

Project Title: Restoration of Native Olympia Oysters within the South Slough Estuary**I. Reporting Period** (07/06 - 12/09; Final Report)**II. Project Narrative (this section is required for the final comprehensive report only)**

The project narrative should identify the *problems* that the project has addressed, describe short- and long-term *objectives and goals* and how they were met, and *explain the relevance* of the project to enhancing habitat and/or to benefiting living marine resources, including a description of any threatened or endangered species the project will benefit.

Problems addressed by the Project: Native Olympia oysters (*Ostrea lurida*) were once abundant and ecologically important components of estuarine communities throughout the Pacific Northwest biogeographic region (Couch and Hassler, 1989; Baker, 1995; Peter-Contesse and Peabody, 2005). Living beds of Olympia oysters occurred within the lower intertidal and shallow subtidal region of bays, estuaries, and tidal inlets where they provided several key ecosystem services including: (a) maintenance of a hardened substratum that served as benthic habitat for many species, (b) biofiltration of phytoplankton and sediment particles from the water column, (c) pelagic-benthic coupling that results in the secondary production of molluscan tissue and other organic materials, and (d) increased biotic diversity and foraging areas for invertebrates, fish, and shorebirds. In addition, the dense beds of Olympia oysters also provided local indigenous people with an important source of food, and larger-scale harvests of *O. lurida* once constituted an economically valuable commercial fishery. Regional popularity of the native oysters as a targeted fishery species lead to over-harvests and the massive removal of shells from the benthic substratum, and these practices contributed to a region-wide collapse in many Pacific coast estuaries during the late 19th and early 20th centuries (Gordon *et al.*, 2001; McGraw, 2009).

Populations of Olympia oysters have also been decimated on a more local scale by natural events that are independent of fisheries harvests. For example, beds of *Ostrea lurida* were historically abundant in the Coos estuary and South Slough (Oregon) where they were utilized extensively as a food source by the indigenous people (Rumrill, 2006). Shell middens that contain Olympia oysters occur along the shoreline of the South Slough (Moss and Erlandson, 1995), and Olympia oyster shells are commonly included in the dredged materials removed from the estuarine channels (Groth and Rumrill, 2009). Beds of *O. lurida* became locally extinct in Coos Bay and South Slough prior to written history due to basin-wide changes in the inputs and distribution of fine sediments. Over the first century following colonization of the shoreline of the Coos estuary by euro-western settlers (*ca.* 1850-1950), aquatic and estuarine habitats within portions of Coos Bay were chronically degraded by growing urbanization and the cumulative effects of sedimentation, log storage, bark decay, dredging, deposition of dredge spoils, diking, filling, domestic and industrial pollution, commercial mariculture of non-native

Pacific oysters (*Crassostrea gigas*), and by the colonization of estuarine habitats by non-indigenous aquatic species. Despite these alterations and degradation of the shoreline (and reduction of the entire wet surface area of the Coos estuary by 26%; Borde *et al.*, 2003), water column and benthic habitat conditions have improved considerably over the past thirty years within particular regions of the tidal basin to the point where they are now conducive to the recovery of native oysters. In 1988, following several years of inadvertent inoculations via commercial shellfish culture activities, discontinuous populations Olympia oysters became re-established at low intertidal and shallow subtidal elevations within the polyhaline (22-28 psu) region of the Coos estuary (Baker, 1995; Baker *et al.* 2000).

Although the isolated populations of Olympia oysters have established a toe-hold within the Coos estuary, widespread recovery of *O. lurida* populations has not occurred due to several potentially limiting factors. These factors include: (a) sub-optimal biotic and physical conditions that may hamper feeding, survivorship, growth, and reproduction; (b) inadequate production and retainment of larval supplies; (c) decreased availability of adequate shell substratum for settlement; (d) poor survival of post-settled juveniles; and (e) predation, competition, and ecological interactions with other established native and non-native species (Brumbaugh *et al.*, 2006; Brumbaugh and Coen, 2009). It is anticipated that once these hurdles are understood and perhaps overcome, it may be possible to initiate recovery of native Olympia oyster beds in a manner that will allow the oyster populations to maintain themselves on a self-sustaining basis. Re-establishment of self-sustaining populations of *O. lurida* is desirable because, in addition to the recovery of the oysters, the growing physical structure of the oyster beds will serve to restore some of the lost ecological functions to the estuarine tidal basin, and the living oyster beds may reach a point in the future where they can provide substantial benefits for diverse communities of invertebrates, fish, shorebirds, and humans (Peter-Contesse and Peabody, 2005).

Goals and Objectives: The overall purpose of this project was to investigate the potential to restore self-sustaining populations of *Ostrea lurida* in the South Slough estuary. Our primary goal was to determine the suite of intrinsic and ecological factors that will contribute to the success of Olympia oyster restoration efforts in the South Slough, and our specific objectives were to: (A) identify an appropriate broodstock source for the import of new oysters; (B) develop a technique to successfully generate a small population of Olympia oysters in the South Slough estuary; and (C) compare the survival and grow rates of juvenile oysters generated from hatchery stock imported from Netarts Bay and by natural recruitment in Coos Bay. We collected Olympia oysters from several locations throughout Coos Bay (2006-07; prior to initiation of the project) and provided about 150 specimens to the Molluscan Broodstock Program (Oregon State University) for inclusion in their evaluation of genetic variability and population connectivity. Analysis of the DNA microsatellites of numerous *O. lurida* populations (2008) revealed that the genetic signatures of adults and juveniles from Coos Bay, OR were nearly identical to the genetic signatures of populations from Netarts Bay, OR and Willapa Bay, WA. The absence of significant microsatellite variability among these discontinuous populations indicates that the populations of *O. lurida* that currently inhabit Coos Bay were most likely re-introduced inadvertently as hitch-hikers during the commercial transport of Pacific oysters (*Crassostrea gigas*) from Willapa Bay prior to 1985. Based on this information, we then obtained Olympia oyster cultch from the Whiskey Creek Shellfish

Hatchery (2008 and 2009; broodstock from Netarts Bay/Willapa Bay) and transported them into an experimental population located at Younker Point, South Slough. A project-specific monitoring station was established at the Younker Point site, and a YSI-6600 multi-parameter datalogger was deployed over the period of (2008-present) to generate time-series measurements of ambient estuarine water parameters including temperature, salinity, and dissolved oxygen. We also recorded periodic measurements of the growth rates of the juvenile Olympia oysters generated by the commercial hatchery (Netarts Bay) and by natural recruitment (Coos Bay) and made side-by-side comparisons of their ecological performance at the Younker Point restoration site. Results generated by this pilot project will be integrated with ongoing efforts in other Pacific Northwest estuaries to develop a realistic strategy and approach to restore self-sustaining populations of *Ostrea lurida* in the South Slough estuary. We anticipate that our efforts within the South Slough estuary will also serve to stimulate further interest in the restoration of Olympia oysters within the local community and with the commercial oyster growers in Coos Bay, and we also hope to help catalyze future oyster restoration efforts in other estuaries located along the southern Oregon coast (*i.e.*, Netarts Bay, Yaquina Bay).

Project Relevance: Restoration of Olympia oysters in South Slough will serve to enhance the process of pelagic-benthic coupling that facilitates transfer of dissolved and particulate nutrients from the water column to the bottom (Dame, 1996; Nelson *et al.*, 2004), and the production of organically-rich fecal material that is used by other benthic organisms. In addition, suspension-feeding and biofiltration by the living oysters will sustain growth of the juvenile and adults, serve to bind and affix the shells to each other, add to the growing complexity of the shell clusters, and further stabilize the soft-sediment environment. Oyster growth will also directly result in secondary production of molluscan tissue and reproductive propagules (eggs, sperm, larvae) that will be indirectly preyed upon by other organisms including snails, seastars, crabs, fishes, and waterfowl (Couch and Hassler, 1989). Finally, the combination of sediment stabilization and biofiltration activities carried out by the living Olympia oysters will also contribute to improvement in the habitat conditions for eelgrass beds, and the complex oyster clusters/mounds will provide additional foraging areas for invertebrates, fish, and shorebirds. Species with the potential to benefit from this project include native eelgrass (*Zostera marina*), a diverse array of benthic marine invertebrates, Dungeness and red rock crabs (*Cancer magister* and *C. productus*), as well as several species of fishes (Pacific salmon, steelhead and cutthroat trout, herring, anchovies, surf perch, shiner perch, juvenile rockfish, starry flounder, gunnels, sculpin), and waterfowl including Brant geese, greater scaup, and scoters.

This project is designed to provide direct benefits to native Olympia oysters as a species-at-risk. Demise of Olympia oysters has occurred to the extent that they are now widely recognized as a special-status species, and they have recently been afforded a high priority for restoration and recovery efforts throughout the Pacific Northwest biogeographic region (NOAA, 2007).

Ostrea lurida are listed by the Oregon Natural Heritage Program (ORNHP) as a Category 3 Species (*i.e.*, species for which more information is needed before their status can be determined, but which may be threatened or endangered in Oregon or throughout their range). The Oregon Department of Fish and Wildlife currently prohibits recreational and commercial harvests of Olympia oysters. In addition, the Olympia oyster is recognized in Washington as a state candidate species, and in California by the California Endangered Species Act (CESA). Populations of Olympia oysters are afforded broader protected status in British Columbia by the

Canadian Species at Risk Act (SARA) as a Schedule 1 Species of Special Concern, and they are the subject of a special recovery plan for species-at-risk (Fisheries and Oceans Canada. 2009). In 2003, Olympia oysters were added to the Pacific Northwest Slow Food USA Program “*Ark of Endangered Culinary Species*” in an effort to publicize threats to the species and to encourage recovery of natural populations and the viability of future harvests.

III. Methodology

Describe the methodology used to undertake on-the-ground activities during this reporting period to achieve the project goals and objectives, including the specific techniques and materials used.

South Slough NERR completed work as described below over the period from July 2006 to December 2009 on the experimental out-planting of native Olympia oysters (*Ostrea lurida*) in the South Slough estuary:

7/06 - 5/07: The South Slough NERR experienced a significant delay in the initiation of local field work in Coos Bay and South Slough due to difficulties in the administration and hiring of personnel who will work within the Oregon Department of State Lands / South Slough NERR to accomplish the tasks and responsibilities associated with this project. In particular, the Reserve had initially planned (July 2006 to April 2007) to fill the personnel requirements with a part-time limited duration position over the period of the grant award. A position description was developed in July 2006 to describe the duties and responsibilities, and the position was to be classified as a Natural Resource Specialist-2 (NRS-2) position.

Numerous adults of *Ostrea lurida* were collected by hand from several locations throughout the Coos Bay estuary for determinations of reproductive status, although we did not conduct on-the-ground outplanting activities during this reporting period.

06/07 - 11/07: The South Slough NERR changed the human resources strategy for implementation of this project to fulfill the workforce obligations with a rotational job assignment by making use of an existing position that currently exists within the agency (classified as an NRS-3 position). The position description and recruitment materials for the rotational NRS-3 position are under development by the human resources office within the Oregon Department of State Lands (10 Aug '07). Due to the difficulties with administration of personnel associated with the project, the Reserve submitted a request for a time extension for award no. NA06NMF4630033. The original time-period for the project was June 2006 to May 2008, and the new time-period for the project was January 2008 to December 2009.

Scott Groth (ODFW) and Steve Rumrill (SSNERR) collected about 200 individuals of *O. lurida* from rip-rap habitat located along the shoreline of the North Bend Airport runway on 27 Sep 2007. These oysters were placed into 4 Vexar-mesh bags and transplanted into the mouth of the South Slough estuary on 4 Oct 2007 where they were hung from the floating dock at the Charleston Distant Water Fleet Facility. The transplanted oysters were checked on 9 Nov (Temp 9.8 °C / Sal 31.5) and on 27 Nov 2007 (Temp 9.9 °C / Sal 32.1), and the oysters appeared healthy on both dates. These observations indicate that the *O. lurida* are able to survive in the higher salinity waters that characterize the marine-dominated region of the South

Slough estuary near the proposed oyster out-planting site at Younker Point. Younker Point is located within the transition zone between the marine-dominated (euhaline) and polyhaline hydrographic regions of the South Slough.

12/07 - 06/08: The South Slough NERR continued to experience a further delay in the initiation of local field work in Coos Bay and South Slough due to difficulties in the administration and hiring of personnel who will work within the Oregon Department of State Lands / South Slough NERR to accomplish the tasks and responsibilities associated with this project. The Reserve worked from July 2006 to March 2008 to complete the personnel administration and recruitment process for the Stewardship Coordinator position (NRS-3) which is supported at a level of 0.4 FTE with \$25,854 of federal grant funds from award no. NA06NMF4630033. Interviews were conducted with prospective candidates on 17 March 2008, and Hans Klausner accepted the position with the South Slough NERR on 23 April 2008.

07/08 – 11/08: Sixty adult Olympia oysters were collected from Coos Bay in June and July 2008 for pathogen testing and histological analysis. These tests are required by the Oregon Department of Fish and Wildlife (ODFW) for approval of an Oyster Transfer Permit. The adult oysters were sent to Dr. Ralph Elston (AquaTechnics, Inc.) for pathogen screening and histological analysis. Due to the presence of tissue irregularities, focal hemocytosis, and nuclear degeneration in about 12-17% of the specimens, our application for the ODFW Oyster Transfer permit was denied and we were unable to transport the locally-adapted adult oysters from Coos Bay to the Whiskey Creek Shellfish Hatchery for broodstock work. Consequently, we modified the design of the common-garden experiment to include placement of adult oysters from Willapa Bay and Coos Bay into mesh bags for outplanting into the estuary.

S. Rumrill, K. Cellura, and R. Arvidson travelled to Willapa Bay, WA (16 July 2008) and collected about 200 adult *O. lurida* from floating docks at Nachotta. In addition, they collected about 120 individuals of *O. lurida* from rip-rap habitat located along the North Bend Airport runway, and from rip-rap habitat located along the shoreline of Coos Bay, on numerous dates in June-August 2008. The oysters collected from Willapa Bay and Coos Bay were used for measurements of shell sizes and in experiments to assess measures of ecological performance. Oyster shell dimensions (*i.e.*, shell length, shell width, shell depth) were measured with digital calipers. A series of laboratory and field experiments were initiated to assess susceptibility of the adult oysters to predation and overgrowth competition. Adult oysters were cleaned of all conspicuous epibionts, measured, affixed to ABS plates with di-isocyanate adhesive (Gorilla Glue), marked, and photographed with a digital camera. Groups of adult Olympia oysters were also placed into Vexar-mesh bags and transplanted into several locations throughout Coos Bay and the South Slough estuary (July & August 2008) where they were hung from floating docks and PVC-pipe frames placed into the substratum.

The Portland office of The Nature Conservancy (Dick Vander Schaaf) worked with the Whiskey Creek Shellfish Hatchery to produce numerous bags of Olympia oyster cultch for a concurrent project in Netarts Bay, OR. A sub-set of the cultch bags were made available for the project in the South Slough estuary. South Slough NERR staff members (S. Rumrill, H. Klausner) and a community volunteer (K. Cellura) travelled to Netarts Bay, OR on 25 July 2008 to meet with the owners of the Whiskey Creek Shellfish Hatchery. Following the meeting, they transported 22 bags of Olympia oyster cultch (each bag contains about 200,000 spat / Willapa

Bay/Netarts broodstock) from the shellfish hatchery to Charleston, OR where they were hung from the floating dock at the Charleston Boat Basin. Hans Klausner supervised the construction of PVC racks used to prevent sedimentation and predation of the transplanted cultch. The PVC racks (3' L X 2' W X 2' H) were placed into the lower intertidal zone in sandy-mud substrata at the Younker Point transplant site. After a period of eight days, the bags of Olympia oyster cultch were transported into the South Slough estuary where they were affixed horizontally to tops of the PVC racks frames with cable ties.

12/08 – 05/09: Hans Klausner completed the permitting responsibilities by coordinating a survey of the project site for potential impacts on cultural resources and following up with the Army Corp of Engineers and NMFS to acquire a Biological Opinion of the project.

The project originally included a reciprocal transplant approach (or common garden experiment) where juvenile oysters (cultch) from two different sources of broodstock (Netarts Bay/Willapa Bay and Coos Bay) were to be placed side-by-side into the tideflats of the South Slough, and the oysters were to be monitored for survivorship, growth, onset of reproduction, and susceptibility to predation, overgrowth competition, and sedimentation. This approach required that we collect mature and gravid specimens of *Ostrea lurida* from populations located within Coos Bay, and transport the adult oysters to the Whiskey Creek Shellfish Hatchery (located in Netarts Bay, OR) for the broodstock spawning and larval culture work. However, our application for an ODFW Oyster Transfer permit was denied in July 2008 due to the presence of tissue irregularities, focal hemocytosis, and nuclear degeneration in about 12-17% of the adult oysters collected from Coos Bay. Denial of the ODFW Oyster Transfer Permit meant that we were unable to transport the locally-adapted adult oysters from Coos Bay to the Whiskey Creek Shellfish Hatchery for broodstock work. Due to the potential for intra-bay transfer of pathogens and/or disease agents that may be responsible for unusual cellular degradation of oyster tissues observed in adults from Coos Bay in 2008, the experimental design was modified to compare the ecological performance of hatchery broodstock from Willapa Bay with the performance of naturally settled larvae generated in Coos Bay. Consequently, we modified the design of the common-garden experiment to include placement of adult oysters from Willapa Bay and Coos Bay side-by-side into mesh bags for outplanting into the estuary. We also obtained twenty-two bags of Olympia oyster cultch from the Whiskey Creek Shellfish Hatchery (during the late summer of 2008), and the bags of oyster shells and living juvenile Olympia oysters were placed onto a series of five PVC-pipe racks placed into the lower intertidal and shallow subtidal zone at Younker Point (South Slough estuary). In addition, spat collector bags (180 bags of Pacific oyster shells) were deployed at three locations in Coos Bay (Sause Brothers dock, Glenbrook Pier, Railroad Bridge) to serve as settlement sites for the planktonic larvae of Olympia oysters. We deployed a YSI-6600 multi-parameter datalogger in the shallow subtidal zone at the Younker Point site to record continuous measurements of several water quality parameters (*i.e.*, water depth, temperature, conductivity, salinity, dissolved oxygen).

Hans Klausner coordinated the deployment and monitoring of 200 bags of oyster shell among four areas where native oyster larval settlement and recruitment have been high. The intent of these shell bags was to collect native larvae in-situ. The shell provides a medium for native larvae to settle upon and the bags were made of a mesh material that ensures sufficient water flow. Bags were suspended by wire rope with carabineers to keep them stationary and to

prevent sedimentation and predation. After approximately six months of deployment, severe degradation of the wire rope used to suspend the bags had occurred. This flaw required H. Klausner to redesign the suspension system and retrofit each of the deployments.

The bags of oyster cultch were monitored on a monthly interval beginning in January 2009. During each monitoring session, the bags were checked and agitated to remove sediment and accumulated debris. Epifouling organisms (primarily colonial tunicates and hydroids) were removed from the mesh bags, and the bags and racks were repositioned (if necessary). A sub-sample of the juvenile *Olympia* oysters was removed from the cultch bags and transported to the Estuarine and Coastal Science Laboratory (ECOS) where they were examined and scored for survival and spat density (# juveniles per shell). Measurements of shell length and width were recorded with digital calipers for 50 to 80 of the juvenile oysters, and then the sub-sample was returned to the cultch bag and re-deployed back into the estuary. South Slough staff member (Adam DeMarzo) retrieved the YSI-6600 multi-parameter datalogger on a monthly basis from the Younker Point site, returned the datalogger to the laboratory for data downloading and recalibration, and then re-deployed the instrument back into the estuarine tidal channel.

06/09 - 12/09: The bags of oyster cultch were monitored on a semi-monthly interval. During each monitoring session, the bags were checked and agitated to remove sediment and accumulated debris. Epifouling organisms (primarily colonial tunicates and hydroids) were removed from the mesh bags, and the bags and racks were repositioned (if necessary). A sub-sample of the juvenile *Olympia* oysters was removed from the cultch bags and transported to the Estuarine and Coastal Science Laboratory (ECOS) where they were examined and scored for survival and spat density (# juveniles per shell). Measurements of shell length and width were recorded with digital calipers for 50 to 80 of the juvenile oysters, and then the sub-sample was returned to the cultch bag and re-deployed back into the estuary. The YSI-6600 multi-parameter datalogger was also retrieved on a monthly basis from the Younker Point site, returned to the laboratory for data downloading and recalibration, and then re-deployed back into the estuarine tidal channel.

South Slough NERR made arrangements in the spring of 2009 with the Whiskey Creek Shellfish Hatchery (Netarts Bay, OR) to conduct broodstock work including spawning of adult oysters, generation of a large-scale batch of *Ostrea lurida* larvae, and production of a cohort of post-settlement juvenile oysters. Broodstock work was initiated by the shellfish hatchery in June 2009, and three-hundred bags of *Olympia* oyster cultch (juvenile *O. lurida* attached to Pacific oyster (*Crassostrea gigas*) shells) were transported by a rented truck from the hatchery to the Charleston Marina on 7 July. The bags of oyster cultch were then immediately transported by small boats to Younker Point (South Slough) where they were deployed in the lower intertidal zone (50 m X 10 m plot) as a series of 30 pyramids (3 rows, 10 pyramids per row). Each pyramid consisted of 10 oyster clutch bags that were stacked on a bag-layer of non-living shells, and the bags were secured with rope to a wood palette. It is estimated that the 300 bags of oyster cultch produced by the shellfish hatchery contained a total of about 4.5 million juvenile *Olympia* oysters. In addition, we retrieved 20 spat collector bags (bags of non-living Pacific oyster shells that served as settlement substrata for *Olympia* oysters / deployed in July 2008 at the mouth of Coalbank Slough (Isthmus Slough, Coos Bay) from the field. The bags were opened, each shell was scrubbed clean to remove epifouling organisms (by a crew of

volunteers from the Oregon Youth Conservation Corps), and the bags were transported to the Younker Point site where they were affixed to a series of four PVC racks placed into the lower intertidal zone.

South Slough NERR continued to work through the summer and fall of 2009 on the experimental out-planting of native Olympia oysters in the South Slough estuary. We successfully maintained and monitored 22 bags of Olympia oyster cultch (derived in 2008 from the Willapa Bay population), 180 spat collector bags (inhabited by locally-adapted juveniles that settled in Coos Bay in 2008), and 300 bags of juveniles obtained from the Whiskey Creek Shellfish Hatchery in 2009. In addition, we also maintained nearly-continuous time series measurements of water quality parameters from the estuarine tidal channel at the Younker Point deployment site.

IV. Results/Progress to Date

Describe in sufficient detail the status of the project (planning/design, implementation, monitoring, complete) in terms of progress and results achieved during the reporting period. This should include information such as the actual acreage that were restored/enhanced/protected or created to date (cumulative), and how this measurement was determined; projected acreage yet to be restored with CRP funds; miles of stream that were opened or will be opened for fish passage; lessons learned during this reporting period; challenges or potential roadblocks to future progress; and an updated timeline of remaining tasks needed to complete project.

7/06 - 5/07: Staff members from the Reserve worked with Chris Castelli (Lands Manager, Oregon Department of State Lands) to obtain a temporary use permit required by ODSL to establish the experimental oyster restoration sites within the South Slough estuary. The temporary use permit specified details about the experimental outplants in the South Slough estuary including the location and elevation in the intertidal zone, the number and size of the oyster cultch bags, the type of shell substratum that will be used for settlement, and a description of the adjacent land uses in the immediate area of the deployment at Younker Point. Several of these details are dependent upon the success of the broodstock collection, spawning success, spat survivorship, and cultch production activities that will take place within a commercial shellfish hatchery. The Reserve also worked with Matt Hunter (Shellfish Program Manager, Oregon Department of Fish and Wildlife) to develop material required for approval of an ODFW oyster transfer permit. The ODFW transfer permit is required because the individuals of *Ostrea lurida* will be collected in Coos Bay, transported to a commercial shellfish hatchery in Netarts Bay for the spawning and rearing of oyster cultch, and then transport back to Coos Bay for the experimental outplanting in the South Slough. The ODFW oyster transfer permit must contain the results of analytical screening tests to ensure that the oysters collected in Coos Bay are free of pathogens and parasites that could potentially be transferred between populations in the different bays.

The issue regarding the source of broodstock for the juvenile oysters that will be placed into the South Slough estuary was resolved based on the comparative analysis of genetic variation found

among populations of *Ostrea lurida* from Coos Bay, Yaquina Bay, Willapa Bay, and several other locations throughout the Pacific northwest. About 150 adult oysters were collected from the shoreline of Coos Bay, and analysis of microsatellite DNA markers in the oyster tissues was carried out in 2006-07 (by D. Stick, M. Camara, and C. Langdon at the OSU Molluscan Broodstock Program / USDA Shellfish Genetics Laboratory) to determine the genetic structure of the recovering population in Coos Bay. Recommendations provided by M. Camara (pers. comm.) indicate that hatchery supplements to the existing populations of *O. lurida* should be derived from local broodstock collected from within Coos Bay, and that the broodstock used for the South Slough outplanting should be collected from the closest source population or a population that experiences very similar ecological conditions, preferably both. Based on these recommendations, the adult oysters that will be used as the broodstock will be collected from the recovering populations of *O. lurida* that occur in Coos Bay in rip-rap habitat along the airport runway and also from pilings and rubble located along the shoreline of North Bend. The adult oysters that will be used as the source of broodstock will be collected during low tides in the spring of 2008.

South Slough NERR contacted the Whiskey Creek Shellfish Hatchery to make arrangements for the spawning of the broodstock oysters and culture of approximately 10-15 million larvae and production of 35-50 bags of cultch in the spring of 2008. The oyster larvae will be settled onto nylon bags that contain shells of non-living oysters. South Slough NERR has a unique opportunity to acquire shells of native oysters for use as the attachment substrata for cultch because large numbers of *O. lurida* shells have been historically deposited in dredge spoils along the shoreline of Coos Bay. An attempt will be made to obtain sufficient shells of native oysters from shorelands managed by the Oregon Department of State Lands and the Oregon International Port of Coos Bay that can be used as the substratum for larval settlement, but in the event that the supplies of Olympia oysters (*O. lurida*) shells are inadequate, we will use the non-living shells of Pacific oysters (*C. gigas*) which are plentiful and readily available in Coos Bay.

06/07 - 11/07: South Slough NERR worked to obtain approval for several additional permits required for the experimental outplanting of the *O. lurida* into the South Slough estuary. The Reserve received notification on 21 Nov 2007 from the Coos County Planning Department that re-establishment of the native oysters is an allowable use in the Natural Aquatic (NA) zoning area of the South Slough. Mike Graybill (Manager, SSNERR) submitted a Notification Form for Minimal Disturbance - General Authorization to the Oregon Department of State Lands (15 Nov 2007), and Craig Cornu (Stewardship Program Coordinator) continued to work with Chris Castelli (Lands Manager, Oregon Department of State Lands) to obtain a Temporary Use Permit required by ODSL to establish the experimental oyster restoration sites within the South Slough estuary. Steve Rumrill (Research Program Coordinator) submitted an application for an ODFW Scientific Collection Permit (26 Nov 2007), and he continued to work to gain approval for an ODFW Oyster Transfer Permit.

12/07 - 06/08: South Slough NERR obtained approval for several permits that are required for the experimental outplanting of the *O. lurida* into the South Slough estuary. These include: (1) notification from the Coos County Planning Department that re-establishment of the native oysters is an allowable use in the Natural Aquatic (NA) zoning area of the South Slough (21 Nov 2007); (2) a Notification Form for Minimal Disturbance - General Authorization to the

Oregon Department of State Lands (15 Nov 2007); (3) a Temporary Use Permit from the Oregon Department of State Lands required to establish the experimental oyster restoration sites within the South Slough estuary (4) a joint National Marine Fisheries Service / Oregon Department of Fish and Wildlife - Scientific Collection Permit (OR2008-4495 / 6 Mar 2008); and (5) a Washington State Scientific Collection Permit (#08-037 / 19 Feb 2008).

Hans Klausner joined the South Slough NERR on April 23 to contribute to the collection of broodstock and the transplanting of shell to South Slough. He tracked up-to-date information on similar restoration projects in the region and monitored the status of potential impacts to the project, particularly the status of *Vibrio* bacteria. H. Klausner is also the lead supervisor of an Oregon Youth Conservation Corps (OYCC) crew dedicated to South Slough projects throughout the summer, and he has enlisted them to prepare shell for recruitment collection that will eventually be transplanted into the South Slough.

On 16 June 2008 a group of 60 adult Olympia oysters were sent to Dr. Ralph Elston (AquaTechnics, Inc.) for a histological investigation of potential pathogens and parasites in the tissues of the adult oysters. The results from the shellfish examination were received on 30 June 2008 and indicate that the Coos Bay populations are free from a series of potentially harmful organisms. However, about 17% of the Olympia oysters from Coos Bay contained cells that exhibited evidence of focal hemocytosis and nuclear degeneration. The cause of the cellular degradation is not known, and it is recommended that the Coos Bay population be isolated during hatchery operations to generate cultch. Based on these results, Steve Rumrill submitted an application to the Oregon Department of Fish and Wildlife (30 June 2008) for a permit to transport about 200 Olympia oysters from Coos Bay to Netarts Bay for the broodstock and hatchery work. The ODFW Oyster Transfer Permit is required because the individuals of *Ostrea lurida* will be collected in Coos Bay (OR) and Willapa Bay (WA), transported to a commercial shellfish hatchery in Netarts Bay (OR) for the spawning and rearing of oyster cultch, and then transported back to Coos Bay for the experimental outplanting in the South Slough. The ODFW Transport Permit request is pending.

Steve Rumrill continued to work with Dr. Mark Camara (US Dept. of Agriculture) over the spring months of 2008 to develop a common garden approach to the experimental outplanting of native Olympia oysters (*Ostrea lurida*) within the South Slough estuary. Information about variability in DNA microsatellites (generated by OSU graduate student D. Stick and M. Camara) indicates that the Olympia oysters from Coos Bay exhibit a tight clustering with the oysters from Willapa Bay (WA) and Tomales Bay (CA), and that the clustering of these disparate populations is most likely an artifact of their inadvertent re-introduction to Coos Bay by the commercial mariculture industry. A reciprocal transplant approach (or common garden experiment) will be used that will include outplanting of juvenile oysters (cultch) from two different sources of broodstock (Willapa Bay and Coos Bay), and the oysters will be placed side-by-side into the tideflats of the South Slough where they will be monitored for survivorship, growth, onset of reproduction, and susceptibility to predation, overgrowth competition, and sedimentation.

An outbreak of *Vibrio tubiashii* bacteria occurred along the Pacific Northwest coast in April and May 2008, resulting in the shut-down of the commercial oyster cultivation operations throughout the northwest and temporary closure of the Whiskey Creek Shellfish Hatchery

(Netarts Bay). The outbreak posed a problem for the Pacific coast commercial oyster industry as well as efforts to restore native oysters because *V. tubiashii* is not pathogenic to humans but is very pathogenic to shellfish, especially the larvae and early settlers. In particular, the *Vibrio* bacteria outbreak raised serious concern about the success of the future years of oyster crops (2008-2010). High numbers of *Vibrio* bacteria were simultaneously detected in Humboldt Bay (CA), Yaquina Bay (OR), Netarts bay (OR), and Willapa Bay (WA) in early May 2008. In order to determine whether *Vibrio* bacteria were present in Coos Bay, S. Rumrill collected triplicate water samples from the South Slough (Charleston) and Coos Bay (North Bend) on 12 May 2008 and sent them to Dr. Ralph Elston (Regional Shellfish Pathologist; AquaTechnics, Inc. / Sequim, WA) for analysis. The water samples from South Slough tested positive for *Vibrio* and the water samples from Coos Bay were negative for *Vibrio*. Hans Klausner maintained an email list of concerned academic investigators, industry scientists, and conservationists to disseminate up-to-date information about the pathogen, and he was responsible for monitoring these communications and relaying pertinent information to the project team.

South Slough NERR contacted Suzanne Cudd (Operations Manager, Whiskey Creek Shellfish Hatchery, Netarts Bay) to make arrangements for the spawning of the broodstock oysters collected from Coos Bay, the culture of approximately 10-15 million larvae, and production of 35-50 bags of cultch in the summer of 2008. The Whiskey Creek Shellfish Hatchery has faced substantial technical difficulties in 2007 and 2008 posed by the outbreak of *Vibrio* bacteria in the nearshore waters and estuaries, and they have been able to obtain and install a seawater filtration and sterilization system that has brought their operations up to about 25% capacity. Completion of the broodstock work by the Whiskey Creek Hatchery is also dependent upon the outcome of the ODFW Oyster Transport permit, and approval by the commercial shellfish hatchery to accept and work with the Olympia oysters collected from Coos Bay. In the event that the ODFW Oyster Transfer Permit is approved, the Coos Bay adult oysters will be transported to Netarts Bay, and oyster larvae will be settled onto nylon bags that contain shells of non-living oysters.

07/08 – 11/08: A second group of 60 adult oysters were collected from Coos Bay and sent to the AquaTechnics Laboratory on 7 July 2008 for further histological examination of potential parasites and pathogens. Unfortunately, about 12% of the second group of oysters also exhibited histological evidence of tissue irregularities, and the ODFW Oyster Transfer Permit was denied. Consequently, it was not possible to conduct the hatchery work in the summer of 2008 required to generate bags of juvenile cultch from the Coos Bay oysters.

Denial of the ODFW Oyster Transfer Permit required re-consideration of the reciprocal transplant approach (or common garden experiment). The new design includes outplanting of juvenile oysters (22 bags of cultch or about 4 million spat) derived from the Willapa Bay population (in the summer of 2008) along with deployment of oyster bags throughout Coos Bay to collect larvae and spat (cultch) produced from the locally-adapted adults (summer 2008). Cultch from the two different sources of broodstock (Willapa Bay and Coos Bay) will be placed side-by-side into the tideflats of the South Slough in the spring of 2009 where they will be monitored for survivorship, growth, onset of reproduction, and susceptibility to predation, overgrowth competition, and sedimentation. The alternative field experiment was initiated in July-August 2008 where 22 bags of oyster cultch developed from Willapa Bay broodstock were

deployed in the South Slough. In addition, 180 spat collector bags (mesh bags containing Pacific oyster shell) were deployed at several locations in Coos Bay to obtain juvenile oysters from the local Coos Bay broodstock.

Steve Rumrill, Kevin Cellura, and Hans Klausner traveled to the Whiskey Creek Shellfish Hatchery (Netarts Bay) on 25 July, and they obtained 22 bags of Olympia oyster cultch (Willapa Bay broodstock) that were donated by The Nature Conservancy from their ongoing project in Netarts Bay. In addition, South Slough NERR staff members Hans Klausner and Don Smith worked with the Oregon Youth Conservation Corps to prepare the 180 spat collector bags filled with Pacific oyster shell. The spat collector bags were deployed in August 2008 from docks, pilings, and a floating barge in Coos Bay to provide shell substrata that will be attractive to settlement of Olympia oyster larvae derived from the local Coos Bay population. After the spat collector bags in Coos Bay are colonized by juvenile Olympia oysters, the bags will be transported into the South Slough in the spring of 2009 where they will be placed side-by-side with the cultch bags which contain juvenile oysters from Willapa Bay.

Steve Rumrill, Kevin Cellura (Marshfield High School), and Rheannon Arvidson (Portland Community College) traveled to Willapa Bay (15-16 July 2008) to collect and transport about 200 adult specimens of *Ostrea lurida* to the laboratories at the University of Oregon – Oregon Institute of Marine Biology. Additional adult oysters were collected from various sites in Coos Bay to provide specimens for comparative measurements of shell sizes and weights, and for summer research projects to investigate susceptibility to predation, overgrowth competition, and hydrodynamic modification by successive generations of growing oysters. In particular, Kevin Cellura initiated a series of laboratory experiments to document the differential susceptibility of adult oysters to predation by crabs (*i.e.*, *Cancer magister*, *C. productus*, *C. attenarius*, *Carcinus maenus*). Rheannon Arvidson prepared numerous specimens of single, double, and triple-stack oysters to represent the successive generations of adults that contribute to clusters in the field, and she worked in a laboratory flow-tank to investigate the alteration of water pathways as they flow around the oysters in moving fluid. Different types of adhesives were used to attach living oysters to ABS plates, and the team worked together to take measurements and photos of the specimens, and to deploy the oysters plates in the field from floating docks. The oyster plates will be monitored throughout the year to assess the susceptibility of the adults to overgrowth competition by colonial tunicates.

12/08 – 05/09: South Slough NERR continued to work through the winter and spring of 2009 on the experimental out-planting of native Olympia oysters (*Ostrea lurida*) in the South Slough estuary. We successfully maintained and monitored 22 bags of Olympia oyster cultch (derived from the Willapa Bay population) and 180 spat collector bags (colonized by locally-adapted settlers from Coos Bay), and maintained nearly-continuous time series measurements of water quality parameters from the estuarine tidal channel at the Younker Point deployment site. We estimate that a combined total of about 350,000 juvenile Olympia oysters currently inhabit the combination of cultch bags and spat collector bags deployed in Coos Bay and the South Slough as a direct outcome from this project. In the event that these juvenile oysters survive to maturity, they will contribute to the recovery of Olympia oyster populations throughout Coos Bay.

Technical information and experience gained by the cooperative broodstock work, local out-planting of cultch bags, and successful settlement and monitoring of juvenile oysters in spat collector bags contributed to development of a collaborative grant proposal submitted jointly by The Nature Conservancy and the Oregon Department of State Lands / South Slough NERR to the NOAA / Marine and Coastal Habitat Restoration Program (6 April 2009). The proposal titled “*Restoration and Recovery of Native Olympia Oysters in Oregon Estuaries*” seeks \$1.5M to establish a series of oyster recovery sites in the polyhaline region of Coos Bay and the South Slough, as well as additional funds (\$2.2M) for large-scale Olympia oyster recovery activities in Netarts Bay, OR (coordinated by The Nature Conservancy; contact – Dick Vander Schaaf). South Slough NERR also developed and submitted a second grant proposal to the US Army Corps of Engineers (8 May 2009). The proposal titled “*A Novel Technique for Restoration of Native Olympia Oysters in Coos Bay and the South Slough National Estuarine Research Reserve*” seeks \$630,000 to establish additional beds of Olympia oysters along the shorelines of dredge spoil islands in Coos Bay, to conduct hydro-acoustic and underwater video surveys of the remaining subtidal oyster populations in the Coos Bay navigational channel, and to develop and deploy geotextile panels as an alternative spat collector technique for experimental oyster beds in the South Slough NERR.

06/09 - 12/09: South Slough NERR continued to work through the summer and fall of 2009 on the experimental out-planting of native Olympia oysters in the South Slough estuary. We successfully maintained and monitored 22 bags of Olympia oyster cultch (derived in 2008 from the Willapa Bay population), 180 spat collector bags (inhabited by locally-adapted juveniles that settled in Coos Bay in 2008), and 300 bags of juveniles obtained from the Whiskey Creek Shellfish Hatchery in 2009. In addition, we also maintained nearly-continuous time series measurements of water quality parameters from the estuarine tidal channel at the Younker Point deployment site.

Over 100 species of non-indigenous aquatic species are known to inhabit Coos Bay, and nearly 60 non-indigenous aquatic species have been documented within the South Slough estuary (Rumrill, 2006). Although commercial oyster aquaculture occurs in both Coos Bay and South Slough (and most likely serves as an important vector for the non-native species), ballast water discharge from international cargo vessels occurs only in Coos Bay. Hans Klausner coordinated an examination of the oyster settlement collector bags deployed previously in Coos Bay. The examination of epifaunal invertebrates and other organisms was conducted by Dr. Jim Carlton and his Marine Bioinvasions class at the Oregon Institute of Marine Biology. The primary groups of invertebrates that were observed included tunicates, bryozoans, hydroids, barnacles, mussels, amphipods, crabs, shrimp, and polychaetes. Of these, two species were observed that were not previously known to occur in the South Slough. These were the Asian amphipod (*Incisocalliope derzhavini*) and Atlantic amphipod (*Monocorophium insidiosum*).

The Reserve’s Administrative Rules explicitly restrict “*the deliberate introduction of a non-native species (or subspecies) within the Research Reserve’s administrative boundaries without the prior approval of the Commission.*” To reduce the possibility of transporting alien species into the South Slough, the project team elected to thoroughly clean the oysters and place them in new bags before transport into South Slough (Younker Point). The intent of this process was to prevent the oysters or the bags from being additional vectors for the introduction of non-

native species. Hans Klausner organized this effort with assistance from volunteers and the Oregon Youth Conservation Corps.

A summary of the total number of *O. lurida* established within the South Slough estuary over the duration of this project is presented in Table 1. We estimate that a combined total of about 3,900,000 juvenile Olympia oysters currently inhabit the combination of cultch bags and spat collector bags deployed in Coos Bay and the South Slough as a direct outcome from this project. In the event that these juvenile oysters survive to maturity, they will contribute directly to the recovery of Olympia oyster populations throughout South Slough and Coos Bay. The bags of oyster cultch were checked over the spring and summer months and the juvenile oysters (Willapa Bay and Coos Bay broodstock) survived well and grew to about 10-12 mm in shell length by July 2009. The largest juvenile oysters reached shell lengths greater than 15 mm by August 2009. In addition, we retrieved 20 spat collector bags (bags of non-living Pacific oyster shells that served as settlement substrata for Olympia oysters / deployed in July 2008 at the mouth of Coalbank Slough (Isthmus Slough, Coos Bay) from the field. The bags were opened, each shell was scrubbed clean to remove epifouling organisms (by a crew of volunteers from the Oregon Youth Conservation Corps), and the bags were transported to the Younker Point site where they were affixed to a series of four PVC racks placed into the lower intertidal zone. The bags of oyster cultch were checked over the spring and summer months and the juvenile oysters (Willapa Bay and Coos Bay broodstock) survived well and grew to about 10-12 mm in shell length by July 2009. The largest juvenile oysters reached shell lengths greater than 15 mm by August 2009. One-hundred and eighty additional spat collector bags were also deployed at the mouth of Coalbank Slough in August 2009 to serve as settlement sites for the planktonic larvae of Olympia oysters. These new spat collector bags will be checked, cleaned of epifouling organisms, and transported into the South Slough in the summer of 2010.

Table 1. Olympia Oysters deployed at Younker Point, South Slough (March 2010)

Group: Source	Deployment Date	Age Class (in March 2010)	Quantity	Deployment Type
A: <u>Hatchery Cultch</u> (Netarts Bay)	July 2008	21 months	20 bags / ca. 450 juvenile oysters per bag (9,000 oysters)	mesh bags supported above bottom by PVC racks
B: <u>Adults</u> (Coos Bay & Willapa Bay)	June-July 2008	ca. 2-3 + years	3 bags / 20 adult oysters per bag (60 oysters)	mesh bags supported above bottom by PVC racks
C: <u>Hatchery Cultch</u> (Netarts Bay)	July 2009	10 months	300 bags / 13000 post larval oysters per bag (3,900,000 oysters)	mesh bags stacked in groups of 10 on wood pallets
D: <u>Settlement Collector</u> (Coos Bay)	August 2009	ca. 19 months	180 bags / ca. 150 juvenile oysters per bag (27,000 oysters)	mesh bags supported above bottom by PVC racks

V. Monitoring and Maintenance Activities

Describe any monitoring and maintenance that has taken place during the reporting period and/or procedures that are being used to evaluate the relative success of the project in achieving its goals and objectives. When will monitoring results become available?

7/06 - 5/07: Determination of the genetic identity of the source populations of broodstock was completed along with the development of the recommendation that hatchery outplants of *O. lurida* should be derived from local broodstock collected from within Coos Bay, and that the broodstock used for the South Slough outplanting should be collected from the closest source population or a population that experiences very similar ecological conditions.

06/07 - 11/07: Due to the absence of substantial genetic variability between the oysters that inhabit Coos Bay and Willapa Bay, the Molluscan Broodstock Program made the recommendation that hatchery outplants of *O. lurida* should be derived from a combination of adults from Willapa Bay and adults from Coos Bay. Consequently, the juvenile oysters (cultch) will be transplanted into the South Slough in the form of a “common garden” experiment.

12/07 - 06/08: Staff members from South Slough NERR (S. Rumrill, A. Helms, A. DeMarzo, C. Cornu, H. Klausner, J. Robinson) provided assistance to the ODFW Shellfish Biologist (Scott Groth) and several other staff members from ODFW on 20-22 May 2008 in an effort to salvage a local population of Olympia oysters that were scheduled for removal from a contaminated former industrial ore processing site. The substratum at the site was contaminated and scheduled for removal by backhoe, but the oyster tissues were not contaminated. The team counted, measured, weighed, and removed a large number of oysters (approximately 4,500 oysters) that were placed into bags in the tidal channel for temporary storage. The bagged oysters were then transplanted back into a clean mixture of new rock and shell placed into the intertidal zone.

07/08 – 11/08: We out-planted 22 bags of Olympia oyster cultch (Willapa Bay broodstock) at the designated transplant site (Yunker Point) within the South Slough estuary during this reporting period. Yunker Point is located within the transition zone between the marine-dominated (euhaline) and polyhaline hydrographic regions of the South Slough. The spat collector bags were placed into the shallow subtidal zone and lower intertidal zone, and they were monitored by snorkeling in late August and September 2008. A sub-sample of the juvenile oysters were collected on October 14 and brought into the laboratory for measurements of shell sizes. The juvenile *Ostrea lurida* in South Slough had average shell dimensions of 4.48 mm in length and 4.71 mm in width (n=25). We also deployed 180 bags of Pacific oyster shell at several locations in Coos Bay during this reporting period. The deployment sites were located in the polyhaline hydrographic region of the Coos estuary, and the bags of Pacific oyster shells were attractive to settling larvae of Olympia oysters. The juvenile *O. lurida* in the Coos Bay spat collector bags had average shell dimensions of 4.16 mm in length and 4.23 mm in width in October 2008 (n=20).

It became apparent during the project that the larvae of *Ostrea lurida* sometimes settle and complete metamorphosis on the shells of living Pacific oysters (*Crassostrea gigas*) which are cultured extensively in commercial mariculture plots throughout the tideflats of Coos Bay. The Pacific oysters are harvested after grow-out periods of 2-3 years, resulting in a potential source of incidental mortality for the native Olympia oysters. It is important to ask: *what % of the local Olympia oyster population is lost due to commercial mariculture of Pacific oysters?* To address this issue, South Slough staff member S. Rumrill counted the number of dead Olympia oyster (*O. conchaphila*) adults that were affixed to Pacific oyster (*C. gigas*) shells that had been cultivated and harvested from commercial oyster plots in Coos Bay. Shells that had been discarded into two piles on the shoreline of the South Slough were examined by hand in August 2008. For shell Pile A, a total of 386 Pacific oyster shells were examined and 15 dead Olympia oysters were observed (4% incidental mortality). Similarly, for Pile B a total of 525 Pacific oyster shells were examined and 18 dead Olympia oysters were observed (3% incidental mortality). These results indicate that about 3-4% of the Pacific oysters cultivated commercially in Coos Bay are colonized by Olympia oysters, and that these Olympia oysters are removed from the population when the Pacific oysters are harvested.

12/08 – 05/09: The bags of Olympia oyster cultch were monitored over the winter and spring months of 2009 (Jan-May). The juvenile oysters derived from Willapa Bay broodstock survived well at the out-planting site in South Slough (Yunker Point), and the oysters remained small in the winter (average shell length 10-11 mm / Jan-Mar) and then began to increase in size in the spring (average shell length 13 mm / May 2009). We estimate that about 290,000 juvenile oysters currently inhabit the cultch bags deployed at Yunker Point. Olympia oyster larvae derived from locally-adapted adults (Coos Bay broodstock) settled in fairly large numbers on the spat collector bags deployed in Coos Bay (Sause Brothers dock, Glenbrook Pier, Railroad Bridge), and the greatest numbers of settlers were observed at the Railroad Bridge site (located near the mouth of Coalbank Slough, Coos Bay). We estimate that about 60,000 juvenile oysters currently inhabit the spat collector bags deployed in Coos Bay. The locally-adapted juvenile oysters from Coos Bay remained at a small size in the winter (average shell length 7 mm / Jan; shell length 8 mm / Mar) and then began to increase in size in the spring (shell length 11 mm / Apr 2009). Substantial variability was observed in the shell sizes reached by the juvenile oysters in Coos Bay and South Slough. The locally-adapted Olympia oysters exhibited greater variability and reached a maximum shell length of 23.5 mm in April 2009 (Coos Bay). In contrast, the juveniles oysters from Willapa Bay exhibited less variability and only reached a maximum shell length of 18.5 mm in May 2009 (South Slough). The spat collector bags currently deployed in Coos Bay (with juvenile Olympia oysters) will be transported into the South Slough in the summer 2009 where they will be placed side-by-side with the cultch bags which contain juvenile oysters from Willapa Bay.

Time-series measurements of estuarine water quality parameters recorded by the YSI-6600 datalogger at the Yunker Point site (South Slough) revealed that the estuarine tidal channel is characterized by distinct wet and dry seasons. For example, during the dry season (*i.e.*, August 2008) the ambient water temperature ranged between 11.5 and 18.2 deg C and ambient salinity ranged between 30.5 and 30.1 (psu). In contrast, during the wet season (*i.e.*, December 2008) the ambient water temperature ranged between 8.1 and 11.4 deg C and ambient salinity ranged between 27.3 and 32.2 (psu). Dissolved oxygen values vary substantially between 5-10 mg/L (with occasional short-term hypoxic events when DO values drop below 2 mg/L) in the dry

season, while they are typically more stable at 7-9 mg/L during the wet season. We do not have comparable time-series data to describe seasonal variability in the ambient water quality parameters in Coos Bay, but we suspect that the juvenile oysters that inhabit the spat collector bags deployed in Coos Bay (Sause Brothers dock, Glenbrook Pier, Railroad Bridge) are subjected to a greater influence of freshwater inputs in the winter from Isthmus Slough, Coalbank Slough, and the Coos River.

06/09 - 12/09: The bags of Olympia oyster cultch were monitored over the summer and fall months of 2009 (Jun-Nov). The juvenile oysters derived from Willapa Bay broodstock survived well at the out-planting site in South Slough (Yunker Point), and the oysters reached an average shell length of about 16.3 mm (Jul 2009). The locally-adapted juvenile oysters from Coos Bay also grew substantially to reach an average shell length of 17.6 mm in July 2009. Substantial variability was observed in the shell sizes reached by the juvenile oysters in Coos Bay and South Slough and greatest variability was observed in the population of locally-adapted Olympia oysters derived from natural settlers in Coos Bay. Olympia oyster larvae derived from locally-adapted adults (Coos Bay broodstock) also settled in fairly large numbers on a series of 180 spat collector bags deployed in Coos Bay (Railroad Bridge; near the mouth of Coalbank Slough, Coos Bay). The spat collector bags currently deployed in Coos Bay (with juvenile Olympia oysters) will be transported into the South Slough in the summer 2010 where they will be placed side-by-side with the cultch bags which contain juvenile oysters from Willapa Bay.

VI. Community Involvement

Describe community support and any public involvement in the project that has occurred during the reporting period, including the specific roles of volunteers in project activities.

07/06 - 5/07: We had not yet engaged the services of community volunteers in the implementation of this project.

06/07 - 11/07: We had not yet engaged the services of community volunteers in the implementation of this project.

12/07 - 06/08: Two summer research interns (Kevin Cellura / Marshfield High School; Rheannon Arvidson / Portland Community College) initiated their work at the SSNERR / Estuarine and Coastal Science Laboratory to investigate ecological aspects of the early recovery of the Olympia oyster populations. Kevin is studying the potential differences in survival, growth, and susceptibility to predation and overgrowth competition between populations of oysters from Coos Bay and Willapa Bay to determine whether the local populations have become better adapted to the ecological conditions within Coos Bay. Rheannon is conducting an investigation of the modification of water flow and turbulence created by single, double, and triple clusters of oysters that recruit and grow in successive generations. Rheannon will also document the colonization of living *O. lurida* by a variety of epifaunal invertebrates including sponges, tunicates, barnacles, and bryozoans.

On 30 June 2008 South Slough NERR purchased a palette of 50 bags of commercial Pacific oyster (*Crassostrea gigas*) shells. These oyster shells were transported to the campus of the University of Oregon Institute of Marine Biology where an 8-person team of volunteers from the Oregon Youth Conservation Corps (OYCC) cleaned the shell bags with a high-pressure hose, and re-bagged the shells into 150 smaller double-bag units. These smaller bags of Pacific oyster shells will be deployed into different regions of Coos Bay during the summer of 2008 as settlement collectors to provide substratum for attachment by the larvae of *Ostrea lurida*.

07/08 – 11/08: Two summer research interns (Kevin Cellura / Marshfield High School; Rheannon Arvidson / Portland Community College) continued their work over the summer of 2008 at the SSNERR / Estuarine and Coastal Science Laboratory to investigate ecological aspects of the early recovery of the Olympia oyster populations. Kevin is studying the potential differences in survival, growth, and susceptibility to predation and overgrowth competition between populations of oysters from Coos Bay and Willapa Bay to determine whether the local populations have become better adapted to the ecological conditions within Coos Bay. Rheannon is conducting an investigation of the modification of water flow and turbulence created by single, double, and triple clusters of oysters that recruit and grow in successive generations. Kevin and Rheannon also documented the colonization of living *Ostrea lurida* by a variety of epifaunal invertebrates including sponges, tunicates, barnacles, and bryozoans.

12/08 – 05/09: Kevin Cellura (Marshfield High School / science teacher) and Steve Rumrill (South Slough NERR) travelled to San Diego (15-17 January, 2009) to participate in the Partners in Science National Conference. Kevin and Steve presented a poster titled “*Restoration and Recovery of Olympia Oysters within Coos Bay and South Slough, Oregon*” and they participated in a series of workshops designed to increase the abilities of high school science teachers and their academic mentors to engage in collaborative research that can include an element of participation during the school year by students. Travel costs for Kevin and Steve to attend the Partners in Science Conference were supported by the Murdock Charitable Trust.

Kevin Cellura (Marshfield High School), Steve Rumrill, Adam DeMarzo, and Hans Klausner (South Slough NERR) retrieved a series of experimental Olympia oyster bags from three locations in Coos Bay (Charleston Marina, Citrus Dock, Sause Brothers Dock) on 23 February 2009 and returned them to the ECOS Laboratory for holding and cleaning. The adult oysters originated from three locations (Willapa Bay, WA, Bunker Hill, and the Coos Bay-North Bend Airport). Steve delivered a series of four seminar presentations on the natural history of Olympia oysters to the students from Marshfield High School (24 February 2009), and about 50 high-school student volunteers participated directly in two laboratory sessions (25 and 26 February 2009) to record measurements of the shell dimensions (length and width) reached by the oysters. These data will be used to augment the information obtained by the ongoing work with juvenile oysters in Coos Bay and the South Slough.

06/09 - 12/09: Kevin Cellura (Marshfield High School / science teacher) and Steve Rumrill worked together to conduct additional research on the ecology of Olympia oysters. Kevin’s internship over the summer months of 2008 and 2009 focused on determination of differences in the ecological performance of the local Olympia oysters from Coos Bay in comparison with Olympia oysters from Willapa Bay, WA. Measurements were taken of the survival and growth

of adult and juvenile oysters that were affixed to a series of ABS settlement plates. The plates were deployed at six locations throughout Coos Bay in the summer of 2008, and the oysters were retrieved, checked for survival and measured for growth in the summer of 2009. Kevin also conducted a series of laboratory experiments to assess the susceptibility of *Ostrea lurida* to predation by several species of crabs and a seastar.

Jacob Evans (COSEE Intern) also worked at the South Slough NERR / Estuarine and Coastal Science Laboratory over the summer of 2009 to investigate alteration of hydrodynamic streamlines by clusters of Olympia oysters. Single, double, triple, and quadruple clusters of oysters were placed into a laboratory flow tank, and they were oriented with regard to the ebb and flood of simulated tidal currents. Thin streamlines of lowfat milk were injected into the flow-field, and the streamlines were recorded by a digital video camera. Analysis of the video images revealed that the oyster clusters result in a 28-30% reduction in the velocity of tidal currents as they pass over the adult oysters. Results from this research project will contribute to the understanding of biofiltration by Olympia oysters, and will help guide the design of experimental oyster restoration plots in the field.

A group of 6-8 crew members from the Oregon Youth Conservation Corps (OYCC) worked with the South Slough NERR to clean, prepare, and transport oyster settlement collector bags in preparation for deployment in the tidal channels of Coos Bay. The OYCC crew also constructed a set of PVC racks that were used to suspend the bags of juvenile oysters above the bottom, and they worked with SSNERR staff members to retrieve the settlement collector, scrub the shells to remove non-indigenous species and epifouling organisms, and prepare the bags for redeployment in the South Slough.

VII. Outreach Activities

Describe any outreach or educational activities (e.g. training, brochures, videos, press releases or public events) related to the project that has occurred during the reporting period.

07/06 - 5/07: Steve Rumrill delivered a presentation to describe the native oyster restoration project to the South Slough NERR Management Commission (17 Aug 2006). In addition, he delivered a seminar titled "*Restoring Olympia Oysters to South Slough*" for the general public as part of the South Slough Winter Seminar Series (31 Mar 2007). Steve Rumrill also worked with Scott Groth (Shellfish Biologist, Oregon Department of Fish and Wildlife) to produce a manuscript titled "*History of Native Oysters (Ostrea lurida) in Oregon Estuaries, and a Description of Recovering Populations in Coos Bay.*" Background information was compiled for many estuaries to summarize the status and extent of knowledge about *O. lurida* populations in Oregon. The historical occurrence of native oysters in Yaquina and Netarts Bays is confirmed by numerous records of fishery landings. In contrast, historic populations in Coos Bay and South Slough are evident by the presence of large shell deposits and shell middens located throughout the polyhaline (>18-30 psu) and mesohaline (>5-18 psu) regions of the estuary. Other Oregon estuaries (such as Tillamook, Alsea, and Umpqua) may have previously had ambient environmental conditions suitable to support self-sustaining populations in the past, but none of these estuaries currently are inhabited by natural populations of *O. lurida*, and they do not have clear records of historical occupation by native Olympia oysters. The manuscript was

submitted to the Journal of Shellfish Research (Feb 2007) for publication in a special issue dedicated to the biology, ecology, and recovery of Olympia oysters.

06/07 - 11/07: Steve Rumrill presented a seminar titled "*Mariculture Development, Ecological Impacts of Pacific Oyster Culture, and Restoration of Native Olympia Oysters in the South Slough Estuary, OR*" at the University of Oregon – Oregon Institute of Marine Biology (27 June 2007), and a presentation to describe the native oyster restoration project at an estuarine habitat advisory workshop hosted by the South Slough NERR (12 July 2007).

12/07 - 06/08: Steve Rumrill delivered a presentation titled "*Restoring Olympia Oysters to South Slough*" to a group of 65 high school students at Glendale High School (1 April 2008).

07/08 – 11/08: Steve Rumrill delivered a presentation titled "*Restoring Olympia Oysters to the South Slough Estuary*" during a weekend short-course on coastal habitat restoration taught at the Oregon Institute of Marine Biology (27 July 2008 / Charleston, OR).

S. Rumrill, K. Cellura, R. Arvidson, and H. Klausner delivered a joint presentation titled "*Restoration of Native Olympia oysters in the South Slough Estuary*" during the summer meeting of the SSNERR Management Commission (24 July 2008 / Charleston, OR).

Rheannon Arvidson presented a seminar titled "*Alteration of Hydrodynamic Flow by Clusters of Olympia Oysters: Why Not All Drag Forces are a Drag*" at the Hatfield Marine Science Center (15 August 2008 / Newport, OR).

Kevin Cellura presented a poster titled "*Predation by Crabs as a Factor in the Restoration of Olympia Oysters in Coos Bay and the South Slough, Oregon*" during the Murdock Trust – Partners in Science Conference (15 August 2008 / Vancouver, WA).

Steve Rumrill presented a seminar titled "*Interactions with non-indigenous aquatic species pose an impediment to recovery of native Olympia oysters (*Ostrea conchaphila*) populations within Coos Bay, Oregon, USA*" at the Annual Meeting of the North Pacific Marine Science Organization (28 October 2008 / Dalian, China).

S. Rumrill, K. Cellura, R. Arvidson, and H. Klausner presented a poster titled "*Re-establishment of Native Olympia Oysters (*Ostrea lurida*) within the South Slough Estuary, Oregon*" at the annual meeting of the National Estuarine Research Reserve System (3-6 November 2008 / Pacific Grove, CA).

12/08 – 05/09: Steve Rumrill presented a seminar titled "*Interactions with non-indigenous aquatic species pose an impediment to recovery of native Olympia oysters (*Ostrea lurida*) populations within Coos Bay, Oregon, USA*" at the annual meeting of the Oregon Wildlife Society (Salishan, OR / 13 February 2009).

Steve Rumrill delivered a series of four classroom lectures on the natural history of Olympia oysters for the students from Marshfield High School (Coos Bay, OR / 24 February 2009). Hans Klausner provided assistance during subsequent laboratory sessions when the high school students recorded measurements of the sizes of juvenile and adult oysters to contribute to the

comparison of ecological performance between the distant (Willapa Bay) locally-adapted (Coos Bay) broodstock populations.

Steve Rumrill delivered a presentation titled “*Restoring Olympia Oysters in Coos Bay and the South Slough Estuary*” during the Pacific Northwest Bivalve Summit (workshop on assessment of at-risk bivalve populations in British Columbia, Washington, Oregon) held in Bellingham, WA (2 April 2009).

Steve Rumrill presented a seminar titled “*Non-indigenous aquatic species pose a hurdle for recovery of native Olympia oysters (Ostrea lurida) in Coos Bay, Oregon, USA*” during a special session on Olympia oysters held at the annual meeting of the Pacific Estuarine Research Society (Bellingham, WA / 4 April 2009).

06/09 - 12/09: Steve Rumrill presented a seminar titled: “*Restoration and Recovery of Native Olympia Oysters within Coos Bay and the South Slough*” to describe the project during the spring seminar series at the Oregon Institute of Marine Biology (5 June 2009).

Staff members from the South Slough NERR delivered a presentation and hands-on demonstration on the natural history and recovery of Olympia oysters during the Coos County Fair (Myrtle Point, OR / July 2009).

Jacob Evans delivered a final seminar titled “*Hydrodynamic Alteration of Tidal Currents by Clusters of Olympia Oysters*” to describe his work at the Oregon Institute of Marine Biology (Charleston, OR / 12 August 2009) and at the Hatfield Marine Science Center (Newport, OR / 14 August 2009).

Kevin Cellura and Steve Rumrill presented a seminar titled “*Olympia Oysters: Are Locals Better?*” during the annual Murdock / Partners in Science Conference (Vancouver, WA / 14 August 2009), and they also presented the seminar at a meeting of the Coos Bay School Board (Coos Bay, OR / 15 September 2009).

Rumrill also delivered a seminar titled “*Non-indigenous aquatic species pose a hurdle for recovery of native Olympia oysters (Ostrea lurida) in Coos Bay, Oregon, USA*” during a session on the ecology of estuarine shellfish held at the biennial conference of the Coastal and Estuarine Research Federation (Portland, OR / 4 November 2009).

A poster titled “*Restoration and Recovery of Olympia Oysters (Ostrea lurida) within the South Slough Estuary*” was presented at the annual meeting of the national Estuarine Research Reserve System (San Diego, CA / 12 November 2009).

VIII. Supporting Materials

Please include any supporting materials relating to the project, such as articles/news clippings, project photographs (before, during, and after--high resolution images on CD ROM are appreciated), project maps, related web sites, and evidence of NOAA Community-based Restoration Program support (e.g. photographs of signs at project sites, funding credit on outreach materials, press releases with complete program name, etc.)

See attached file for Figures 1-24.

Literature Cited:

Baker, P. 1995. Review of the ecology and fishery of the Olympic oyster, *Ostrea lurida*, with annotated bibliography. J. Shellfish Research 14:501-518

Baker, P., N. Richmond, and N. Terwilliger. 2000. Re-establishment of a native oyster, *Ostrea conchaphila*, following a natural local extinction. In, J. Pedersen, ed., Marine Bioinvasions: Proceedings of the First National Conference, MA MIT Sea Grant Program, pp. 221-231.

Borde, A.B., R.M. Thom, S.S. Rumrill, and L.M. Miller. 2003. Geospatial habitat change analysis in Pacific Northwest coastal estuaries. Estuaries 26:1104-1116.

Brumbaugh, R.D., M.W. Beck, L.D. Coen, L. Craig, and P. Hicks. 2006. A Practitioners Guide to the Design and Monitoring of Shellfish Restoration Projects: An Ecosystem Services Approach. The Nature Conservancy, Arlington, VA. 28 pp.

Brumbaugh, R.D., and L.D. Coen. 2009. Contemporary approaches for small-scale oyster reef restoration to address substrate versus recruitment limitation: a review and comments relevant for the Olympia oyster, *Ostrea lurida* carpenter 1864. J. Shellfish Research 28:147-161.

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Fisheries and Oceans Canada. 2009. Management Plan for the Olympia oysters (*Ostrea conchaphila (lurida)*) in Canada. Species at Risk Act, Management Plan Series. Fisheries and Oceans Canada, Ottawa VI + 31 pp.

Gordon, D.C., N.E. Blanton, and T.Y. Nosh. 2001. Heaven on the Half Shell: The Story of the Northwest's Love Affair with the Oyster. Washington Sea Grant Program / West Wind Press, Portland, OR 160 pp.

Groth, S. and S. Rumrill, 2009. History of native oysters (*Ostrea lurida*) in Oregon estuaries, with a description of recovering populations in Coos Bay. J. Shellfish Research 28:51-58.

McGraw, K.A. 2009. The Olympia oyster, *Ostrea lurida* Carpenter 1864 along the west coast of North America. J. Shellfish Research 28:5-10.

Moss, M.L., and J.M. Erlandson, 1995. An Evaluation, Survey, and Dating Program for Archaeological Sites on State Lands of the Northern Oregon Coast, with reports on

Archeological Surveys of South Slough (Coos Bay) and of Intertidal Fishing Sites. Final Report #9404, Oregon State Historic Preservation Office, 134 pp.

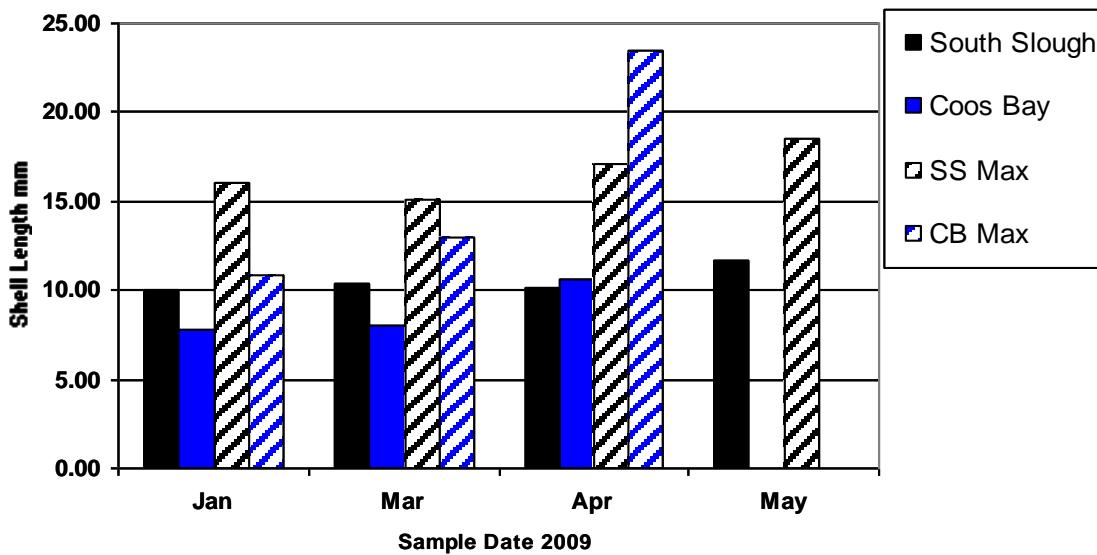
Nelson, K.A., L.A. Leonard, M.H. Posey, T.D. Alphin, and M.A. Mallin. 2004. Using transplanted oyster beds to improve water quality in small tidal creeks: a pilot study. *J. Exp. Mar. Biol. Ecol.* 298:347-368.

NOAA, 2007. West Coast Native Oyster Restoration: 2006 Workshop Proceedings. US Department of Commerce, NOAA Restoration Center. 108 pp.

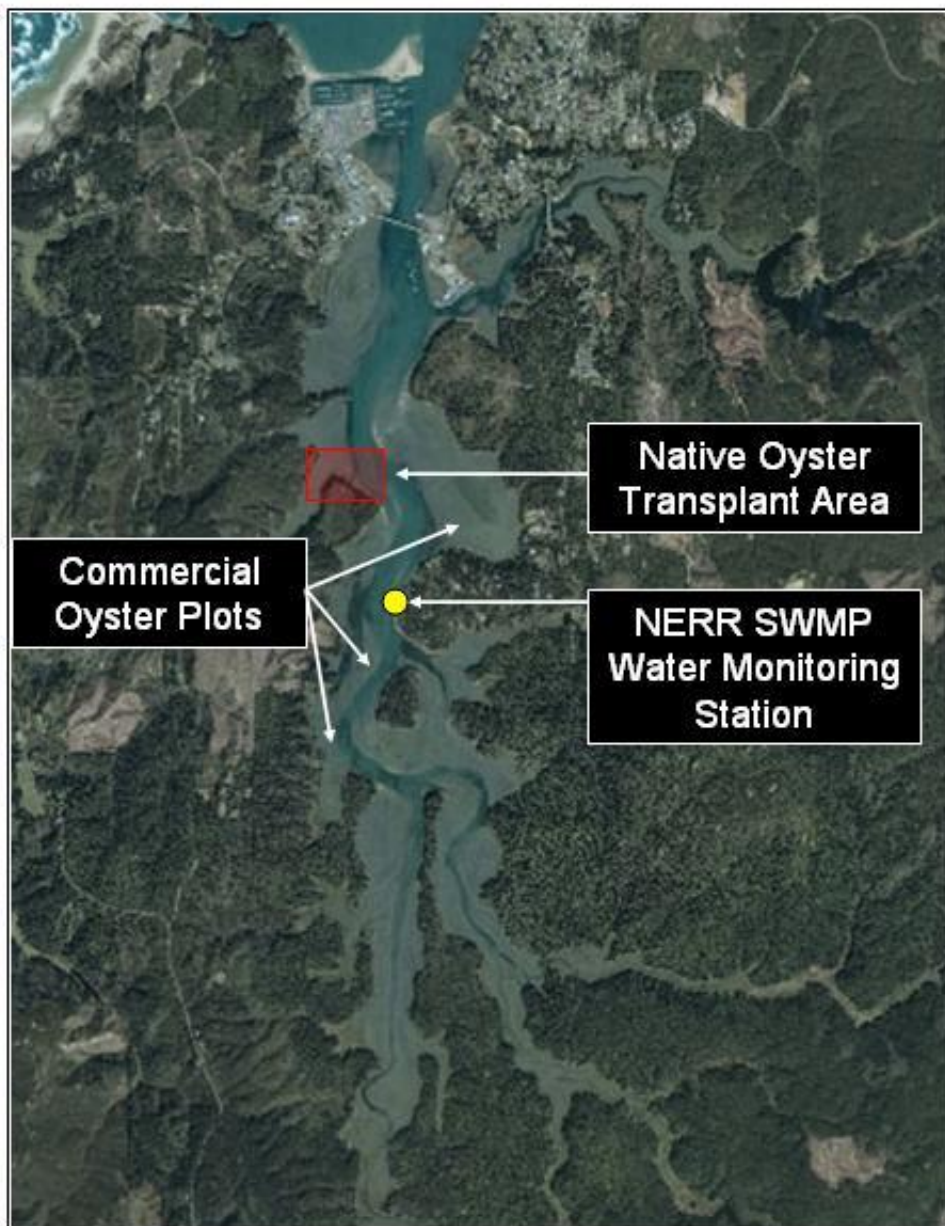
Peter-Contesse, T., and B. Peabody. 2005. Re-establishing Olympia Oyster Populations in Puget Sound, Washington. Washington Sea Grant Publication WSG-AS 05-04, 9 pp.

Rumrill, S.S. 2006. The Ecology of the South Slough Estuary: Site Profile of the South Slough National Estuarine Research Reserve. NOAA/Oregon Department of State Lands 238 pp.

Comparison of Growth Rates for Juvenile Olympia Oysters between Coos Bay and South Slough



**Project Area: Restoration of Native Olympia Oysters
Within The South Slough Estuary, Oregon**



IX. Funding Information (Cash and In-kind)

- Itemized Budget table (similar to example below) showing expenses incurred during the reporting period, for both NOAA funds and matching contributions, as follows. Budget categories should correspond to those described in the approved proposal.

Overall Project Budget:

COST CATEGORY	YEAR 1		YEAR 2		TOTALS	
	NOAA	MATCH	NOAA	MATCH	NOAA	MATCH
Personnel:					\$52,922	
1. Research Assistant (LD NRS salary)	17,892		18,732			
(LD NRS OPE)	7,962		8,336			
2. Principal Investigator (S. Rumrill)		20,800		20,800		
4. TNC Consultation (D. Vander Schaff)		5,000		5,000		\$56,600
5. SSNERR Volunteers		2,500		2,500		
Services/Supplies:					\$12,000	
1. Field / lab supplies	3,500		4,500			
2. Office supplies	500		500			
3. Local travel / boats	1,000		2,000			\$3,000
4. ECOS Lab use		1,500		1,500		
Special Payments:					\$10,000	
1. Genetic analysis	4,000					
2. Broodstock oysters	3,000		3,000			
TOTALS:	\$37,854		\$37,068		\$74,922 NOAA	
	MATCH \$29,800		MATCH \$29,800		MATCH \$59,600	

- Budget Narrative: Briefly describe expenditures by category and explain any differences between actual and scheduled expenditures. Include documentation of volunteer hours and in-kind donations.

Anticipated Project Expenses (Year 1):

- \$17,892 personnel / salary LD NRS-2 step 2 (\$2,982/mo X 6 mo)
- \$7,962 personnel / OPE LD NRS-2 step 2 (salary X 44.5%)
- \$5,000 services & supplies / field, lab, office supplies, boats
- \$3,000 purchase of broodstock oysters / set #1
- \$4,000 genetic analysis of broodstock oysters

TOTAL Year 1: \$37,854

Anticipated Project Expenses (Year 2):

- \$18,732 personnel / salary LD NRS-2 step 3 (\$3,122/mo X 6 mo)
- \$8,336 personnel / OPE LD NRS-2 step 3 (salary X 44.5%)
- \$5,000 services & supplies / field equipment, hobo meters, office supplies
- \$3,000 purchase of broodstock oysters / set #2
- \$2,000 services & supplies / local travel - boat use

TOTAL Year 2: \$37,068

NOAA Restoration Center

OMB Approval No. 0648-0472

Community-based Restoration Program (CRP)

Expires 05/31/2009

Project Data Form

CONTACT INFORMATION

Contact Name: **Steven S. Rumrill**

Contact Title: **Research Program Coordinator**

Organization (Grantee): **South Slough National Estuarine Research Reserve**

Street Address: **61907 Seven Devils Road**

City: **Charleston** State: **OR** Zip: **97420**

Phone: **(541) 888-2581 ext. 302** Fax: **(541) 888-2733**

E-mail: **Steve.Rumrill@state.or.us**

Organization website (if applicable): **<http://www.oregon.gov/DSL/SSNERR/>**

PROJECT INFORMATION

Project Title: **Restoration of Native Olympia Oysters within the South Slough Estuary**

Project Award Number: **0648-0472** Project Reporting Period: **1 Jul 2006 – 31 Dec 2009**

Project Location

City: **Charleston**

County: **Coos County** State: **OR** Zip Code: **97420**

Congressional District(s): **4th Congressional District**

Landmark (e.g. road intersection, beach): **South Slough Estuary**

Land Ownership (check one): Public: Private: Both:

Geographic Coordinates (in decimal degrees, if readily available)

Longitude (X-coord): **N 43 18.843** Are there multiple project sites for this award? Yes No

Latitude (Y-coord): **W 124 19.270** Yes No

River Basin: **Winchester Creek / Coos River Watershed (USGS Cat. Unit 17100304)**

Geographic Identifier (e.g. Chesapeake Bay): **Coos Bay / South Slough**

Project Start Date: **1 Jul 2006** Project End Date: **31 Dec 2009**

Project Volunteers

Number of Volunteers: **3 (K. Cellura, R. Arvidson)** Volunteer Hours: **Interns: 1120 hrs (15 Jun 2008 to 15 Aug 2009)**

J. Evans)
6 (Oregon
Youth
Conservation
Corps)

OYCC: 308 hrs (1 Jun 2008 to 15
Aug 2009)

* If multiple project sites are part of the same award, please duplicate this form and submit required information for each site

Brief Project Description (1-2 sentences) describing project and what it hopes to accomplish:
The primary emphasis of this project is to initiate restoration of self-sustaining populations of native Olympia oysters (*Ostrea lurida*) to the South Slough estuary.

List of Project Partners and their contributions (e.g. cash, in-kind, goods and services, etc.)

South Slough NERR (in-kind contribution of staff time)

The Nature Conservancy of Oregon (in-kind contribution of consultation services)

Volunteers (contribution of volunteer hours to assist with field and lab work)

If permits are required, please list the permits pending and those acquired to date:

Oregon Department of State Lands, Temporary Use Permit (required by ODSL to establish the experimental oyster restoration sites within the South Slough estuary)

Oregon Department of Fish and Wildlife (Scientific Collection Permit)

Washington State Scientific Collection Permit

Oregon Department of State Lands (Oyster Transfer Permit / denied)

South Slough NERR obtained approval for several permits that are required for the experimental outplanting of the *O. conchaphila* into the South Slough estuary. These include: (1) notification from the Coos County Planning Department that re-establishment of the native oysters is an allowable use in the Natural Aquatic (NA) zoning area of the South Slough (21 Nov 2007); (2) a Notification Form for Minimal Disturbance - General Authorization to the Oregon Department of State Lands (15 Nov 2007); (3) a Temporary Use Permit from the Oregon Department of State Lands required to establish the experimental oyster restoration sites within the South Slough estuary (4) a joint National Marine Fisheries Service / Oregon Department of Fish and Wildlife - Scientific Collection Permit (OR2008-4495 / 6 Mar 2008); and (5) a Washington State Scientific Collection Permit (#08-037 / 19 Feb 2008).

RESTORATION INFORMATION- Please complete this section to the best of your ability. Information below will be confirmed via site visit or phone call by NOAA staff before the close-out of an award.

List the habitat type(s) and acres restored/enhanced/protected or created to date (cumulative) and remainder to be restored/enhanced/protected or created (projected) with CRP funds by the end date of the award. If the project restores fish passage, list the stream miles opened upstream and downstream for fish access. Actual and Projected columns should add up to the total(s) for acreage to be restored with CRP funds indicated in the approved proposal.

Habitat Type (e.g. tidal wetland, oyster reef, mangrove)	Actual Acres Restored (To date-cumulative)	Projected Acres (i.e. Remainder to be restored with CRP funds by award end date)	Actual Stream Miles Opened for Fish Access	Projected Stream Miles Opened for Fish Access (i.e. Remainder to be restored with CRP funds by award end date)
Intertidal oyster beds	0.27 ac	0.27 ac	NA	NA

What indirect benefits resulted from this project? (e.g. improved water quality, increased awareness/stewardship):

Provision of benthic habitat for diverse communities of estuarine invertebrates and fish; improved water quality and removal of particulate material from the water column; increased awareness of the ecological values and ecosystem services provided by beds of native shellfish in Oregon estuaries

List of species (fish, shellfish, invertebrates) benefiting from project (common name and/or genus and species):

- | | |
|--|---|
| 1. Olympia oysters (<i>Ostrea lurida</i>) | 6. Porcelain crab (<i>Petrolisthes cinctipes</i>) |
| 2. Dungeness crab (<i>Cancer magister</i>) | 7. Barnacles (<i>Balanus glandula</i>) |
| 3. Red rock crab (<i>Cancer productus</i>) | 8. Grass shrimp (<i>Crangon franciscorum</i>) |
| 4. Shore crab (<i>Hemigrapsus oregonensis</i>) | 9. Staghorn sculpin (<i>Leptocottus armatus</i>) |
| 5. Shore crab (<i>Hemigrapsus nudus</i>) | 10. |

MONITORING ACTIVITIES

List of monitoring techniques used (e.g. salinity, fish counts, vegetation presence/absence):

- | | |
|---|-----|
| 1. Genetic identity (DNA microsatellites) | 6. |
| 2. Oyster survivorship | 7. |
| 3. Oyster growth | 8. |
| 4. Oyster reproduction | 9. |
| 5. | 10. |

Report Prepared By: _____

Signature

Date

Please send semi-annual and final progress reports and supporting materials to:

NOAA Restoration Center F/HC3
1315 East-West Highway
Silver Spring, MD 20910

ATTN: NOAA Community-based Restoration Program Progress Reports

The Progress Report Narrative Format and Project Data Form are available on the NOAA Restoration Center website at:

http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/index.html. Electronic submissions are encouraged. Please submit electronic progress reports on PC compatible floppy disk or CD ROM in Microsoft Word, WordPerfect or PDF formats.

Be sure to save a copy of each report for your records; subsequent submissions of the Project Data Form need only add outstanding information, so that the form is completed in its entirety as part of the final comprehensive progress report.

Questions? Please call 301-713-0174 and ask to speak with NOAA Community-based Restoration Program staff

NOTICE

Responses to this collection are required of grant recipients to support the NOAA Community-based Restoration Program. The information provided will be used to evaluate the progress of the work proposed under the grant/cooperative agreement and determine whether the project conducted under the grant/cooperative agreement was successfully completed. Public reporting burden for completing the progress report narrative and project data form is estimated to average fifteen hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the information needed and completing and reviewing the collection of information. Responses to this information collection are required to retain funding provided by the NOAA Community-based Restoration Program. Confidentiality will not be maintained – the information will be available to the public. Send comments regarding this burden estimate or any other aspects of this collection of information, including suggestions for reducing this burden, to the NOAA Fisheries Office of Habitat Conservation, Restoration Division, F/HC3, 1315 East West Highway, Silver Spring, MD 20910.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.

The information collected will be reviewed for compliance with the NOAA Section 515 Guidelines established in response to the Treasury and General Government Appropriations Act, and certified before dissemination.