HABITAT RESTORATION: BAINBRIDGE ISLAND NEARSHORE

The Salish Sea's nearshore begins in shallow salt water and extends up the beach to the land and plants beyond the high tides. Nearshore habitats provide an important transition where sediment and food move from land to sea and where rich habitats allow fish and wildlife to thrive. When shoreline armoring, also called bulkheads, is placed within the nearshore and the native vegetation is eliminated, beaches are shortened, sediment that feeds the beach is lost, and shade and food sources provided by vegetation are no longer as available for forage fish and juvenile salmon. On Bainbridge Island, the Powel Shoreline Restoration Project removed over a quarter of a mile of shoreline armoring from a private residential property on Port Madison Bay (Figure 1). The goal of the project is to reestablish and support natural physical processes important to a number of species while at the same time complementing residential uses.

The physical nearshore processes shape habitat that supports biological functions and many interconnected species. Salt marsh plants and seaweed and native marine riparian vegetation contribute to the base of marine and other food webs, while also providing shade for fish moving along the shoreline. Insects and other invertebrates associated with these plant communities are important food for fish, making up half or more of the stomach contents of juvenile Chinook salmon in the nearshore (Brennan et al, 2004). The physical and living components of a healthy nearshore even provide water quality benefits by capturing and converting contaminants that might otherwise flow directly into marine waters.

Development of nearshore areas has a significant effect on the health and integrity of marine habitats that are important to juvenile Chinook and chum salmon and their invertebrate prey resources (Toft et al. 2007, Heerhartz et al. 2015). The nearshore is also essential for spawning of forage fish (an important prey item for maturing and adult salmon, Rice 2006), and for the accumulation of beach wrack and recruitment of logs (Heerhartz et al. 2014) that provide structure and material to support the base of the food chain.

The Powel property is similar to other residential properties throughout the Puget Sound region, where land development and shoreline armoring have altered approximately 90 percent of the nearshore from their historic conditions. Restoration of these nearshore habitats is a key action for salmon and multi-species recovery and is supported by local, state and federal agencies, Native American tribes, nongovernmental organizations and other conservation organizations.

"Voluntary partnerships are the cornerstone of Puget Sound recovery. Thanks to the Puget Sound Partnership and Bainbridge Island Land Trust and the Powel family, we're seeing the benefits of coordination among families, community organizations, and public agencies. By working together, regionally and locally, we are prioritizing projects and finding creative, cost-effective ways to cleanup, restore, and protect our beaches and waterways." - Sen. Christine Rolfes (D-23rd District).

Suggested citation: Adams, J., B. Padgham, J. Toft. 2015. Habitat Restoration: Bainbridge Island Nearshore. Puget Sound Partnership, Tacoma, WA. <u>http://www.psp.wa.gov/effectiveaction.php</u>.



Figure 1. Map of Bainbridge Island and a red circle around the Powel property at the north end of the Island, with an inset indicating its position in the Puget Sound.

1992

• Bainbridge Island Land Trust (BILT) and Powel family establish conservation easement on the privately owned property.

2004

• The Bainbridge Island Nearshore Assessment (a 2003 Salmon Recovery Funding Board project) ranks Port Madison Bay as "moderate to high impact" area, making it focus for nearshore restoration.

2008

- Powel family requests BILT advice and technical assistance to rebuild section of failing bulkhead.
- Discussions transition from rebuilding bulkhead to shoreline restoration.

2009

- BILT and Powel family host shoreline ecologists, tribal and state representatives, and other experts to evaluate the potential for a shoreline restoration project.
- Parties encourage a restoration design.
- BILT and Powel family submit proposal to State Salmon Recovery Funding Board (SRFB).
- Puget Sound Acquisition and Restoration Fund (PSAR) grant awarded for restoration design.
- Discussion of project monitoring initiated, recognizing that monitoring funding would not be provided through the project grants.

2010

- Site assessment and restoration alternatives evaluated by stakeholder group.
- Powel Shoreline Restoration Design Project produces final report including Coastal Geologic Services engineered restoration design, revegetation plan, and cost estimate for implementation (Brennan, Johannessen, and Padgham, 2011).
- Monitoring recommendations included in the plan.

2011

- BILT and Powel family submit and are awarded PSAR funding (Project #11-1505) for implementing restoration actions.
- Financial and volunteer support from the family, BILT, PSAR and volunteer efforts contribute towards obtaining permits, hiring restoration specialists, project engineers, bulkhead removal contractors, and other elements of project implementation.

2012

- Permits for the project are obtained and contractors are hired.
- Baseline photo points are established to document property response to restoration actions.
- Volunteer-assisted shoreline monitoring begins, led by Washington Sea Grant and WSU Kitsap County Extension.
- Bulkhead removal work begins in late summer.
- Invasive plants in the riparian area are removed and replaced with native plants.
- Powel/BILT conservation easement amended to strengthen protection of the shoreline and restoration actions in perpetuity.
- Community and neighborhood outreach and property tour activities take place.

Ongoing

- Monitoring continues with photo documentation, plant survival, cultural resources monitoring, and physical and biological profiles.
- Plant survival monitoring concluded spring 2015 with 85% plant survival rate.
- Stewardship and maintenance of the restoration site continues by the landowner and BILT.
- Use of the property as a showcase continues with significant community outreach.

PROJECT SUMMARY

The Powel Restoration Project was planned, designed, and implemented to restore marine shoreline on private residential property. The Powel property includes two parcels, nearly 11.8 acres of tideland, nearshore and upland property and more than a third of a mile of marine shoreline. With the exception of two small shoreline segments, the entire 1800 linear feet of shoreline was armored with a variety of structures, including rock rip rap revetments, creosote timber walls, rock and mortar walls, concrete walls, and concrete debris (Figure 2). Much of the armor was aged and in a state of disrepair (Figure 3).

The Powel Shoreline Restoration Project focused on removing bulkheads from the shore, restoring riparian vegetation, increasing shallow intertidal habitat, and monitoring the implementation and effectiveness of the actions taken. The project has also been an important showcase for bulkhead removal as a safe and attractive option for private properties in Puget Sound.

The project was completed in two phases: Phase I Planning and Design, and Phase II Implementation, both of which received funding support through the Washington State Recreation and Conservation Office (RCO) Salmon Recovery Funding Board (PSAR funds). BILT was the project sponsor for both phases with the Powel family being deeply engaged in all steps of the process. A number of stakeholders – from permitting agencies to restoration ecologists – were engaged in the design to ensure a balance of ecological restoration goals and residential living. The stakeholder group met eight times during a 12-month period to review various drafts of the design and specific design details, ask questions, recommend revisions, and resolve differences in preferences for alternative restoration actions, including no action or limits on proposed actions. The final design, approved by all parties, included engineered drawings, a riparian vegetation enhancement plan, cultural resources findings, recommendations for implementation, a draft monitoring plan, and cost estimates for the implementation of the restoration project (Brennan, Johannessen, and Padgham, 2011).

The design did not include extensive reshaping of the grade or slope of the shoreline or the addition of gravel to the shoreline (beach nourishment). The design essentially called for the bulkhead to be removed and let nature take its course to restore and enhance the natural character and ecological attributes of the shoreline. The plan also called for the addition of 2500 native plants to enhance the riparian area. Allowing natural nearshore processes to enhance ecological structure and functions will provide for a more resilient shoreline (Brennan, Johannessen, and Padgham, 2011), in addition to eliminating the cost or need by the landowner to repair, maintain or replace armor or bulkheads in the future.

The restoration actions supported local and regional salmon recovery and restoration planning efforts. The Bainbridge Island Nearshore Assessment Williams et al. 2004) ranked Port Madison Bay as mostly "moderate to high impact", which made it a focus area for nearshore restoration. The nearshore environment has been identified as a priority in both the West Sound Watersheds Salmon Recovery Plan and the Puget Sound Action Agenda, with reduction of shoreline armoring a Vital Sign indicator used to guide Puget Sound restoration.

Specifically, key issues and actions addressed in the project include:

- Bulkheads are a major limiting factor for reestablishing shoreline processes and functions and are considered a major limiting factor for salmon recovery. Bulkheads and associated fill were removed from over 1544 linear feet.
- Port Madison historically contained significant fringe marsh, most of which has been lost as a result of filling and construction of bulkheads. With the removal of bulkheads, salt marsh vegetation can reestablish within the intertidal area.

- Sediment supply and sediment transport and deposition have been disrupted as a result of the bulkheads. The project design removed bulkheads and nonnative fill without a lot of engineered reshaping or sloping. The shore can now naturally reshape itself and sediment can deposit naturally through the project site.
- Restoring natural processes and functions requires restoring shoreline vegetation. The Powel property hosted landscaped gardens, grass and nonnative plants along the shoreline prior to restoration efforts. During restoration actions, invasive plants were removed and 2500 native plants were added.
- Implementing stewardship incentives will increase private landowner restoration projects. Cost sharing in the design and restoration implementation and providing technical assistance with permitting and project management provided the landowner with incentives to restore the shore, rather than rebuild the bulkheads.
- Providing landowner education encourages removal of bulkheads and other activities to protect and restore shoreline habitats. The Powel family was engaged in every aspect of this project and continues to care for their property. Neighbors in the Port Madison area became acutely aware of the project through communications and outreach efforts, as well as property site visits. This project also demonstrates how restoration actions can take place on privately owned shorelines in a way that balances restoration with residential use. The project acts as a showcase in education and outreach efforts to other shoreline landowners, increasing awareness of the importance of the nearshore habitat and the options available to private landowners to voluntarily restoring nearshore habitats in Puget Sound.
- With significant, publicly funded restoration projects, it is important to understand the physical and biological response to bulkhead removal, and how effectively the project design was implemented to achieve project goals. Monitoring of the site before and after bulkhead removal and during the process addresses that need. For this project, a monitoring plan was developed that included photo documentation, cultural resources monitoring, project implementation, physical and biological profiling and vegetation monitoring. Due to funding not being available to support the monitoring efforts, at this time, most monitoring is being conducted through volunteer efforts and project partners.



Figure 2. Pre-restoration project conditions at Powel property showing different types of armor.



Figures 3. Examples of armoring at the Powel property before removal.

RESTORATION FRAMEWORK

Overall Goal: Restore natural shoreline processes, structure, and functions on a private property in a manner compatible with the residential use. The restored shoreline will increase intertidal area, enhance saltmarsh and shoreline vegetation, and improve access to the beach and shoreline aesthetics for the landowners.

- Increase high quality upper intertidal habitat as refuge and food sources for small and juvenile fish.
- Reconnect low bluffs to natural erosion processes while a resilient natural shoreline protects manmade structures.
- Increase the area available for saltmarsh plant establishment and restore a diverse community of native shoreline riparian plants.
- Increase local and regional community engagement and education opportunities.

Monitoring Goals: Assess the degree of erosion and biological response where bulkheads were removed and vegetation restored.

- Measure the physical shape of the beach using vertical profiles at 9 locations on the property.
- Measure the density and percent cover of plants and animals near Mean Higher High Water.
- Measure riparian native plant diversity.
- Document the availability of terrestrial insects as prey for aquatic animals where restoration occurred versus where bulkhead was retained.
- Photo document the project over time.

EXPECTED OUTCOMES

- Upper intertidal area will increase.
- Salt marsh vegetation will colonize newly available habitat.
- Vegetated shorelines will provide additional prey resources, diverse canopy cover providing multiple species benefits, and shade along the shore.
- Natural shoreline will be resilient to erosion protecting residential infrastructure while providing sediment deposits to the beach.
- Landowners will be satisfied with their shoreline access and aesthetic.

ACTIONS

The Powel restoration project consists of several overarching components with a number of associated actions. Table 1 provides an overview of project actions and associated results. Table 2 represents the effort, collaboration, decision-making, results and challenges that were apart of successfully achieving outcomes in Table 1.

Actions taken at the Powel property include those intended to meet the restoration goals of the project, while harmonizing those goals with residential uses and values. In addition, actions were taken to monitor before, during and after the restoration actions to assess the project's implementation and effectiveness.

Table 1. Major project actions and results.

Bulkhead removed (lineal feet)	Non-native fill removed (tons)	Intertidal habitat exposed (square feet)	Invasive plants removed (square feet)	Native plants planted (#)
1544	1340	17,500	40,000	2500

Table 2. An overview of project elements and the results of associated actions.

GOAL	ACTIONS	RESULTS	CHALLENGES
Restore nearshore	 Removed 1,540 feet of bulkhead and fill material behind bulkhead Exposed 0.4 acres of intertidal area Removal completed in 16 days Cost: \$223,500 	 Saltmarsh vegetation expanded Insect food for fish increased Erosion was not observed on property Naturally resilient shoreline means no ongoing maintenance, repair, or replacement of bulkhead by landowner in the future 	 Obtaining permits to remove bulkheads was expensive and unpredictable Planning construction around residential property use during construction Project funding did not support monitoring costs
Restore native plants	 Removed nearly 1 acre of non-native plants Planted 2,500 native plants Volunteers donated 325 hours to plant and maintain vegetation Landowner continues to maintain plants Cost: \$60,655 	 85% of new plants survived Experimental pickleweed planting survived and spread Photos demonstrate changes in vegetation and shoreline 	 Landowner preference restricted plant diversity and planting area Shell middens, indicating historic cultural resources, restricted weed control and increased maintenance costs
Educate and engage community	 Hosted outreach events Engaged and coordinated with neighbors Cost: \$60,000 	 More than 500 decision makers, scientists, students, volunteers, and community members have visited the property since 2008 Landowners and neighbors overwhelmingly pleased with outcome 	 The large number of requests to visit property was unanticipated

RESULTS: RESTORING HEALTHY ESTUARINE HABITAT

Restore the Shore

• Implementation of the project design went very much as planned. The design removed armor without a lot of engineered reshaping or sloping of shore bank taking place, though non-native fill was removed. The shore is naturally reshaping itself, revealing compact glacial till soils in most areas. Sediment is now able to deposit naturally through the project site.

Restore Native Plants

• Native riparian vegetation and riparian ecological function and connection had been lost as a result of shoreline development. These connections were restored as barriers were removed and salt marsh and upland vegetation allowed to expand. Photo documentation clearly shows changes in site characteristics and vegetation development (Figure 4).

Community Engagement

- A host of outreach and volunteer events with numerous partner organizations have allowed other community members, shoreline homeowners, and decision makers to see first-hand the implementation and benefits of bulkhead removal on private property. The landowners and neighbors have been overwhelmingly pleased with the project's construction, education, and outcome.
- More than 500 decision makers, scientists, students, volunteers, and community members have visited the property since 2008.
- A project brochure was produced, over 835 individuals have visited the project webpage, and a number or presentations about the project were given to local and region audiences.
- Local media coverage of project has been exceptional.
- Project has resulted in inquiries from private landowners about shoreline restoration on their property.

Monitoring

- When monitoring was first explored for the Powel project, staff recognized that no outside funding was available for monitoring, but that not monitoring the progress of such a significant project would be a lost opportunity. Tools and monitoring protocols at hand were adapted for use in monitoring the project. The volunteer assisted monitoring efforts provided a great deal of information on the project's effectiveness and also on the approaches that might be taken for monitoring such projects in the future.
- One of the goals of bulkhead removal is to allow for sediment to naturally deposit onto beaches. Monitoring profiles of the property took place from the low tide to the high tide (See Figure 5) to estimate erosion. Sediment moved very little around the Powel property in the three years of monitoring since the bulkheads were removed. Figure 5 illustrates.
- Overall insect density and taxa richness (number of different taxa) were higher at the restored site than the site with a bulkhead (Figure 6). These results were significant at p<0.05 for density, and marginally significant at p<0.1 for taxa richness. This is an encouraging signature after initial restoration, as the vegetation will continue to grow and support diverse insect communities.
- Across all monitoring transects, the number of salt marsh plant species present increased from 1 species pre-restoration to 3 species after bulkheads were removed (Figure 7). Percent cover of salt marsh plant species was also consistently higher after restoration, as the plants were able to use upper intertidal habitat where that habitat did not previously exist. While natural recruitment of Pickleweed (Salicornia virginica) from existing project seedbed is expected to expand into intertidal area over time, monitoring results indicated that experimental Pickleweed planting in one reach of the

project area appears to bolster reestablishment. Physical and biological data can be used to learn more about the natural history and distribution of nearshore plants and animals. More than 200 species of diverse taxa (invertebrates, vegetation, etc.) have been documented at the Powel property intertidal and riparian areas over the course of the project.



Figure 4. Photo monitoring of Reach 4 before, during, and up to 2.5 years after bulkhead removal illustrates the enhancement of salt marsh and riparian vegetation. While salt marsh vegetation was present at the base of the bulkhead prior to restoration, the removal of the bulkhead allows vegetation to spread and naturally transition into the riparian area, and vice versa.



Figure 5. Adjusted vertical profile measurements taken annually along Powel Profile A show that the beach slope has not changed significantly and that erosion at the bluff to date is happening slowly. The 2012 and 2013 profile start points have been adjusted because they were located based on triangulation. A permanent marker was established in 2014 providing greater consistency from that time forward.



Figure 6. The number of unique insect species ("taxa richness") and the total number of individual insects (density) were both greater at the restored location compared to a location that had a bulkhead and nonnative plants. More insects were observed at the restored site even though 2015 was a drought year which may have affected both plants and insects.

Saltmarsh Vegetation pre/post-restoration



Figure 7. After the bulkhead was removed, saltmarsh plants came back to colonize the restored area. Native plants such as pickleweed dramatically increased the plant cover from 0 to over 20%. Measurements were taken at approximately mean higher high water (MHHW) where bulkheads and fill blocked the beach.

CHALLENGES

Restoration-related

- Implementing construction activities on residential use property in ways that did not impact existing infrastructure was difficult but achievable.
- Tides had to be carefully considered for timing and ability to remove bulkheads.
- Working in a busy harbor used by a number of private boats required notification and schedule adjustments.
- The large number of requests to visit property was unanticipated.
- Cultural Resources restricted activities for removing invasive plants through mechanical means and required repeated manual maintenance visits.
- The landowner takes on responsibility for ongoing invasive weed management.
- Landowner preference and residential use restricted plant diversity and positions in some areas.
- Water availability from pond or domestics sources was sometimes unpredictable. Re-rigging irrigation system and reworking landowner involvement in watering was necessary. Inconsistent source of water for irrigating plants effected survival rates in some areas of the property
- Protection of cultural resources restricted invasive weed control methods, increasing maintenance time and expense.

Monitoring-related

- The large numbers of photo documentation images accumulated during the project can be difficult to effectively manage and interpret. Guidance that could be consistent across projects would be helpful.
- Cultural resource monitoring is ongoing and has become a long-term responsibility of the project sponsor.
- Volunteer assisted monitoring techniques evolved over the course of the project, making some analyses challenging, but improving the quality of more recently collected data.
- Prioritization of the protocols necessary to address goals of the project also changed over time.
- Volunteer assisted monitoring data can have multiple goals (outreach, natural history, analysis), and it can be difficult with limited resources to address all three.

LESSONS LEARNED

Restoration related

- In projects involving private landowners, engage them and require them to be involved in all aspects of the project.
- Requesting feedback from a multi-disciplined, cohesive stakeholder group in the design phase led to continued involvement in implementation and assistance with the permitting process.
- Having a rigorous contracting procedure that also involves the landowner led to hiring the right group of contractors willing to work within the confines of residential properties with sensitivity towards the landowners.
- On significant projects with outreach goals, anticipate a large number of requests to tour the property.
- The project and property speak for themselves anecdotally, the comments received from neighbors and passersby reflected positive community interest and support of the project.

• Creating a way to track inquiries from landowners about their interest in shoreline restoration on their own properties that may have resulted from their knowledge of the project could help illustrate the importance of implementing pilot projects such as the Powel project. Work with local jurisdictions (such as Cities or Counties) to track potential increases in inquiries from landowners for shoreline restoration projects.

Monitoring related

- Having a well-developed and funded monitoring plan prior to restoration is important in order to clearly demonstrate how project actions are meeting project goals and objectives.
- Design monitoring to reflect the goals of the project, and take advantage of existing experiences and tools like the Shoreline Monitoring Toolbox (Washington Sea Grant website).
- Terrestrial insect abundance and diversity is a good measure of beach health because insects rely on vegetation and provide preferred food for salmon and other fish.
- Forethought and consistency with monitoring protocols, sample processing, data entry, and data analysis can lead to stronger quantitative analysis and quicker processing of samples. Involving partners and providing effective guidance allows volunteers to richly contribute to our understanding of the physical and biological responses to restoration.
- Volunteer assisted monitoring at the Powel project illustrates that volunteer assisted data collection can have multiple benefits: outreach, natural history, and statistical analysis.
- Volunteer assisted monitoring techniques evolved over the course of the project, making some analyses challenging, but improving the quality of more recently collected data. Volunteers can collect reliable data and should be considered as a resource for collecting data for most of the protocols in the Shoreline Monitoring Toolbox (WSG website).
- Monitoring the density and diversity of plants in quadrats where armor was removed was effective at illustrating the presence of additional habitat for some beaches.
- Measurements of beach profiles are more precise with technical survey gear such as auto-levelers. The stick-and-line method can be useful if the line is a set length and if the horizon is farther away. Still, any error in the stick and line method affects the shape of the rest of profile and can be magnified by other error. An autolevel and stadia rod obtain a new reading each time, and for \$200-400 and a brief training, can make volunteer data on beach shape and erosion much more accurate and objective.
- For quantitative monitoring techniques, a minimum of 3 replicates and preferably 5 or more will allow and improve statistical analysis. From lessons learned about the types of data that would be most useful in a project like this, a limited number of focused monitoring activities will allow volunteers to focus and collect the best data without over taxing their availability.
- From photos to animal densities to elevations, significant time will be needed to manage collected data, and existing and additional guidance developed through the Shoreline Monitoring Toolbox or other resources would help make data management more consistent and more broadly informative.

PROJECT COSTS

Table 3. Project components and costs.

Project Action Item	Cost
Restoration Design	\$ 132,943
Bulkhead Removal	\$ 223,500
Vegetation Restoration	
Removal of invasive, planting of natives, maintenance	\$ 60,655
Monitoring	
Implementation and Cultural Resources	\$ 5,845
Effectiveness Monitoring (staff)	\$ 26,114
Value of citizen and student volunteer time	\$ 16,630
Communications/Outreach/Administration	\$ 60,000
Total Project Costs (includes rounded figures and volunteer hours)	\$ 525,687
Total Value of Volunteer contributions (included in Total Project Costs)	\$ 24,780

It is estimated that if the Powel's had chosen to repair or replace their bulkhead instead of restoring the shore, the cost of the replacement would have been approximately \$512,000 with ongoing maintenance costs. The actual monetary costs of the restoration actions (not including monitoring) were less that the cost of rebuilding the bulkhead. In addition, the ecological benefits of a restored shore have long-term benefits beyond the initial capital investment made.

Table 4. Project funders.

Project Partner, Sponsor, or Funding Source	Amount
The Powel Family and Bainbridge Island Land Trust (project sponsor/manager) – this figures does not include time spent by family members on all project components	\$56,054
Puget Sound Acquisition and Restoration (PSAR)	\$132,943
Salmon Recovery Funding Board (SRFB)	\$293,910
US EPA through the Puget Sound Partnership	\$22,400
Value of Citizen and Student Volunteers Time	\$24,780

LINKS TO THE ACTION AGENDA

Bainbridge Island nearshore restoration at the Powel property has contributed to the 2020 target for the Shoreline Armoring Vital Sign and has advanced Action Agenda Strategies A6 (Protect and Recover Salmon) and B2 (Protect and Restore Nearshore and Estuary Ecosystems).



ACKNOWLEDGEMENTS

Restoring shoreline connections and habitat at the Powel property would not have been possible without the interest, vision, support and commitment of the Powel family from beginning to end and beyond.

We also wish to express our deep appreciation to all the citizen and student volunteers without whom monitoring of this project wouldn't have been as successful or as visible to the broader community, and with whose support the impact and lessons of the project will be measured and shared long after the funding reports have been filed.

The Powel Shoreline Restoration Project was an endeavor undertaken by a diverse set of partners and contractors, enriching project effectiveness. These partners include:

Bainbridge Beach Naturalists, Bainbridge Island Land Trust, City of Bainbridge Island, Coastal Geologic Services, Cultural Resources Consultants, Jim Brennan (Marine Ecological Consulting Services), JTC Marine, Puget Sound Partnership, Sea Grant Washington, Sound Native Plants, Sound Bulkead, Suquamish Tribe, US Army Corps of Engineers, UW School of Aquatic and Fishery Sciences, Washington Department of Fish and Wildlife, Washington State University Kitsap County Extension, Washington Recreation and Conservation Office, West Sound Watersheds Council.

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