Restoration of the Olympia Oyster, *Ostrea lurida*, in Fidalgo Bay and Cypress Island

Year Sixteen Report

Skagit County Marine Resources Committee

Prepared by Paul Dinnel

December 2018

Skagit MRC

Northwest Straits INITIATIVE

partners in marine conservation

Acknowledgments

The Skagit County Marine Resources Committee thanks the following for their invaluable assistance with our Olympia oyster restoration project in Fidalgo Bay:

Project Management: Paul Dinnel, Skagit MRC Olympia oyster lead; Tracy Alker, Skagit County Public Works; staff of the Northwest Straits Foundation, and Sasha Horst and Lucas Hart, Northwest Straits Commission.

Project Technical Support: Brady Blake, WDFW, David Way, WDNR and Brian Allen, Betsy Peabody, Ryan Crim and other staff of Puget Sound Restoration Fund.

Permission to Plant Seed at the Trestle, Cap Sante Marina, and Cypress Island sites: City of Anacortes, Port of Anacortes and the Washington Department of Natural Resources.

Oyster Shell Donation and Funding: Paul, Steve and Scott Blau, Blau Oyster Company, Samish Island for their periodic donations of cultch bag shell and the Rose Foundation for Communities and the Environment for funding the 2018 addition of shell substrate in Fidalgo Bay.

Volunteers: Paul Dinnel, Erica Pickett, Pete Haase, Erik Dinnel, Dixon Elder, Chris Brown, Hal Lee, Jack Middleton, Sarah Tchang, Vicki McNeil, Brian Walker, Caden Walker, Lynn Lichtenberg, Nate Biletnikoff, Robert Lord, Candice Trusty, Kirsten Boesen, Don Klopfer, Darla Smith, Annie Thomas, Gina Johnson, Wayne Huseby, and Jennifer Selvig.

Report Reviewer: Vicki McNeil and Tracy Alker

Partner Organizations: Northwest Straits Commission, Northwest Straits Foundation, Puget Sound Restoration Fund, Samish Tribe, Swinomish Tribe, Coastal Volunteer Program at Padilla Bay, Salish Sea Stewards, Skagit County Public Works, Shell and Andeavor (now Marathon) Refineries, Blau Oyster Company, Rose Foundation for Communities and the Environment, WDFW, WDNR, NOAA, Shannon Point Marine Center, Western Washington University, City of Anacortes and Port of Anacortes.

PUGETSOUND PARTNERSHIP

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

This project has been funded wholly or in part by the United States Environmental Protection Agency via the Puget Sound Partnership and the Northwest Straits Commission. The contents of this document do not necessarily reflect the views and policies of the United States Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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Restoration of the Olympia Oyster, *Ostrea lurida*, in Fidalgo Bay, Washington --Year Sixteen Report

Abstract

The Olympia oyster, *Ostrea lurida*, is native to the Pacific Coast of North America ranging from Sitka, Alaska to Baja California and is the only oyster species native to the U.S and Canadian west coasts. Populations declined rapidly after the arrival of European settlers and overharvest was apparent in the late 1800's. In the early 20th century, severe pollution from pulp and paper mills heavily impacted Pacific oyster (*Crassostrea gigas*) cultivation and may have had significant adverse effects on Olympia oyster populations, especially in South Puget Sound. In Anacortes, WA, a restoration project began in Fidalgo Bay in 2002, a cooperative project between Skagit County Marine Resources Committee (Skagit MRC), Puget Sound Restoration Fund, Washington Department of Fish and Wildlife and other partners to establish several Olympia oyster beds. Subsequent to successful planting of seed oysters in 2002 and again in 2003, 2004 and 2006, survival rate, growth and natural recruitment have been deemed high, and natural recruitment was seen in Fidalgo Bay at areas outside the seed planting sites, with exceptionally high recruitment in 2015. In 2012 and 2013, "wide area" surveys of Fidalgo Bay were undertaken at nine areas in addition to yearly monitoring of the original trestle seeding site. In 2012-2013, the trestle area around the original seeding plots was extensively surveyed beyond the normal yearly monitoring efforts and an additional eight sites in Fidalgo Bay were examined for Olympia oysters and substrate composition. An additional two sites outside of Fidalgo Bay were also surveyed in 2014: 1) The southeast shore of Guemes Island (just north of Fidalgo Bay) was surveyed for the presence/absence of Olympia oysters that may have originated from spawning in Fidalgo Bay; none were found. In 2018, 14 areas were part of an updated "wide area" survey to assess increased/decreased oyster densities since 2012-14. Shell cultch bags to monitor natural post-larval recruitment were deployed at 19 sites around Fidalgo Bay from 2011 through 2017. Results of sampling the recruitment bags indicate that annual recruitment is highly variable and that most recruitment takes place on the eastern side of the bay, likely due to local summer current patterns. In an effort to improve recruitment on the western side of the bay, Skagit MRC planted seed oysters in the northwestern corner of the bay (Cap Sante Marina area) in 2016. An experiment to assess survival and growth was initiated in 2016 in newly restored marsh channels at Secret Harbor, Cypress Island, about five miles northwest of Fidalgo Bay. Results of this experiment showed that one location in the main channel of the restoration area was able to support Olympia oysters, although sedimentation was high due to the rawness of the new restoration. In 2013, Skagit MRC worked with Puget Sound Restoration Fund to deploy a total of 2.5 acres of new Pacific oyster substrate in four plots on the eastern shore of Fidalgo Bay. Monitoring from 2014 to 2018 has shown Olympia oyster recruitment to be exceptionally high in these new plots. Since 2002, the estimated abundance of Olympia oysters in Fidalgo Bay has steadily increased from about 50,000 oysters to about 2.9 million oysters in 2018. In 2018, two new 1/2 acre shell enhancement plots were added to Fidalgo Bay by Puget Sound Restoration Fund, one just north of the trestle on the east side of the bay and one on Weaverling Spit. The Weaverling Spit plot was then seeded with juvenile hatchery raised juvenile oysters in an attempt to increase larval abundance on the west side of Fidalgo Bay.

Introduction

Native to the marine waters from Sitka, Alaska to Baja California, the Olympia oyster (*Ostrea lurida*) is the only oyster species native to the Pacific Coast of North America (Ricketts and Calvin 1968). Native tribes recognized the Olympia oyster's significance and settled where they could harvest the oysters and other shellfish as food resources. The Skokomish Tribe knew them as Tusa'yad (Steele 1957). Although native American exploitation of the Olympia oyster began in the pre-colonial days, harvest and cultivation of the beds in Willapa Bay, Puget Sound and Hood Canal began in the late 1850's and later included diking systems that were fairly elaborate (Steele 1957). During the California gold rush of the 1850's, oyster prospectors found sparse Olympia oyster resources in California estuaries (Ingersoll 1881) and oyster laden schooners from Puget Sound and Willapa Bay soon filled the need generated in California, transporting Olympia oysters south and garnering as much as a dollar per oyster. In the late 1800's and early 1900's, the commercial viability of the Olympia oyster was seriously compromised due to overharvest and wholesale destruction of their reef-like habitats (PSAT 2003). Additionally, the operation of pulp and paper mills between the 1930's and 1950's created severe water quality problems for Pacific oyster (*Crassostrea gigas*) culture (Couch and Hassler 1989) and may have helped speed the demise of Olympia oysters in some locations, especially in South Puget Sound (Cook et al. 1998, 2000, Baker 1995, Blake and Bradbury 2012). In the 1850's in Puget Sound, 10,000 bushels of Olympia oysters were harvested and that number rose to 130,000 bushels by 1890. During the 1900's harvests declined, and by around 1980 effectively no harvest of wild Olympia oysters was reported.

Olympia oysters are native to Puget Sound, unlike the Pacific oyster, which was imported from Japan, and is now found naturally in many areas (Suttles 1974). Additionally imported, although unintentionally, Japanese oyster drills (*Ocenebra japonica*) and other potential oyster predators and parasites were brought to Washington from Japan with the Pacific oysters (Robinette et al. 2004; Barsh et al. 2004, Blake and Bradbury 2012). Historic Olympia oyster beds are reported to have existed in the North Puget Sound region in Boundary Bay (just north of the Canadian border), Drayton Harbor, Bellingham Bay, Chuckanut Bay, Orcas and Shaw Island areas, Fidalgo Bay, Similk Bay, Samish Bay, Padilla Bay, Dugalla Bay, Penn Cove (Blake and Bradbury 2012), and Guemes Island (from a report of Indians living on Guemes Island providing Spanish explorers with "verdigones") (Suttles 1974). Early Guemes Island Indians were reported to have harvested oysters as reported by Ashbach and Veal (1986) and additionally from a bay on the northeastern side of Whidbey Island (*Northwest Enterprise* 1884, *Skagit News* 1888, Townsend 1893, Hatch et al. 2005). In Samish Bay (*The Coast* 1907) and perhaps Bellingham Bay (Townsend 1893), quantities of Olympia oysters were historically found but are very rare today (Cook et al. 1998, 2000; Baker 1995). Brady Blake (WDFW, pers. comm.) has indicated that there is solid evidence that there were as many 2,000 acres (with the possibility of substantially more) of Olympia oyster beds in both Samish and Padilla Bays prior to their wholesale exploitation (PSRF 2012). In the early 1900's in Similk Bay, an attempt to raise Olympia oysters was made but did not continue (*Anacortes American* 1906). In recent years an occasional Olympia oyster has been identified from various North Puget Sound locations including Bellingham Bay, Cypress Island, (Stahl 1999), Drayton Harbor (Brady Blake, WDFW, pers. comm.), Samish Bay and Lopez Island (Betsy Peabody, Puget Sound Restoration Fund, pers. comm.). Olympia oysters are a small oyster, with maximum sizes being reported as 75 mm (Hertlein 1959) to 90 mm (Harbo 1997). They are much smaller than the Pacific oyster and are usually smaller than the Washington recreational size limit of 2.5" for oysters.

Olympia oysters and their beds are valuable to the local ecosystem. They provide three-dimensional habitat for many marine species. In addition, oysters are filter feeders, feeding on phytoplankton and purifying the water, which helps to maintain water quality in the estuaries in which they are found. If successfully restored, they may also provide future opportunities for harvest, offering both a recreational and tribal cultural resource (Gregory and Volety 2005, Luckenbach et al. 1999). In order to identify the current populations of Olympia oysters in Puget Sound, to improve, manage and enhance the species and its population by natural and artificial means, and to investigate their genetic integrity, the Washington Department of Fish and Wildlife (WDFW) drafted a Olympia oyster recovery plan in the late 1990's (Cook et al. 1998), although this plan was never implemented by WDFW. However, a consortium of government agencies, tribes, non-profit organizations, industry, academia and citizen volunteers has worked with WDFW to promote native oyster restoration efforts in Puget Sound during the last two decades. In 2004 and 2005, in order to advance Puget Sound restoration projects, NOAA's Community Restoration Fund awarded restoration grants to the Puget Sound Restoration Fund (PSRF). Additional funds were awarded in 2010 to Northwest Straits Foundation (NSF) by the National Fish and Wildlife Foundation to increase restoration works in North Puget Sound and the Rose Foundation for Communities and the Environment provided funds to PSRF for the 2018 shell enhancement in Fidalgo Bay.

The Skagit County Marine Resources Committee (Skagit MRC) worked with the Samish and Swinomish Tribes, PSRF, Taylor Shellfish Farms, Shell Puget Sound Refinery, the City of Anacortes and others in 2002 to plant Olympia oyster seed next to the trestle in South Fidalgo Bay as part of North Puget Sound Restoration efforts (Robinette and Dinnel 2003, Barsh 2003). This signified the first Olympia oyster restoration effort in the North Sound area other than several minute plantings on Orcas Island (Betsy Peabody, PSRF, pers. comm.). Since the initial seeding of Olympia oysters in Fidalgo Bay in 2002, various other restoration efforts have ensued in the North Puget Sound Region using broodstock from the growing population in Fidalgo Bay. These efforts include: 1) Lone Tree Point and Kiket Island lagoons in Skagit and Similk Bays being managed by the Swinomish Tribe (Barber et al. 2013, 2015, 2016; Greiner et al. 2015), 2) Fisherman Bay on Lopez Island being managed by nonprofit organization Kwiaht (*The Islands' Weekly* 2013), 3) Discovery Bay, Jefferson County managed by WDFW and the Jefferson Marine Resources Committee (Lull 2010), 4) Sequim Bay, Clallam County managed by the Clallam County Marine Resources Committee (Clallam MRC 2015) and 5) Chuckanut Bay, Whatcom County, managed by Whatcom MRC (Rose 2018).

In 2001, both Samish Bay and Fidalgo Bay were originally considered as planting sites and Fidalgo Bay was selected when it was found to be free of Japanese oyster drills that can negatively impact restoration efforts. The first seeding took place in 2002. In 2003 and 2004, further oyster seed were planted and growth and survival were monitored (Robinette et al. 2004, Barsh et al. 2004). In 2004, evidence was found of natural spawning when cultch shells deployed to catch spat showed post-larval recruitment (Dinnel et al. 2005) and this monitoring has continued. In 2006, Fidalgo Bay received a supplement of Pacific oyster shell to increase habitat, help in oyster bed building and encourage post-larval recruitment as well as additional seed (Dinnel et al. 2006, 2009a, 2009b). In 2010 through 2016, survival and growth of the Olympia oysters were monitored, cultch shell bags and shell strings were assessed for natural recruitment, and four future oyster seed planting locations were assessed for suitability (Dinnel et al. 2011, Gabrian-Voorhees et al. 2013). This report covers continuing restoration and monitoring activities carried out during 2017 and 2018 and includes a report on the results of a Cypress Island experiment.

Project Goals

In May 1998, WDFW published the Department's plan for Olympia oyster restoration in Washington State titled "Olympia oyster stock rebuilding plan for Washington State public tidelands" (Cook et al. 2000). Although never actually implemented by WDFW, 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. The long term objectives included:

- ✓ Define the current and historic range of Olympia oysters
- ✓ Develop Olympia oyster genetic integrity guidelines for artificial stock enhancement
- ✓ Define habitat requirements and contemporary habitat limiters
- ✓ Identify areas for protection and restoration
- ✓ Define site-specific habitat limitations and species interactions that would affect Olympia oyster stocks, and
- ✓ Restore and protect stocks as needed to achieve the stock rebuilding goal.

In September 2010, participants in the third West Coast Olympia Oyster Workshop (NOAA/PSRF 2010) held at Suquamish, WA, discussed the current status of Olympia oyster restoration on the West Coast and considered future restoration activities. One informal agreement was that, based on the apparent success of the Fidalgo Bay restoration effort, restoration activities should be extended to up to ten new sites around the North Puget Sound region over the next 10 years.

In 2012, WDFW updated their 1998 Olympia oyster plan to provide a document that summarized the history of the Olympia oyster in Puget Sound and to provide guidance to the many groups now involved in restoration activities (Blake and Bradbury 2012). In that document WDFW identified 19 priority restoration sites in Puget Sound, with six of those sites being in the North Puget Sound sub-basin (Drayton Harbor, Bellingham Bay, [including Portage Island and Chuckanut Bay], Samish Bay, Padilla Bay, Fidalgo Bay and Similk Bay). In 2015, a consortium of groups published "A guide to Olympia oyster restoration and conservation" that described environmental conditions and sites that support sustainable populations of Olympia oysters throughout it's entire Pacific Coast range (Wasson et al. 2015). Wasson et al. (2016) have also described environmental factors that affect natural recruitment of oysters at 37 sites from southern California to British Columbia. Also in 2015, PSRF authored a new protocol using shell strings to standardize the monitoring of post-larval recruitment of Olympia oysters throughout all of Puget Sound (PSRF 2015). In addition, Skagit MRC worked with WDFW to monitor bi-weekly post-larval settlement patterns in Fidalgo Bay during the summers of 2017 and 2018 using stacks of ceramic tiles.

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 U.S. 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 any oyster restoration may include, but are not limited to, maximizing:

- ✓ Recruitment to the fishery

- ✓ Spawning output
- ✓ Species diversity of the oyster bed community, and
- ✓ Water filtration and nutrient cycling.

Given the above goals and guidelines for oyster restoration projects, the following are Skagit MRC's goals for restoration of Olympia oysters in Skagit County waters:

1. Identify areas within Skagit County that might be good sites for restoration
2. Define site-specific habitat limitations and species interactions that would affect Olympia oyster stocks
3. Restore and protect stocks at selected sites to achieve stock rebuilding goals, including:

    - Conduct test seedings at promising sites
    - Monitor survival and growth of seedlings
    - Monitor and assess the spread of Olympia oysters from natural spawning
    - Determine the best "bed structure" for each site, and
    - Control predators where necessary and possible.

4. Identify sources and sinks for natural larval recruitment
5. Engage community volunteers to assist with restoration monitoring efforts
6. Use adaptive management to modify restoration efforts based on lessons learned from local plantings and other information gleaned from other restoration efforts in Puget Sound, and
7. Participate in public education and outreach.

Methods

Monitoring Trestle Restoration Plot B for Survival and Growth

Olympia oyster seed set on Pacific oyster shell cultch were planted at the south Fidalgo Bay trestle restoration site in three plots, A, B and C (Figs. 1-4) in 2002, 2003, 2004 and 2006 for an estimated total of 1,429,570 seed planted. Seed survival and growth, together with subsequent natural recruits, were monitored from fall 2002 through summer 2018 in Plot B. In 2006 and 2008, non-seed bearing Pacific oyster shells were added to the site because evidence indicated that oyster larvae prefer to settle on oyster shell (White et al. 2009) and this substrate is lacking in Fidalgo Bay. Subsequent to the addition of non-seed bearing shell, 1/4 m^2 quadrat (1/10 m^2 in 2016-2018) sampling (Fig. 5) was used in Plot B to quantify oyster densities and sizes. In years prior to 2015, two haphazard samples were collected north of each of the 14 trestle pilings next to Plot B. From 2015 to 2018, only 14 samples were collected to minimize sampling-related impacts to the plot. All live Olympia oysters, clam shells, and oyster shells were counted within each quadrat sample. During Plot B monitoring, all live Olympia oysters in each quadrat sample were measured, their sizes recorded and the oysters returned to Plot B.

Settlement Bags - Sampling to Assess Natural Recruitment within Fidalgo Bay

Bags of clean Pacific oyster shell cultch (Fig. 6) were deployed in the springs of 2007 to 2018 (except 2010) around Fidalgo Bay and at one location each in Padilla Bay and Guemes Channel close to Fidalgo Bay (Fig. 7) to monitor for larval oyster settlement and to try to discern the extent to which larvae may be distributed from spawning at the trestle restoration site or, in recent years, other areas in Fidalgo Bay. These bags were collected in the spring of the year following

deployment and all shells in each bag were checked for juvenile oysters. All juvenile oysters found in the bags were measured for shell length.

Shell String Sampling

Shell string sampling was initiated by PSRF in 2015 as a way to standardize the Puget Sound-wide collection of annual recruitment data (PSRF 2015). Shell strings consist of 11 Pacific oyster shells, with holes drilled in them, threaded on a 1 m-long wooden dowel (Fig. 6). The bottom shell serves as a platform to keep the other 10 shells from contacting bottom sediments. The top 10 shells are the settling substrate for oyster larvae. In June 2015 through June 2018, shell strings were deployed at the Fidalgo Bay trestle site alongside the usual three cultch bags used in the past to monitor natural recruitment. The shell strings were retrieved in late August of the same year of deployment and all Olympia oysters from each shell string were counted and measured. Deployment of shell strings alongside the bags will gradually allow a comparison of these two methods.

Ceramic Tile Sampling for Biweekly Larval Settlement

In 2017, WDFW initiated a spatfall collector program aimed at collection of biweekly Olympia oyster larval settlement in various Puget Sound locations, including Fidalgo Bay with the assistance of community volunteers. The spatfall collectors consisted of stacks of five 10.5 x 10.5 ceramic tiles, glazed sides up. Settling oyster larvae always settled on the rough undersides of the tiles. The tiles were deployed in tile holders fastened to rebar stakes (Fig. 6).

In 2017, spatfall collectors were deployed at the north and south "derelict barges" on the east side of Fidalgo Bay and at the trestle plot B alongside the recruitment shell bags and shell strings described above. The collectors at both barge locations were collected and replaced at two week intervals from June 25 to September 15 (except the north barge collection ended August 17) while the trestle collectors were deployed from June 25 and collected only once on August 17. In 2018, spat collectors were only deployed at the north barge location, with collection/replacement at two week intervals beginning May 25 and continuing through September 20.

Upon retrieval, each set of tiles were gently washed and refrigerated in plastic bags until assessed for settlement. The tiles were assessed by scanning the bottom side of each tile with a dissecting microscope at 10x magnification, with oyster verification at 40x. Examples of newly settled Olympia oyster larvae appear in Fig 8.

"Wide Area" Sampling to Assess Natural Recruitment

In the summer of 2012, a "wide area" survey was undertaken at the trestle restoration site and four surrounding areas (Gabrian-Vorhees 2013). This was the largest assessment of Olympia oysters in Fidalgo Bay area undertaken since the project began and was accomplished with the assistance of Skagit County Beach Watchers, Western Washington University staff, graduate and undergraduate students as well as many community volunteers. These surveys assessed the numbers of oyster shells, clam shells and live Olympia oysters in systematically collected ¼ m^2 quadrat samples in and around the trestle restoration plot, the rip-rapped causeway, and the outfall channel and delta of Crandall Spit lagoon (Fig. 8; Gabrian-Vorhees 2013). In 2013 four additional areas were also surveyed including: East Fidalgo Bay between the two old barge structures, from the trestle to the shell berm located south of the trestle, Weaverling Spit between the east end of the spit and the Samish Tribal RV Park, the west side of the bay between the old plywood mill site and the house

about 1/2 mile south of the mill site. Additionally, the southeast side of Guemes Island (Fig. 2) was also checked for any signs of settlement by larvae possibly exported from Fidalgo Bay.

In 2018, the sampling program noted above was repeated in most of the previously sampled areas plus a number of new areas (i.e., north of the north barge structure and the high channels near Sharps Corner) since Olympia oyster settlement has been very high since the 2012-2014 surveys. This sampling was generally less intense than the 2012-2014 sampling and was designed to provide estimates of oyster density changes in each of the areas. The 2018 sampling used 1/10 m^2 (instead of 1/4 m^2) quadrats, with samples collected systematically along transects. Only live Olympia oysters were counted during these surveys. Methods used at each of these areas surveyed in 2013-2014 and in 2018 are described below.

Between the old Plywood Mill Site and the first house to the south.

2013

This area (Area 3, Fig. 9) was sampled along 25 transects (15 m apart) running perpendicular to shore starting from the mid-tide line. Seven to eleven 1/4 m^2 quadrat samples were collected along each transect at 3 m intervals (20 to 30 m total distance). All live Olympia oysters, oyster shells and clam shells were counted in each sample, and the oysters measured. A total of 238 samples were collected in this area in 2013.

2018

This area was not quantitatively sampled in 2018. Rather, the area was walked to see if any Olympia oysters could be found.

East end of Weaverling Spit to the Tribal RV Park.

2013

The area between the east end of Weaverling Spit and the Samish Tribal RV Park (Area 4, Fig. 9) was sampled along 25 transects (15 m apart) running perpendicular to shore starting from the mid-tide line. Eleven 1/4 m^2 quadrat samples were collected along each transect at 3 m intervals (30 m total distance). All live Olympia oysters, oyster shells and clam shells were counted in each sample, and the oysters measured. A total of 275 1/4 m^2 samples were collected in 2013.

2018

The Weaverling Spit area was again sampled in 2018 along 10 transects (30 m apart) running perpendicular to shore starting from the mid-tide line. Nine 1/10 m^2 quadrat samples were collected along each transect at 3 m intervals (25 m total distance). Only live Olympia oysters were counted in each sample, but not measured. A total of 90 1/10 m^2 samples were collected in 2018.

North and south sides of the riprap causeway.

2012

The north and south sides of the riprap causeway (to the west of the wooden trestle, Areas 5 and 6, Fig. 9) were sampled along east-west transects running most of the length of the causeway, with the transects being located near the lower edges of the sloping parts of the bottom below the riprap. A total of 79 1/4 m^2 samples were collected along the north side of the causeway over a distance of 475 m and 61 samples collected on the south side over a distance of 365 m.

2018

The two sides of the causeway were resampled in 2018. A total of 31 1/10 m^2 samples were collected along the north side of the causeway over a distance of 365 m and 43 samples were collected on the south side over a distance of 510 m

Trestle.

2012

The area underneath the wooden trestle on the east side of Fidalgo Bay (Area 7, Fig. 9) was sampled along transects positioned at each set of pilings numbered from 30 to 100 (starting at piling set 30 counting from the east shore and proceeding westward). A total of 698 1/4 m^2 samples was collected covering an area of 7,781 m^2.

2018

The trestle plot was resampled in 2018 when an abbreviated set of 142 1/10 m^2 samples was collected throughout the original plot.

Southeast side of Fidalgo Bay, from the trestle, south to the shell berm.

2013

This was an area (Area 8, Fig. 9) of very low Olympia oyster density and was surveyed by walking the area (about 200 x 30 m) and generally assessing the number of oysters in this area. Six 30 m long transects, spaced about 120 m apart, were walked to observe the numbers of Olympia oysters present. No quadrat samples were collected.

2018

This area was not resurveyed in 2018 but casual observations suggested that oyster densities had not changed much since the 2013 survey.

East side of Fidalgo Bay between the south barge structure and the northern shell enhancement plot.

2013

The area between the old barges (Areas 9 and 10, Fig. 9) was sampled along 25 transects (15 m apart) running perpendicular to shore starting from the mid-tide line. Eight to eleven 1/4 m^2 quadrat samples were collected along each transect at 3 m intervals (20 to 30 m total distance, depending on depth of the mud). All live Olympia oysters, oyster shells and clam shells were counted in each sample, and the oysters measured. A total of 265 1/4 m^2 samples were collected in 2013.

2018

The area between the old barges (Area 9, Fig. 9) was again sampled along 19 transects (15 m apart) running perpendicular to shore starting from the mid-tide line. Nine 1/4 m^2 quadrat samples were collected along each transect at 3 m intervals. Only live Olympia oysters were counted in each sample, but not measured. A total of 171 1/4 m^2 samples were collected in 2018. Additionally, the area between the north barge structure and the northern shell enhancement plot was added to the sampling matrix. In this location (Area 10, Fig. 9) we collected 99 1/10 m^2 samples along eleven transects (15 m apart) running perpendicular to shore starting from the mid-tide line. Nine 1/10 m^2 quadrat samples were collected along each transect at 3 m intervals (25 m total distance).

Just west of the northern shell enhancement plot (at Shell Refinery's RV Park).

This area (Area 11, Fig. 9) was not sampled in 2013 but was sampled in 2018 along ten transects (10 m apart) running perpendicular to shore starting from the mid-tide line. Nine 1/10 m^2 quadrat samples were collected along each of the ten transects at 3 m intervals. A total of 90 1/10 m^2 samples were collected in 2018.

Area northwest of the northern shell enhancement plot (west of Shell's RV Park).

This area (Area 12, Fig. 9) was not sampled in 2013 but was sampled in 2018 along eight transects (15 m apart) running perpendicular to shore starting from the mid-tide line. Nine 1/10 m^2 quadrat

samples were collected along each of the eight transects at 3 m intervals. A total of 72 1/10 m^2 samples were collected in 2018.

Crandall Spit Lagoon outfall area.

2012

The channel and lagoon outflow delta (Area 13, Fig. 9) was sampled at 6 spots in the outflow channel and along 7 transects of variable lengths in the delta area. A total of 69 1/4 m^2 samples were collected at 3 m intervals in the channel and in the delta area.

2018

The lagoon channel and delta area were resampled in 2018. The channel and lagoon outflow delta was sampled at 6 spots in the outflow channel and along 7 transects of variable lengths in the delta area. A total of 107 1/10 m^2 samples were collected at 3 m intervals in the channel and in the delta area.

Sharps Corner channels, south Fidalgo Bay.

The far south end of Fidalgo Bay near the Sharps Corner Highway 20 intersection (Area 14, Fig. 10) was sampled for Olympia oysters in 2018 in one of four of the high tidal channels (most westerly one) just offshore of the salt marsh. The tidal elevation of the oysters in these channels was about +3' MLLW. Twenty 1/10 m^2 quadrat samples were collected at 3 m intervals along the length of the western channel that contained the oysters. Population estimates for oysters in the other three channels were then estimated by visually comparing the oyster numbers with the estimate obtained from the sampling of the northern channel.

Cap Sante Marina Seed Plots

Extensive monitoring of Olympia oysters since 2002 has shown that almost all natural recruitment is limited to the eastern side of Fidalgo Bay. This is likely due to summer current patterns that are chiefly north-south in nature and which do not facilitate larval transport from one side of the bay to the other (Eric Grossman, USGS, pers. comm.). Given the desirability of establishing a population on the west side of the bay to serve as another larval source, Skagit MRC and the Port of Anacortes approved a project to plant oyster seed in the Cap Sante Marina area of northwest Fidalgo Bay (Fig. 11). This effort was funded by the Skagit Restoration Initiative, administered by the Northwest Straits Foundation (NWSF). Skagit MRC worked with Puget Sound Restoration Fund and the Port of Anacortes (the property owner) to add Olympia oyster seed to the Cap Sante Marina area.

In 2016, 20 bags of Olympia oyster seed were produced by Puget Sound Restoration Fund (PSRF) at their Manchester, WA shellfish hatchery and transferred to the marina area. These bags of seed were then assessed for juvenile oyster density in the bags, measured and then half of the seed bags were spread at one location just inside the northern rock breakwater (Area 1, Fig. 11) and the other half at one location at Seafarers Park (Area 2, Fig. 11). In addition, juvenile oysters from the 2015 batch of settlement bags (collected in June 2016) were added to this site to increase the number of Olympia oysters in this area. These two new plots were then monitored using haphazard sampling (1/10 m^2 quadrat samples) for density and oyster sizes in 2017 and 2018.

Fidalgo Bay Shell Plots to Enhance Olympia Oyster Settlement

In 2012, the Northwest Straits Foundation, working in conjunction with Skagit MRC, retained PSRF to enhance the east shoreline of Fidalgo Bay with at least 1/2 acre of Pacific oyster shell to encourage the formation of several new Olympia oyster beds. This work was funded using Skagit

Restoration Initiative funds administered by the Northwest Straits Foundation. In November 2013, PSRF personnel completed the spreading of 250 yd^3 of oyster shell (previously inspected by WDFW) obtained from Blau Oyster Company on Samish Island. The operation used a barge to transport the oyster shell and a fire hose to disperse the shell at high tide (Fig. 12). Four shell plots were established collectively covering about 10,000 m^2 (about 2.5 acres - see Fig. 13). PSRF personnel also sampled each plot for Olympia oyster recruitment one year later in November 2014 to assess the magnitude oyster recruitment to the new shell beds (PSRF 2014). These plots were then assessed by volunteers for density and oyster sizes during the summers of 2015 through 2018.

In October 2018, an additional 1/2 acre of shell was added to each of two locations: Weaverling Spit to the east of the Samish RV Park and just north of the trestle on the east side of the bay (Fig. 14). In early November 2018, 56 bags of oyster seed on cultch were added to the shell enhancement plot at Weaverling Spit.

Cypress Island Experimental Seed Bags

Shell middens in Secret Harbor on the southeast side of Cypress Island (about 5 miles northwest of Fidalgo Bay, Fig. 2) have been found to contain Olympia oyster shells up to a size of 70 mm, probably dating to pre-1870 (Maurice Major, WDNR, pers. comm. by way of Lisa Kaufman, NWSF). Secret Harbor has been the site of a recent shoreline restoration project to remove an old dike and restructure a marsh/channel habitat. The partners in this effort have been the Washington Department of Natural Resources and the Samish Tribe. Given the new channel habitats at this site, Skagit MRC initiated a small experimental study to see if Olympia oysters would survive and grow in these newly created channels. Four bags of Olympia oyster seed on Pacific oyster cultch were purchased from PSRF's Manchester hatchery and transported to Cypress Island in July 2016 for planting in three channel locations and in one location in the offshore intertidal area (Fig. 15). The approximate tidal elevations of the bags were +4', 5', 6' and 7' MLLW, with the lowest bag being the one in the outside channel. A sampling of one of the bags indicated that the density of the seed was about 4.5 seed per cultch shell with an average shell length of 7.5 mm in early June 2016. Two of these bags (middle and low channel locations) were equipped with HOBO® U24 salinity and temperature data loggers set to collect data at 30 minute intervals for the next year. The data loggers and shell bags were recovered in July 2017 and the contents of the bags assessed for oyster survival and growth.

Overwintering Oyster Seed for Whatcom MRC

About 40 bags of Olympia oyster seed on Pacific oyster cultch were purchased by Whatcom MRC in 2017 for eventual dispersal in the Chuckanut Bay area of Whatcom County. WDFW recommended that these seed oysters be overwintered in Fidalgo Bay prior to introduction to Chuckanut Bay. This was accomplished by volunteers from both Whatcom and Skagit Counties, who deposited the bags near the Fidalgo Bay trestle in late summer 2017. These bags were then recovered in May 2018 and relocated to Chuckanut Bay.

Results

Trestle Plot B Monitoring

Olympia Oyster Densities, 2002 Through 2018. Plot B oyster densities averaged about 45/m^2 in 2002 and 2003, increased to 130/m^2 in 2011 and decreased to an average of about 42/m^2 between 2013 and 2017, with a low of 23 oysters/m^2 in 2018 (Table 1, Fig. 16). The last addition of seed to

Plot B was in 2006; thus, increases in oyster density from 2008 through 2011 is due to natural recruitment. The lower densities of oysters in Plot B since 2011 are possibly due to the deterioration of the Pacific oyster shells added in several previous years. There seems to be fewer cultch shells in the samples in recent years and the shells appear to be getting smaller and more eroded through time. Other possible reasons for the decreases in Plot B oyster densities could be natural mortality due to old age, reduced natural recruitment in this area, decreased cultch shell quality due to fouling organisms, and the possible impact of many years of sampling (walking on the bed). In terms of total numbers of Olympia oysters in Plot B, the population has ranged from an estimated 46,184 oysters in 2002 to a high of 130,520 oysters in 2011. Since 2011, the population has gradually decreased to about 23,000 oysters in 2018 (Table 1).

Oyster Sizes. Olympia oysters in Plot B have been measured for size when sampled yearly. After seeding in 2006, average shell length increased until the addition of small seed oysters in August 2005 (Fig. 17). Samples from Plot B from 2008 to 2011 showed a gradually aging population of oysters with signs of varying degrees of natural recruitment over the years. In 2018, the size of Olympia oysters sampled in Plot B averaged 37.9 mm and ranged from 8 to 56 mm shell length with about 25% of the total being identified as spat derived from the 2017 spawning (size range = 8-30 mm). Fluctuation in average size of Olympia oysters at the trestle will most likely be the rule as new oysters are recruited via spawning and older oysters die.

Settlement Bags – Sampling to Assess Natural Recruitment Within Fidalgo Bay

In 2004, 2005 and 2007, clean Pacific oyster cultch shells in bags were hung along the length of the trestle next to the seed planting beds and were checked for natural recruitment of Olympia oysters at the trestle site one year after deployment. A low density of natural recruitment was found in 2005 and 2007. From 2007 through 2017, bags of clean cultch shells were placed at the trestle and around Fidalgo Bay, as well as nearby locations at northwest March's Point and in Guemes Channel (Fig. 7). Each of these bags were then recovered approximately one year later and assessed for numbers of settled oysters and their sizes.

No Olympia oysters were found in any bags in 2008 and 2009, indicating recruitment failures in 2007 and 2008. The shell bags recovered in 2010 showed high natural recruitment, which was limited to south Fidalgo Bay. Minor natural recruitment was observed in the bags in 2012, 2013 and 2014, with substantial recruitment in 2014 and very high recruitment in 2015. Moderately high recruitment took place in 2016 and 2017. See Table 2 for average annual post larval recruitment at trestle Plot B and Table 3 for a detailed listing of recruitment at all sites for all years.

The average recruitment in the three replicate cultch bags at trestle Plot B has ranged from a low of zero to a high of 428 oysters/100 cultch shells (Table 2). Only minor recruitment has occurred at cultch bag stations along the western side of the bay and at Crandall Spit near the northeast entrance to the bay. Recruitment has yet to be observed in bags deployed outside of Fidalgo Bay at northeast March's Point or in Guemes Channel (Table 3, Fig. 18).

Shell String Sampling

The three shell string samplers collected in August 2015 (deployed in June, 2.5 months earlier) from trestle Plot B had an average of 24.0 Olympia oyster recruits per shell, with an average length of 7.6 mm (Table 4). The second set of trestle plot shell strings collected one year after deployment (June 2016) had an average of 9.5 oysters/shell, with an average length of 19.6 mm. The three cultch bags collected the same time at the trestle had a density of 5.4 oysters/shell with an average length

of 23.0 mm (Table 3). Four other shell string-cultch bag combinations were also collected in June 2016 from areas along the east side of Fidalgo Bay. A comparison of all seven shell string:cultch bag combinations shows that both the average densities and oyster lengths were similar for the 2016 samples (Table 4).

The three shell string samplers collected in August 2016 (deployed in June, 2.5 months earlier) from trestle Plot B had an average of 0.9 Olympia oyster recruits per shell, with an average length of 4.0 mm (Table 4). Settlement on the shell strings in August 2016 was only about 4% of that seen in August 2015.

Ceramic Tile Sampling for Biweekly Larval Settlement

Stacks of five ceramic tiles (only the top four were used for oyster counts - Fig. 6) were set in three places (north barge, south barge and trestle) in Fidalgo Bay in 2017 and in one place (north barge) in 2018 to assess timing of larval settlement. Settlement was variable between the three locations in 2017 but showed the same basic temporal pattern of settlement. A comparison of 2017 vs. 2018 for the same location (north barge) showed that settlement began about one month earlier in 2018 (early June) compared to 2017 and that settlement was complete in late September (Fig. 19). Peak settlement was in early August in 2017 (average of 53 spat/tile) whereas settlement was virtually zero in August 2018 with the highest settlement being in September (16 spat/tile) (Fig . 19).

"Wide Area" Sampling to Assess Natural Recruitment

"Wide area" sampling in 2012-13 resulted in collection of 1,726 1/4 m^2 quadrat samples in seven areas of Fidalgo Bay, which resulted in a baseline for future "wide area" surveys. Results of the 2012 sampling are recorded in Appendix Table 1 in Skagit MRC's Year Ten Report (Gabrian-Voorhees et al. 2013) and the results of the 2013 sampling are reported in Appendix Table 1 in Skagit MRC's Year Fourteen Report (Dinnel 2016). The results of the 2018 "wide area" sampling efforts are discussed below and itemized by sample in Appendix 1 of this report for the 2018 samples. Locations of the 13 "wide area" sampling plots are shown in Figs. 8-10.

Between the Old Plywood Mill Site and the First House to the South. A total of 238 1/4 m^2 samples were collected in this area covering 9,870 m^2 in 2013 (Area 3, Table 5, Fig. 9). No oysters were found in the 239 quadrat samples collected at this location in 2013 nor were any observed in the general area. This area was walked (not sampled with quadrats) in 2018 and found to still have no oysters present.

East End of Weaverling Spit to the Tribal RV Park. A total of 90 1/10 m^2 samples were collected on the northern edge of Weaverling Spit (Area 4) in 2018, covering an area of 8,889 m^2 (Table 5, Fig. 9). Based on the transect sampling, we estimated a total of 2,933 oysters were in this area (average of 0.33 oysters/m^2) in 2018 compared to zero oysters being found here in 2012.

Riprap Causeway, North Side. In 2012, the density of Olympia oysters was found to be 0.4 oysters/m^2 for a total estimated population of 2,550 oysters. In 2018, we resampled the same area (Area 5, Fig. 9) and found a density of 20.3 oysters/m^2 for a total estimated population in this area of 30,755 (Table 5).

Riprap Causeway, South Side. In 2012, the density of Olympia oysters was found to be 0.9 oysters/m^2 for a total estimated population of 2,550 oysters. In 2018, we resampled the same area

(Area 6, Fig. 9) and found a density of 20.7 oysters/m^2 for a total estimated population in this area of 44,588 (Table 5).

Trestle. The area under and along the trestle on the east side of Fidalgo Bay (Area 7, Fig. 9) was sampled intensively in 2012 when 698 1/4m^2 samples were collected. At that time we determined that there was an average density of 20.4 oysters/m^2 in this area which translated to a total oyster population of 158,732. We repeated quadrat sampling in this area in 2018 when we collected a subset of 142 1/10 m^2 samples, which yielded an estimate of 10.5 oysters/m^2 and a total oyster population in this area of 81,690.

Southeast Side of Fidalgo Bay, From the Trestle, South to the Shell Berm. An area covering about 18,500 m^2 southeast of the trestle (Area 8, Table 5, Fig. 9) was surveyed in 2014 by walking six transects to assess presence/absence of Olympia oysters in this area. No quadrat samples were collected (Dinnel 2016). This area was not resurveyed but was scanned for any obvious changes since 2014. As was the case in 2014, Olympia oysters were very sparse in this area and most of those observed were nestled in mud. The exception to this was that we observed relatively high numbers (10-50) of oysters settled in small pools scoured out by waves in front of about a dozen small to medium-sized boulders. The best estimate of oyster density in this area in 2014, based on the observed number of oysters along the six transects, was 0.02 oysters/m^2. For 2018, we assumed that the densities were fairly similar based on casual observations. We estimated the total oyster population in this area to be about 500 for both 2014 and 2018.

East Side of Fidalgo Bay From the South Derelict Barge North to the Northernmost Shell Enhancement Bed. A total of 387 1/10 m^2 samples were collected on the east side of Fidalgo Bay in 2018 in Areas 9 and 10 (Table 5, Fig. 9) covering 51,867 m^2. The average Olympia oyster densities were 4.8/m^2 in the southern portion (Area 9) and 3.8/m^2 in the northern portion (Area 10) with a total estimated population of 233,589 oysters for the two areas combined. Most oysters in this area were nestled in mud or attached to sparse clam or oyster shells and the oysters were often concentrate in small areas where the habitat was optimal (e.g., in pools with shell rubble). A detailed listing of all sampling data for this site is recorded in Appendix 1.

Little Crandall Spit West of the Northern Shell Enhancement Plot. This area (Area 11, Fig 9) was first sampled in 2018, so no comparisons with previous data are possible (other than the fact that there were no oysters in this area prior to restoration efforts begun in 2002). In 2018, we collected 90 1/10 m^2 quadrat samples in this area and determined there to be an average density of 55.0 oysters/m^2 for a total estimated population of 271,315 oysters.

Little Crandall Spit Northwest of the Northern Shell Enhancement Plot. Again, this area (Area 12, Fig 9) was sampled for the first time in 2018 when at total of 72 1/10 m^2 quadrat samples were collected, which indicated an average density of 1.8 oysters/m^2 for a total estimated population of 5,430 oysters.

Crandall Spit Lagoon outfall and delta. This area (Area 13, Fig. 9) was sampled in 2012 when 70 1/4 m^2 were collected. This sampling resulted in an estimated average density of 0.1 oysters/m^2 for a total estimated population of 156 oysters. A repeat sampling of this area in 2018 with 107 1/10 m^2 quadrat samples yielded an estimated average density of 0.09 oysters/m^2 for a total estimated population of 1,260 oysters (the area sampled was larger than in 2012).

Sharps Corner Channels. Some of the intertidal (~+3' MLLW) channels just offshore of the high intertidal marsh area (Area 14, Fig. 10) on the south end of Fidalgo Bay were first found to contain

Olympia oysters in 2017. We sampled one of those channels in 2018 using a series of 20 1/10 m^2 quadrat samples along a transect through the middle of the western most channel. Sampling in this channel produced a density estimate of an average of 204.0 oysters/m^2 for a total estimated population of 18,360 oysters. We then visited three adjacent channels to the east and found oysters in the nearest two, but none in the third channel. Although the second and third channels were not quantitatively sampled, we did visually estimate the number of oysters in these two channels by comparing them to the first sampled channel. Using this method, we estimate that there are a total of 82,620 oysters in these three channels (Table 5). Additionally, a fifth channel, located further east of the first four channels was observed to contain oysters when visited in 2017. The above population estimated does not include any of these oysters.

Cap Sante Marina/Seafarers Memorial Park Seed Plots

Twenty four bags of Olympia oyster seed produced by PSRF were planted at Cap Sante Marina/Seafarers Memorial Park in March 2016 at Area 2 (Fig. 11). Sampling of these bags of seed at planting showed densities of about 230 oyster seed/bag with average shell lengths of 4-7mm. Because the densities of seed in these bags were substantially less than anticipated (target was 300 seed/bag), an additional 3,830 juvenile oysters recovered from our 2015-2016 cultch monitoring bags were also added to this area. The average size of these oysters was 20 mm. A second batch of 10 bags of PSRF seed were obtained in June 2016 and spread inside the northern Cap Sante Marina breakwater (Area 1, Fig. 11). These bags were estimated to contain about 660 seed each, for a total of about 6,600 seed. The average size of these seed was 7.5 mm.

Oyster survival at these two locations was substantially less than anticipated with Area 1 2017 and 2018 survival rates of 5.0% and <0.1%, respectively. Survival at Area 2 was about the same at 0.6% for 2017 and 0.2% for 2018.

East Fidalgo Bay Shell Plots to Enhance Olympia Oyster Settlement

In 2012, PSRF was tasked with deploying at least 1/2 acre of Pacific oyster shell on the east side of Fidalgo Bay. They exceeded that amount by putting out about 2.5 acres of shell in four locations (Fig. 13). Their assessment of Olympia oyster recruits in the shell plots one year later (November 2014) showed that oysters had settled on the shell following the 2014 spawning season, and that the average density in the four plots at that time was about 60 juvenile oysters/m^2, with an average size of about 9 mm (PSRF 2014). Assessments in the summers of 2015 and 2016 found average plot densities to have substantially increased to 200 and 435 oysters/m^2, respectively. Settlement appeared to be unequal in the four plots, ranging from 6 to 90 oysters/m^2 in 2014, 50 to 397/m^2 in 2015 and 230 to 680 oysters/m^2 in 2016. In 2017, oyster densities in these plots increased again by about 13% but then decreased substantially (~37%) in 2018 (Table 6, Fig. 16). The highest densities of oysters were consistently in the north and south shell plots, possibly due to current patterns on the east side of the bay.

In November 2014, the average size of shell plot oysters was about 9 mm, which was the result of the 2014 summer spawning season. In 2015, 2016, 2017 and 2018 the average sizes of oysters in the shell plots (all plots combined) were: 23, 27, 30 and 36 mm. The size-frequency histogram for 2017 and 2018 shows that there is a healthy distribution of all oyster sizes up to 62 mm and that growth was good between 2017 and 2018 (Fig. 17).

In October 2018, an additional 1/2 acre of Pacific oyster shell was added by PSRF just north of the trestle on the east side of the bay. This should help to increase the number of oysters in the bay and provide yet another spawning source within the bay.

Weaverling Spit Shell Enhancement

A 1/2 acre plot on Weaverling Spit was enhanced in October 2018 by adding Pacific oyster shells via a barge and fire hose operation (Fig. 12). Once the shell enhancement was in place, 56 bags of Olympia oyster seed on cultch were added to the plot in November 2018. The oyster seed were set and raised at PSRF's Manchester Hatchery, with brood stock from Fidalgo Bay. Density of seed on the cultch shells averaged 5.2 oysters/shell for a total number of seed planted being 87,360 (56 bags x 300 shells/bag). The average size of the seed at planting was 17.3 mm with a range of 10-26 mm (Fig. 24).

Estimated Number of Olympia Oysters in Fidalgo Bay

The yearly total number of live Olympia oysters in Fidalgo Bay was estimated using results of the various sampling programs including: 1) routine monitoring of trestle Plot B; 2) the "wide area" surveys in 2012, 2013 and 2018; 3) sampling of the shell enhancement plots deployed in 2013; and 4) magnitude of annual post-larval recruitment from the cultch bag monitoring. The estimated number of oysters for the first few years after seeding (2002-2004) were in the 40,000 to 50,000 range and basically reflected the number of seed oysters that had survived. The numbers then gradually increased from 2005 to 2013 when the estimate was 240,000. The number of oysters then increased dramatically from 2014 to 2017 with an estimate of about 3.5 million in 2017, but then a drop in 2018 to about 2.9 million oysters (including the new seed oysters added to Weaverling Spit in November 2018) (Table 7).

Cypress Island Experimental Seed Bags

The four bags of Olympia oyster seed planted in the Secret Harbor marsh restoration area on Cypress Island were recovered in July 2017, one year after planting them in July 2016. Survival in the four bags ranged from zero at the highest tidal elevation (+7' MLLW) to 1.98 oysters/cultch shell at the low channel (+5' MLLW) location. Survival was substantially less at the other two locations compared to the low channel location. Additionally, oyster growth was optimum at the low channel site, with growth being roughly 1/2 as much at the middle channel and intertidal locations (no survivors at the high channel site) (Table 8).

The temperature and salinity data collected by the HOBO data loggers provide clues as to the differences in oyster survival between the middle and lower channel locations. The middle channel bag was basically high and mostly dry (it sat in a trickle of freshwater) at low and medium tides while the bag in the lower channel was mostly covered by water during the same tides, and this water remained fairly saline during low tide periods. As a result, the middle bag oysters were subjected to higher temperatures during the summer and lower temperatures during the winter. Oysters in the lower channel experienced temperatures about 5 ^{o}C lower in the summer and about 3 ^{o}C warmer during the winter (Fig. 25).

Volunteer Monitoring

Marine bivalves, including oysters, provide many "goods and services" to human populations in the areas of water quality, coastal protection, harvests of wild and cultured foods/shells, biodiversity,

biotechnology (especially drugs and pharmaceuticals) and volunteerism. Restoration projects and programs benefit from community participation via an added labor force and by fostering community investment and support, which is critical for project success and future restoration investments. Community participants gain physically and psychologically rewarding experiences from being a part of restoration projects, while fostering an environmental ethos. Oyster restoration serves as particularly ideal opportunities for engaging community volunteers (DeAngelis et al. 2019).

Skagit County is particularly blessed with a wealth of great volunteers. A total of twenty-three volunteers participated in Fidalgo Bay and Cypress Island Olympia oyster restoration planning, monitoring and report preparation during 2017 and 2018. The total estimated time spent by volunteers during this time was 489 hours. This included the following activities: planning meetings and communications with Puget Sound Restoration Fund, tribal biologists and WDFW personnel; application for WDFW transfer permits; filling, deploying and retrieving cultch shell bags, shell strings and tile stacks to monitor natural recruitment; annual monitoring of trestle Plot B; "wide area" sampling in 2018; monitoring of the two seed plots at Cap Sante Marina/Seafarers Memorial Park; collection and assessment of experimental oyster seed bags and temperature and salinity recording devices at Secret Harbor on Cypress Island; oyster presentations to the 2017 and 2018 Salish Sea Stewards classes; preparation of an oyster poster and presentation of same at several events; data entry and analyses; preparation of proposals, quarterly reports and this report covering the last two years of oyster-related activities; and preparation of a manuscript for publication in *Goods and Services of Marine Bivalves* (Smaal et al. 2019).

Discussion

In 2002, Skagit MRC committed to working with PSRF, WDFW and other partners in reestablishing Olympia oysters in Fidalgo Bay with the first addition of hatchery-produced seed to the trestle area in the southern portion of the bay. Over the course of the first four years, the total number of seed added to the bay was about 1.5 million. As of 2018, the number of oysters has gradually grown to approximately 2.9 million oysters (Table 7), thanks in large part to the deployment of 250 yd^3 of Pacific oyster shell in 2013, which now covers an area of 2.5 acres (split between four plots) on the eastern shore of the bay.

Since the beginning of our seeding efforts, we have continually monitored one of the trestle seed plots (Plot B), which is situated in a shallow pool area at low tide. The number of Olympia oysters in Plot B started at about 46,000 and gradually grew to about 130,000 in 2011, only to shrink to about 23,000 in 2018 (Table 1). The primary reasons for the decrease in the number of oysters seems to be the loss of shell substrate due to shell erosion and fragmentation as well as competition for settlement space from sponges, bryozoans and barnacles. The lesson here seems to be, that while the pool area keeps the oysters protected by buffering high and low temperatures, this advantage seems minimal due to the factors noted above. The four new shell plots established north of the trestle in 2013 are higher and drier than Plot B and the integrity of those shells may be aided by periodic drying at low tides, which should help control of competitive fouling organisms.

The use of shell cultch bags to monitor the relative strength of yearly Olympia oyster post-larval recruitment has proven to be very successful in providing information on temporal and spatial settlement patterns. Natural oyster settlement was zero to minimal in Fidalgo Bay from 2005 to 2009, followed by a very strong settlement in 2009, as indicated by the recruitment bags collected in 2010. Following 2010, settlement was again minimal until 2014 and 2015, with the 2015 set being exceptionally high (Table 2).

Annual recruitment of invertebrate broadcast spawner species often tends to be highly variable, and this is no exception for the Olympia oyster. Wasson et al. (2015), who has summarized annual Olympia oyster recruitment patterns in 28 West Coast embayments, found that 14 of the 28 bays had occasional years without any settlement (including Fidalgo Bay) and six bays had routine recruitment failure. The causes of these failures are likely due to various reasons including: 1) bay size and configuration, 2) current patterns within and outside of the bay, 3) water temperatures and salinities, 4) abundance of food resources (algae) and 5) oyster population size. Given the dramatic increase in the numbers of Olympia oysters in Fidalgo Bay in the last several years (about 12 times higher in 2018 compared to 2013; Table 7), it will be interesting to see if permanent bed structures will be maintained and expanded or if new beds evolve in areas that have not been artificially enhanced with Pacific oyster shells.

Spatial patterns of settlement in Fidalgo Bay have been nicely defined by annual deployment of cultch monitoring bags at 17 locations around the bay and at two locations just outside of the bay entrance. Results of the cultch bag sampling from 2008 to 2018 strongly indicate that most larvae are retained inside the bay and that settlement has almost exclusively been limited to the east side of the bay, with the focal points being the east shore (Areas 7-12, Fig 9) and causeway area (Areas 5 and 6, Fig. 9). Few oyster larvae are making their way to the west side of the bay due to largely north-south flowing currents during the summer on each side of the bay with little mixing between them (Eric Grossman, USGS, pers. comm.). The observation that most larvae are being retained within Fidalgo Bay is reinforced by the total lack of juvenile oysters in the east March's Point and Guemes Channel shell cultch bags (Fig. 18) and the lack of any settlement on southeast Guemes Island. We hypothesize that the oyster settlement pattern will change in the future due to two factors: 1) many more spawning oysters now inhabit the bay and 2) the placement of seed oysters at Cap Sante marina in the northwest portion of the bay in 2016 and on Weaverling Spit in 2018. These seed oysters should help to export larvae into the north/south flowing current on the west side of the bay.

The four new Pacific oyster shell plots established on the eastern side of the bay by PSRF in 2013 have acted as magnets for Olympia oyster larvae, resulting in an average of 202 oysters/m^2 in 2018, which is more than twice the density (100 oysters/m^2) considered by WDFW to constitute a successful Olympia oyster bed. So far, these new shell plots have maintained their structural integrity even though they are located in fairly silty areas. It will be interesting to follow the evolution of these plots in terms of functional structure as well as continued settlement to see if they successfully produce long-term Olympia oyster beds. The initial success of these plots suggested that it was time to deploy additional shell plots on the west side of the bay where both shell habitat and oyster settlement have been virtually absent. This was partially accomplished in 2018 with a 1/2 acre shell deployment to Weaverling Spit.

One surprising thing in 2017 was the discovery of Olympia oysters in four of the channels at the far south end of Fidalgo Bay (Sharpes Corner area, Fig. 10). Oyster larvae settled onto clam shells found in the bottoms of the channels and thrived in this environment, which is kept wet by freshwater runoff during low tides. Dispersal of oyster larvae this far south was unexpected but consistent with current models derived by Eric Grossman, USGS (pers. comm.). At this time, we do not know if these oysters are reproducing and producing larvae that may further populate the south end of the bay.

Results of the small experiment to test the survival and growth of Olympia oysters in the intertidal channels associated with the newly restored marsh/channel habitats at Secret Harbor, Cypress Island

indicated that three of the four channels areas were likely too high and dry for oysters, but that the fourth site in the lower main channel was a possible candidate for future Olympia oyster seeding since high salinity water was retained in this area at low tide. However, one problem with this site was sedimentation, which partially buried the shell bag and seed oysters. It is possible that sedimentation will be less in the future as the currently raw nature of the restoration landscape matures.

Project Media Coverage

Anacortes American:

https://www.goskagit.com/anacortes/news/native-oyster-restoration-taking-off-in-fidalgo-bay-waters/article_7742b876-a014-11e8-9afd-c7a453ddb8fb.html

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Tables

Table 1. Estimated density and number of live Olympia oysters in trestle Plot B based on 1/4 m^2 or 1/10 m^2 quadrat samples collected 2002 through 2018.

Month/Year	Oysters/m^2	Total Live Oysters in Plot B
May 2002	46.0	46,184
April 2003	43.6	43,774
May 2004*		
April 2005*		
August 2006*		
May 2007*		
June 2008	84.4	84,738
May 2009	91.6	91,966
July 2010	110.8	111,243
June 2011	130.0	130,520
July 2012	112.4	112,850
July 2013	32.3	32,429
June 2014	46.4	46,586
May 2015	42.6	42,770
May 2016**	38.6	38,754
May 2017**	52.9	53,112
June 2018**	22.9	22,992

*No measurements made on a density/m^2 basis in these years.
** Collected 1/10 m^2 quadrat samples 2016-2018. All others were 1/4 m^2 samples.

Table 2. Average number of Olympia oyster recruits found in the three cultch shell bags deployed at trestle Plot B from 2005 to 2017 and recovered one year later.

Year	Average Number of Oysters/100 cultch shells
2004	46.5
2005	0.0
2006	4.6
2007	0.0
2008	0.0
2009	266.4
2010	NS
2011	5.8
2012	18.3
2013	5.8
2014	93.2
2015	428.4
2016	186.0
2017	101.6

NS = Not sampled

Table 3. Summary table of all cultch bag monitoring data (post-larval recruits/100 cultch shells) from 19 stations in and around Fidalgo Bay, 2005-2017.

Year	NE March's Point	Crandall Spit	North Barge	South Barge	Plot B West	Plot B Middle	Plot B East	SE of Trestle	South Shell Berm	Causeway South	Causeway North	Weaverling Spit	Samish RV Park	South of Plywood Mill	Fidalgo Marina	Anacortes Marina	Sea Farers Park	Cap Sante	Guemes Channel
2004	NS	NS	NS	NS	10.7	66.7	62.1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
2005	NS	NS	NS	NS	0.0	0.0	0.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
2006	NS	NS	NS	NS	13.8	0.0	0.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	0.0	31.7	Lost	283.0	166.0	290.6	342.7	344.7	Lost	109.8	35.7	0.0	2.3	5.7	NS	NS	Lost	0.0	0.0
2010	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
2011	Lost	Lost	29.1	21.7	2.6	1.2	13.6	5.9	Lost	3.9	4.3	1.2	1.2	0.0	Lost	Lost	4.5	0.0	0.0
2012	0.0	5.2	61.8	69.2	22.0	14.3	18.5	37.0	Lost	42.7	30.2	0.0	1.9	1.5	1.9	Lost	0.0	0.0	0.0
2013	0.0	Lost	Lost	Lost	2.6	1.2	13.6	5.9	Lost	83.0	66.0	12.7	0.0	2.0	0.0	0.0	0.0	0.0	0.0
2014	0.0	Lost	132.0	66.2	69.4	87.5	122.7	105.2	Lost	161.1	191.2	18.4	1.6	1.8	0.0	0.0	1.4	1.2	0.0
2015	0.0	Lost	660.0	398.1	605.0	451.2	229.0	1234.0	61.4	611.1	609.1	128.9	Lost	0.0	Lost	10.6	0.0	0.0	0.0
2016	NS	Lost	Lost	289.7	Lost	186.0	Lost	750.8	Lost	302.0	274.2	56.1	3.4	0.0	Lost	0.0	1.4	0.0	0.0
2017	0.0	36.2	211.7	91.8	92.0	90.0	122.9	281.8	Lost	205.9	193.5	43.4	0.0	0.0	Lost	2.6	0.0	0.0	0.0
Ave. =	0.0	14.6	156.4	135.5	82.0	91.4	77.1	276.5	20.5	152.0	140.4	26.1	1.2	1.1	0.4	1.9	0.8	0.1	0.0

NS = Not sampled

Table 4 . All shell string results from the Trestle Plot B site in Fidalgo Bay, 2015 through 2018. Shell strings of ten Pacific oyster shells were deployed in May or June of each year and retrieved in late August. Values are average number of Olympia oysters/cultch shell.

Location	August 2015	August 2016	August 2017	August 2018
Trestle Plot B, East	20.4	0.4	0.03	0.0
Trestle Plot B, Middle	21.7	2.1	0.01	0.2
Trestle Plot B, West	29.9	0.3	0.05	0.4
Average number/cultch shell	24.00	0.93	0.03	0.20
Average shell length, mm	7.6	4.0	7.4	6.5

Table 5. Summary table of "wide area" Olympia oyster surveys in Fidalgo Bay, summer of 2018. See Figures 9-11 for the plot locations.

Area Number	Location	Area, m^2	Number of Samples ($1/10m^2$)	Area Population Estimate
1	Cap Sante Marina north breakwater	50	25	20
2	Sea Farers Park	50	25	200
3	South of Old Plywood Mill site	13,950	0	0*
4	Weaverling Spit	8,889	90	2,933
5	Riprap causeway, north side	1,515	31	30,755
6	Riprap causeway, south side	2,154	43	44,588
7	Trestle	7,780	142	81,690
8	South of trestle to shell berm	18,500	0	500*
9	South derelict barge north to north derelict barge	36,400	288	174,814
10	North derelict barge north to west end of north shell bed	15,467	99	58,775
11	Little Crandall Spit west of north shell bed	4,933	90	271,315
12	Northwest of area number 11	3,000	72	5,430
13	Crandall Spit lagoon outfall/delta	13,545	107	1,260
14	South Fidalgo Bay high channels (4)	360	20	82,620
15	South shell enhancement plot	3,945	10	844,230
16	South-central shell enhancement plot	1,939	10	191,961
17	North-central shell enhancement plot	2,121	5	216,342
18	North shell enhancement plot	2,080	10	817,440
4	Weaverling Spit seed addition, November 2018			87,360
	Total	136,678	1,067	2,911,733

*Estimated by casual observations

Table 6. Densities and total numbers of Olympia oysters by month and year for the four east side shell plots.

	Density (oysters/m^2)			
Month/Year	North (1)	North Middle (2)	South Middle (3)	South (4)
November 2014	89.6	6.4	67.2	80.0
July 2015	284.8	49.6	68.8	396.8
July 2016	680.0	307.2	230.4	526.4
June 2017	611.0	NS	147.0	297.0
July 2018	393.0	102.0	99.0	214.0
Plot size (m^2)	2,080	2,121	1,939	3,945

Total Number of Oysters

Month/Year	North (1)	North Middle (2)	South Middle (3)	South (4)	Total in All Plots
November 2014	186,368	13,574	130,301	315,600	645,843
July 2015	592,384	105,202	133,403	1,565,376	2,396,365
July 2016	1,414,400	651,571	446,746	2,076,648	4,589,365
June 2017	1,270,880	456,100*	285,033	1,171,665	3,183,678
July 2018	817,440	216,342	191,961	844,230	2,069,973

* Plot not sampled in 2017 but number of oysters estimated based on trends on the other three plots.

Table 7. Estimated number of all Olympia oysters in Fidalgo Bay by year.

Year	Number of Oysters
2002	50,000
2003	45,000
2004	40,000
2005	90,000
2006	80,000
2007	100,000
2008	90,000
2009	80,000
2010	140,000
2011	140,000
2012	160,000
2013	240,000
2014	850,000
2015	2,600,000
2016	3,078,000*
2017	3,525,000
2018	2,912,000

* Due to a spreadsheet error, the estimate for 2016 in the 2016 report (Dinnel 2016) of 4,589,365 oysters was incorrect. It is corrected here.

Table 8. Number, densities, percent survival and sizes of Olympia oysters and cultch shells found in the four seed bags planted in four locations at Cypress Island in July 2016 and recovered in July 2017.

Bag	Number of Live Oysters	Number of Cultch Shells	Average Oysters Per Cultch Shell	Percent Survival	Average Size, mm
Upper Channel	0	68	0.00	0.0	---
Middle Channel	12	98	0.12	2.7	12.7
Lower Channel	89	45	1.98	44.0	24.1
Intertidal	27	47	0.57	12.7	15.4

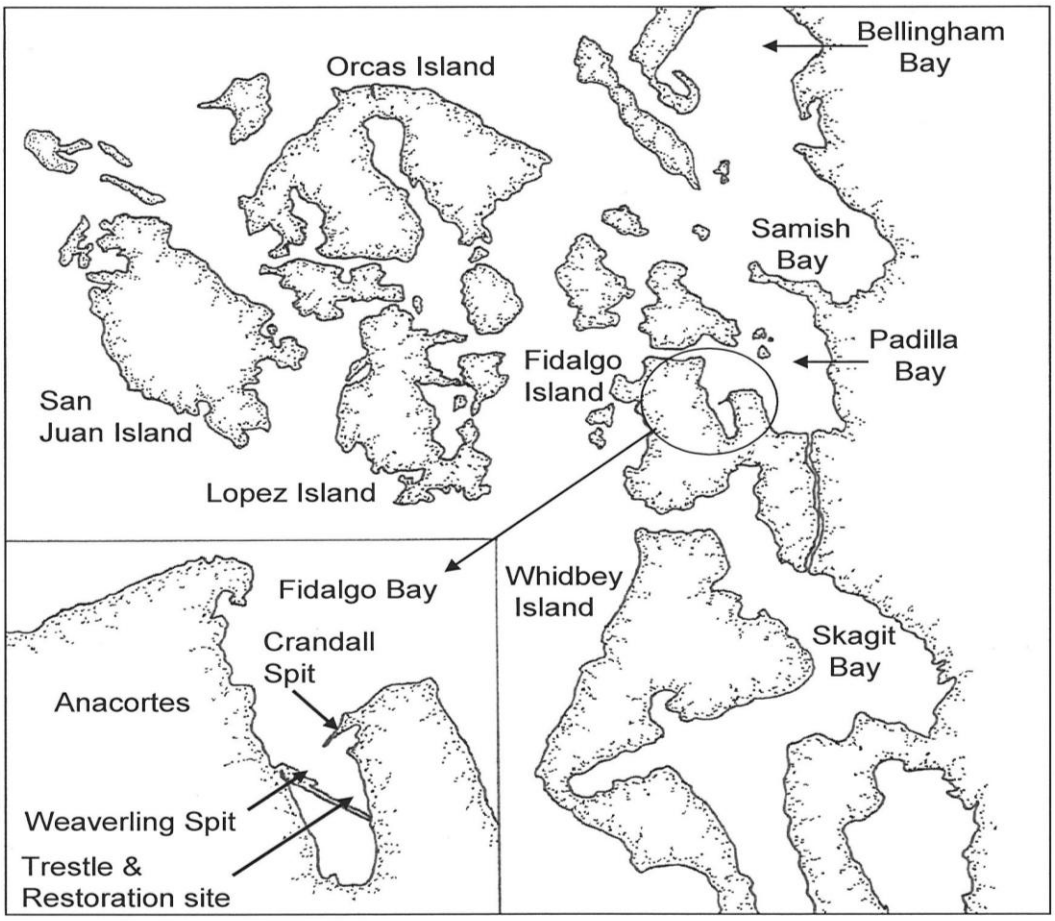

Figure 1. Drawing of North Puget Sound showing the location of Fidalgo Bay. Figure from Dinnel et al. 2009b.

Figure 2. Map showing the locations of Skagit MRC Olympia oyster operations, in and around Fidalgo Bay, 2002-2018. Photo source: Google Earth.

Figure 3. Location of the trestle Olympia oyster restoration site (circle) in South Fidalgo Bay. Photo source: WDOE online Shoreline photo collection.

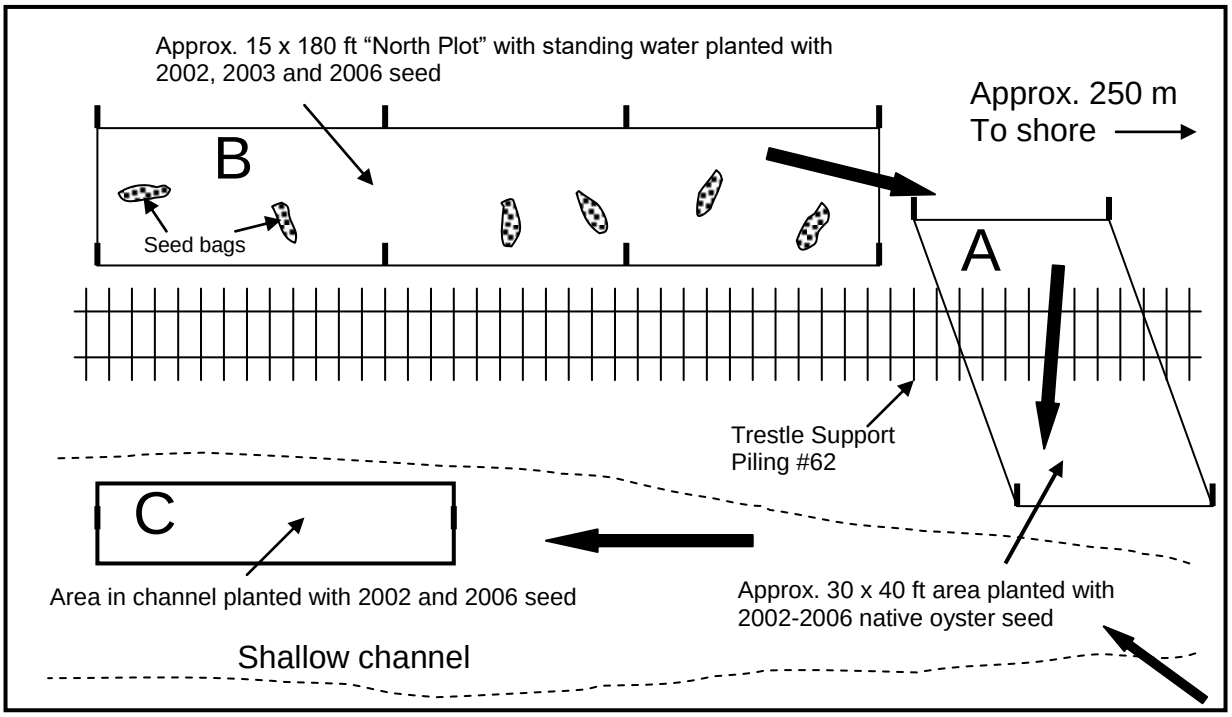

Figure 4. Trestle site plan showing the seeding locations at Plots A, B and C. Large arrows show the directions of water drainage at low tide. Map derived from a drawing by Robert Knowles.

Figure 5. Example of the ¼ m^2 quadrat used to sample Olympia oysters, clam shells and oyster shells during trestle Plot B and "wide area" sampling. Smaller size quadrats have also been used.

Figure 6. Photograph of post-larval recruitment sampling tools used in Fidalgo Bay. Left: cultch bag of Pacific oyster shells; Middle: shell string (ten shells on a stick); Right: ceramic tiles, 5 tiles to a rack.

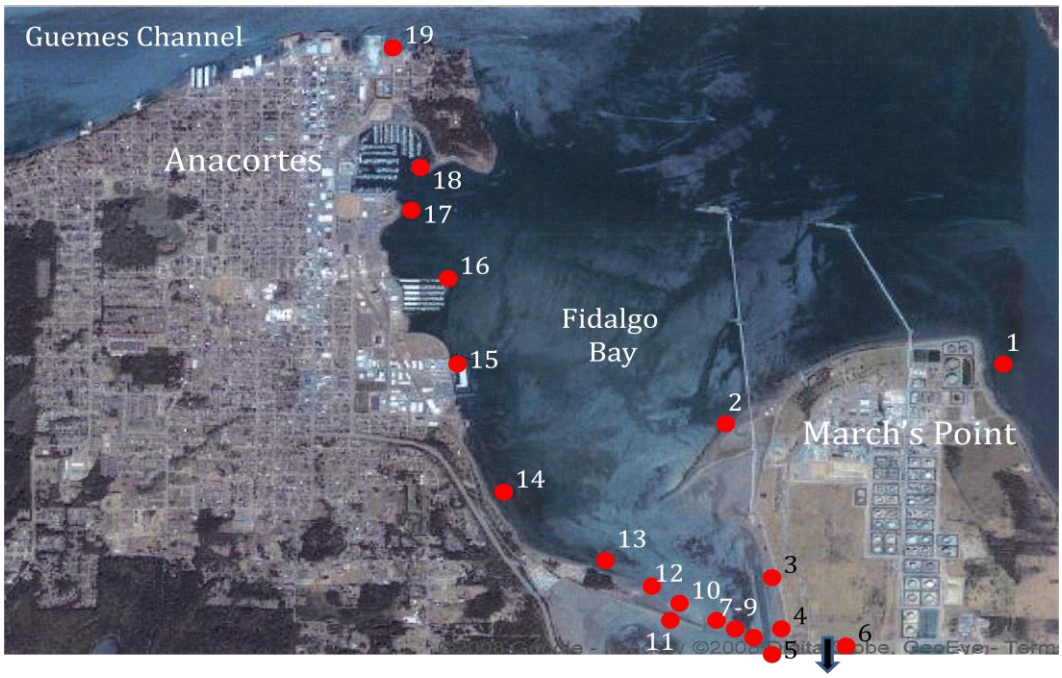

Figure 7. Photograph of Fidalgo Bay showing the locations where larval settlement cultch bags were typically deployed on an annual basis, 2011 to 2018. Station 6 was at the west end of the south Fidalgo Bay shell berm several hundered meters south of the trestle. Photo source: Google Earth.

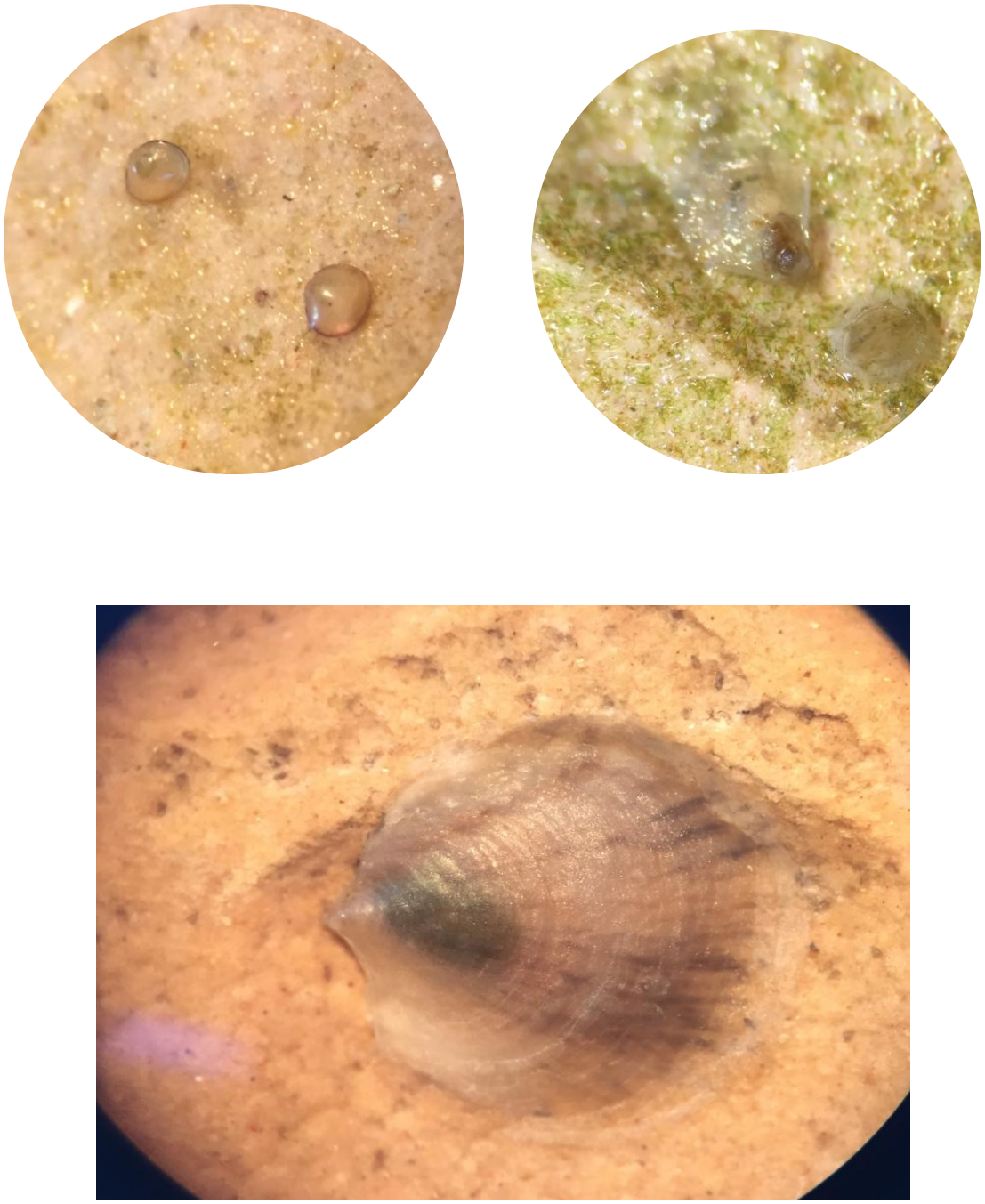

Figure 8. Microphotographs of post-larval Olympia oysters at about 1-3 days post settlement (upper left), about 1-2 weeks post settlement (upper right) and about 4 weeks (bottom).

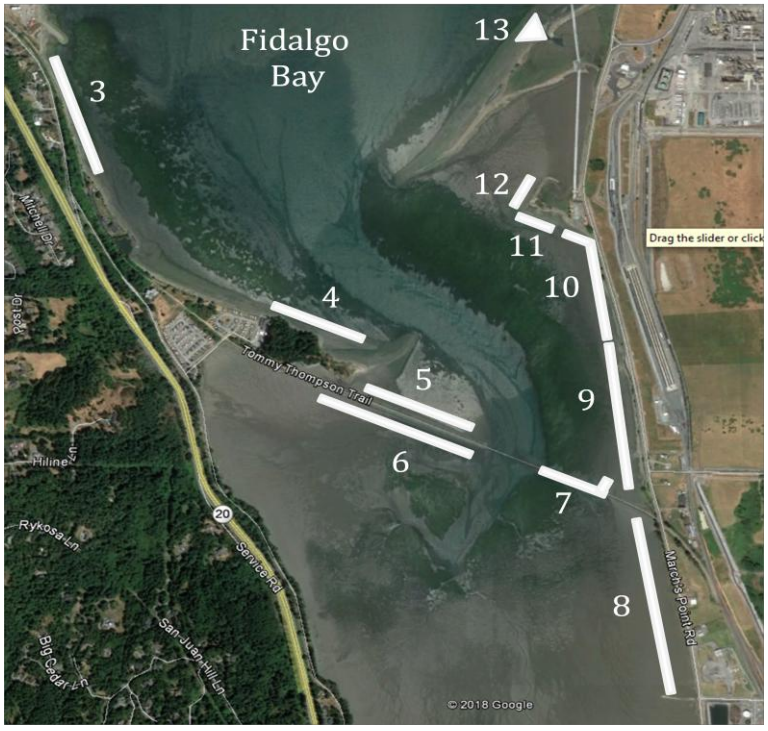

Figure 9. Map of south Fidalgo Bay showing the areas included in the 2012-2013 and 2018 "wide area" sampling for Olympia oysters. See Table 5 for location descriptions. Photo source: Google Earth.

Figure 10. Locations in south Fidalgo Bay where Olympia oysters were found in the high intertidal channels near Sharpes Corner Highway 20 intersection in 2017 and 2018. This is Area 14 noted in Table 5.

Figure 11. Photograph of Cap Sante Marina (top, area 1) and Seafarers Memorial Park (bottom, area 2) areas of NW Fidalgo Bay where two new Olympia oyster seed plots were established in 2016. Photo source: Google Earth.

Figure 12. Photograph showing barge and fire hose deployment of Pacific oyster shell onto the tidal flats of Fidalgo Bay to enhance Olympia oyster settlement.

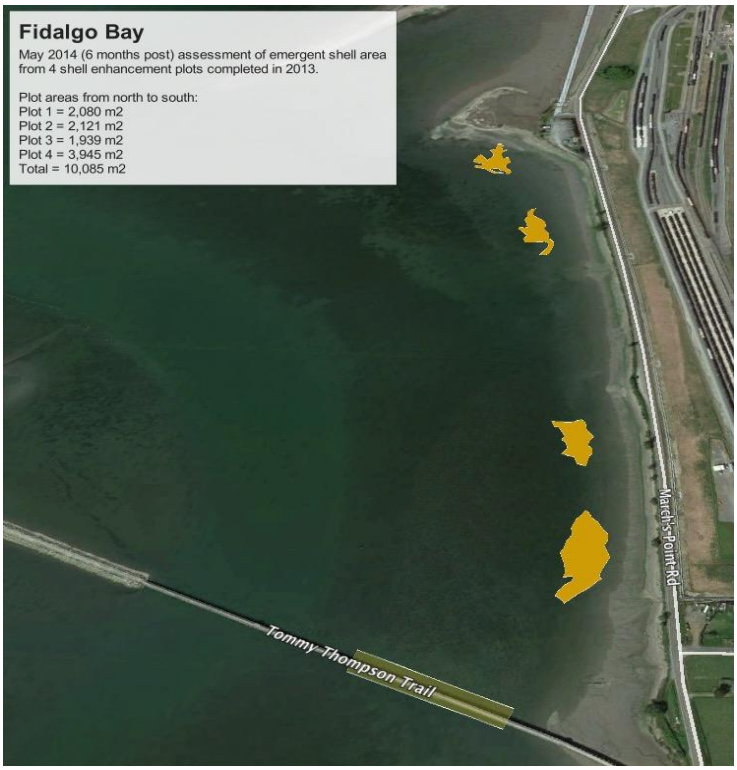

Figure 13. Locations of the shell enhancement plots on the east Fidalgo Bay shoreline established by Puget Sound Restoration Fund in November 2013. Figure from Brian Allen, PSRF.

Figure 14. Locations of the shell enhancement plots on Weaverling Spit ("Shell Plot Samish") and east Fidalgo Bay just north of the trestle ("Shell Plot Swinomish") established by Puget Sound Restoration Fund in October 2018. Figure from Brian Allen, PSRF.

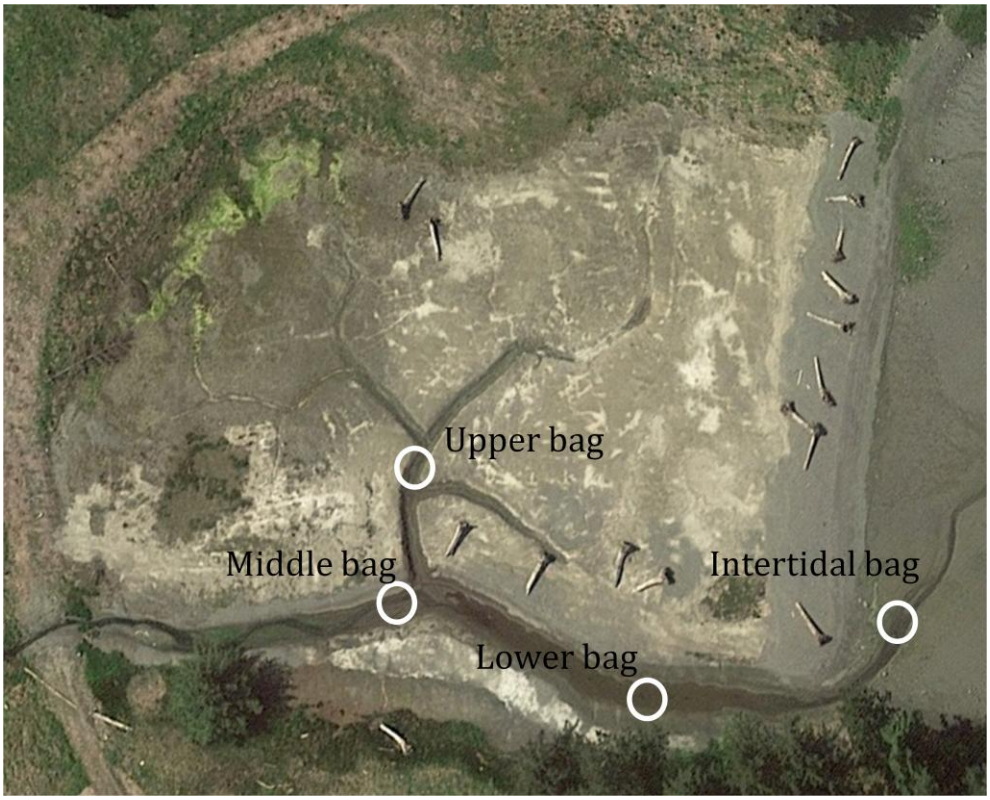

Figure 15. Photograph of the Washington Department of Natural Resources newly restored saltwater marsh at Secret Harbor on Southeast Cypress Island and locations (white circles) of Skagit MRC's experimental seed bags and the two data loggers (middle and lower channel, attached to the bags). Photo source: Goggle Earth.

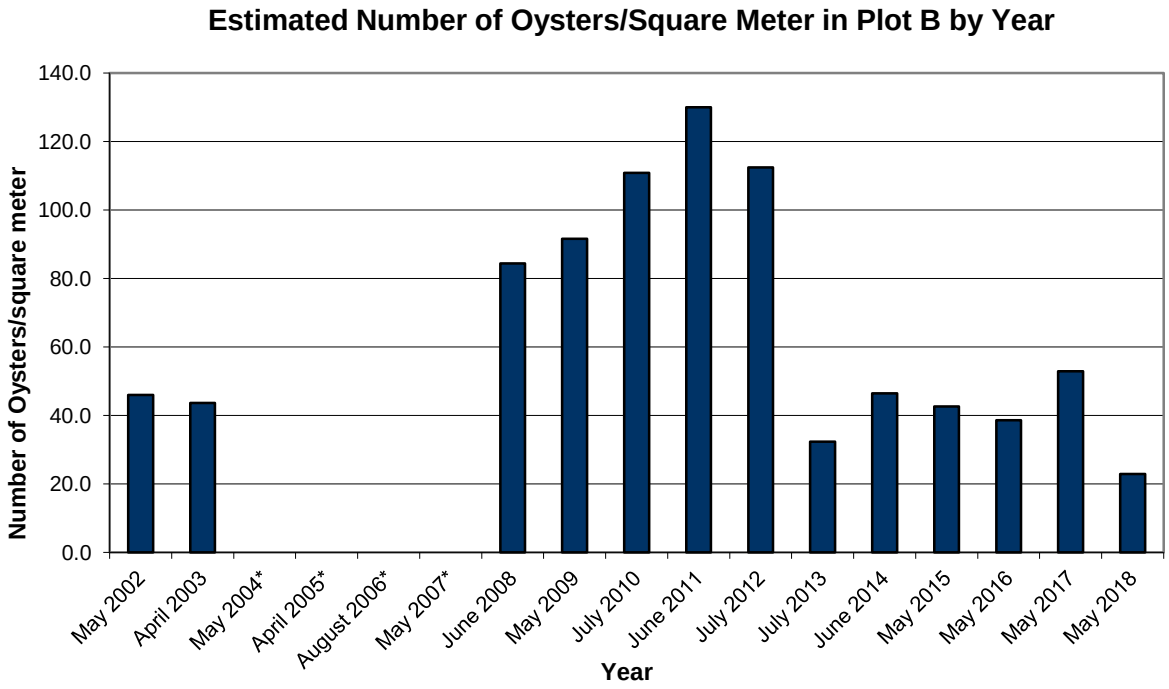

Figure 16. Estimated number of Olympia oysters/m^2 in trestle restoration Plot B, 2002-2018. Sampling designed to estimate the number of oysters/m^2 was not conducted in 2004-2007.

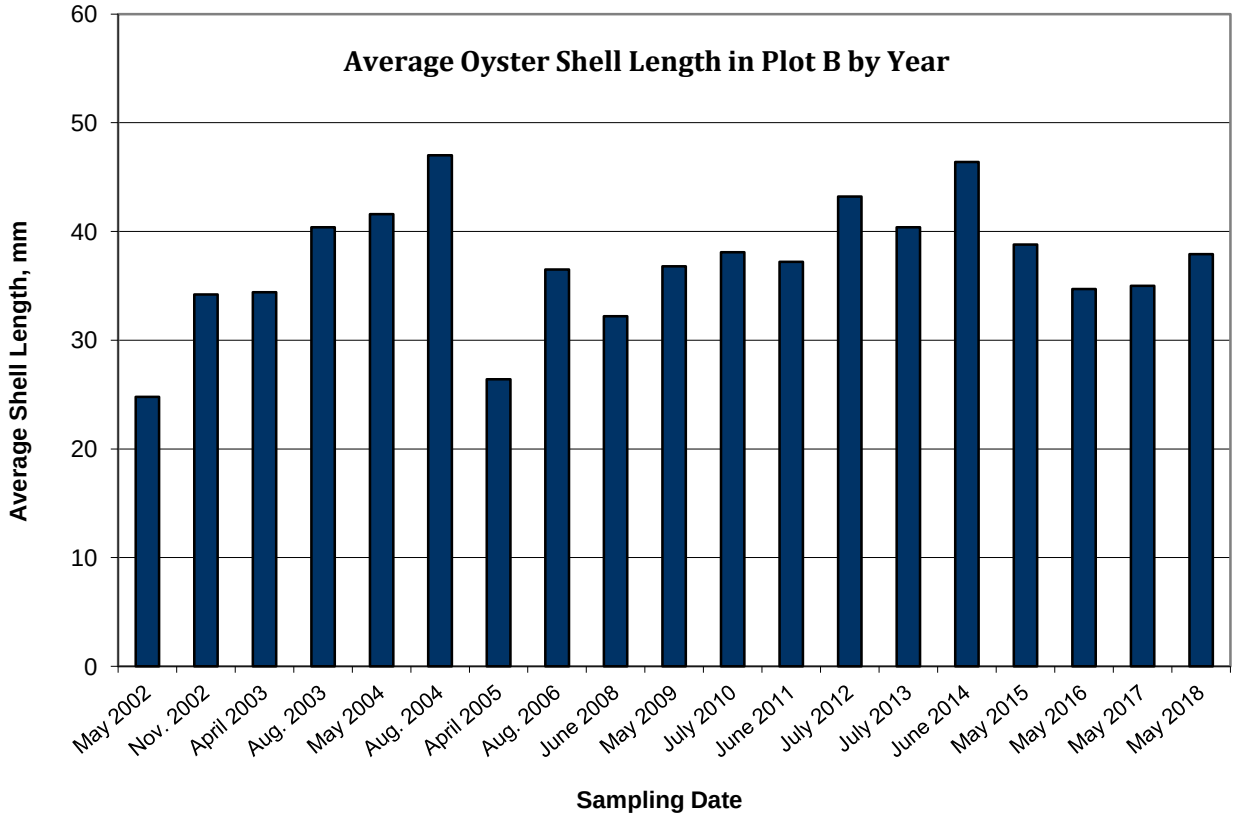

Figure 17. Average Olympia oyster shell length by sample date for oysters sampled at the trestle restoration Plot B from May 2002 to May 2018.

Figure 18. Average number of Olympia oyster natural recruits/100 cultch shells found in all of the annual monitoring cultch bags by location in and around Fidalgo Bay from 2011 through 2018. Number of bags sampled at each location from 2004 through 2018 ranged from 3 to 11 with an average of 7.4. Two locations had zero settlement (0) while the other sites ranged from 0.2 to 216 recruits/100 cultch shells. The size of the dots on the map indicate the following average recruitment values (from small to large): 0.1-10, 10.1-50, 50.1-100, 100.1-200, and >200 recruits/100 cultch shells.

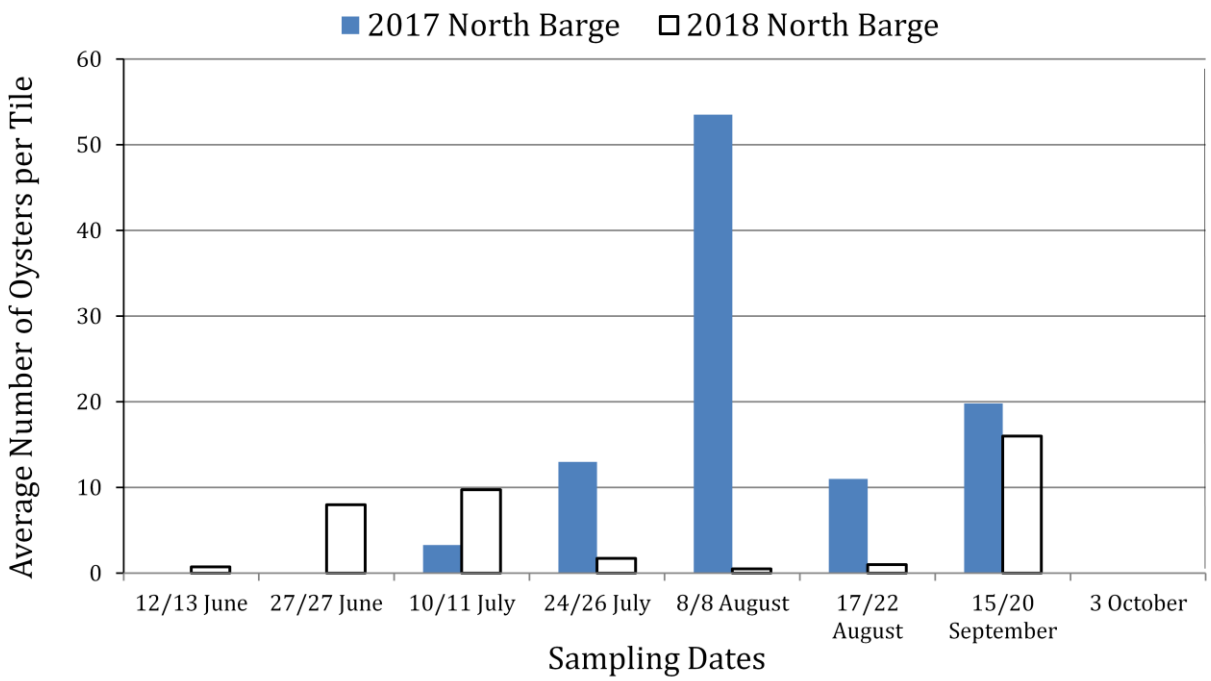

Figure 19. Average number of post-larval Olympia oysters per ceramic sampling tile, 2017 and 2018 at the north barge location on the eastern side of Fidalgo Bay. No spat were found in October 2017 and samples were not collected in October 2018.

Figure 20. Photograph in 2016 of the southern shell enhancement plot established along the east side of Fidalgo Bay by PSRF in November 2013. A cultch shell monitoring bag is in the foreground.

Figure 21. Example of the heavy Olympia oyster natural recruitment on one of the shell enhancement plots observed in 2016. The recruits are a mix of oysters that settled in the summers of 2014 and 2015.

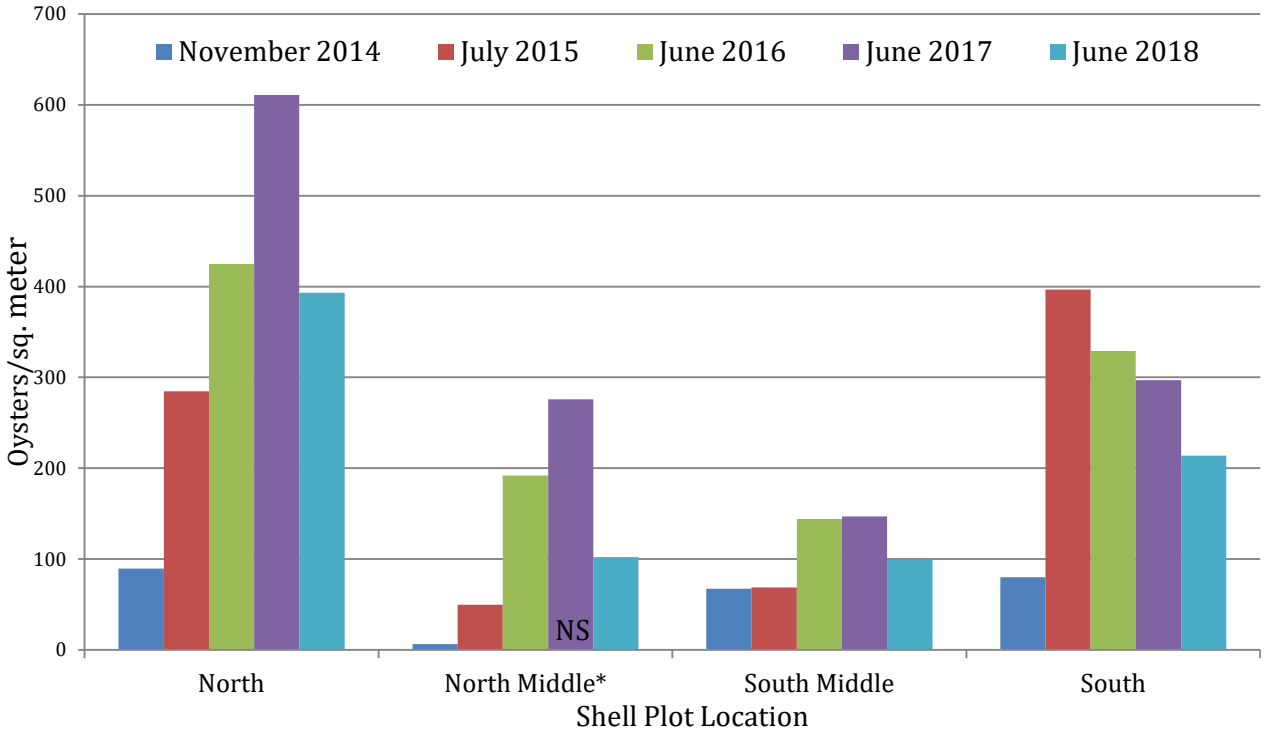

Figure 22. Graph showing densities of Olympia oysters following five years of larval recruitment to the east Fidalgo Bay shell plots constructed in November 2013 by PSRF. NS = this plot not sampled in 2017, but was estimated relative to the other sampled plots.

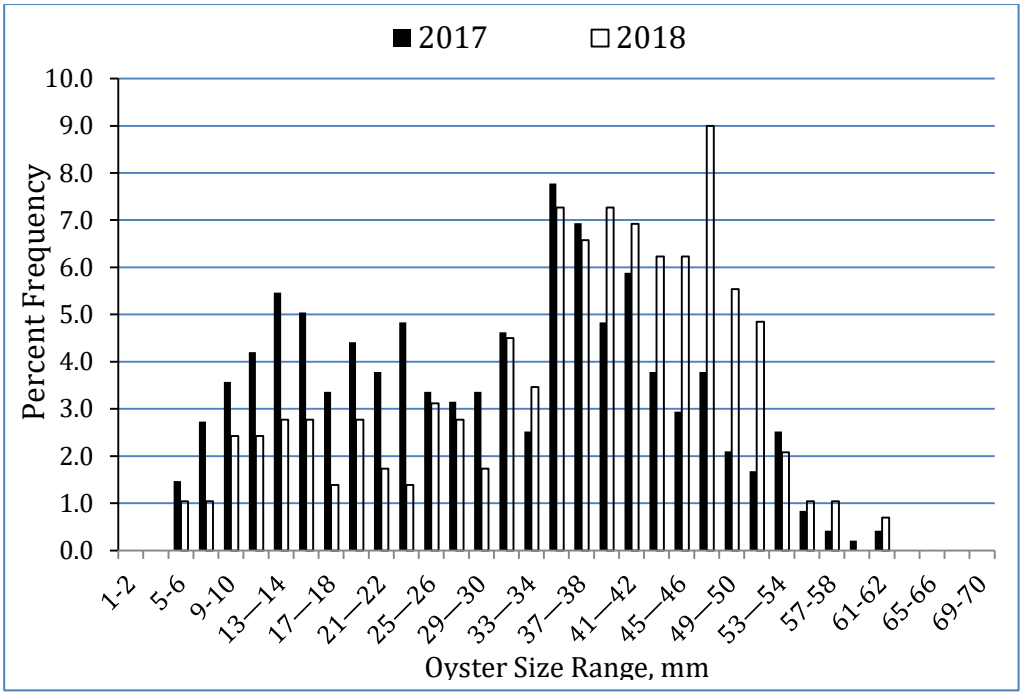

Figure 23. Length frequency histogram of Olympia oyster sizes in the east Fidalgo Bay shell plots during 2017 and 2018 (all plots combined).

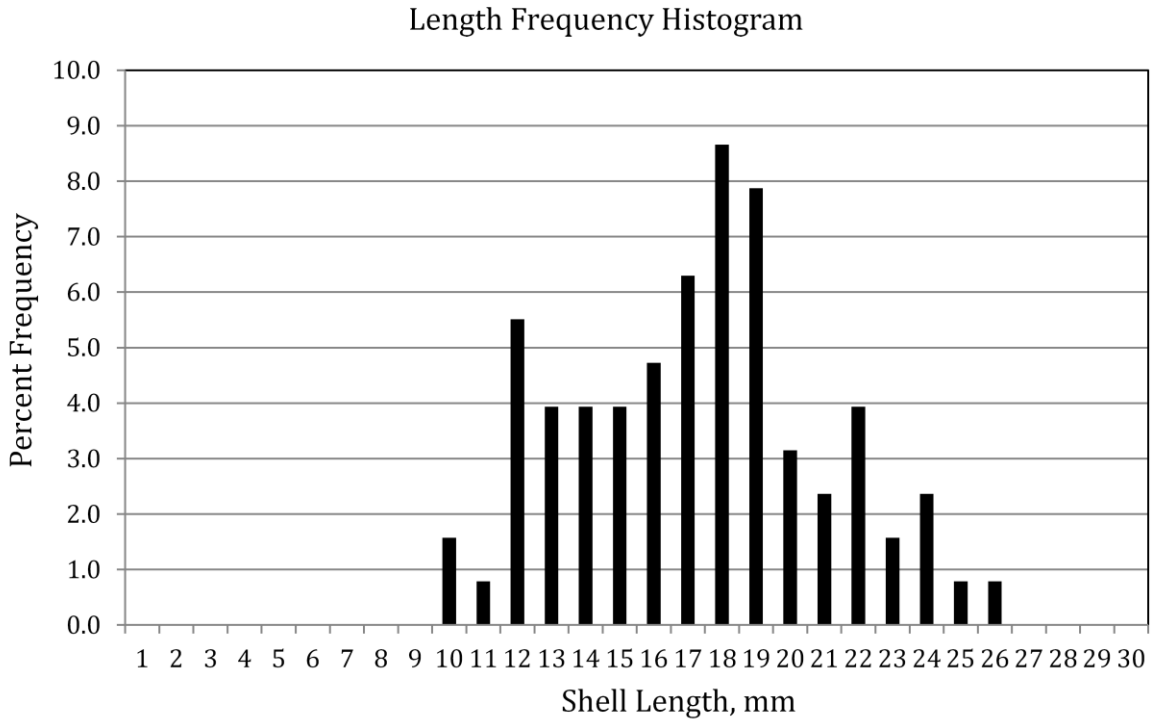

Figure 24. Histogram of the sizes of Olympia oyster seed planted on Weaverling Spit in November 2018.

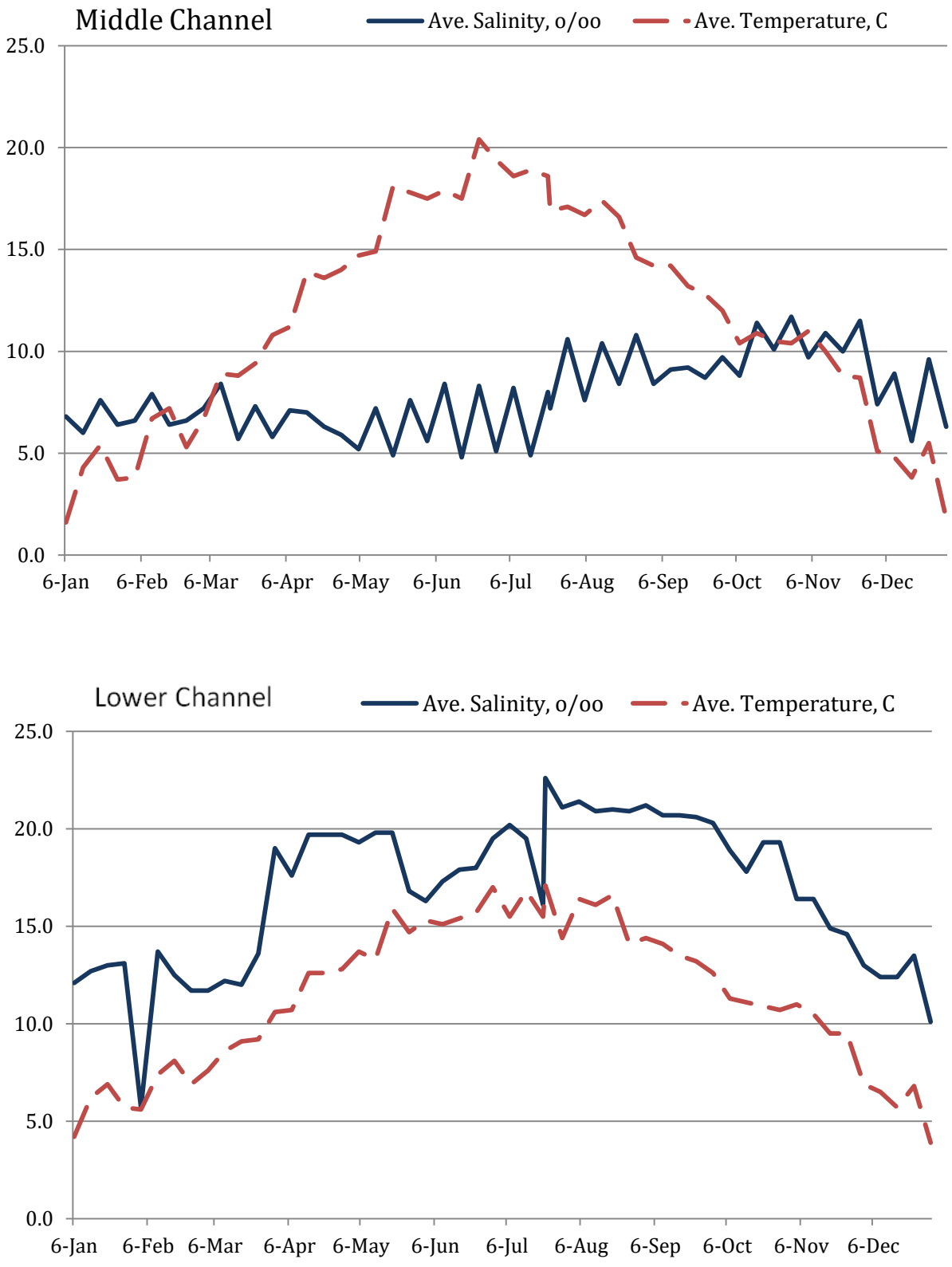

Figure 25. Average weekly temperatures and salinities for a one year period (July 2016 to July 2017) as recorded by HOBO data loggers at the Cypress experimental site. The loggers were attached to the bags at the middle (top) and lower channel (bottom) bags.

APPENDIX

Appendix Table 1. Numbers of Olympia oysters (clam shells and oysters shells were not counted in 2018) collected in 1/10 m^2 quadrat samples around Fidalgo Bay in 2018. The numbers in parentheses refer to the areas identified in Table 5 and Figures 8 and 10.

East Shore of Fidalgo Bay between the south shell bed & north barge structure.
Samples collected in north-south direction at 50 foot intervals.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
1-0 (north)	Not Sampled	Not Sampled	0
1-10	NS	NS	1
1-20	NS	NS	0
1-30	NS	NS	0
1-40	NS	NS	0
1-50	NS	NS	0
1-60	NS	NS	0
1-70	NS	NS	0
1-80	NS	NS	0
2-0	NS	NS	0
2-10	NS	NS	1
2-20	NS	NS	0
2-30	NS	NS	0
2-40	NS	NS	0
2-50	NS	NS	1
2-60	NS	NS	1
2-70	NS	NS	0
2-80	NS	NS	0
3-0	NS	NS	0
3-10	NS	NS	0
3-20	NS	NS	0
3-30	NS	NS	1
3-40	NS	NS	1
3-50	NS	NS	0
3-60	NS	NS	0
3-70	NS	NS	0
3-80	NS	NS	0
4-0	NS	NS	0
4-10	NS	NS	0
4-20	NS	NS	0
4-30	NS	NS	0
4-40	NS	NS	0
4-50	NS	NS	0
4-60	NS	NS	2
4-70	NS	NS	1

4-80	NS	NS	0
5-0	NS	NS	0
5-10	NS	NS	0
5-20	NS	NS	0
5-30	NS	NS	0
5-40	NS	NS	0
5-50	NS	NS	0
5-60	NS	NS	1
5-70	NS	NS	0
5-80	NS	NS	0
6-0	NS	NS	0
6-10	NS	NS	0
6-20	NS	NS	0
6-30	NS	NS	0
6-40	NS	NS	0
6-50	NS	NS	1
6-60	NS	NS	0
6-70	NS	NS	0
6-80	NS	NS	0
7-0	NS	NS	0
7-10	NS	NS	0
7-20	NS	NS	0
7-30	NS	NS	1
7-40	NS	NS	0
7-50	NS	NS	1
7-60	NS	NS	0
7-70	NS	NS	0
7-80	NS	NS	0
8-0	NS	NS	0
8-10	NS	NS	0
8-20	NS	NS	0
8-30	NS	NS	0
8-40	NS	NS	1
8-50	NS	NS	0
8-60	NS	NS	0
8-70	NS	NS	0
8-80	NS	NS	0
9-0	NS	NS	0
9-10	NS	NS	0
9-20	NS	NS	0
9-30	NS	NS	0
9-40	NS	NS	0
9-50	NS	NS	0
9-60	NS	NS	0
9-70	NS	NS	0
9-80	NS	NS	0

10-0	NS	NS	1
10-10	NS	NS	0
10-20	NS	NS	0
10-30	NS	NS	0
10-40	NS	NS	1
10-50	NS	NS	0
10-60	NS	NS	0
10-70	NS	NS	0
10-80	NS	NS	0
11-0	NS	NS	3
11-10	NS	NS	6
11-20	NS	NS	1
11-30	NS	NS	2
11-40	NS	NS	0
11-50	NS	NS	0
11-60	NS	NS	3
11-70	NS	NS	2
11-80	NS	NS	4
12-0	NS	NS	2
12-10	NS	NS	0
12-20	NS	NS	2
12-30	NS	NS	2
12-40	NS	NS	1
12-50	NS	NS	1
12-60	NS	NS	2
12-70	NS	NS	0
12-80	NS	NS	1
13-0	NS	NS	0
13-10	NS	NS	3
13-20	NS	NS	2
13-30	NS	NS	1
13-40	NS	NS	1
13-50	NS	NS	0
13-60	NS	NS	2
13-70	NS	NS	2
13-80	NS	NS	0
14-0	NS	NS	4
14-10	NS	NS	0
14-20	NS	NS	0
14-30	NS	NS	3
14-40	NS	NS	1
14-50	NS	NS	5
14-60	NS	NS	3
14-70	NS	NS	1
14-80	NS	NS	1
15-0	NS	NS	1

15-10	NS	NS	2
15-20	NS	NS	0
15-30	NS	NS	1
15-40	NS	NS	9
15-50	NS	NS	8
15-60	NS	NS	4
15-70	NS	NS	1
15-80	NS	NS	6
16-0	NS	NS	0
16-10	NS	NS	0
16-20	NS	NS	4
16-30	NS	NS	1
16-40	NS	NS	3
16-50	NS	NS	0
16-60	NS	NS	0
16-70	NS	NS	0
16-80	NS	NS	0
17-0	NS	NS	6
17-10	NS	NS	0
17-20	NS	NS	3
17-30	NS	NS	5
17-40	NS	NS	11
17-50	NS	NS	8
17-60	NS	NS	9
17-70	NS	NS	5
17-80	NS	NS	11
18-0	NS	NS	1
18-10	NS	NS	0
18-20	NS	NS	7
18-30	NS	NS	2
18-40	NS	NS	5
18-50	NS	NS	5
18-60	NS	NS	1
18-70	NS	NS	4
18-80	NS	NS	2
19-0	NS	NS	0
19-10	NS	NS	0
19-20	NS	NS	0
19-30	NS	NS	1
19-40	NS	NS	6
19-50	NS	NS	0
19-60	NS	NS	1
19-70	NS	NS	4
19-80 (south)	NS	NS	0

Weaverling Spit between the eastern end of the spit to the Samish headquarters building. Samples collected at east-west intervals of 100 feet.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
1-0 (east)	Not Sampled	Not Sampled	0
1-10	NS	NS	0
1-20	NS	NS	0
1-30	NS	NS	0
1-40	NS	NS	0
1-50	NS	NS	0
1-60	NS	NS	0
1-70	NS	NS	0
1-80	NS	NS	0
2-0	NS	NS	0
2-10	NS	NS	0
2-20	NS	NS	0
2-30	NS	NS	0
2-40	NS	NS	0
2-50	NS	NS	0
2-60	NS	NS	0
2-70	NS	NS	0
2-80	NS	NS	0
3-0	NS	NS	0
3-10	NS	NS	0
3-20	NS	NS	0
3-30	NS	NS	0
3-40	NS	NS	0
3-50	NS	NS	0
3-60	NS	NS	0
3-70	NS	NS	0
3-80	NS	NS	0
4-0	NS	NS	0
4-10	NS	NS	0
4-20	NS	NS	0
4-30	NS	NS	0
4-40	NS	NS	0
4-50	NS	NS	0
4-60	NS	NS	0
4-70	NS	NS	0
4-80	NS	NS	0
5-0	NS	NS	0
5-10	NS	NS	0
5-20	NS	NS	0
5-30	NS	NS	0
5-40	NS	NS	0

5-50	NS	NS	0
5-60	NS	NS	0
5-70	NS	NS	0
5-80	NS	NS	0
6-0	NS	NS	0
6-10	NS	NS	0
6-20	NS	NS	0
6-30	NS	NS	0
6-40	NS	NS	0
6-50	NS	NS	0
6-60	NS	NS	0
6-70	NS	NS	0
6-80	NS	NS	0
7-0	NS	NS	0
7-10	NS	NS	0
7-20	NS	NS	0
7-30	NS	NS	1
7-40	NS	NS	0
7-50	NS	NS	0
7-60	NS	NS	0
7-70	NS	NS	0
7-80	NS	NS	0
8-0	NS	NS	1
8-10	NS	NS	0
8-20	NS	NS	0
8-30	NS	NS	0
8-40	NS	NS	0
8-50	NS	NS	1
8-60	NS	NS	0
8-70	NS	NS	0
8-80	NS	NS	0
9-0	NS	NS	0
9-10	NS	NS	0
9-20	NS	NS	0
9-30	NS	NS	0
9-40	NS	NS	0
9-50	NS	NS	0
9-60	NS	NS	0
9-70	NS	NS	0
9-80	NS	NS	0
10-0	NS	NS	0
10-10	NS	NS	0
10-20	NS	NS	0
10-30	NS	NS	0
10-40	NS	NS	0
10-50	NS	NS	0

10-60	NS	NS	0
10-70	NS	NS	0
10-80 (west)	NS	NS	0

East Shore of Fidalgo Bay between the north shell bed & mid-north shell bed.
Samples collected in north-south direction at 50 foot intervals.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
1-0 (south)	Not Sampled	Not Sampled	0
1-10	NS	NS	0
1-20	NS	NS	0
1-30	NS	NS	0
1-40	NS	NS	7
1-50	NS	NS	1
1-60	NS	NS	0
1-70	NS	NS	3
1-80	NS	NS	0
2-0	NS	NS	0
2-10	NS	NS	0
2-20	NS	NS	0
2-30	NS	NS	0
2-40	NS	NS	0
2-50	NS	NS	0
2-60	NS	NS	0
2-70	NS	NS	0
2-80	NS	NS	1
3-0	NS	NS	0
3-10	NS	NS	0
3-20	NS	NS	0
3-30	NS	NS	0
3-40	NS	NS	0
3-50	NS	NS	0
3-60	NS	NS	0
3-70	NS	NS	0
3-80	NS	NS	0
4-0	NS	NS	0
4-10	NS	NS	0
4-20	NS	NS	0
4-30	NS	NS	0
4-40	NS	NS	2
4-50	NS	NS	2
4-60	NS	NS	0
4-70	NS	NS	0
4-80	NS	NS	0
5-0	NS	NS	0

5-10	NS	NS	0
5-20	NS	NS	0
5-30	NS	NS	0
5-40	NS	NS	0
5-50	NS	NS	0
5-60	NS	NS	0
5-70	NS	NS	0
5-80	NS	NS	0
6-0	NS	NS	0
6-10	NS	NS	0
6-20	NS	NS	0
6-30	NS	NS	1
6-40	NS	NS	0
6-50	NS	NS	0
6-60	NS	NS	0
6-70	NS	NS	0
6-80	NS	NS	0
7-0	NS	NS	0
7-10	NS	NS	0
7-20	NS	NS	0
7-30	NS	NS	0
7-40	NS	NS	0
7-50	NS	NS	0
7-60	NS	NS	0
7-70	NS	NS	0
7-80	NS	NS	0
8-0	NS	NS	0
8-10	NS	NS	0
8-20	NS	NS	0
8-30	NS	NS	0
8-40	NS	NS	0
8-50	NS	NS	4
8-60	NS	NS	0
8-70	NS	NS	0
8-80	NS	NS	0
9-0	NS	NS	0
9-10	NS	NS	0
9-20	NS	NS	1
9-30	NS	NS	1
9-40	NS	NS	0
9-50	NS	NS	14
9-60	NS	NS	0
9-70	NS	NS	0
9-80	NS	NS	0
10-0	NS	NS	0
10-10	NS	NS	0

10-20	NS	NS	0
10-30	NS	NS	0
10-40	NS	NS	0
10-50	NS	NS	1
10-60	NS	NS	0
10-70	NS	NS	0
10-80	NS	NS	0
11-0	NS	NS	0
11-10	NS	NS	0
11-20	NS	NS	0
11-30	NS	NS	0
11-40	NS	NS	0
11-50	NS	NS	0
11-60	NS	NS	0
11-70	NS	NS	0
11-80	NS	NS	0

Causeway, South Side. Samples collected in east-west direction at 40 foot intervals Samples collected in east-west direction at 40 foot intervals along one linear transect near base of slope.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
0 (west)	Not Sampled	Not Sampled	2
40	NS	NS	0
80	NS	NS	3
120	NS	NS	2
160	NS	NS	2
200	NS	NS	1
240	NS	NS	1
280	NS	NS	6
320	NS	NS	7
360	NS	NS	0
400	NS	NS	7
440	NS	NS	9
480	NS	NS	7
520	NS	NS	22
560	NS	NS	3
600	NS	NS	3
640	NS	NS	1
680	NS	NS	0
720	NS	NS	0
760	NS	NS	1
800	NS	NS	1
840	NS	NS	0
880	NS	NS	0

920	NS	NS	1
960	NS	NS	0
1000	NS	NS	1
1040	NS	NS	0
1080	NS	NS	0
1120	NS	NS	0
1160	NS	NS	1
1200	NS	NS	0
1240	NS	NS	0
1280	NS	NS	0
1320	NS	NS	1
1360	NS	NS	0
1400	NS	NS	1
1440	NS	NS	0
1480	NS	NS	0
1520	NS	NS	1
1560	NS	NS	1
1600	NS	NS	0
1640	NS	NS	1
1680 (east)	NS	NS	3

Causeway, North Side. Samples collected in east-west direction at 40 foot intervals along one linear transect near base of slope.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
0 (east)	Not Sampled	Not Sampled	0
40	NS	NS	1
80	NS	NS	3
120	NS	NS	0
160	NS	NS	6
200	NS	NS	2
240	NS	NS	3
280	NS	NS	0
320	NS	NS	8
360	NS	NS	3
400	NS	NS	2
440	NS	NS	6
480	NS	NS	10
520	NS	NS	0
560	NS	NS	0
600	NS	NS	0
640	NS	NS	2
680	NS	NS	7
720	NS	NS	4
760	NS	NS	0

800	NS	NS	0
840	NS	NS	4
880	NS	NS	0
920	NS	NS	1
960	NS	NS	0
1000	NS	NS	0
1040	NS	NS	0
1080	NS	NS	0
1120	NS	NS	1
1160	NS	NS	0
1200 (west)	NS	NS	0

Trestle Wide Area Plot. Two samples collected at each of pilings 30 to 100, east to west.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
30-20N (east)	Not Sampled	Not Sampled	2
30-10S	NS	NS	0
31-20N	NS	NS	0
31-10S	NS	NS	1
32-0	NS	NS	0
32-20S	NS	NS	1
33-10N	NS	NS	0
33-33S	NS	NS	5
34-10N	NS	NS	0
34-10S	NS	NS	0
35-30N	NS	NS	1
35-10S	NS	NS	0
36-20N	NS	NS	0
36-20S	NS	NS	0
37-20N	NS	NS	1
37-20S	NS	NS	2
38-30N	NS	NS	1
38-10S	NS	NS	0
39-20N	NS	NS	1
39-20S	NS	NS	1
40-10N	NS	NS	0
40-10S	NS	NS	0
41-40N	NS	NS	0
41-20S	NS	NS	7
42-0	NS	NS	0
42-30S	NS	NS	0
43-20N	NS	NS	8
43-10S	NS	NS	0
44-20N	NS	NS	0

44-20S	NS	NS	4
45-10N	NS	NS	0
45-20S	NS	NS	8
46-0	NS	NS	0
46-20S	NS	NS	4
47-40N	NS	NS	2
47-10S	NS	NS	1
48-30N	NS	NS	0
48-10S	NS	NS	0
49-0	NS	NS	0
49-10S	NS	NS	0
50-0	NS	NS	0
50-10S	NS	NS	1
51-30N	NS	NS	5
51-10S	NS	NS	3
52-0	NS	NS	0
52-10S	NS	NS	1
53-10N	NS	NS	1
53-10S	NS	NS	1
54-10N	NS	NS	0
54-10S	NS	NS	1
55-40N	NS	NS	0
55-20S	NS	NS	5
56-0	NS	NS	0
56-10S	NS	NS	0
57-20N	NS	NS	2
57-10S	NS	NS	0
58-0	NS	NS	0
58-20S	NS	NS	4
59-10N	NS	NS	0
59-20S	NS	NS	7
60-20N	NS	NS	5
60-30S	NS	NS	1
61-30N	NS	NS	0
61-10S	NS	NS	0
62-20N	NS	NS	6
62-10S	NS	NS	0
63-30N	NS	NS	1
63-20S	NS	NS	2
64-20N	NS	NS	1
64-10S	NS	NS	0
65-30N	NS	NS	1
65-20S	NS	NS	3
66-20N	NS	NS	3
66-30S	NS	NS	1
67-30N	NS	NS	4

67-30S	NS	NS	3
68-20N	NS	NS	2
68-30S	NS	NS	3
69-30N	NS	NS	1
69-10S	NS	NS	0
70-20N	NS	NS	1
70-30S	NS	NS	2
71-20N	NS	NS	0
71-30S	NS	NS	0
72-30N	NS	NS	3
72-10S	NS	NS	0
73-20N	NS	NS	4
73-30S	NS	NS	2
74-30N	NS	NS	2
74-30S	NS	NS	1
75-10N	NS	NS	0
75-20S	NS	NS	0
76-40N	NS	NS	1
76-30S	NS	NS	1
77-40N	NS	NS	0
77-20S	NS	NS	2
78-20N	NS	NS	0
78-10S	NS	NS	0
79-40N	NS	NS	2
79-20S	NS	NS	2
80-30N	NS	NS	2
80-20S	NS	NS	0
81-0	NS	NS	0
81-10S	NS	NS	0
82-40N	NS	NS	1
82-20S	NS	NS	1
83-20N	NS	NS	1
83-20S	NS	NS	0
84-30N	NS	NS	1
84-10S	NS	NS	0
85-40N	NS	NS	0
85-20S	NS	NS	0
86-40N	NS	NS	0
86-10S	NS	NS	0
87-40N	NS	NS	0
87-20S	NS	NS	0
88-0	NS	NS	0
88-10S	NS	NS	0
89-10N	NS	NS	0
89-20S	NS	NS	0
90-20N	NS	NS	0

90-10S	NS	NS	0
91-0	NS	NS	0
91-10S	NS	NS	0
92-10N	NS	NS	0
92-20S	NS	NS	0
93-0	NS	NS	0
93-10S	NS	NS	0
94-30N	NS	NS	0
94-20S	NS	NS	0
95-20N	NS	NS	1
95-20S	NS	NS	0
96-40N	NS	NS	0
96-10S	NS	NS	0
97-20N	NS	NS	0
97-10S	NS	NS	0
98-10N	NS	NS	0
98-10S	NS	NS	0
99-20N	NS	NS	1
99-10S	NS	NS	0
100-20N	NS	NS	0
100-10S	NS	NS	0

Area southwest of the Shell RV Park, Little Crandall Spit.
Samples collected along north-south transects 30 feet apart.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
1-0 (east)	Not Sampled	Not Sampled	0
1-10	NS	NS	0
1-20	NS	NS	0
1-30	NS	NS	0
1-40	NS	NS	0
1-50	NS	NS	11
1-60	NS	NS	29
1-70	NS	NS	10
1-80	NS	NS	3
2-0	NS	NS	0
2-10	NS	NS	0
2-20	NS	NS	0
2-30	NS	NS	0
2-40	NS	NS	1
2-50	NS	NS	10
2-60	NS	NS	3
2-70	NS	NS	4
2-80	NS	NS	16
3-0	NS	NS	0

3-10	NS	NS	0
3-20	NS	NS	0
3-30	NS	NS	0
3-40	NS	NS	1
3-50	NS	NS	3
3-60	NS	NS	1
3-70	NS	NS	5
3-80	NS	NS	6
4-0	NS	NS	0
4-10	NS	NS	0
4-20	NS	NS	0
4-30	NS	NS	1
4-40	NS	NS	1
4-50	NS	NS	7
4-60	NS	NS	7
4-70	NS	NS	7
4-80	NS	NS	5
5-0	NS	NS	1
5-10	NS	NS	7
5-20	NS	NS	0
5-30	NS	NS	3
5-40	NS	NS	8
5-50	NS	NS	0
5-60	NS	NS	10
5-70	NS	NS	13
5-80	NS	NS	12
6-0	NS	NS	0
6-10	NS	NS	9
6-20	NS	NS	7
6-30	NS	NS	21
6-40	NS	NS	17
6-50	NS	NS	0
6-60	NS	NS	4
6-70	NS	NS	12
6-80	NS	NS	1
7-0	NS	NS	1
7-10	NS	NS	0
7-20	NS	NS	1
7-30	NS	NS	0
7-40	NS	NS	0
7-50	NS	NS	7
7-60	NS	NS	35
7-70	NS	NS	9
7-80	NS	NS	6
8-0	NS	NS	0
8-10	NS	NS	12

8-20	NS	NS	9
8-30	NS	NS	36
8-40	NS	NS	18
8-50	NS	NS	5
8-60	NS	NS	7
8-70	NS	NS	0
8-80	NS	NS	6
9-0	NS	NS	0
9-10	NS	NS	0
9-20	NS	NS	3
9-30	NS	NS	37
9-40	NS	NS	0
9-50	NS	NS	0
9-60	NS	NS	14
9-70	NS	NS	9
9-80	NS	NS	9
10-0	NS	NS	0
10-10	NS	NS	0
10-20	NS	NS	2
10-30	NS	NS	0
10-40	NS	NS	0
10-50	NS	NS	0
10-60	NS	NS	3
10-70	NS	NS	5
10-80 (west)	NS	NS	5

In Channel/delta area of outflow from Crandall Spit Lagoon.
Samples collected along east-west transects 20 feet apart.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
Channel - 1	Not Sampled	Not Sampled	0
Channel - 2	NS	NS	0
Channel - 3	NS	NS	0
Channel - 4	NS	NS	0
Channel - 5	NS	NS	1
Channel - 6	NS	NS	0
7-0	NS	NS	0
7-10W	NS	NS	0
7-20W	NS	NS	0
7-30W	NS	NS	0
7-40W	NS	NS	0
7-50W	NS	NS	0
7-10E	NS	NS	0
7-20E	NS	NS	0
7-30E	NS	NS	0

7-40E	NS	NS	0
7-50E	NS	NS	0
9-0	NS	NS	0
9-10W	NS	NS	0
9-20W	NS	NS	0
9-30W	NS	NS	0
9-40W	NS	NS	0
9-50W	NS	NS	0
9-60W	NS	NS	0
9-10E	NS	NS	0
9-20E	NS	NS	0
9-30E	NS	NS	0
9-40E	NS	NS	0
9-50E	NS	NS	0
9-60E	NS	NS	0
11-0	NS	NS	0
11-10W	NS	NS	0
11-20W	NS	NS	0
11-30W	NS	NS	0
11-40W	NS	NS	0
11-50W	NS	NS	0
11-60W	NS	NS	0
11-10E	NS	NS	0
11-20E	NS	NS	0
11-30E	NS	NS	0
11-40E	NS	NS	0
11-50E	NS	NS	0
11-60E	NS	NS	0
13-0	NS	NS	0
13-10W	NS	NS	0
13-20W	NS	NS	0
13-30W	NS	NS	0
13-40W	NS	NS	0
13-50W	NS	NS	0
13-60W	NS	NS	0
13-70W	NS	NS	0
13-10E	NS	NS	0
13-20E	NS	NS	0
13-30E	NS	NS	0
13-40E	NS	NS	0
13-50E	NS	NS	0
13-60E	NS	NS	0
13-70E	NS	NS	0
15-0	NS	NS	0
15-10W	NS	NS	0
15-20W	NS	NS	0

15-30W	NS	NS	0
15-40W	NS	NS	0
15-50W	NS	NS	0
15-60W	NS	NS	0
15-70W	NS	NS	0
15-10E	NS	NS	0
15-20E	NS	NS	0
15-30E	NS	NS	0
15-40E	NS	NS	0
15-50E	NS	NS	0
15-60E	NS	NS	0
15-70E	NS	NS	0
17-0	NS	NS	0
17-10W	NS	NS	0
17-20W	NS	NS	0
17-30W	NS	NS	0
17-40W	NS	NS	0
17-50W	NS	NS	0
17-60W	NS	NS	0
17-70W	NS	NS	0
17-80W	NS	NS	0
17-10E	NS	NS	0
17-20E	NS	NS	0
17-30E	NS	NS	0
17-40E	NS	NS	0
17-50E	NS	NS	0
17-60E	NS	NS	0
17-70E	NS	NS	0
17-80E	NS	NS	0
19-0	NS	NS	0
19-10W	NS	NS	0
19-20W	NS	NS	0
19-30W	NS	NS	0
19-40W	NS	NS	0
19-50W	NS	NS	0
19-60W	NS	NS	0
19-70W	NS	NS	0
19-80W	NS	NS	0
19-10E	NS	NS	0
19-20E	NS	NS	0
19-30E	NS	NS	0
19-40E	NS	NS	0
19-50E	NS	NS	0
19-60E	NS	NS	0
19-70E	NS	NS	0

19-80E	NS	NS	0

East Shore of Fidalgo Bay between north end of the south shell bed & south barge structure. Samples collected in north-south direction at 50 foot intervals.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
1-0 (north)	Not Sampled	Not Sampled	0
1-10	NS	NS	0
1-20	NS	NS	0
1-30	NS	NS	0
1-40	NS	NS	0
1-50	NS	NS	4
1-60	NS	NS	0
1-70	NS	NS	0
1-80	NS	NS	4
2-0	NS	NS	0
2-10	NS	NS	0
2-20	NS	NS	3
2-30	NS	NS	1
2-40	NS	NS	2
2-50	NS	NS	2
2-60	NS	NS	1
2-70	NS	NS	2
2-80	NS	NS	0
3-0	NS	NS	0
3-10	NS	NS	0
3-20	NS	NS	3
3-30	NS	NS	2
3-40	NS	NS	4
3-50	NS	NS	1
3-60	NS	NS	6
3-70	NS	NS	0
3-80	NS	NS	0
4-0	NS	NS	0
4-10	NS	NS	0
4-20	NS	NS	0
4-30	NS	NS	1
4-40	NS	NS	2
4-50	NS	NS	2
4-60	NS	NS	1
4-70	NS	NS	4
4-80	NS	NS	0
5-0	NS	NS	3
5-10	NS	NS	0
5-20	NS	NS	0

5-30	NS	NS	0
5-40	NS	NS	2
5-50	NS	NS	2
5-60	NS	NS	10
5-70	NS	NS	2
5-80	NS	NS	0
6-0	NS	NS	1
6-10	NS	NS	1
6-20	NS	NS	1
6-30	NS	NS	0
6-40	NS	NS	8
6-50	NS	NS	0
6-60	NS	NS	5
6-70	NS	NS	7
6-80	NS	NS	6
7-0	NS	NS	0
7-10	NS	NS	0
7-20	NS	NS	0
7-30	NS	NS	0
7-40	NS	NS	0
7-50	NS	NS	0
7-60	NS	NS	0
7-70	NS	NS	0
7-80	NS	NS	0
8-0	NS	NS	0
8-10	NS	NS	0
8-20	NS	NS	0
8-30	NS	NS	0
8-40	NS	NS	0
8-50	NS	NS	0
8-60	NS	NS	0
8-70	NS	NS	0
8-80	NS	NS	0
9-0	NS	NS	0
9-10	NS	NS	0
9-20	NS	NS	0
9-30	NS	NS	0
9-40	NS	NS	0
9-50	NS	NS	0
9-60	NS	NS	0
9-70	NS	NS	0
9-80	NS	NS	0
10-0	NS	NS	0
10-10	NS	NS	0
10-20	NS	NS	0
10-30	NS	NS	0

10-40	NS	NS	0
10-50	NS	NS	1
10-60	NS	NS	0
10-70	NS	NS	0
10-80	NS	NS	0
11-0	NS	NS	0
11-10	NS	NS	3
11-20	NS	NS	6
11-30	NS	NS	1
11-40	NS	NS	0
11-50	NS	NS	26
11-60	NS	NS	0
11-70	NS	NS	0
11-80	NS	NS	0
12-0	NS	NS	0
12-10	NS	NS	0
12-20	NS	NS	0
12-30	NS	NS	0
12-40	NS	NS	1
12-50	NS	NS	0
12-60	NS	NS	0
12-70	NS	NS	1
12-80	NS	NS	0
13-0	NS	NS	0
13-10	NS	NS	0
13-20	NS	NS	0
13-30	NS	NS	0
13-40	NS	NS	0
13-50	NS	NS	0
13-60	NS	NS	0
13-70	NS	NS	0
13-80	NS	NS	0

East Shore of Fidalgo Bay, muddy inlet west of Shell RV Park, starting 30m south of two pilings. Samples collected in south to north direction at 50 foot intervals.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
1-0 (south)	Not Sampled	Not Sampled	0
1-10	NS	NS	1
1-20	NS	NS	0
1-30	NS	NS	1
1-40	NS	NS	1
1-50	NS	NS	1
1-60	NS	NS	0
1-70	NS	NS	0

1-80	NS	NS	1
2-0	NS	NS	0
2-10	NS	NS	1
2-20	NS	NS	0
2-30	NS	NS	0
2-40	NS	NS	0
2-50	NS	NS	0
2-60	NS	NS	0
2-70	NS	NS	1
2-80	NS	NS	0
3-0	NS	NS	0
3-10	NS	NS	0
3-20	NS	NS	0
3-30	NS	NS	0
3-40	NS	NS	0
3-50	NS	NS	0
3-60	NS	NS	0
3-70	NS	NS	1
3-80	NS	NS	0
4-0	NS	NS	0
4-10	NS	NS	0
4-20	NS	NS	0
4-30	NS	NS	0
4-40	NS	NS	0
4-50	NS	NS	2
4-60	NS	NS	0
4-70	NS	NS	0
4-80	NS	NS	0
5-0	NS	NS	0
5-10	NS	NS	0
5-20	NS	NS	0
5-30	NS	NS	0
5-40	NS	NS	0
5-50	NS	NS	0
5-60	NS	NS	0
5-70	NS	NS	0
5-80	NS	NS	0
6-0	NS	NS	0
6-10	NS	NS	0
6-20	NS	NS	0
6-30	NS	NS	0
6-40	NS	NS	0
6-50	NS	NS	0
6-60	NS	NS	0
6-70	NS	NS	0
6-80	NS	NS	0

7-0	NS	NS	0
7-10	NS	NS	0
7-20	NS	NS	0
7-30	NS	NS	1
7-40	NS	NS	0
7-50	NS	NS	0
7-60	NS	NS	0
7-70	NS	NS	0
7-80	NS	NS	0
8-0	NS	NS	0
8-10	NS	NS	2
8-20	NS	NS	0
8-30	NS	NS	0
8-40	NS	NS	0
8-50	NS	NS	0
8-60	NS	NS	0
8-70	NS	NS	0
8-80	NS	NS	0

Sharps Corner, South Fidalgo Bay Channels, 16 July 2018.

1/10m^2 transect samples collected in the northern most channel at 10' intervals starting ~100 m from highway. Oyster populations in the other three channels were visually estimated based on the north channel appearances. For area calculation, estimated the channel width to average 1.5 m.

Sample Number	Number of Clam Shells	Number of Oyster Shells	Number of Native Oysters
0	Not Sampled	Not Sampled	0
10	NS	NS	0
20	NS	NS	2
30	NS	NS	1
40	NS	NS	6
50	NS	NS	0
60	NS	NS	14
70	NS	NS	0
80	NS	NS	31
90	NS	NS	41
100	NS	NS	0
110	NS	NS	0
120	NS	NS	0
130	NS	NS	47
140	NS	NS	64
150	NS	NS	81
160	NS	NS	31

170	NS	NS	21
180	NS	NS	26
190	NS	NS	43