvest in the late 1800s and early 1900s severely compromised the commercial viability of the Olympia oyster. In addition, severe water quality problems generated by pulp mills in the 1930s to 1950s drove the Olympia oyster to near extinction (Couch & Hassler 1989), thereby terminating the Washington Olympia oyster industry (Cook et al. 1998, Baker 1995).

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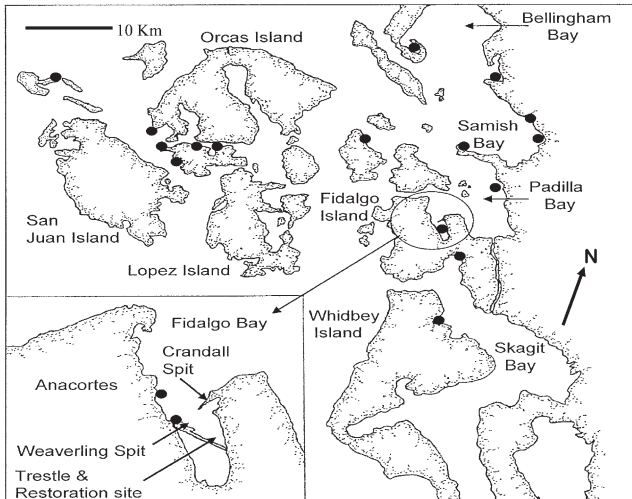
Olympia oysters that supported a thriving oyster industry in the mid-1800s. One reason for rebuilding Olympia oyster populations is to regain the ecosystem benefits associated with larger assemblages. At one time, Olympia oyster beds formed “foundation” communities in Puget Sound and in coastal estuaries. If Olympia oyster beds play roles similar to oyster reefs in other places (Luckenbach et al. 1999, Gregory & Volety 2005), then they may have provided important ecosystem services by providing habitat complexity and water filtration.

In the North Puget Sound region, historical Olympia oyster beds are reported to have existed in the Orcas and Shaw Island areas, Bellingham Bay, Chuckanut Bay, Samish Bay, Padilla Bay, Fidalgo Bay, Similk Bay, and from a bay on the north-eastern side of Whidbey Island (Fig. 1, Hatch et al. 2005). North Sound locations where a few Olympia oysters have been found recently include Samish Bay and Lopez Sound (Betsy Peabody, pers. observation). However, the lack of information on the North Sound region makes it difficult to assess the health and extent of North Sound populations. In the North Sound region, commercial quantities of Olympia oysters were only known from Samish Bay, and possibly Bellingham Bay, where they are extremely scarce today (Cook et al. 1998, Baker 1995).

In May 1998, the Washington Department of Fish and Wildlife (WDFW) published the Department’s plan for Olympia oyster restoration in Washington State (Cook et al. 1998). The goal of this plan was “To restore and maintain native oyster populations on public tidelands in their former range.” The short-term goal of WDFW was to identify locations and general abundance of current populations of Olympia oysters in Puget Sound. Among other things, the long-term objectives included: (1) Define current and historic ranges of Olympia oysters, (2) identify areas for protection and restoration, (3) define site-specific habitat

\*Corresponding author. E-mail: padinnel@aol.com.

†The taxonomy of the Olympia oyster has been in dispute since Harry (1985) proposed synonymy of *Ostrea lurida* Carpenter 1864 and *Ostrea conchaphila* Carpenter 1857. Polson et al. (2009) provide molecular evidence that the Olympia oyster refers to the nominal species, *Ostrea lurida* Carpenter 1864. In view of their genetic data, and for consistency, the original taxon, *Ostrea lurida*, is used throughout this volume to refer to the Olympia oyster, which is distributed from approximately Baja California (Mexico) to southeast Alaska.



**Figure 1.** Map of the North Puget Sound region showing locations of historical Olympia oyster beds (●) (Hatch et al. 2005) and the trestle enhancement site in Fidalgo Bay (inset).

limitations and species interactions that could affect Olympia oyster stocks, and (4) restore and protect stocks as needed to achieve the stock rebuilding goal.

Volunteers and local stewardship programs can play key roles in helping to restore Olympia oyster populations. In 2002, the Skagit County Marine Resources Committee (Skagit MRC—a county commissioner-appointed volunteer committee funded by the Northwest Straits Commission) teamed with various partner organizations and community volunteers to plant Olympia oyster seed in South Fidalgo Bay as part of the North Puget Sound rebuilding effort (Robinette & Dinnel 2003, Barsh 2003, Dinnel et al. 2004). Other than several small parallel plantings on Orcas Island, this represented the first Olympia oyster rebuilding effort in the North Sound area.

Much can be learned from the substantial amount of work directed at restoring decimated American oyster (*Crassostrea virginica*) populations on the East and Gulf state coastlines of the United States. Eggleston (1995) has pointed out that a conceptual framework should be developed for guiding oyster restoration efforts and that this framework should address two questions: (1) what are the management goals in terms of restoration efforts and (2) what spatial arrangements (e.g., bed location, size, shape) of oyster habitat best meet these management goals? The management goals of oyster restoration may include, but are not limited to, maximizing (1) recruitment to the fishery, (2) spawning output, (3) species diversity of the oyster bed community, and (4) water filtration and nutrient cycling.

Given the earlier mentioned goals and guidelines for oyster restoration projects, the following are Skagit MRC's goals for rebuilding Olympia oyster beds in Skagit County waters: (1) identify one or more areas in Skagit County that might be good sites for enhancement; (2) use volunteers to plant hatchery-derived Olympia oyster seed and monitor survival, growth, and natural recruitment; (3) Modify substrate as necessary to provide a firm base for oyster seed and provide additional postlarval recruitment substrate; (4) assess summer temperature profiles to verify that proper temperature conditions for spawning exist in Fidalgo Bay; and (5) use adaptive management to modify rebuilding efforts

based on lessons learned from local efforts and information gleaned from other rebuilding efforts in Puget Sound.

## METHODS

South Fidalgo Bay was selected as the first rebuilding site for five reasons: (1) a Olympia oyster bed existed historically in Fidalgo Bay (Hatch et al. 2005); (2) potential brood stock was discovered in nearby Samish Bay, making seed production with North Sound genetic stock possible; (3) the MRC and Puget Sound Restoration Fund (PSRF) agreed to collaborate on a Olympia oyster rebuilding project in Fidalgo Bay; (4) suitable substrate and conditions exist in South Fidalgo Bay; and (5) the City of Anacortes authorized the project on city-owned tidelands under an old railway trestle.

### The Rebuilding Site

The rebuilding site is located under and alongside an old railway trestle that has recently been converted to a walking and biking trail (Fig. 1, Fig. 2). The substrate under the trestle is much firmer than the surrounding tidal flats because of the earlier addition of gravel and gradual accumulation of clam and oyster shells from recreational harvest activities. The site was divided into three seeding areas (Fig. 2): (A) an area that had flowing seawater at low tide, (B) an area of standing water at low tide, and (C) a shallow channel. The tidal elevation of all three areas ranges from about  $-2$  to  $-4$  feet MLLW.

### Seeding History

The trestle site was first seeded in April 2002 with approximately 20,000 1+ aged Olympia oyster seed. These seed were set on Pacific oyster (*Crassostrea gigas*) shells (cultch) by Taylor Shellfish Farms and produced using brood oysters that were collected in Samish Bay (Fig. 1). In August 2003, an estimated 91,360 0+ aged Olympia oyster seed were planted. The brood stock was from Samish Bay and seed were set on Pacific oyster cultch by the Lummi Tribal hatchery, north of Bellingham. In 2004 and again in 2006, additional Olympia oyster seed were produced by the Lummi Tribal hatchery using brood stock from Lopez Island (Fig. 1) in 2004 and from the trestle enhancement site in 2006. Details of all four seeding operations are shown in Table 1.

### Substrate Enhancement

Fidalgo Bay is generally lacking the necessary oyster bed structure on low intertidal areas on which Olympia oyster larvae can set. To improve the fledgling bed structure and provide additional postlarval recruitment substrate, approximately five cubic yards of old Pacific oyster shell was spread at trestle enhancement beds B and C (Fig. 2) in 2006. An additional five cubic yards of shell was distributed on nearby Weaverling Spit (Fig. 1, inset) sites to investigate the utility of these areas as future rebuilding beds.

### Survival and Growth Monitoring

Survival of Olympia oysters planted in 2002 through 2004 was assessed from May 2002 through August 2006 by counting

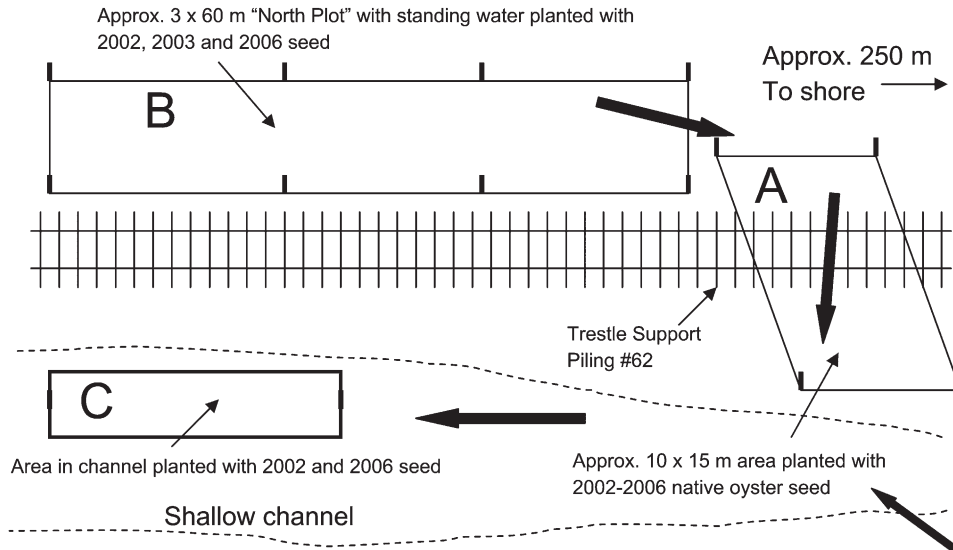


Figure 2. Trestle enhancement site showing the seeding locations, 2002 to 2006. Large arrows show the directions of water drainage at low tide. Map derived from detailed site drawings by Robert Knowles, Skagit County Marine Resources Committee.

live and dead (shell scars) oysters on haphazardly selected samples of oyster cultch shells collected from areas A and B (Fig. 2). Growth was monitored in November 2002 and in August of 2003, 2004, and 2006 by measuring to the closest mm about 100 haphazardly collected Olympia oysters from areas A (2002 to 2004) and B (2006) (Fig. 2).

#### Sampling to Assess Natural Recruitment

In June 2003, 15 cultch bags of clean Pacific oyster shell were placed adjacent to, and between, the 2002 Olympia oyster seed planted in areas A and C (Fig. 2) to monitor for natural recruitment from the seed planted in 2002. Nineteen additional cultch bags were deployed in 2004 along the length of the trestle. The bags were spaced at about 50 m intervals and tied to the pilings. Bags were deployed starting at piling set 21 near the eastern shore and ended at piling set 104, next to the midbay channel.

Natural recruitment of oyster spat was first detected in the spring of 2005 and volunteers returned to the trestle site in June 2005 to sample the cultch bags that had been deployed in 2004. They collected about 20–30 shells from each of 19 bags, washed them, and assessed them for spat settlement. Juvenile oysters

were identified as either Olympia or Pacific oysters, counted and measured to the nearest mm.

#### Exploration of Additional Planting Locations

Various other locations within Fidalgo Bay and in nearby Padilla Bay were investigated during the summer of 2006 as possible sites for establishing future Olympia oyster beds. Each site was checked for suitability based on stability of substrate, tidal elevation, presence of standing or flowing seawater during periods of extreme low tides, and presence of Olympia oysters.

#### Temperature Profiles

Continuous monitoring temperature sensors (HOBO Water Temp Pro, V2) were deployed from May to August 2006 at three Fidalgo Bay sites to monitor summer temperature patterns to provide a better understanding of the effect of temperature on seed survival, growth, and spawning success. The 3 locations selected for sensors were: (1) the trestle enhancement site, (2) Weaverling Spit to the west of the trestle site, and (3) the entrance to Crandall Spit Lagoon (Fig. 1, inset). All sensors were anchored so that they were located at the

TABLE 1.

Number of bags of Olympia oyster seed, average number of shells/bag, average seed density on cultch shells, total number of seed planted, and average length of seed planted at the South Fidalgo Bay trestle site, 2002 to 2006.

Year	Number of Bags Seeded	Average Number of Shells/Bag	Average Number of Seed/Shell	Total Number of Seed Planted	Average Seed Length, mm
2002	20	240	5.2	24,960	24.8
2003	39	331	7.0	91,360	5.1
2004	37	300	17.0	188,700	9.5
2006	170	270	24.5	1,124,550	4.8
<b>Total</b>	266	—	—	1,429,570	—

water/sediment interface and recorded and stored temperatures every 15 min. Data were downloaded in August 2006.

## RESULTS

### *Oyster Seed Survival—2002 Through 2006*

Survival of *Olympia* oysters at the trestle rebuilding site, based on counts of live/dead oysters on haphazardly sampled cultch shells, remained high from 2002 through 2006. The average number of live oysters/cultch shell sampled over this period ranged from 3.4–10.5, excluding the addition of new seed in August 2006 (Table 2). The average number of dead oysters for these same sampling periods ranged from 0.1–3.7/cultch shell. Based on these data, percent survival ranged from a high of 97.1 in November 2002 to a low of 73.9 in August 2006. The estimated number of surviving oysters per sample date, calculated by factoring in both survival and periodic new seedings, ranged from 21,800 in May 2002 to a high of 1,350,000 after seed addition in August 2006 (Table 2).

### *Oyster Seed Growth*

Growth of the first seed planted in May 2002 (one-year-old seed with an average shell length of 24.8 mm) at the trestle site was followed until August 2004, after which it became difficult to separate out this cohort from later seedings. These seed grew to an average shell length of 34.2 mm by November 2002, 40.4 mm by August 2003 and 47.0 mm by August 2004, with a maximum shell length of 62 mm (Fig. 3).

In August 2004 and August 2006, *Olympia* oysters from all cumulative seedings (2002, 2003, 2004) were sampled for average size. Average shell length for all oysters combined was 29.9 mm in August 2004 and 36.5 mm in August 2006, with the maximum size being 64 mm in August 2006 (Fig. 4). Also shown in Figure 4 (oval) is a size range of *Olympia* oysters that are too small to be from the 2004 seeding. Our observations, plus information from Ken Chew, University of Washington (pers. comm. as cited by Couch & Hassler 1989), that *Olympia* oysters in Washington reach shell lengths of 35–45 mm in three years, indicate that growth rates for juvenile *Olympia* oysters are such that 2004 seed oysters averaging 9.5 mm (range 5–13 mm) in August 2004 should have reached a minimum size of 25–

30 mm by August 2006. Thus, we suspect that the oysters indicated in the oval in Figure 4 are from natural setting larvae that probably originated from spawning at the trestle enhancement site.

### *Reproductive Condition*

Subsamples of 10–18 adult *Olympia* oysters were collected from the Fidalgo Bay trestle site in May, June, and August 2006 to check their reproductive condition. One of the 10 oysters collected in May 2006 had eggs in the mantle cavity, whereas most of the others showed signs of some gonad development. One of 18 oysters sampled in June 2006 had developed motile larvae in the mantle cavity, whereas most of the others were in various stages of development. None of the 12 oysters sampled in August 2006 had any larvae in the mantle cavity and most showed signs of diminishing gonad sizes.

### *Natural Recruitment*

The series of bags of clean cultch shells hung along the length of the trestle and near the seed planting beds were checked in August 2004 and April 2005 for signs of natural recruitment at the trestle site. No signs of postlarval recruitment were found in 2004, but a low density of natural spat was observed on the clean cultch shells in April 2005. Volunteers collected and assessed samples of shells from the shell bags at the trestle in late June 2005. Of 442 shells sampled, they found a total of 104 juvenile oysters that had set from natural spawning, for an average density of 0.24 spat/cultch shell. However, analysis of these spat by Puget Sound Restoration Fund personnel found that essentially all of these spat were juvenile Pacific oysters.

During the summer of 2006 we conducted several checks of old Pacific oyster shells, clam shells, and wood and metal debris at the trestle site and found low densities of *Olympia* oysters attached to these substrates. These *Olympia* oysters had to have come from naturally spawned larvae, because some oysters were found on old seed cultch and on top of seed oysters planted in the last few years. These oysters were likely recruits from spawn from the trestle enhancement site. Some of the natural recruits were at least 2–3 y old. The source of these larger *Olympia* oysters is still open to speculation. They may have been present at the time of the first seeding, but overlooked at that time or they

TABLE 2.

Average numbers and percentages of live and dead *Olympia* oysters per cultch shell and total number of surviving oysters at the trestle site for sample dates from May 2002 through August 2006.

Date	Average Number Live/Cultch Shell	Average Number Dead/Cultch Shell	Percentage Live oysters	Estimated Total Surviving Oysters
May 2002	4.8	0.7	87.3	21,800
Nov.2002	3.4	0.1	97.1	24,200
April 2003	4.6	0.8	85.2	21,300
August 2003	4.7	1.2	79.7	19,900
May 2004	22.5	2.4	90.4	105,200
April 2005	8.7	2.6	77.0	234,900
August 2006*	10.5	3.7	73.9	225,400
August 2006**	24.5	Not counted		1,350,000

\*Prior to seed addition in August 2006.

\*\*Density of live seed oysters added in August 2006.



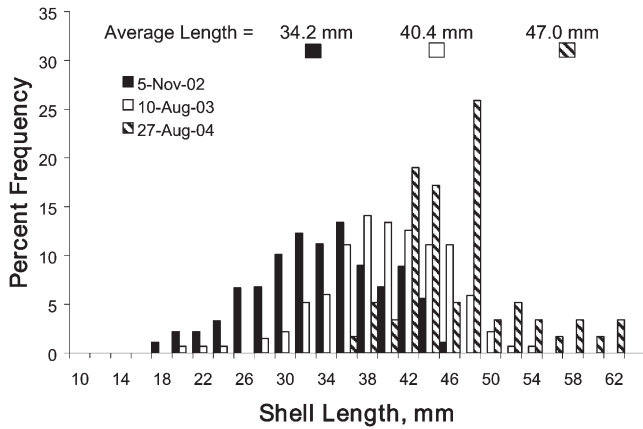


Figure 3. Size histogram for three sampling dates of the 2002 Olympia oyster seed planted in May 2002 at the trestle site as one-year old seed at an average shell length of 24.8 mm. Number of oysters measured for each date ranged from 50–90.

may have come from a spawning of the seed planted in 2002 (as age 1 + oysters), which may have spawned in 2002 or 2003.

*Exploration of Additional Planting Locations*

Four new sites in Fidalgo Bay were explored as possible sites for future Olympia oyster enhancement. Two new sites on Weaverling Spit (Fig. 1, inset) were selected for seeding in 2006, and each site was enhanced with about five cubic yards of Pacific oyster shell and seeded with 10 bags of seed each. A third site, about 0.5 km north of the Fidalgo Bay trestle, had some standing water at low tide but also had a marginally soft bottom. No seed oysters were planted at this site. The fourth site was Crandall Spit Lagoon (Fig. 1, inset), which has a small amount of standing water at low tide and a drainage channel that flows throughout low tide periods. Investigation of this site revealed the presence of several dozen medium sized (30–50 mm) Olympia oysters in the outflow channel of the lagoon; however, the source of these oysters is unknown. They may have been present prior to any rebuilding efforts in Fidalgo Bay, or

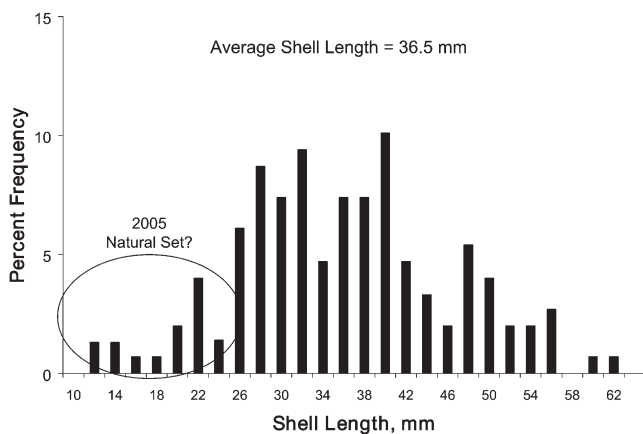


Figure 4. Size histogram of Olympia oyster shell lengths measured from the trestle site in August 2006. This population included seed planted in 2002, 2003, and 2004. The oval indicates Olympia oysters that may have set naturally in 2005. No seed were planted in 2005 and seed oysters planted in 2004 should have been at least 25 mm long in August 2006.

they may have grown from larvae spawned in 2003 or 2004 at the trestle enhancement site. Regardless, the presence of these oysters indicated that the best option for future restoration activities at this site would be habitat enhancement (e.g., adding substrate) rather than placement of seed oysters.

*Temperature Profiles*

Sensors continuously monitored temperatures at the water/sediment interface at three locations in Fidalgo Bay from mid-May to early August 2006. The temperature profile for the trestle enhancement site showed that water temperatures during periods of high tide ranged from about 12°C to 15°C, whereas temperatures reached highs of 28°C during low tide periods. The temperature profile for the Weaverling Spit site showed a cooler temperature regime, with low tide temperatures only reaching about 20°C. The third site, Crandall Spit Lagoon, showed an intermediate temperature profile, with low tide temperatures reaching about 26°C.

When the temperature profiles are presented as average weekly temperatures (Fig. 5), it is clear that the Weaverling Spit site is the coolest, followed by the trestle site and Crandall Spit Lagoon. The overall average temperatures, for the period 28 May through 5 August 2006 were 14.5°C, 16.1°C, and 17.0°C, for the Weaverling Spit, trestle and Crandall Spit Lagoon sites, respectively.

**DISCUSSION**

The success of the 2002, 2003, and 2004 seedings, in terms of survival and growth, indicated that the Fidalgo Bay trestle location is a viable rebuilding site in North Puget Sound (Robinette & Dinnel 2003, Robinette et al. 2004, Dinnel et al. 2004, 2005, 2006). The area underneath the trestle, and within about 3 m on either side, has a very firm substrate composed of gravel and accumulations of clam and oyster shells. Areas further from the trestle (about 3–10 m) still have firm substrate and standing water at extreme low tides, but also have increased siltation that has caused a minor amount of mortality of very small seed oysters. Predation by crabs, drills, diving ducks, and other predators continues to be low.

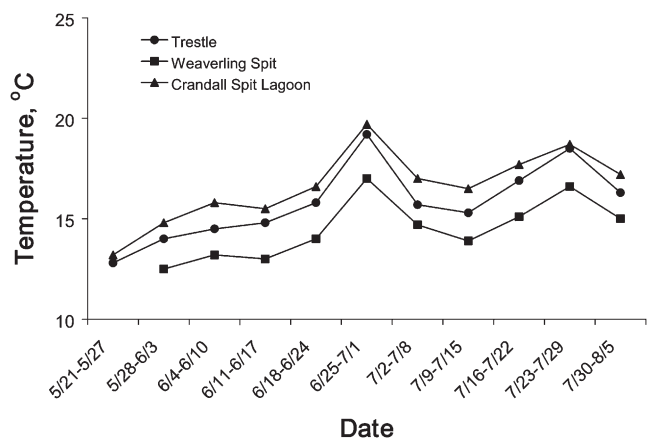


Figure 5. Average weekly temperatures recorded at 15-min intervals from May 21 to August 8, 2006 at the Fidalgo Bay trestle enhancement site, Weaverling Spit and Crandall Spit lagoon.

Growth of all four batches of oyster seed is gradually providing the beginnings of a structured oyster bed at the trestle site. The main seeding sites at the trestle (areas A, B, and C in Fig. 2), as well as some of the outer fringes of the trestle site, were enhanced in 2006 by adding Pacific oyster shells to the silty substrate to provide solid support for *Olympia* oyster seed and to provide additional settlement substrate for naturally-spawned larvae.

An experimental bed structure using rocks and oyster shell was constructed by the Samish Tribe on Weaverling Spit and seeded with *Olympia* oyster seed in 2003 (Barsh 2003, Barsh et al. 2004). However, assessment of this site in 2006 showed that there were no surviving *Olympia* oysters. This site was higher than the trestle site and did not have any standing water present during periods of very low tides. Therefore, this site was abandoned in 2006 in favor of two other sites that do have standing water at extreme low tides. Each of these two sites was "firmed up" by the addition of approximately five cubic yards of Pacific oyster shell. Each site was seeded with about 65,000 *Olympia* oyster seed set on Pacific oyster cultch in August 2006. These sites will be monitored for survival and growth in coming years to determine if they will support a *Olympia* oyster bed.

The goal of this project is to establish a *Olympia* oyster bed that successfully spawns, produces larvae, and acts as a "source population" that exports larvae to other areas. The larval stage lasts from about 11–30 days (Imai et al. 1954, Allen 2005), during which time the larvae will be distributed by water currents. However, there is little information about how far larvae will be dispersed, and dispersion is certainly a function of the specific locale and larval behavior. One study by Quayle (1969) found that Pacific oyster larvae could be transported by currents as far as 56 km in the Canadian Strait of Georgia. Because the larval duration of the *Olympia* oyster (15–30 days) is about the same as the Pacific oyster (Kennedy & Breisch 1981, Collet et al. 1999), *Olympia* oyster larvae could possibly be transported this same distance, assuming similar currents and larval behaviors. However, in Fidalgo Bay, larvae would be shed into the water at the head of a relatively quiet bay, and many larvae may not be transported outside the bay where stronger currents prevail.

Because the trestle population is the only known concentration of *Olympia* oysters in the North Puget Sound region, we may be able to trace settlement patterns within and outside Fidalgo Bay and determine the extent of larval transport during subsequent years. Care will have to be taken to differentiate *Olympia* oyster spat from Pacific oyster spat because Pacific oysters cultured in nearby Samish Bay can spawn in rare years and distribute larvae as far south as Fidalgo Bay (as evidenced by Pacific oysters that have settled on rocks from a spawning in the late 1990s). Indeed, we found a modest set of Pacific oyster spat on both oyster and clam shells at the trestle site from an apparent spawning and settlement in 2004.

One concern about rebuilding *Olympia* oyster stocks in Fidalgo Bay and North Puget Sound was that water temperatures may not be sufficiently high enough in some locations for successful spawning and larval production. Given our observations in 2006, this does not seem to be a significant issue. According to Allen (2005), *Olympia* oysters start to spawn when water temperatures are consistently greater than 12.5°C. Temperature data collected at three sites in Fidalgo Bay (Fig. 5) show that temperatures were suitable enough by about mid to late May

2006 to allow spawning. One *Olympia* oyster was found to contain brooding larvae on June 12, 2006. Some *Olympia* oysters are now recruiting to the trestle enhancement bed, and the likely larval source is the bed itself, because no other significant populations of *Olympia* oysters have been found in or around Fidalgo Bay. A small population of adult *Olympia* oysters was located in 2006 in the outflow of Crandall Spit Lagoon, about 2 km north of the trestle enhancement site (Fig. 1, inset). However, it is not clear at this time if those oysters were the result of a previous trestle spawning (possibly in 2002 or 2003), or if they were present independent of the trestle population.

As of August 2006, *Olympia* oysters have only been planted at the South Fidalgo Bay sites (trestle and Weaverling Spit) and represent the only enhancement locations in the North Puget Sound region, except for a few small plantings on private property on Orcas Island. Restoration of *Olympia* oysters in the North Sound region will likely require more enhancement sites so that naturally-spawned larvae are produced at a "network" of sites. Additional sites in Skagit County where successful seeding might be accomplished include the numerous shallow channels of Padilla Bay and Samish Bay, where *Olympia* oysters occasionally can be found. Lack of a formalized restoration plan for the Padilla Bay Research Reserve has caused a postponement of any seeding activities until a later date.

Future restoration activities include continued monitoring of the trestle and Weaverling Spit enhancement beds, monitoring for spawning and larval recruitment, and seeding in adjacent Padilla Bay.

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