Habitat Fast Facts

Elliott Bay Seawall Project

Seattle's deep water piers were no accident—over time, the city built westward into the water. As a result, 60 percent of the waterfront is covered by piers and other over-water structures, resulting in stark contrasts between light and dark areas. The naturally lighted areas along the central waterfront show a diversity of aquatic plant and animal life, from rockweed and sea lettuce to numerous perch species and salmon, while the dark areas (under piers) do not support plant growth and have limited species present.

Juvenile salmonids journey from the Green/Duwamish River watershed along the central waterfront. Of the five million estimated salmonids that exit the Duwamish, some 50 percent "turn right" and travel up Seattle's Central Waterfront (along the seawall project area) toward Myrtle Edwards Park.

Migrating salmon are less susceptible to predators in locations with better habitat conditions, including shallow water and areas with natural cover. Restoring the salmon migration corridor and improving ecosystem productivity are important objectives of the Elliott Bay Seawall Project. The City of Seattle and the U.S. Army Corps of Engineers view this project as an opportunity to highlight habitat restoration along Seattle's urbanized downtown waterfront. Options to improve habitat are being studied and include light penetrating surfaces, habitat benches, cobble reefs, substrate diversity, textured seawall faces, and plantings.

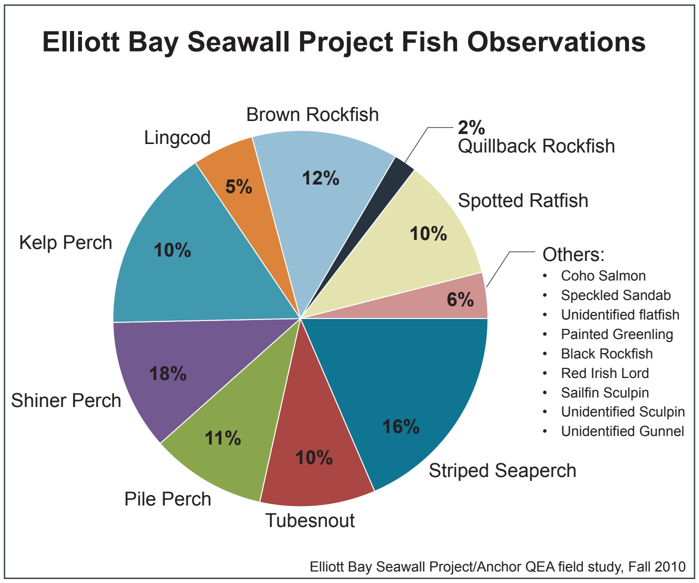
Assessing the nearshore habitat – populations and distributions

- Within the Elliott Bay Seawall Project corridor, seven species of salmonids are present, including Chinook, coho, chum, sockeye, and pink salmon. Additionally, cutthroat, steelhead, and bull trout have been observed.
- Juvenile salmon migrate in the spring and summer, but different types of fish (perch and others) are present at all times of the year. Adult salmon return in the fall and winter to the Green/Duwamish watershed.
- Juvenile chum and Chinook salmon are the most dependent on nearshore habitats, where they feed and develop before migrating to pelagic (open water) marine habitats (Levy and Northcote 1982; Simenstad et al. 1982; Groot and Margolis 1991; Levings 1994; Cordell et al. 1997; Quinn 2005).

Light areas (between piers) have rich habitat.

Dark areas (under piers) support little habitat.

- Estuaries and the marine nearshore are important foraging areas for juvenile salmon. In general, these areas provide abundant prey resources for juvenile salmon to grow rapidly.
- Research has documented clear relationships between light levels and submerged aquatic vegetation. Areas with low light levels have limited aquatic vegetation while lighted areas support a rich and diverse assemblage of submerged aquatic vegetation, including seaweeds such as green, brown, and red macroalgae, and eelgrasses.



Divers conducting snorkel surveys along the Elliott Bay Seawall observed a number of fish species and aquatic vegetation.

Light

Issues:

- Large overwater structures, such as the piers along the seawall, cast shadows that create dark areas with sharp contrasts to the unshaded areas. In particular, a stark contrast between plant life between piers and plant life under piers has been directly observed along the seawall (Anchor QEA 2010).
- For juvenile salmon, light is tremendously important because it is necessary for spatial orientation, prey capture, schooling, predator avoidance, and migration navigation (Simenstad et al. 1999). Shade cast by overwater structures changes the lighting conditions for juvenile salmon and requires their eyes to physiologically change in order to adjust to the light environment. Shaded areas under large overwater structures can affect the availability of potential prey and the juvenile salmon's ability to detect potential prey.
- Contrasts in the lighting conditions affect salmonid behavior: it can take 20 to 40 minutes for a juvenile salmonid to adjust from dark to light, or vice versa (Brett and Ali 1958; Ali 1958; Protasov 1970; see Simenstad et al. 1999). The greater the magnitude of contrast in light intensity, the longer it will take for juvenile salmon eyes to adapt to the new light environment.
- Efforts are underway to advance the state of the science—at night, ambient light from street lights and buildings cause salmonids to similarly delay at pier edges (on-going Anchor QEA study for seawall project).

Next steps:

- Light monitoring as part of the fish survey by the Elliott Bay Seawall habitat team over a six month period is helping our team to understand existing light conditions above and below piers.
- If the light to dark transitions at piers can be reduced, then juvenile salmon may migrate more easily along the shoreline and find better opportunities for avoiding predators and feeding.

- To improve the nearshore corridor by providing light to the areas below, cantilevered decks could include light penetrating surfaces.
- Light penetrating surfaces can be easily used on overwater structures to allow light to reach areas underneath the structures. The feasibility and cost of different light penetrating surfaces (e.g. glass blocks) are being evaluated as part of project design, in cooperation with the waterfront design team.

Depth

Issues:

- Juvenile salmon depend upon shallow water habitats and tend to restrict their movements to habitats less than six feet deep until they reach a size that allows them to explore deeper water habitats (Southard et al. 2006; Shared Strategy 2005).
- The smallest juvenile salmon are primarily associated with the shallowest habitats, which provide refuge from predation and food to help the fish grow rapidly (Fresh and Averill 2005; King County and Washington State Conservation Commission 2000; City of Seattle 2003).
- Due to the filling and build out of the shoreline, combined with berths dredged for ships, lighted areas between piers are generally deep water, while shallow water remains in unlighted areas under the piers.
- Shallow water habitats are important refuges for small fish because large predatory fish cannot access these areas. Estuaries and the marine nearshore provide refuge areas for juvenile salmon to avoid fish or bird predators.

Next steps:

- Intertidal habitat benches provide shallower nearshore habitat and help to create a continuous shallow water corridor for juvenile salmon to travel along the waterfront.

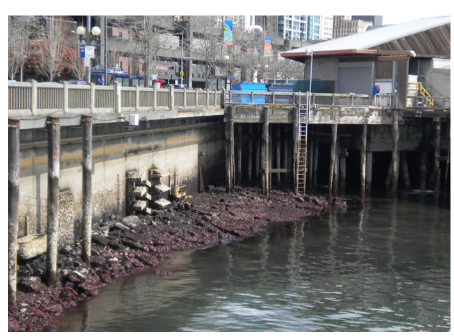
Substrate

Issues:

- There are predominantly three substrate types along the seawall: sand/silt/shell hash covers the most area (approximately 70 percent of total area surveyed), followed by rock (approximately 20 percent), and gravel/cobble (three percent).
- Shoreline development in Elliott Bay has eliminated nearly all shoreline sediment sources and drift to the seawall project area. Limited contributions of sediment may enter Elliott Bay via stormwater outfalls; otherwise, some fine sediment from the Duwamish River may be transported to the project area.
- Substrates most suitable for the production of prey species for salmonids do not occur at appropriate depths or locations along the corridor.

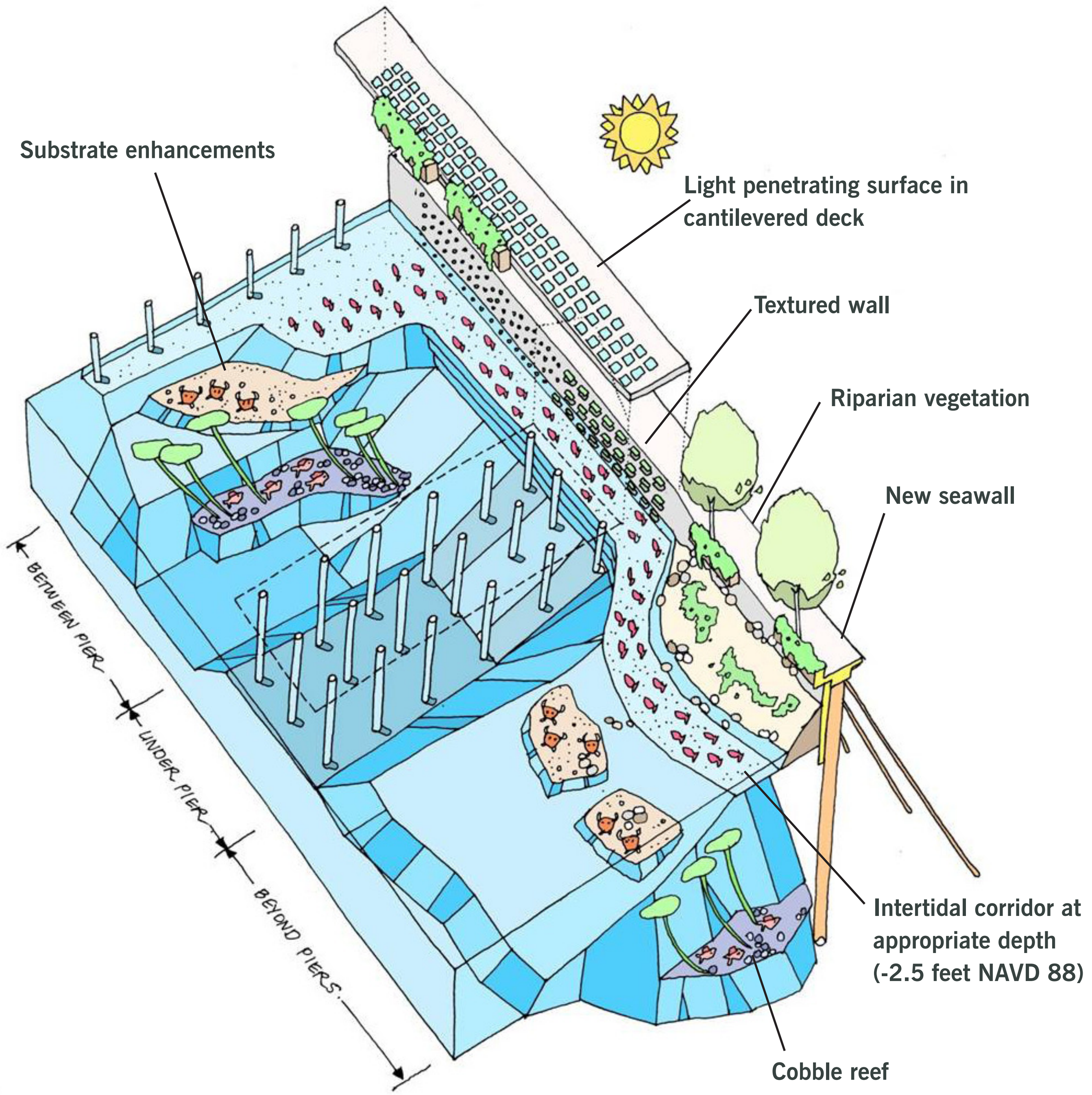
Next steps:

- By increasing light transmitted to the aquatic habitats below piers, increased primary production (plant/vegetation) and associated invertebrates would boost overall ecosystem productivity and improve juvenile salmonid foraging and growth opportunities.
- Substrate enhancement measures, including confined sediment under piers, habitat benches between piers, and textured walls, are being explored as methods to increase plant and invertebrate growth along the migration corridor.
- Further offshore, measures such as cobble reefs and substrate enhancement are being considered to improve ecosystem productivity and enhance habitat for other species, based on success in other areas of Elliott Bay.



Low tide along the seawall shows a pilot project by the City of Seattle/University of Washington to monitor growth on textured wall panels.

Examples of potential Elliott Bay Seawall Project habitat improvements



For more information

Web: www.seattle.gov/transportation/seawall.htm

Email: seawall@seattle.gov

Project Hotline: 206-618-8584

For references noted please see Elliott Bay Seawall Project "Selected Habitat References."

Americans with Disabilities Act (ADA) Information: Materials can be provided in alternative formats—large print, Braille, cassette tape, or on computer disk—for people with disabilities by contacting Paul Elliott, 206-684-5321, seawall@seattle.gov. Persons who are deaf or hard of hearing may make a request for alternative formats through the Washington Relay Service at 7-1-1.

SDOT
Seattle Department of Transportation

Selected Habitat References

Ali, M. A. 1958. The ocular structure, retinomotor and photobehavioral responses of juvenile Pacific salmon. Ph.D. dissertation, Univ. British Columbia, Vancouver BC, Canada.

Ali, M.A. 1959. The ocular structure, retinomotor and photo-behavioral responses of juvenile Pacific salmon. Canadian Journal of Zoology. 37:965-996.

Anchor QEA, LLC. 2010. Survey of aquatic habitats and biological communities along Elliott Bay Seawall. Final report submitted February 2011.

Brett, J. R., and M. A. Ali. 1958. Some observations on the structure and photomechanical responses of the Pacific salmon retina. J. Fish. Res. Board Can. 15:815-829.

City of Seattle. 2003. Seattle's Urban Blueprint for Habitat Protection and Restoration. Prepared by City of Seattle's Salmon Team. December 2003.

Cordell, J.R., L.M. Tear, K. Jensen, and V. Luiting. 1997. Duwamish River Coastal America restoration and reference sites: Results from 1996 monitoring studies. FRI-UW-9709. School of Fisheries, Fisheries Research Institute, University of Washington, Seattle, Washington.

Fresh, K. and D. Averill. 2005. Salmon in the Nearshore and Marine Waters of Puget Sound. In: Redmond et al. [eds.] Regional Nearshore and Marine Aspects of Salmon Recovery in Puget Sound. Delivered to Shared Strategy for Puget Sound for inclusion in their regional salmon recovery plan.

Groot, C. and L. Margolis, Editors. 1991. Pacific Salmon Life Histories. UBC Press. Vancouver, British Columbia, Canada. 564 pp.

King County and Washington State Conservation Commission. 2000. Habitat Limiting Factors and Reconnaissance Assessment Green/Duwamish and Central Puget Sound Watersheds Water Resource Inventory Area 9 and Vashon Island.

Levings, C. D. 1994. Life on the edge: Structural and functional aspects of Chinook and coho salmon rearing habitats on the margins of the lower Fraser River. In Salmon ecosystem restoration: Myth and reality, Proceedings of 1994 Northeast Pacific Chinook and Coho Salmon Workshop, p. 139-147. Oregon Chapter, Am. Fish. Soc., Corvallis, OR.

Levy, D A. and T G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River Estuary. Canadian Journal of Fisheries and Aquatic Sciences 39:270-276.

Protasov, V. R. 1970. Vision and near orientation of fish. Israel Program for Scientific Translations, Jerusalem. 175 pp.

Quinn, T.P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. American Fisheries Society and University of Washington Press, Seattle, Washington.

Shared Strategy. 2005. Regional Nearshore and Marine Aspects of Salmon Recovery in Puget Sound. Compiled and edited by Scott Redmond, Doug Myers, and Dan Averill – Puget Sound Action Team. From contributions by the editors and Kurt Fresh and Bill Graeber, NOAA Fisheries. Delivered to Shared Strategy for Puget Sound for inclusion in their regional salmon recovery plan. June 28, 2005.

Simenstad, C. A., K. L. Fresh, and E. O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: An unappreciated function. In: V.S. Kennedy [ed] Estuarine Comparisons. pp.343-365. Academic Press, Toronto.

Simenstad, C.A., B.J. Nightingale, R.M. Thom, and D.K. Shreffler. 1999. Impacts of Ferry Terminals on Juvenile Salmon Migrating along Puget Sound Shorelines – Phase I: Synthesis of State of Knowledge. Washington State Transportation Center (TRAC) Research Report WA-RD-472.1, Seattle, Washington.

Southard, S. L., R. M. Thom, G. D. Williams, J. D. Toft, C. W. May, G. A. McMichael, J. A. Vucelick, J. T. Newell, and J. A. Southard. 2006. Impacts of ferry terminals on juvenile salmon movement along Puget Sound shorelines. Washington State Dept. of Transportation, Olympia, WA.