Restoring the Beaches of Puget Sound – Two Promising Prototypes in Everett, WA

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Abstract

The majority of the east side of Puget Sound was hardened with riprap and bulkheads during the 20th Century, and much of this hardened shoreline is occupied by the Burlington Northern Santa Fe Railroad (BNSF). Restoration of more natural shoreline habitats, and the processes that sustain those habitats have been identified by several regional restoration planning efforts that are underway in the Sound as one of the elements critical to salmon recovery. This paper describes two projects that have been completed in Everett, Washington that have sought to restore a more natural shoreline habitat in areas where existing infrastructure precludes re-establishment of natural processes. These projects have created a more natural beach profile with a beach face, storm berm, and backshore along approximately 0.6 km of hardened shoreline. Physical monitoring has shown that the 335-m pebble/sand beach constructed near Mukilteo, using 10,700 m^3 of material has responded to the ambient wave environment much as predicted through two winters. Biological monitoring at this beach has shown a high level of biological activity by juvenile salmonids and forage fish. However, it is not yet certain if forage fish (sand lance) that previously spawned in sand at the base of the railroad bulkhead will spawn significantly on the new beach. The second project used 46,000 m^3 of clean sand, dredged from the Snohomish River Navigation Channel to extend Jetty Island 300 m to the south along an artificial, riprap, training jetty. Construction was completed in February 2007 and only limited monitoring is reported. The ecological and fiscal costs and benefits of both projects are being analyzed.

Introduction

Known and potential ecological effects of shoreline armoring are widely recognized by biologists and resource managers in the Puget Sound and Georgia Basin region and have been well summarized by Williams and Thom (2001). Scientists developing plans to restore depleted anadromous fish runs in Puget Sound have called for restoration of nearshore ecological function along many kilometers of Puget Sound shoreline (Shared Strategy 2007). Ecological functions can best be restored through restoration of the physical and hydrologic processes that support those functions. One major challenge to restoring these physical processes is that most of the armoring in question has been placed to protecting public or private land uses. In areas where restoring those physical processes (e.g., feeder bluffs) that form and maintain natural beaches is not possible, beach function may nonetheless be restored by other means.

This paper describes two recent projects constructed near Everett, Washington (Figure 1) where the objective was to rebuild the beach in front of armored beach segments to provide the full extent of foreshore, storm berm, and backshore that would be expected to

occur naturally in the extant wave exposure, and given the presumed types of natural sources of sediment.

The Port of Everett Rail/Barge Transfer Facility Beach Restoration

Background. The Port of Everett (Port) has constructed a new rail/barge transfer facility along the westernmost shoreline of the City of Everett (Figure 1). The primary use of the facility will be to transport aerospace components to various industries at Paine Field. To support existing and new aerospace programs, the facility must provide the flexibility to transport larger cargo containers from the Port to Paine Field with minimal disruption of rail traffic on the Burlington Northern/Santa Fe Railroad (BNSF) mainline. A major restoration opportunity was identified during project permitting and design. Specifically, restoration of approximately 1,100 feet of shoreline beginning at the east end of an existing tank farm fill and extending under the new pier to the east along the BNSF tracks (Photos 1, 2). Net alongshore sediment transport is to the east (Schwartz et al. 1991).

Figure 1: Vicinity map, site 1 is the rail/barge transfer facility and site 2 is the Jetty Island extension

Photo 1: Pre-construction aerial photo detailing hardened shoreline, derelict tank farm, and BNSF main line.

Photo 2: Pre-construction photo on eastern side of proposed enhancement looking west toward derelict tank farm.

Construction. The project design included a coarse beach core with at mixed sediment beach face and a sandy backshore (Figure 2). It was expected that waves would sort the mixed sediment placed on the beach face to provide bands of predominantly sand sediment and shell that are preferred spawning habitat for forage fish. Construction of the beach restoration began in September 2005 with placement of approximately 7,100 metric tons of the beach core material, 7.6-cm minus rounded river gravel. The beach face material, approximately 6,600 metric tons of habitat mix of 3.8-cm minus sand, granules, and pebbles, was placed and graded to a 7h:1v slope; east of the pier this work was completed in December 2005 (Photo 3); west of the pier, the beach was completed in

January 2006. Approximately 2,675 metric tons of backshore sand was placed in May and June 2006. Approximately 15 cm of topsoil was added and mixed in with the sand in October 2006 to aid in establishment of backshore vegetation. All materials were brought to the site by truck and graded to the specified contours by tracked equipment.

Figure 2: Beach design concept

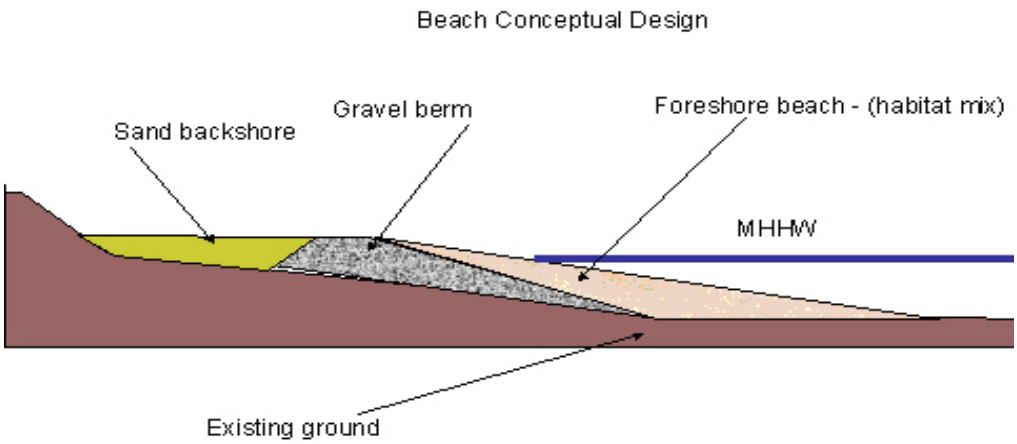

Photo 3: Completed beach east of pier, December 2005

Monitoring. Monitoring of project performance is expected to continue for 10 (biological performance) to 20 (physical performance) years. Comparisons will be made between conditions at the project site after construction and those that were present before construction, or which exist on an adjacent reference beach similar in form to the constructed beach. One full year of monitoring (2006) has been completed with the following results:

Physical monitoring of beach stability and sediment movement (May and November 2006) showed that the larger central portion (approximately 300 m) of the restored area showed only minor redistribution of sediments and a few cm of accretion. A substantial storm berm had formed and a large number of large woody debris pieces had accumulated (Photo 3). The western end (approximately 25 m) of the reconstructed beach had lost some finer material from the surficial habitat mix. This material may have been deposited in the backshore immediately to the east and/or transported to the accreting beach face farther to the east. The east end of the restored beach, which was unconfined by terrain features, was expected to lose material to the east. As of November 2006, the beach profile located 10 m from the end of the construction had lost approximately 1.0 m from the beach face. This material had been moved eastward by waves forming a gradual and natural-appearing transition with the unrestored beach in front of the railroad bulkhead to the east (Photo 4).

No significant difference was seen between the density of epibenthic zooplankton on the project and reference beaches. Epibenthos at both beaches in April 2006 was dominated by gammarid amphipods.

No significant difference was seen in the mean catch of juvenile salmonids at the four locations fished with a 37-m beach seine in April and May 2006. Numbers and length frequency of juvenile chum, coho, and Chinook salmon were quite similar between the project and reference beaches. Sand lance schools were captured in various sets at both project and reference beaches. We conclude that biological performance of the beach is largely as expected: There is high use of this shoreline near the mouth of the Snohomish River by juvenile salmonids; in the long term, habitat created may be more suitable for spawning by surf smelt than by sand lance but a single sand lance egg was found in samples from the restored beach in January 2007.

Photo 4: Transition zone between restored and unrestored beach in front of railroad bulkhead (looking east)

Corps of Engineers and Port of Everett Jetty Island Extension

The Corps of Engineers is responsible for maintenance dredging of the lower Snohomish River navigation channel and the Port of Everett is responsible for sediment disposal. Since 1990 there has been a strong emphasis on beneficial use of dredged materials for habitat enhancement (e.g., Houghton and Gilmore 1995) and capping of contaminated bottom areas. Jetty Island (Figure 1, Site 2) was created by hydraulic placement of dredged materials on the west side of a 3-km long rock jetty built about 1905 to protect the channel and Everett harbor. Excellent marine and upland habitats (a sandy beach, log-strewn backshore, and thriving dune and scrub-shrub uplands) have been created and periodically enhanced along the northern three quarters of the island but the southern quarter of the rock jetty crosses the lower intertidal zone as a steep rocky shoreline (Photo 5, right side).

We designed a project that was included in the Snohomish River Basin Salmon Conservation Plan (SBSRF 2005) to place a large volume of clean sand along the rock jetty extending south from the island uplands to improve the nearshore migration corridor for juvenile salmonids. In February 2007, the Corps of Engineers dredged the lower channel and hydraulically placed approximately 45,000 m^3 of sand along the west side of the jetty essentially extending the island shoreline by approximately 1,000 feet (Figure 3, Photo 6). The new island section has a backshore of approximately 75 feet in width that is expected to be colonized by native vegetation and a natural sloping beach face. We have designed a long-term monitoring program for the site that will carried out with the aid of the People for Puget Sound Stewardship program. The foreshore will be shaped by wave action and is expected to develop a storm berm that was will accumulate a substantial quantity of large woody debris; late winter floods in 2007 had already deposited over 2 dozen pieces of large wood on the beach by March 2007.

Photo 5: Rock jetty looking south – pre-project (November 2006).

Figure 3: Jetty Island cross-section pre-/post beach nourishment (rock jetty on the left)

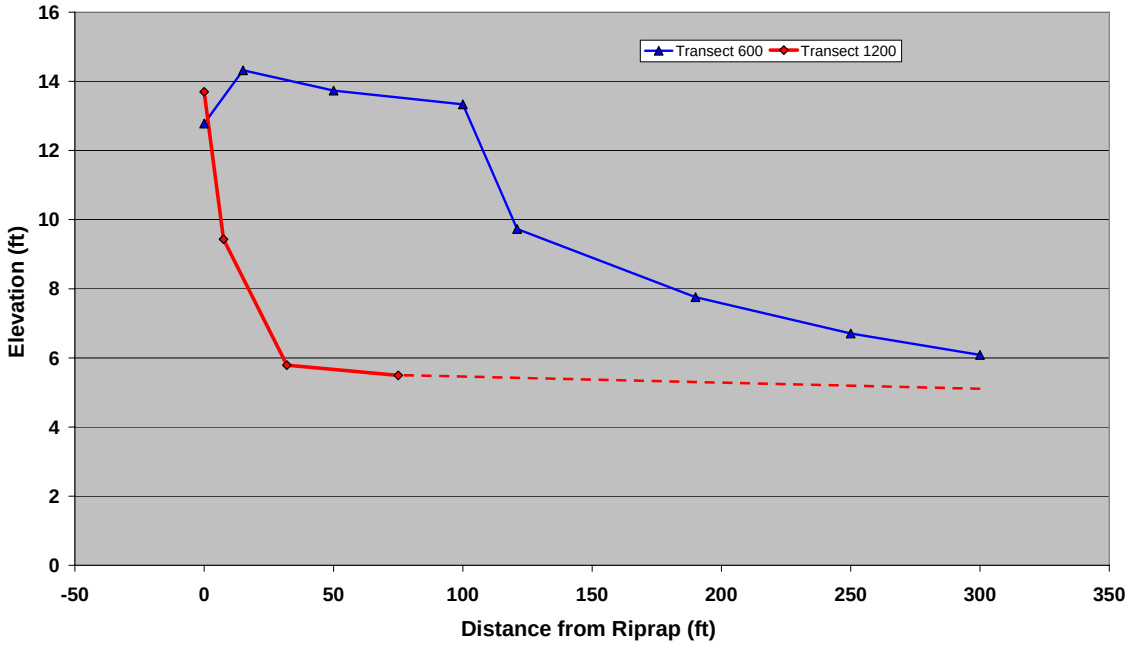

Photo 6: Rock jetty looking south – post-project (March 2007)

Summary

Two projects have been completed in the Everett area that provide excellent examples of how artificially nourished beaches in central Puget Sound can be expected to be shaped by existing wave and current environments and what levels of ecological functions can be expected to result. Long-term monitoring is planned for both projects to examine the

longevity and stability of the restored ecological functions as well as material placement. The restored sand/pebble beach at the RB/TF site has shown excellent stability during the first two winters of monitoring with minor losses of materials from either end of the restored reach. This project has also shown expected biological performance with presence of invertebrates and use by juvenile salmonids that are comparable to those on a nearby, similar reference beach.

The Jetty Island extension project has only been in place for 2 months as of this writing and will be monitored for physical and biological performance over the coming years.

Costs of both projects, despite the sharp differences in materials used and mode of sediment placement, were quite similar at approximately $60,000US per 30 linear meters of beach restored. Several factors related to the nature of each project suggest that this figure should be considered an upper bound of the costs of similar future projects although neither project had any property acquisition cost.

References

Houghton, J.P., and R.H. Gilmour, 1995, Ecological functions of a saltmarsh/mudflat complex created using clean dredged material at Jetty Island, Washington, Pages 323-332 in Puget Sound Research '95: proceedings, Puget Sound Water Quality Authority, Olympia, WA.

Schwartz, M.L., B.D. Harp, B.E. Taggart, and M. Chrzastowski, 1991, Net shore drift in Washington state: Vol. 3, Central Puget Sound region. Washington Dept. Ecol., Shorelands and Coastal Zone Management Program, Olympia, WA.

Shared Strategy. 2007. http://www.sharedsalmonstrategy.org/RecoveryPlan.htm

Williams, G. and R. Thom, 2001, White Paper: Marine and estuarine shoreline modification issues. Submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Transportation, by Battelle Marine Sciences Laboratory, Sequim, WA.