PUGET SOUND MARINE AND NEARSHORE GRANT PROGRAM

ANALYSIS OF STRATEGIC CAPITAL INVESTMENTS FOR HABITAT RESTORATION AND PROTECTION

A REVIEW OF GRANT PROGRAM RESULTS, PART 3

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September 2016

This project has been funded in part by the United States Environmental Protection Agency under assistance agreement PC 00J29801 to Washington Department of Fish and Wildlife. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

The authors wish to thank Maria Hunter, Hugh Shipman, Leska Fore, Patricia Jatczak, Maggie Mckeown, and Elene Dorfmeier for reviewing a previous version of this report. Their insightful comments improved the final product. Kris Symer prepared Figure 1 and provided design assistance.

KEY RESULTS

Since 2011, the Puget Sound Marine and Nearshore Grant Program has invested National Estuary Program (NEP) funds to implement priorities outlined in the Action Agenda for Puget Sound. Habitat restoration and protection has been a major focus of the program, with 27 restoration, acquisition, social marketing, and education/outreach, and social marketing grants funded through 2014.

The projects described in this report are the result of $7,228,000 in NEP investments matched by over $17,414,000 of state funding. Measurable results* of these investments include:

- 48 acres of subtidal rocky reef habitat uncovered by removal of 220 derelict fishing nets;
- 423 acres of restored and/or enhanced tidal hydrology at 3 major river deltas (19% of progress reported to date for the Estuaries Vital Sign indicator target);
- 57 acres of restored and/or enhanced tidal hydrology in 2 small estuaries;
- 0.92 mile (4,801 linear feet) of shoreline armor removed (37% of progress reported to date for the armor removal component of the Shoreline Armoring Vital Sign indicator target);
- 373 acres of shoreline habitat and 2.85 miles (13,582 feet) of shoreline permanently protected;
- 600 toxic creosote pilings removed; and
- interpretive signs at 6 beach restoration sites and 3 videos intended to build public and landowner awareness of the importance of shoreline processes for a healthy Puget Sound.

* These output numbers suggest more precision than likely exists. The shoreline length metrics were recorded in miles protected or restored, which is a coarser scale than is appropriate for smaller sites.

PROJECT OUTCOMES

Most of the restoration projects described in this report involved removal of impairments (dikes and bulkheads) to underlying physical processes (tidal hydrology and sediment supply/transport) that build and maintain habitats upon which species like salmon depend. For example, restoring sediment supply through armor removal is expected to result in beaches with elevations and substrate characteristics necessary to support forage fish spawning. Since forage fish are critical in Puget Sound's food web, the benefits associated with restoring these geomorphic processes would ultimately extend to mammals, birds, and salmon. The ultimate goal of this focus on *process-based*, rather than *species-based*, restoration is self-sufficient systems that maintain themselves with little or no subsequent human intervention.

Owing to the recent timing of the restoration projects, specific physical and biological outcomes in the estuaries and beaches where projects occurred have not yet been sufficiently measured. Therefore, this report focuses on evaluating project costs relative to the area restored. There was a very large range of calculated cost per acre values, with beach projects being significantly more expensive compared to estuary projects. Further analysis revealed that this variation is a result of non-equivalent reporting of area restored (or "treated") for these groups of projects.

For beach projects, "area restored" refers to locations where construction activity occurred. For most of the estuary projects, the reported area restored also includes lands adjacent to the construction footprint where tidal inundation was reintroduced. Armor removal and beach nourishment would similarly be expected to improve habitat outside of the immediate construction area, but changes to beach structure and addition of sediment resulting from beach restoration are more difficult to measure and have not been quantified to date. This discrepancy between measurements understates the benefits of beach projects relative to estuary projects, and has implications for cost-effectiveness evaluations conducted for both program performance evaluations and proposal ranking/selection. **A major lesson of this analysis, therefore, is that robust cost-benefit analyses of beach restoration projects should extend beyond the linear shoreline feet where the project occurred, to include the full "footprint" of the restoration efforts, including intertidal and subtidal habitats affected.**

We offer a conceptual model for organizing direct outputs and resulting outcomes that can be applied during proposal review/ranking processes, as well as to guide monitoring and adaptive management efforts, to encourage recognition of this nuanced distinction.

RECOMMENDATIONS

(1) While reviewing and ranking armor removal proposals, strive to maximize potential project outcomes by including sediment supply and transport (as the key habitat-forming process for Puget Sound beaches) rather than exclusively focusing on the construction zone and outputs such as length of armor removed. The scale of a project relative to the size of its drift cell and the proportion of the drift cell with functional sediment dynamics are important evaluation criteria in this context. Keep in mind that the 2016 ranked list of armor removal Near Term Actions (NTA)[1] was the results of a scoring process that lacked these considerations.

(2) Use existing technical tools related to shoreline mapping, sediment input, and drift cell prioritization to identify areas where beach restoration and Shore Friendly incentive investments would have the most impact.

(3) Continue to support monitoring of project performance relative to intended physical and biological outcomes. In the near-term, emphasize investment in monitoring beach geomorphology after armor removal projects because this information is most crucial for optimizing selection of future projects.

Additional recommendations for specific categories of investments are included throughout the report. Where applicable, we note where our recommendations relate to specific NTA proposals included in the 2016 Action Agenda Update.

[1] NTAs are new programs, projects, investigations, or other actions intended to advance priority recovery sub-strategies. Ranked lists of NTAs can be found on the Puget Sound Partnership's 2016 Near Term Action Proposals website.

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TABLES AND FIGURES

1. BACKGROUND

The Washington Department of Fish and Wildlife (WDFW) and the Washington Department of Natural Resources (WDNR) together serve as the Marine and Nearshore Lead Organization (LO) responsible for developing a 6-year strategy to implement priorities of the Action Agenda for Puget Sound. The Puget Sound Marine and Nearshore Grant Program ("the Grant Program") awards funds provided under the U.S. Environmental Protection Agency's (EPA) National Estuary Program (NEP) for projects related to protecting and restoring marine and nearshore habitat. The Grant Program organized their investments into five areas:

1) effective regulation and stewardship,

2) strategic capital investments for habitat restoration and protection,

3) addressing high priority threats,

4) cross cutting issues, and

5) adaptive management.

Since 2011, the Grant Program has funded more than 50 projects. Work on grants awarded during Rounds 1-4 of the current 6-year funding cycle has largely been completed. During Round 5, the Grant Program funded the Puget Sound Institute (PSI) to analyze and synthesize results of the first 4 years of awards. As part of an adaptive management strategy, the aim of this grant is to evaluate past results in order to inform and optimize outcomes at project, programmatic, and Puget Sound recovery levels.

PSI is evaluating the Grant Program's portfolio of projects in groups by investment area. The projects reviewed in this report are grouped in the strategic capital investments for habitat restoration and protection investment area. Two previous reports, Kinney et al. (2015) and Kinney et al. (2016), evaluate results of the other investment areas. The Grant Program's objective for the capital projects was to:

> *"Further reduce development pressures in the nearshore by implementing strategic restoration and acquisition projects."*

Locations of the 12 restoration sites, 7 property acquisitions, and 220 derelict fishing net removal sites that received Grant Program funding during Rounds 1-4 are shown in Figure 1. This investment area also included development of a social marketing strategy to encourage preferred shoreline armoring behaviors, and outreach/education on beach restoration (Table 1).

The Grant Program invested just over $7,228,000 of capital funds in the projects described in this report. Project data was obtained from RCO's Project Information System (PRISM) and Grant Program records. A few projects remain in progress, so scope and/or cost information may change.

Figure 1: Acquisition and Restoration Project Locations

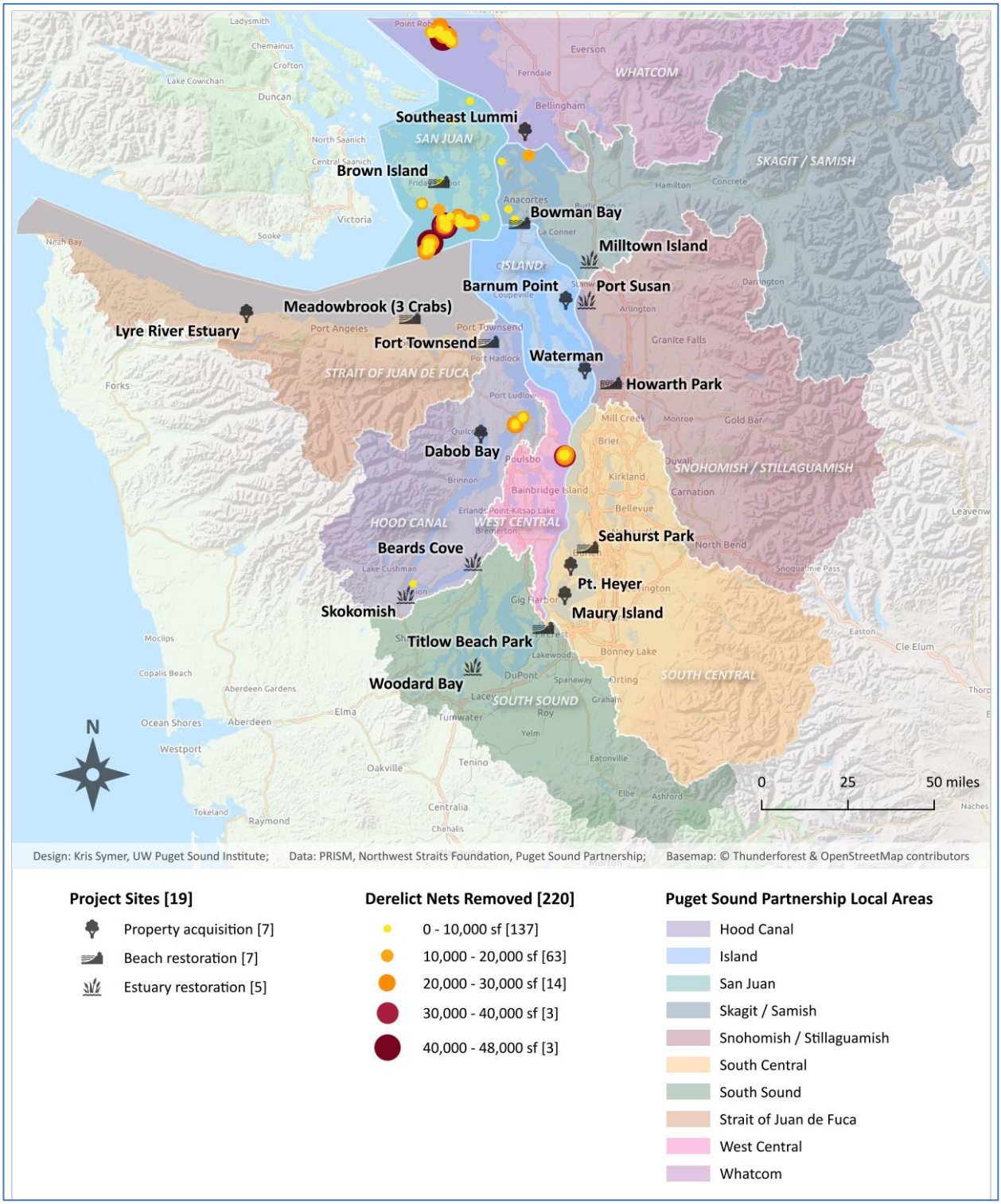
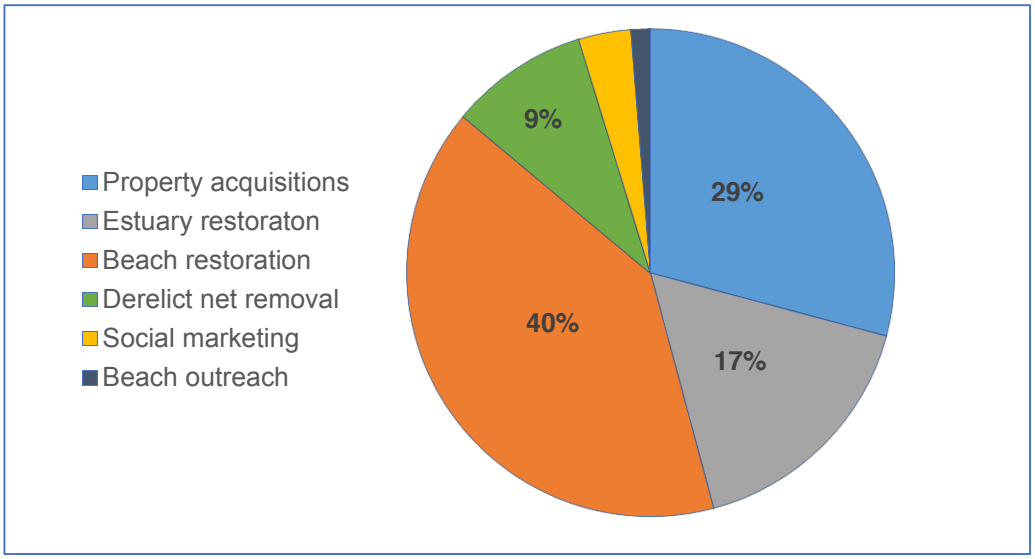


Table 1: Strategic Capital Investments (Rounds 1-4)

Grant Awards	Project Partners
Protection of high-quality habitat at 7 sites (Table 2)	Estuary and Salmon Restoration Program, Recreation and Conservation Office, and numerous local sponsors
Puget Sound Derelict Net Removal and Pilot Response	Northwest Straits Foundation
5 estuary restoration projects (Table 3) 7 beach restoration projects (Table 4)	Estuary and Salmon Restoration Program, Recreation and Conservation Office, and numerous local sponsors
Public Engagement and Education on Beach Restoration (Table 5)	Multiple awards
Social Marketing Strategy to Reduce Puget Sound Shoreline Armoring[2]	Colehour + Cohen, Social Marketing Services, Futurewise, Coastal Geologic Services, and Applied Research Northwest

Figure 2 shows how investments were allocated among the various types of projects. Acquisition of intact bluff-backed beaches and armor removal projects received the bulk of capital funds. Beaches were a program priority because they tended to be underfunded, relative to other critical habitats like estuaries, by other state and federal funding sources.

Figure 2: Capital Investments by Category



[2] This grant was evaluated as part of PSI's regulatory effectiveness and stewardship investment area analysis report (Kinney et al. 2015) because of that report's focus on shoreline armoring incentives.

2. PROTECTION AWARDS

This section describes investments related to Action Agenda sub-strategies B2.1 (Permanently protect priority nearshore physical and ecological processes and habitat, including shorelines, migratory corridors, and vegetation particularly in sensitive areas such as eelgrass beds and bluff backed beaches) and B3.1 (Protect intact marine ecosystems particularly in sensitive areas and for sensitive species).[3]

2.1 INVESTMENT STRATEGY

The Grant Program partnered with the Estuary and Salmon Restoration Program (ESRP) to identify property acquisition proposals well-aligned with Action Agenda protection strategies.

ESRP was created in 2006 to implement restoration projects using guidance and strategies developed as part of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP). The program provides funding and technical assistance for process-based[4] habitat protection and restoration in Puget Sound. ESRP has a record of selecting projects that address priority ecosystem impairments using a rigorous technical peer review process. ESRP is administered by WDFW in partnership with the Recreation and Conservation Office (RCO). Additional technical support is provided by the National Oceanographic and Atmospheric Administration's (NOAA) Restoration Center Northwest and the Puget Sound Partnership (PSP).

The Grant Program determined that working with ESRP would be the most efficient and effective way to allocate NEP funds. During their first year, the Grant Program was able to quickly identify high-priority, "ready to go" acquisitions by using rankings from ESRP's competitive project evaluation and selection process.[5] This strategy also allowed the Grant Program to leverage other funding sources, including the Puget Sound Acquisition and Restoration Fund, Aquatic Lands Enhancement Account, and Salmon Recovery Grants (details provided in Section 7.3 and Figure 6).

Later, the Grant Program issued their own request for proposals (RFP) for marine shoreline protection. RCO provided fiscal and contract management. This solicitation addressed Action Agenda priorities by focusing on protection of sediment supplies and feeder bluffs in areas facing significant development pressures.

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[3] Sub-strategies were reorganized for the 2016 Action Agenda. The new numbers are 16.1 and 17.1.

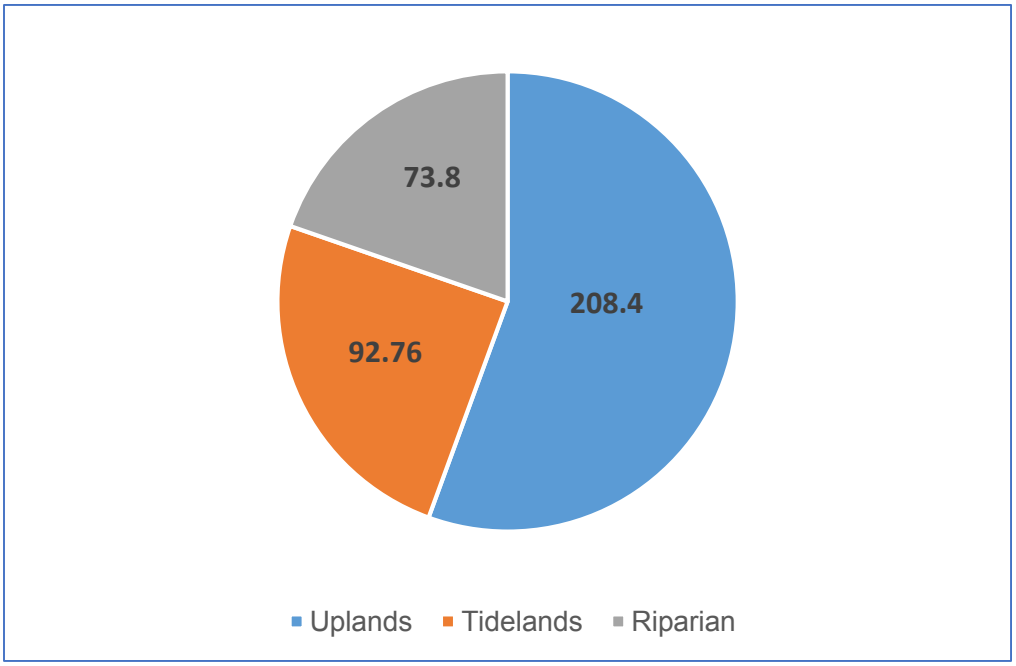
[4] Process-based protection and restoration focuses on key natural processes—such as hydrology, sedimentology, geomorphology—that create and sustain nearshore habitat structure and function (Goetz et al. 2004). This emphasis on underlying ecosystem processes impacted by human use and activity is expected to provide greater long-term project sustainability and less maintenance relative to species-specific enhancement efforts.

[5] ESRP solicits restoration and protection proposals every other year. All phases of projects—acquisition, feasibility, design, restoration, and monitoring—are eligible. Proposals are evaluated by a multi-disciplinary technical review team composed of members from multiple agencies and organizations. The review team scores projects using criteria such as ecological importance, technical merit, readiness, cost effectiveness, and public support. This transparent process results in a ranked project list identifying the most promising restoration and protection opportunities.

2.2 RESULTS

- In 2011, three sites containing bluff-backed beaches were acquired: Barnum Point, Dabob Natural Area, and Point Heyer.
- Four sites were selected for acquisition in 2014: Southeast Lummi, Waterman, Lyre River Estuary, and Maury Island.
- Additional acreage was acquired as part of restoration projects described later in this report.
- These investments protected a total of 373 acres (Figure 3) and 2.85 miles of marine shoreline. Protection in perpetuity was secured through fee title acquisition or conservation easements.
- Although quantitative data on physical and biological benefits associated with these properties is lacking, important considerations related to their ecological value include: presence of a stream/estuary; high potential sediment source; intact riparian and upland forest; and proximity to other protected sites (Table 1).
- The average cost per acre protected was $34,511 (Figure 4).

Figure 3: Total Acres Protected by Habitat Type

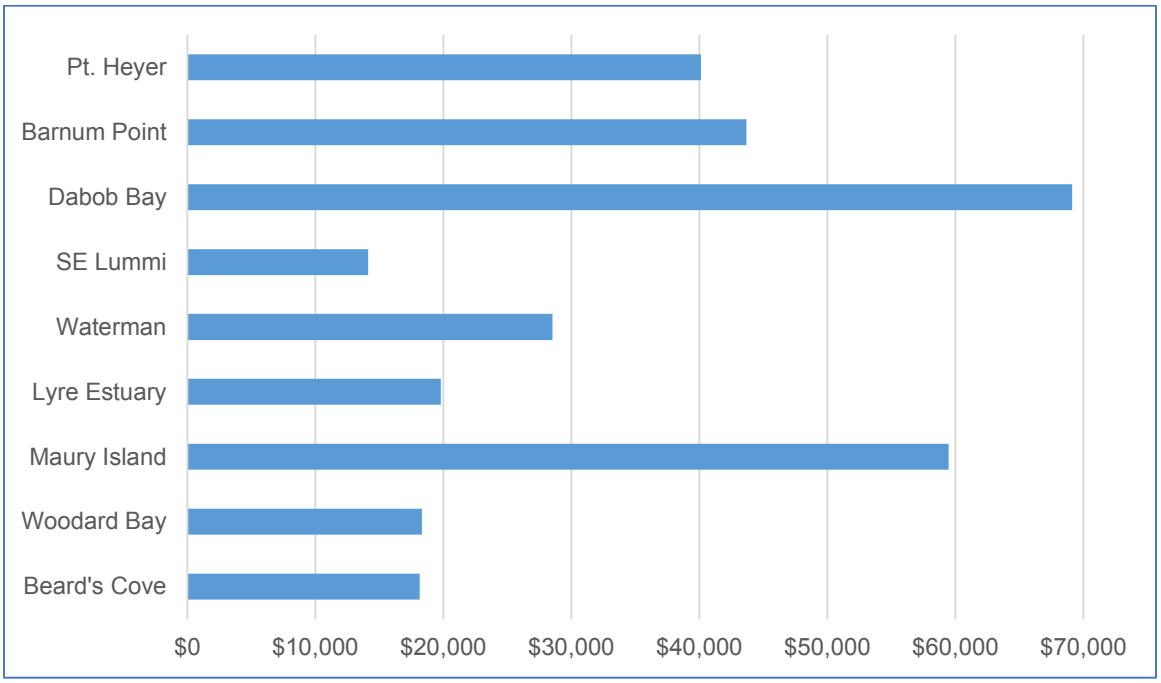


Includes habitat acquired as part of the Woodard Bay and Beard's Cove restoration projects discussed in Sections 4 and 5.

Table 2: Protection Awards

Site	Description	Local Sponsor(s)	Status
Pt. Heyer **King County**	Protected 4 parcels totaling 25.87 acres with 1000 feet (0.19 mile) of shoreline including intact feeder bluff. Part of a larger preservation effort for the Pt. Heyer drift cell, one of the few highly functioning drift cells in Central Puget Sound and location of the largest salt marsh in King County.	King County	Acquisitions complete
Barnum Point **Island County**	Protected a total of 48 acres with 2270 feet (0.43 mile) of shoreline. Site includes an exceptional feeder bluff that supplies sediment to 2 drift cells in Port Susan Bay.	The Nature Conservancy	Acquisitions complete
Dabob Bay **Jefferson County**	Protected 17.6 acres with 600 feet (0.11 mile) of shoreline. The site contributes sediments to a 6-mile-long drift cell and multiple sand spits within the bay. Part of a larger preservation effort for WDNR's Dabob Bay Natural Area.	Northwest Watershed Institute and The Nature Conservancy	Acquisitions complete
Southeast Lummi **Whatcom County**	Protected 2 parcels totaling 109.1 acres with 4,000 feet (0.76 mile) of shoreline. Approximately 20 acres of uplands and 500 feet of shoreline have been degraded by mining activities; a portion of the award funded a feasibility study of restoration of these areas.	Lummi Island Heritage Trust	Acquisitions complete
Waterman **Island County**	Protected 4 parcels totaling 59 acres with 2,000 feet (0.38 mile) of shoreline including intact feeder bluff.	Whidbey Camano Land Trust	Acquisitions complete
Lyre River Estuary **Clallam County**	Protected 50.51 acres with 2,600 feet (0.49 mile) of shoreline. Site includes a barrier beach and feeder bluff. This was one part of a larger acquisition effort that conserved 279.2 acres in the Lyre River watershed. The Lyre is now one of a few remaining rivers on the Olympic Peninsula with potential to maintain an intact river corridor from the Olympic Mountains to the Strait.	North Olympic Land Trust	Acquisitions complete
Maury Island **King County**	Protected 26.86 acres and 1,112 feet (0.21 mile) of marine shoreline. Project includes future removal of 700' of shoreline armoring to reconnect historically "Exceptional Feeder Bluff" and "Feeder Bluff" to adjacent beaches. The parcels border WDNR's Maury Island Aquatic Reserve and King County's Piner Point Natural Area.	King County	Acquisitions complete, restoration planned 2017

Figure 4: Acquisition Cost Per Acre



Raw data provided in Table 6, Table 7, and Table 8 (Appendix A). Restoration costs for Maury Island, Woodard Bay, and Beard's Cove are excluded.

2.3 RECOMMENDATIONS

Consider expanding the use of conservation easements to maintain residential properties in an unarmored condition.

- NTA 2016-0172, Expand Conservation District Shore Friendly programs across Puget Sound, ranked 37 – This proposal was unique among the many Shore Friendly proposals in that it included work by Capitol Land Trust to develop shoreline conservation easement tools and templates for rapid, permanent protection of critical habitats/processes like feeder bluffs.

3. DERELICT NET REMOVAL

This grant advanced Action Agenda sub-strategy B3.2 (Implement and maintain priority marine restoration projects)[6] and the associated legacy net removal Near Term Action (B3.2 NTA 1 from the 2012/2013 Action Agenda).

3.1 INVESTMENT STRATEGY

In late 2011, the Grant Program convened subject-matter experts to help define their marine investment strategy. The top 2 priorities to emerge were:

- removal of remaining legacy fishing nets in shallow-water[7] areas, and
- strengthening the system for removing lost nets as quickly as possible.

Lethal entanglement of fish, birds, marine mammals, and invertebrates occurs when fishing nets are caught on rocky areas and become derelict. Snagged nets can also block access and physically damage rocky reef habitats.

Derelict gear is a well-documented threat to marine species and habitats in Puget Sound. Beginning in 2002, the Northwest Straits Foundation (NWSF) has worked cooperatively with a number of partners to remove derelict fishing gear. They locate derelict nets using sidescan sonar, then use teams of divers to remove the nets.

During Round 3, FY2012 funds were awarded to NWSF to address these identified needs. NWSF had the expertise, experience, net location data, and relationships with tribal fisheries managers to perform this work quickly and cost-effectively.

3.2 RESULTS

3.2.1 LEGACY NET REMOVAL

- Removal of 220 nets, uncovering 48.1 acres of benthic marine habitat.
- Carcasses of 22 birds, 1,262 fish, and 40,567 invertebrates were *observed* entangled in these nets at the time of retrieval.
- These 220 nets would have likely entangled an estimated 579 birds, 9,521 fish, 4.3 million invertebrates, and 1,710 marine mammals annually (NWSF 2014). This estimate is based on extrapolation of entanglement data from 604 previously (2004-2007) removed nets; repeat dive surveys of 4 snagged nets during summer 2007 to observe daily catch and decomposition rates; and a model developed by Gilardi et al. (2010).

[6] Sub-strategies were reorganized for the 2016 Action Agenda. The new number is 17.2.

[7] In this context "shallow" was defined by dive depth capabilities and refers to waters ≤105 feet deep.

- Habitat impacted by these nets was expected to recover quickly, based on a previous evaluation of post-removal species presence.[8]
- The average cost per acre of benthic habitat restored by derelict net removal was $13,895.

3.2.2 PILOT REPORTING, RESPONSE, AND RETRIEVAL PROGRAM

- NWSF program staff and field crews, in coordination with WDFW, developed, tested, and are implementing a process for coordinated response to reports of newly lost nets.
- The aim of this program is to ensure that WDFW fisheries managers and enforcement staff, NWSF's field crew, and tribal fisheries co-managers are all aware of and able to respond immediately to reports of lost nets.
- NWSF conducted outreach with non-tribal commercial fishermen subject to new mandatory reporting requirements, as well as 8 tribes working proactively with their fishermen to report lost nets.[9]
- During the grant reporting period, the partners received 26 new reports of possible derelict nets.[10] Three were determined not to be fishing nets, 10 were removed, 9 were not found, and 4 were determined not to be derelict.
- The majority of lost nets reported to WDFW were immediately forwarded to NWSF's field crew via an online reporting system developed for the project. This greatly enhanced their ability to track lost nets quickly, and follow-up with the reporters and fishery managers.
- Coordinating with net owners provides them with an opportunity to retrieve their own nets, and prevents unnecessary deployment of net removal vessels and divers. Five of the 10 nets removed during the reporting period were removed by tribal fisheries agencies, the fishermen themselves, or others.
- Three of the lost nets were reported by the tribal fishermen who lost them. Other reporters included recreational fishermen, private citizens, Port of Kingston, Bureau of Land Management personnel, and WDNR personnel. Notably, no reports were received from non-tribal commercial fishermen.[11]

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[8] NWS Marine Conservation Initiative (2009) evaluated relative abundance of 4 species groups (kelp/seaweed/ hydroids, sessile invertebrates, mobile invertebrates, and fish) at 4 net removal sites and 4 control sites. One year after removal, relative abundances between the removal sites and control sites differed by only 6%.

[9] Tribal fisheries are not subject to Washington State's reporting law.

[10] These reports were initially received in a variety of ways: 6 through the new NWSF online reporting system, 5 by phone to NWSF, 11 by WDFW phone hotline, 2 by phone call to WDFW enforcement, and 2 by phone call to Natural Resources Consultants (NWSF's field project manager). One new net was discovered during routine NWSF removal operations.

[11] During Round 6 (2015), the Grant Program funded NWSF to conduct additional outreach activities intended to reduce loss of commercial fishing nets and increase reporting of lost nets.

4. ESTUARY RESTORATION PROJECTS

This section describes investments related to Action Agenda sub-strategy B2.2 (Implement prioritized nearshore and estuary restoration projects and accelerate projects on public lands).[12]

4.1 INVESTMENT STRATEGY

The first group of restoration projects funded by the Grant Program were also identified from ESRP's 2010 ranked list. They considered projects scheduled for construction in 2012, then scored the remaining projects based on the following evaluation criteria:

- large acreage relative to investment
- location on public or permanently conserved lands
- target ecological processes in large river deltas
- flood protection component
- utilize cost-effective approach.

4.2 RESULTS

- Three of the five estuary investments focused on the restoration of natural hydrologic processes on 423 acres of habitat in major river deltas, Skokomish, Stillaguamish (Port Susan project), and Skagit (Milltown Island project). This was accomplished through removal of dikes and excavation of tidal channels.
- The Woodard Bay project removed toxic creosote pilings from a pier located at the mouth of Chapman Bay and planted riparian vegetation. This project is part of a comprehensive, phased effort to acquire and restore a large complex of nearshore habitats in WDNR's Woodard Bay Natural Resources Conservation Area (NRCA).
- At Beard's Cove, intertidal fill was removed and tidal channels were excavated in a small river estuary to reclaim historic tidelands. The site is immediately adjacent to the Klingel Estuary Restoration Project completed in 2011.
- Construction of these projects resulted in a combined total of:
    - 1.77 miles of dike removed,
    - 4.3 miles of tidal channel restored or created,
    - 10 culverts modified or removed
    - 600 creosote pilings removed, and
    - 8.2 acres of riparian and/or wetland habitats planted.

[12] Sub-strategies were reorganized for the 2016 Action Agenda. The new number is 16.2.

- For the three delta projects, average cost per acre restored was $6,619. However, all these projects were discrete phases of long-term restoration efforts with multiple components.[13] Costs exclude preliminary work completed as part of previous project phases. ESRP data on costs for the entire lifecycle of similar projects indicate costs range from $20,000 to $160,000 per acre, depending on the need for infrastructure realignment (Cereghino 2015).
- This discrepancy illustrates that PRISM data (the source of financial data for this report) on "total project cost" do not always reflect all costs incurred through a project life cycle—especially for large, complex projects like these. Projects may have multiple PRISM entries or phases, and/or costs recorded outside of the PRISM accounting system. The reader should keep in mind that the comparative "cost per acre" or "cost per linear foot" values provided in this report are predominantly construction costs. We have taken care to compare costs for equivalent project element(s) to the extent possible. For example, we have separated acquisition, design, and outreach/education costs within projects where applicable.

4.3 RECOMMENDATIONS

Consider collaborating with ESRP to develop a strategy for prioritizing pocket estuary restoration project proposals. Though the Estuaries Vital Sign indicator and draft Implementation Strategy[14] focuses on large Chinook natal rivers, the majority of the 2016 NTA proposals associated with the Vital Sign involved small estuary projects.

- While evaluating projects for funding in the interim, keep in mind that pocket estuaries within 5 miles of natal estuaries are thought to be most important for migrant salmon fry (Redman et al. 2005).
- Many pocket estuary proposals involve replacement of undersized culverts under roadways along the shoreline. Where these roadways are vulnerable to tidal flooding, projects could further sea level rise preparedness goals. For example, the Harper Estuary bridge project (NTA 216-0234).

[13] Duffy and Fore (2015) provide an overview of previous and planned phases of Skokomish River estuary restoration. Additional project fact sheets and background summaries, prepared by PSP's Effectiveness Monitoring Program, are available at http://www.psp.wa.gov/evaluating-effective-action.php.

[14] Implementation Strategies are plans for achieving 2020 recovery targets for Puget Sound Vital Signs.

Table 3: Estuary Restoration Projects

Project	Description	Local Sponsor(s)	Construction Status
Skokomish **Mason County**	Expand the Skokomish River's brackish water zone by re-establishing historic tidal channel networks and freshwater wetland inputs. Restored hydrology for 223 acres, allowing salmonid access to 150 acres of channel and wetland habitats suitable for rearing, refuge, and spawning. 1.25 miles of existing and relict tidal channels were improved through removal of 10 culverts, breaching of roadbeds, and construction of a bridge. This project was Phase 3 of a larger restoration effort; Phases 1 and 2 restored tidal inundation to former agricultural areas.	Mason Conservation District and Skokomish Tribe	Complete
Port Susan **Snohomish County**	Removal of 3.75 miles of dike to restore riverine and tidal processes to 150 acres of diked former tidal marsh. Almost 1 mile of new dike was built to protect neighboring farmland. Part of a larger programmatic effort to restore hydrology in the Stillaguamish River estuary. Included initial phase of post-restoration monitoring.	Nature Conservancy	Complete
Milltown Island **Skagit County**	Removal of 0.07 mile of dike and creation of 0.17 mile of tidal channel to restore tidal function and fish access to 50 acres of scrub-shrub delta wetlands. Included 1.2 acres of wetland plantings, as well as post-construction monitoring of this and previous restoration projects at Milltown Island and neighboring Wiley Slough.	Skagit River System Cooperative	Complete
Woodard Bay **Thurston County**	Acquisition of 27.9 acres of riparian habitat. Riparian plantings on 1 acre. Improved 0.3 acre of subtidal habitat by removing 600 creosote pilings from a pier at the mouth of Chapman Bay.	WDNR	Complete
Beard's Cove **Mason County**	Removal of intertidal fill, structures, and invasive plants to restore 1,500 feet (0.28 mile) of shoreline and 7.3 acres of tidal marsh within the Union River estuary. Nearly 1,200 feet (0.23 mile) of tidal channels was excavated and 5 acres was planted. Included fee simple acquisition of 2 acres and conservation easement on 6.1 acres.	Great Peninsula Conservancy	Complete

5. BEACH RESTORATION PROJECTS

This group of grants targeted Action Agenda sub-strategy B2.3 (Remove armoring, and use soft armoring replacement or landward setbacks when armoring fails, needs repair, is non-protective, and during redevelopment).[15]

5.1 INVESTMENT STRATEGY

In 2012, the Grant Program met with subject-matter experts from state resource agencies, NOAA's Restoration Center Northwest, and the Northwest Indian Fisheries Commission (NWIFC) to refine criteria for consideration when selecting their next group of restoration investments.

This group identified beach restoration as an underfunded priority. Armor removal projects were generally under-represented in ESRP's portfolio, and tended to rank lower during the review process relative to large estuary projects. This is because ESRP evaluation criteria favor projects on large complex landscapes (ESRP 2014). The area restored for the Grant Program-funded delta projects ranged from 50 to 223 acres. By comparison, the area restored for Grant Program-funded beach projects was less than an acre to 11 acres.

Beach restoration projects were identified by means of a general solicitation, conducted in partnership with ESRP. The RFP focused on restoration of sediment supply and specifically sought proposals to:

- improve habitat and ecosystem processes along marine shorelines by removing armoring or other shoreline modifications,
- provide high visibility and public access and opportunities for public education about alternatives to shoreline armoring, and
- provide long-term public access and protection of restored sites.

The experts consulted also recommended the Grant Program consider ways to motivate private landowners to change armoring behaviors. They issued a RFP for development of a social marketing strategy to reduce shoreline armoring in Puget Sound. The result was the "Shore Friendly" framework developed by Colehour + Cohen et al. (2014).

5.2 RESULTS

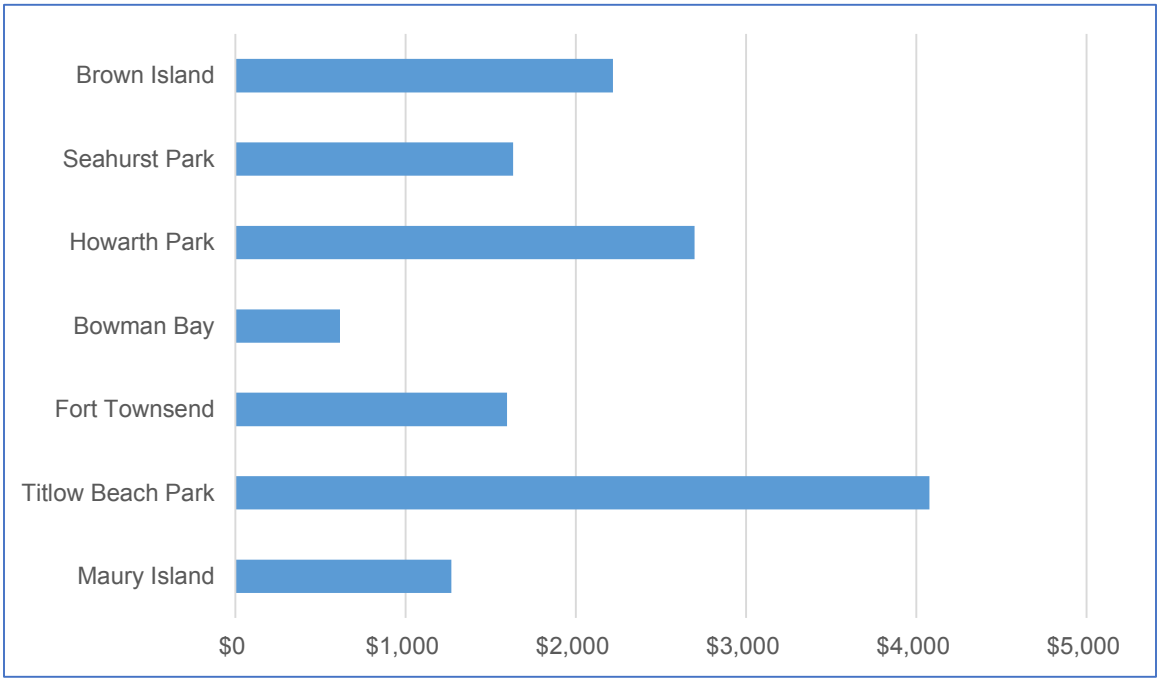
- Six armor removal projects were selected for investment during this time period: Brown Island, Seahurst Park, Meadowbrook, Howarth Park, Bowman Bay, and Titlow Beach Park. Future armor removal is planned as part of the Maury Island acquisition.
- As a result of these investments, 0.92 mile of armor will be removed from Puget Sound shorelines. These projects will restore 21.6 acres of beach and marine riparian habitat. Additional acreage outside of the construction footprint is expected to benefit from increased

[15] Sub-strategies were reorganized for the 2016 Action Agenda. The new number is 16.3.

sediment supply resulting from these projects, but the total area affected cannot be quantified at this time.

- All but one of the armor removal projects is located on public property which allows public access.
- The average cost/projected cost per linear foot of shoreline restored/to be restored is $2,024 (Figure 5).
- When "cost per acre" values were calculated for these projects, the range was enormous and did not appear to reflect varying levels of project complexity (e.g., inclusion of beach nourishment, extensive fill removal, or toxics remediation). This indicates "cost per linear foot" may be a more reliable performance metric for armor removal projects. Using a length, rather than an area, metric corresponds with the way the Vital Sign indicator target is structured.

Figure 5: Armor Removal Cost Per Linear Foot of Shoreline



5.3 RECOMMENDATIONS

Improve reporting metrics by focusing on feet—not miles nor acres—of armor removed. Even more useful would be data on feeder bluff length and type, though this would require site-level geological analysis by a qualified professional.

Table 4: Beach Restoration Projects

Project	Description	Local Sponsor	Construction Status
Brown Island **San Juan County**	Armor removal along 53 feet (0.01 mile) of shoreline at the base of a privately owned feeder bluff.	Friends of the San Juans	Complete
Seahurst Park **King County**	Armor removal, slope regrading, and beach nourishment along 2640 feet (0.5 mile) of shoreline during Phase 2 of a large, multi-partner beach restoration effort. Project included invasives control and riparian plantings on 2 acres.	City of Burien	Complete
Meadowbrook (3 Crabs) **Clallam County**	Armor removal along 53 feet (0.01 mile) of shoreline as part of a larger restoration effort for the lower Dungeness River.	North Olympic Salmon Coalition	Began summer 2016
Howarth Park **Snohomish County**	Armor removal along 422 feet (0.08 mile) of shoreline as part of a larger beach nourishment project along 4.5 miles of railroad-impounded shoreline.	Snohomish County	Began summer 2016
Bowman Bay **Skagit County**	Design for armor removal along 528 feet (0.1 mile) of shoreline in Deception Pass State Park. Construction was funded in Round 5.	Northwest Straits Foundation	Complete
Fort Townsend **Jefferson County**	Design for removal of intertidal fill, armor removal, and slope regrading along 317 feet (0.06 mile) of bluff-backed beach in Fort Townsend State Park. Construction was funded in Round 5.	Northwest Straits Foundation	Began summer 2016
Titlow Beach Park **Pierce County**	Design for armor removal and beach nourishment along 158 feet (0.03 mile) of shoreline. Includes 0.6 acre of riparian planting. Surveys revealed arsenic and lead contaminant levels above applicable standards, so contaminant remediation will be required. Construction was funded in Round 5.	South Puget Sound Salmon Enhancement Group	Expected to begin fall 2016

6. BUILDING KNOWLEDGE AND AWARENESS OF RESTORATION BENEFITS

These grants advanced Action Agenda sub-strategy B4.2 (Increase access to and knowledge of publically owned Puget Sound shorelines and the marine ecosystem).[16]

6.1 INVESTMENT STRATEGY

A key part of the Grant Program's investment strategy is to build public and landowner awareness of the importance of shoreline processes for a healthy Puget Sound. The intended results are a reduction in demand for shoreline modifications, and support for future restoration and stewardship on public and private lands.

6.2 RESULTS

Primary outreach methods include interpretive signs at restored beaches, project videos posted/shared online, and on-site education. Specific products and programs resulting from these awards are detailed in Table 5. The interpretive signs are likely to reach hundreds of park visitors per year. The Brown Island video was viewed 1,480 times in the first 7 months after its release. The Bowman Bay video was viewed 965 times in the first 6 months after its release.

These outreach efforts support implementation of the "Shore Friendly" social marketing framework developed by Colehour + Cohen et al. (2014) with Grant Program Funding. Shore Friendly was developed to motivate residential shoreline landowners to voluntarily choose alternatives to hard armor. A key strategy is changing perceptions regarding the desirability of and necessity for bulkheads. These outreach materials and programs reinforce key Shore Friendly messages about the natural beauty of unarmored beaches, the habitat impact of bulkheads, and ease of waterfront access. The site visit and influencer programs could be models for similar efforts in other counties.

[16] Sub-strategies were reorganized for the 2016 Action Agenda. The new number is 18.2.

Table 5: Beach Restoration Outreach Awards

Project	Grantee	Products and Programs	Status
Brown Island **San Juan County**	Friends of the San Juans	Video: A Place at the Table: Benefits of Beach Restoration Influencer workshops Interpretative sign Participating landowners give presentations to MRCs, LIOs, Realtors	Ongoing
Seahurst Park **King County**	Environmental Science Center	Documentary video: Local Treasure Interpretive signs Beach Heroes Program for 1,900 students	Ongoing
Meadowbrook (3 Crabs) **Clallam County**	North Olympic Salmon Coalition	Interpretive signs Site tours and public workshops	Underway
Bowman Bay **Skagit County**	Northwest Straits Foundation	Video: Bowman Bay Restoration Project Interpretive signs, web content, press releases, and articles Onsite education	Ongoing
Fort Townsend **Jefferson County**	Northwest Straits Foundation	Interpretive signs, web content, press releases, and articles Onsite education	Underway
Howarth Park **Snohomish County**	Snohomish County Parks	Interpretive signs at Howarth Park and the Mukilteo Ferry Terminal landing at Edgewater Beach	Underway

7. INVESTMENT PERFORMANCE

This section describes overall performance of the Grant Program's capital investments in relation to the 5 goals developed for this element of the program in 2011:

1) measurable results in the near-term
2) consistency with stated habitat protection and restoration priorities
3) leverages additional funding
4) sustainable project benefits
5) supports the State's draft climate change adaptation strategies.

7.1 MEASURABLE RESULTS IN THE NEAR-TERM

The Grant Program's partnership with ESRP allowed them to utilize an existing competitive process to expend NEP funds rapidly and contribute to high-ranking projects. Outputs of the Grant Program's capital investments and state matching funds[17] are substantial:

- 48 acres of subtidal rocky reef habitat uncovered by removal of 220 derelict fishing nets;
- 423 acres of restored and/or enhanced tidal hydrology at 3 major river deltas;
- 57 acres of restored and/or enhanced tidal hydrology in 2 small estuaries;
- 373 acres of habitat and 2.85 miles (13,582 feet) of shoreline permanently protected;
- 0.92 mile (4,801 linear feet) of shoreline armor removed; and
- 600 creosote pilings removed.

The reader should note that these output numbers suggest more precision than likely exists. In several cases the shoreline length metrics were recorded in miles protected or restored, which is a coarser scale than is optimal for smaller sites. For example, two projects described in Table 4 each involve removal of 53 feet of armor because the default minimum length on PRISM appears to be 0.01 mile.

7.2 CONSISTENCY WITH STATED HABITAT PROTECTION AND RESTORATION PRIORITIES

Round 1-4 capital investments resulted in progress toward PSP's 2020 targets for two Vital Sign Indicators: shoreline armoring and estuaries. Investments were also consistent with Action Agenda sub-strategies B2.1, B2.2, B3.1, and B3.2.

[17] The outputs listed here result from all project funding, not only the NEP contributions. See Figure 6.

7.2.1 ESTUARIES INDICATOR TARGETS

The estuaries indicator has two targets for 2020:

1) 7,380 acres of estuarine wetlands restored to tidal flooding in Puget Sound's 16 large river[18] deltas by 2020.

2) All Chinook natal river deltas meet 10-year salmon recovery goals by 2020 (or 10% of restoration need as proxy for river deltas lacking quantitative acreage goals in salmon recovery plans).

TARGET 1: The progress summary provided in the most recent State of the Sound report indicates that a cumulative total of 2,260 acres was restored between 2006 and 2014 (Hamel et al. 2015). The 3 estuary projects funded in 2011—Skokomish, Port Susan, and Milltown Island (Skagit)—contributed to restoration of 423 acres to tidal flooding in 3 of the specified river deltas (Skokomish, Stillaguamish, and Skagit). This acreage represents 19% of the cumulative progress towards the Estuaries Vital Sign Indicator. The Meadowbrook (3 Crabs) project will restore tidal inundation to an additional acreage in the Dungeness River estuary. The Beard's Cove project funded in 2012 included restoration of tidal hydrology to 7.3 acres in the Union River estuary (a small river not specified in the indicator target).

TARGET 2: No data were reported in Hamel et al. (2015) because not all salmon recovery watersheds have set quantitative goals for river deltas.

7.2.2 SHORELINE ARMORING INDICATOR TARGETS

The Grant Program's strategy to emphasize beach projects was a result of expert input during Round 3 planning. Restoration of large river deltas was seen as an area with significant attention and funding opportunities already available. By comparison, the experts noted there was a general lack of leadership for "beach problems." The Grant Program filled this identified void by focusing their later investments outside of the major river deltas.

The shoreline armoring indicator has three targets:

1) Between 2011 and 2020, the total amount of armoring removed should be greater than the total amount of new armoring.

2) Feeder bluffs receive strategic attention for removal of existing armoring and avoidance of new armoring.

3) Soft shore techniques are used for all new and replacement armoring, unless it is demonstrably infeasible.

[18] The rivers are: Deschutes, Dosewallips, Duckabush, Dungeness, Duwamish, Elwha, Hamma Hamma, Nisqually, Nooksack, Puyallup, Quilcene, Samish, Skagit, Skokomish, Snohomish, and Stillaguamish.

TARGET 1: Hamel et al. (2015) reported that between 2011 and 2014:

- new armoring was constructed at an average pace of 0.7 mile (3,700 feet) per year;
- armoring was removed at an average rate of 0.4 mile (2,200 feet) per year;
- a net cumulative gain of 1.1 miles (6,000 feet) of armor was observed;
- the pace of construction of new armoring had slowed since 2012; and
- in 2014, for the first time, more armoring was removed than added.

Five of the eight armor removal projects funded by the Grant Program *should* be included in these figures.[19] These projects—Brown Island, Seahurst Park, Howarth Park, Bowman Bay, and Fort Townsend—resulted in removal of 0.75 mile (3,960 feet). This represents 37% of the 2.02 miles (10,647 feet) of armor removed between 2011 and 2014, as reported by Hamel et al. (2015). However, there are limitations associated with using HPA data to track this indicator. Some restoration projects may be classified as "replacement" rather than "removal" and HPAs are not required for projects with federal lead agencies (e.g. Seahurst Park).

TARGET 2: No data were reported in Hamel et al. (2015). The Grant Program's acquisitions will permanently protect 2.6 miles (13,582 feet) of beaches, with the majority of this length backed by intact feeder bluffs. Additionally, three of the funded armor removal projects (Brown Island, Seahurst Park, and Fort Townsend) involved removal of armoring to reconnect 0.57 mile (3,010 linear feet) of feeder bluffs with adjacent beaches.

TARGET 3: No data were reported in Hamel et al. (2015). However, Grant Program investments in the Marine Shoreline Design Guidelines and the Shore Friendly Social Marketing Strategy are expected to encourage application of soft shore techniques.

7.3 LEVERAGES ADDITIONAL FUNDING

The partnership with ESRP also allowed the Grant Program to easily leverage state funds (Figure 6). Every dollar of NEP money contributed was or will be matched by over $3 of state, local, or non-profit money. Delivering funds through a single fiscal and contracting agent made contract management more efficient. Additionally, benefits from property acquisitions at Woodard Bay and Dabob Bay are amplified due to their addition to existing conservation lands managed by WDNR's Natural Areas Program.

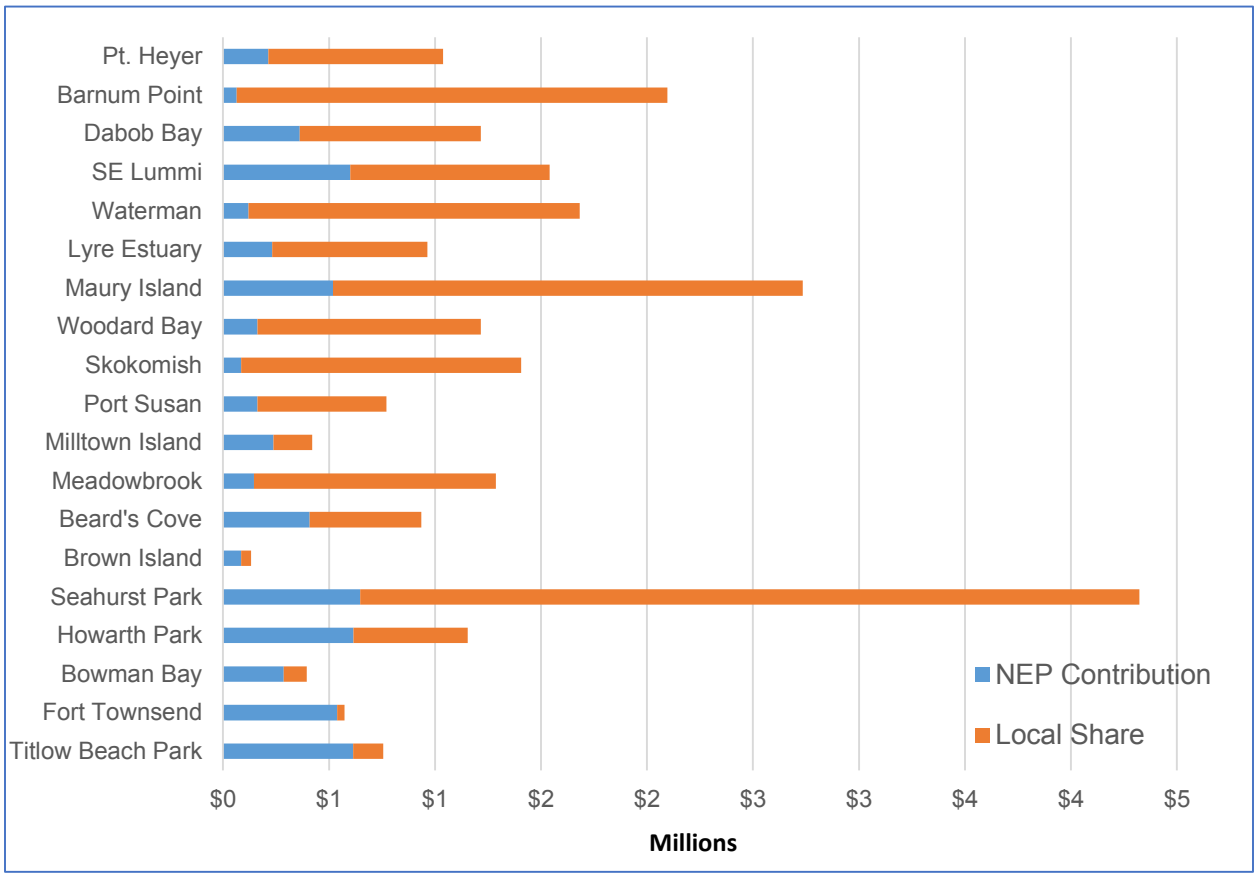
7.4 SUSTAINABLE PROJECT BENEFITS

The Grant Program addressed sustainability of project benefits with their focus on process-based, rather than species-based, restoration and protection. By removing impairments (e.g., dikes and bulkheads) to

[19] Unlike the Estuaries Vital Sign, where indicator progress is tabulated *after* a project is constructed, data for the Shoreline Armoring Vital Sign is compiled from Hydraulic Project Approvals (HPAs) issued by WDFW *prior to* construction. HPAs for Meadowbrook (3 Crabs), Titlow, and Beard's Cove were issued in 2015 or 2016 (per PRISM records), and will be counted in the next State of the Sound Report.

underlying physical processes (e.g., tidal hydrology and sediment supply) that build and maintain habitats, these projects result in systems that can maintain themselves with little or no subsequent human intervention. Post-construction monitoring funded during Round 5 will support learning about physical and biological responses to restoration actions, and can be used to verify assumptions about ongoing system sustainability.

Figure 6: NEP Contributions as Proportion of Project Costs



Costs include awards for design and education/outreach, where applicable.

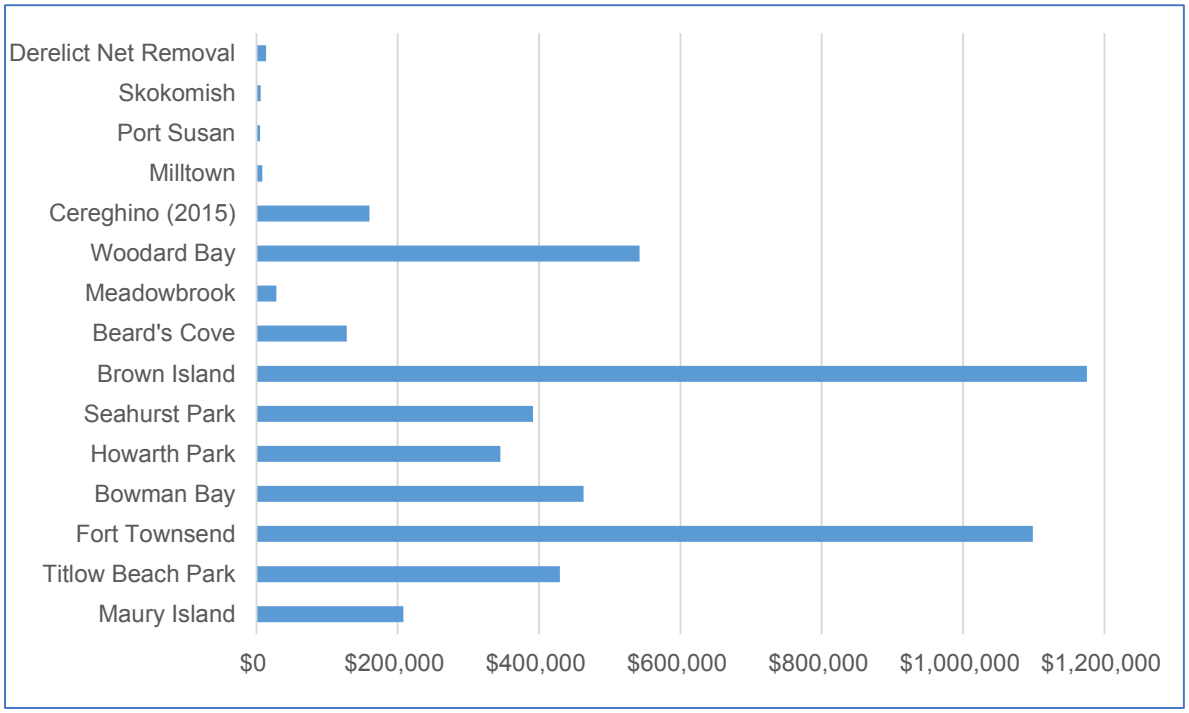
7.5 SUPPORTS DRAFT STATE CLIMATE CHANGE ADAPTATION STRATEGIES

Grant Program capital investment decisions align with several adaptation strategies and actions recommended in Washington State's (now finalized) climate change response strategy (Ecology 2012). These include: protecting connectivity to allow for species migration; restoring and maintaining wetlands; preserving sediment transport processes; preserving habitat; and using alternatives to traditional "hard" shore armoring. In particular, the Grant Program's focus on sediment supply and transport addresses a stressor contributing to increased vulnerability to sea level rise.

8. PROJECT COSTS AND OUTPUTS/OUTCOMES

When selecting their first group of restoration projects to receive funding, the Grant Program sought proposals that would restore large acreage relative to investment. Beach restoration projects score poorly in assessments of area restored per dollar spent, because of their small size. The area restored for the Grant Program-funded delta projects ranged from 50 to 223 acres. By comparison, the area restored for beach projects was <1 to 11 acres. As shown in Figure 7, this translates to a very large range of calculated "cost per acre" values with beach projects being significantly more expensive per acre.

Figure 7: Restoration Cost Per Acre as Reported in PRISM



However, "restored" can mean a restoration activity or the restored condition of the habitat (Koontz and Thomas 2012). The "acres treated" metric provided in PRISM is ambiguous on this nuanced distinction, and thus measures non-equivalent results for different types of projects. In some cases it tracks project output, and in others project outcomes.[20] As shown in Figure 8, the PSNERP-ESRP model for process-based restoration involves restoration activities (outputs) that result in hydrogeomorphic improvements (intermediate outcome) that cause ecological responses (end outcome).

For beach projects, the reported area treated is a project output (shaded box in Figure 8). It represents the construction footprint—the area directly affected by armor removal, slope regrading, and/or beach nourishment activities. An outcome of this work is improved sediment supply to down-drift beaches.

[20] **Outputs** are direct results of an action, while **outcomes** are desired changes or benefits. Outcomes are longer-term and influenced by factors out of the proponent's control (Koontz and Thomas 2012).

Measuring this outcome is difficult, because quantifying changes to down-drift beach structure would require multiple seamless bathymetric-topographic surveys collected over a long time scale.

By contrast, the reported area treated for delta projects actually represents an immediate project outcome (shaded box in Figure 8). The output occurs in the immediate construction footprint, which consists of the dike and channel alignments. Yet the reported hydrological benefits extend well beyond this area to surrounding lands below the highest reach of tides, which can be quantified with one pre-construction topographic survey.

The discrepancy between these measurements understates the benefits of beach projects relative to estuary projects, and has implications for both program performance evaluations and proposal ranking/selection. This effect may extend to other project types with relatively high calculated costs per acre (e.g., toxics removal at Woodard Bay). Taking care to specify the difference between restoration outputs and outcomes can help frame future project selection decisions, as well as investments in monitoring and adaptive management. Monitoring of end outcomes could validate hypotheses at the center of the process-based model for habitat restoration in Puget Sound (Thom 2007).

Figure 8: Outputs and Outcomes for Process-Based Restoration

	Output	Immediate Outcome	Intermediate Outcome	End Outcome
PSNERP-ESRP conceptual model for process-based restoration	Remove or modify stressor impairing habitat-forming hydrogeomorphic processes	Physical processes restored	Habitat structure restored and sustained	Habitat supports species and biotic communities
Delta projects	Remove dike, rebuild tidal channels	Tidal hydrology restored in areas adjacent to construction footprint	Improvements in physical KEAs like tidal channel formation, maintenance, and connectivity[21]	Improvements in biological KEAs like vegetation community composition, detritus recruitment and retention
Beach projects	Remove armor, regrade slope	Sediment supply and transport restored in areas adjacent to construction footprint	Improvements in physical KEAs like coastal sediment dynamics, intertidal zone profile	Improvements in biological KEAs like SAV beds, forage fish spawning areas, marine riparian vegetation

Shaded boxes are the result reported as PRISM "acres treated" metric

[21] **Key ecological attributes (KEAs)** are patterns of biological structure and composition, ecological processes, environmental regimes, and other environmental constraints necessary for an ecosystem component to persist (Puget Sound Recovery Implementation Technical Team 2015). The Puget Sound Chinook monitoring and adaptive management framework provides example KEAs, as well as associated status indicators, useful for monitoring outcomes of estuarine and beach restoration efforts.

This same model could also guide efforts to measure progress and validate assumptions associated with regulatory effectiveness and incentive grants. Promulgation of updated Hydraulic Code regulations, approval of local Shoreline Master Program updates, and implementation of Shore Friendly campaigns are outputs that should increase desired armoring behaviors and then improve physical and biological parameters.

9. RECOMMENDATIONS

1) Use findings and products of ongoing ESRP Learning Program[22] investigations related to shoreline mapping, sediment input, and drift cell prioritization as decision support tools to identify areas where beach restoration and Shore Friendly incentive investments would have the most impact. These investigations include:

   - Mapping bluffs and beaches for sediment supply (Project #13-1556) – systematic collection of high-resolution baseline data on beach and bluff topography, sediment texture, beach wrack, overhanging vegetation, and large woody debris along up to 320 miles of beaches, with 40 miles surveyed 3 additional times to document seasonal and episodic beach change[23]
   - Identifying target beaches to restore and protect (Project #14-2308) – beach strategy geodatabase development including refinements to several nearshore datasets, including shore armor mapping, net shore-drift, shoretypes, and parcel data, as well as workshops with potential end-users of the data[24]
   - Bulkhead removal planning (Project #14-2306) – monitoring changes in ecological and geomorphological parameters following armor removal from the toe of a historic feeder bluff along Eld Inlet in Olympia

   Results of these efforts will provide quantitative information on sediment supply rates, a better understanding of how sediment supply affects beach structure, and finer-scale geospatial data on current levels of degradation. The availability of the time-series bathymetric/topographic data generated through Ecology's mapping project will enable future quantification of the down-drift outcomes of armor removal projects. These new tools will improve the Grant Program's ability to prioritize restoration proposals, and target funding for Shore Friendly incentive programs.

2) While reviewing beach project proposals, strive to move beyond consideration of project outputs (length of armor removed) to maximize project outcomes. Sediment supply is particularly important

[22] ESRP invests approximately 10% of funding during each grant cycle to assess the results of completed work and address data gaps with the intent of increasing the efficiency and effectiveness of future program investments (ESRP 2014).

[23] This work builds upon two previous projects funded by the Grant Program. Kaminsky et al. (2014) piloted the use of boat-based LiDAR in Puget Sound to develop sediment budgets for the Elwha and Dungeness drift cells in Clallam County. Feeder bluff maps prepared by MacLennan et al. (2013) were used for site identification/prioritization.

[24] This work builds upon previous geodatabase tools developed and/or updated with Grant Program funding, including MacLennan et al. (2013) and Colehour + Cohen (2014b).

as the volume, rate, and distribution of sediment in a drift cell affects beach structure (width, slope, and substrate per Dethier et al. 2016) and is likely to drive shoreline response to sea level rise (Johannessen et al. 2014). Decision criteria could include outcome factors such as:

- the scale of the project relative to the size of its drift cell;
- percent of the drift cell with functional sediment dynamics (Puget Sound Recovery Implementation Technical Team 2015);
- the location of armor relative to mean higher high water - Dethier et al. (2016) observed more negative impacts at sites where armor was more than 1 vertical foot below MHHW; and
- extent and distribution of uninterrupted transport zones (Puget Sound Recovery Implementation Technical Team 2015).

3) Consider funding monitoring of project performance relative to intended physical (immediate and intermediate) and biological (end) outcomes. Compilation of project-level results from existing and new studies would create a growing knowledge base that could be used to refine program goals, principles, and investments. Several 2016 NTA proposals relate to this recommendation:

   - NTA 2016-0398, Strategic mapping of priority drift cells for protection/restoration, ranked 8 – This proposal is an expansion of Ecology's ESRP-funded mapping effort. It includes repeat surveys and additional baseline surveys.
   - NTA 2016-0369, River sediment delivery to Puget Sound delta and nearshore environments, ranked 37
   - NTA 2016-0328, Monitoring the effectiveness of shoreline restoration, ranked 44 – This proposal would monitor biological (end) outcomes of shoreline projects with an emphasis on salmon and herring.
   - NTA 2016-0324, Monitoring biological endpoints of eelgrass restoration, ranked 58 – This proposal would monitor biological outcomes of eelgrass projects with an emphasis on marine fish and invertebrates.
   - NTA 2016-0119, Shoreline Monitoring Toolbox protocol implementation and data management, ranked 115
   - NTA 2016-0123, Beach strategies for nearshore restoration and protection in Puget Sound, ranked 121 – This proposal is the second phase of Coastal Geologic Services' ESPR-funded beach strategy development intended to identify parcel-scale beach restoration and protection priorities.

4) Gather and record more precise data on project implementation, costs, and expected outputs to enable better effectiveness analyses, articulation of lessons learned, and improvements to project selection processes.

   - Information on factors that influence per unit costs and variability in costs, such as real estate values; presence of infrastructure that needs to be protected or relocated; and public access.
   - Information on factors that influence project benefits and inform Vital Sign reporting, such as tidal elevation of the shore protection structure and landform type (e.g. feeder bluff, feeder bluff exceptional, transport zone, etc.).

- Before, during, and after construction photographs to support post-project communications, outreach, and social marketing efforts that highlight the aesthetic and access benefits of unarmored beaches.

5) Build regional capacity for specialized technical support on geological and engineering issues associated with shoreline projects.
   - NTA 2016-0268, Expand Conservation District shoreline technical assistance in Puget Sound, ranked 48 – This proposal includes funding for the WA State Conservation Commission engineering cluster and supplemental consulting geotechnical/coastal engineers to provide expertise and support to local programs.
   - NTA 2016-0380, MSDG engineering technical assistance, training, and outreach, ranked 115

10. ACRONYMS AND ABBREVIATIONS

Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
ESRP	Estuary and Salmon Restoration Program
LIO	Local Implementing Organization
LO	Lead Organization
MLLW	Mean Lower Low Water
MRC	Marine Resources Committee
NEP	National Estuary Program
NOAA	National Oceanographic and Atmospheric Administration
NCRA	Natural Resources Conservation Area
NTA	Near Term Action
NWIFC	Northwest Indian Fishing Commission
NWSF	Northwest Straits Foundation
PSEMP	Puget Sound Ecosystem Monitoring Program
PSI	Puget Sound Institute
PSP	Puget Sound Partnership
RCO	Washington Recreation and Conservation Office
RFP	Request for Proposals
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources

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APPENDIX A: PROJECT DATA FROM PRISM DATABASE

The values provided in the following tables were used to calculate the cost and result metrics we report. Data were obtained from PRISM Project Snapshots.

As described in Section 4.2, "total project cost" figures reported in PRISM do not always include costs for the full project life cycle. We took care to compare costs for equivalent project element(s) to the extent possible. For example, by separating out acquisition, design, and outreach/education costs from construction cost where possible. A detailed accounting of all work conducted to get projects completed is beyond the scope of this report.

Reported restoration project results ("total acres treated") obtained PRISM were sometimes duplicative. For example, treatments like plantings and invasives control or slope regrading and beach nourishment occurred within the same footprint. We took care not to double count acreage impacted by such treatments, so that our total acres treated values are not larger than the actual affected area. For projects where there was uncertainty about summing treatment areas, we looked at supporting documents and/or engineering drawings to judge those that did or did not overlap.

Table 6: Property Acquisitions

	Miles Shoreline	Feet Shoreline	Total Acres	Cost	NEP Contribution	Cost per Acre
Pt. Heyer Project #11-1282	0.19	1000	25.87	$1,037,946	$212,333	$40,122
Barnum Point Project #11-1651	0.43	2270	48	$2,096,451	$64,300	$43,676
Dabob Bay Project #11-1657	0.11	600	17.6	$1,216,500	$362,366	$69,119
SE Lummi Project #14-1870	0.76	4000	109.1	$1,200,000	$600,000	$10,999
Waterman Project #14-1917	0.38	2000	59	$1,682,967	$120,000	$28,525
Lyre River Estuary Project #14-1998	0.49	2600	50.51	$964,000	$231,329	$19,085
Woodard Bay Project #10-1116	—	—	27.9	$511,059	*	$18,318
Beard's Cove Project #14-1326	0.28	1,478	8.1	$147,000	*	$18,148
Maury Island Project #14-2226	0.21	1,112	26.86	$1,597,584	$519,216	$59,478
TOTAL	**2.85**	**15,060**	**373**	**$10,453,507**	**$2,109,544**	**$28,030**

Average cost per acre conserved — $34,163

* NEP dollars contributed to restoration at these sites (see Table 7).

Table 7: Estuary and Marine Projects

	Total Acres Treated	Primary Restoration Actions	Cost	NEP Contribution	Cost per Acre
AGRICULTURAL DELTA PROJECTS					
Skokomish Project #11-1361	223	6,600 yards of tidal channel created/modified, culvert removal, and bridge construction	$1,405,665	$85,253	$6,303*
Port Susan Project #11-1650	150	1.4 miles of dike removed and 1 mile built to protect neighboring farmland	$771,049	$162,450	$5,140
Milltown Island Project #11-1669	50	0.7 mile of dike removed, 300 yards of tidal channel created, and 1.2 acres of wetland planting	$420,745	$237,197	$8,415
OTHER PROJECTS					
Meadowbrook** Project #11-1343	45	0.3 mile of dike removal, in-channel modifications. and armor removal	$1,272,776	$130,982***	$28,294
Woodard Bay Project #10-1116	1.3	600 creosote pilings removed	$705,000	$162,450	$542,308
Beard's Cove Project #14-1326	12.3	Intertidal fill removed, 0.23 mile of tidal channel created	$935,000	$409,000	$76,016
Derelict Net Removal	48.1	220 nets removed	$668,360	$668,360	$13,895
TOTAL	**529.7**		**$6,178,595**	**$1,855,692**	**$11,664**

* When all project elements and phases are considered, ESRP data show that restoration of large agricultural deltas can be expected to cost between $20,000 to $160,000 per acre depending on the need for infrastructure realignment (Cereghino 2015).

** The Meadowbrook armor removal project is included here because the armor removal is one component of a larger restoration project to reconnect Meadowbrook Creek to the lower Dungeness River. Available cost estimates were not detailed enough to assign costs for armor removal versus estuarine project elements like channel modification and dike removal.

*** Excludes $15,000 award for education and outreach (described in Section 6).

Table 8: Armor Removal Projects

	Total Acres Treated	Miles Removed	Feet Removed	Cost	NEP Contribution	Cost per Linear Foot
Brown Island Project #13-1177	0.1	0.01	53	$117,525	$69,975*	$2,217
Bowman Bay Project #13-1235	0.7	0.1	528	$324,020	$215,000*	$614
Seahurst Park Project #09-1415	11	0.5	2640	$4,307,743	$646,937*	$1,632
Ft. Townsend** Project #13-1234	0.46	0.06	317	$505,468	$471,100*	$1,595
Howarth Park Project #13-1106	3.3	0.08	422	$1,138,764	$600,000*	$2,698
Titlow Beach Project #15-1447	1.5	0.03	158	$644,065	$615,000*	$4,076
Maury Island Project #14-2226	3.1	0.14	700	$936,712	***	$1,338
TOTAL	**20.16**	**0.92**	**4,818**	**$7,974,297**	**$2,618,012**	**$1,655**

Average cost per linear foot of beach restored — $2,024

* Excludes $15,000 for education and outreach (described in Section 6). Costs also exclude design work for three projects funded separately during Round 3: Bowman Bay - $55,820; Ft. Townsend - $52,126; Titlow Beach - $92,065

** We found an error in the PRISM project snapshot for the Ft. Townsend armor removal project. The "Project Metrics" section listed 0.26 mile of shoreline to be treated for armor removal. When this value was used to calculate the cost per linear foot of armor removed, the result was significantly lower than other armor removal projects. We reviewed the design documents attached to the project snapshot and determined that the engineering plans specify 0.06 mile of armor removal.

*** NEP dollars contributed to property acquisition at this site (see Table 6).