

Duwamish Blueprint

Salmon Habitat in the Duwamish Transition Zone



Duwamish Blueprint
Working Group

November 6, 2014



Green/Duwamish and
Central Puget Sound
Watershed, WRIA 9

**GREEN / DUWAMISH
AND**



Urban Waters
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Duwamish Blueprint: Salmon Habitat in the Duwamish Transition Zone

Prepared for the Green/Duwamish and Central Puget Sound (WRIA 9)
Watershed Ecosystem Forum



November 6, 2014

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Cover photos:

Upper right – Volunteers planting native vegetation along the bank of the Duwamish River. Photo courtesy of Elsa Sargent.

Upper left - North Wind's Weir during low tide, August 8, 2014. This project was completed in 2010.

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Executive Summary

Introduction

Salmon recovery in the Green/Duwamish watershed depends on improving the quality and quantity of estuarine habitat in the Duwamish estuary. In particular, migrating juvenile Chinook salmon need more and better “transition zone” habitat where they can feed, take shelter, and osmoregulate as they transition from being freshwater fish to saltwater fish.

This Duwamish Blueprint (Blueprint) is a working draft that intends to provide guidance to governments, businesses, and citizen groups as they improve the aquatic ecosystem of the Duwamish estuary, with a focus on the area between river miles 10-1, generally from Tukwila, near the I-5/599 interchange, downstream/north to almost Harbor Island and the West Seattle Bridge. The Blueprint has been developed to implement Program D-3 (page 7-82) from the 2005 “WRIA 9 Salmon Habitat Plan: Making Our Watershed Fit for a King” (WRIA 9 Steering Committee 2005). The Blueprint was originally drafted in 2006 by WRIA 9 staff and multiple stakeholders. In 2014, the Duwamish Blueprint Working Group, which consisted of WRIA 9 stakeholders and staff familiar with the Duwamish and estuary restoration, updated the 2006 draft using more recent information about the Superfund Cleanup and related mitigation efforts, scientific data, and experience implementing Duwamish habitat projects.

The key parts of this Blueprint are:

1. Summary of the problem, including challenges and opportunities
2. Characteristics of transition zone habitat that will benefit salmonids (salmon and trout)
3. List of potential, completed, and in progress habitat projects
4. Evaluation criteria for potential projects
5. Strategy for moving projects forward
6. Recommendations for habitat maintenance, monitoring and adaptive management

Foundation

The Blueprint recognizes the following significant facts:

- A healthier Duwamish estuary will contribute to the improvement of the health of the Puget Sound ecosystem and the health of animal populations that are listed as threatened or endangered under the federal Endangered Species Act;
- The Duwamish corridor is the industrial heart of western Washington, providing valuable goods and services, serving as a vital transportation link, and supporting thousands of above-average wage jobs;
- The Duwamish is a living river that provides cultural and social value to the community in addition to economic goods and services;
- There are a variety of other activities and planning efforts that will influence and can be influenced by salmon habitat recovery efforts, most significantly, the Superfund designation of the lower 5.3 miles of the river and the cleanup of contaminated sediments;

- Because of the extensive urbanization in this part of the watershed, opportunities to restore or create habitat are limited, but they do arise; and
- Past efforts have shown that habitat can be restored and created in the Duwamish and that salmonids will make use of these habitats.

The Blueprint rests on the following assumptions:

- Creating more transition zone habitat is a necessary condition for recovery of Chinook salmon populations in the Green/Duwamish River;
- While scientific understanding of salmonid use of the Duwamish estuary is evolving, enough is known to be able to take actions during 2014-2025 that will build on previous efforts and contribute to a healthier river;
- Restoration of the estuary to pre-development conditions is not possible but ecological functions can be improved in a heavily urbanized setting;
- Governments, businesses, and citizens can continue to work together to improve the health of Duwamish estuarine ecology without significantly impairing other non-ecological uses;
- Habitat projects from river mile 10 to river mile 1 will provide transition zone habitat for salmonids;*
- Habitat projects will provide cultural and social values by increasing the number of green spaces and access points to the river; and
- Adding approximately 40 acres of new habitat in the Duwamish transition zone during 2014-2025 will significantly contribute to increased productivity of the Green/Duwamish watershed for the fall Chinook salmon population.

Transition Zone Defined

For the purpose of this Blueprint, the transition zone is defined as extending from river mile 10 (upstream of the Interstate 5 crossing of the Duwamish) to river mile 1 (between Kellogg Island and the West Seattle Bridge) (Figure 2). This definition is based on information available to date and the conclusions of the majority of scientists who have provided input. Additional information and/or further analysis may lead to adjustments in the transition zone definition.

Because of the importance of the transition zone and the high cost of improving habitat in the Duwamish, it should be a goal of monitoring and adaptive management to further refine our understanding of the scope and nature of the transition zone, and how fish use the habitats there.

Transition Zone Habitat Recommendations

The Blueprint makes the following recommendations regarding potential habitat projects:

- The creation of at least 40 acres of new habitat that supports transition zone functions by

* River mile marking systems vary for the Duwamish. River miles in this document are based on those in the WRIA 9 Strategic Assessment (WRIA 9 Technical Committee, 2005) and Salmon Habitat Plan (WRIA 9 Steering Committee, 2005). For maps showing river miles, see the map in this document and http://your.kingcounty.gov/dnrp/library/2005/kcr1876/FIGS_11X17/Fig7-4.pdf

2025. Habitat potential is further specified for five different reaches in the transition zone (Appendix A, Table 1). Approximately 31 acres of habitat were created in the Duwamish transition zone between about 1988 and 2014 (WRIA 9 Implementation Technical Committee 2012 and unpublished data).

- Larger projects – that is, two acres in size or greater – are highest priority because they are more likely to support a diverse ecosystem and because of the economies of scale associated with design, permitting, construction, maintenance, and monitoring. However, smaller projects are still welcome as much needed incremental additions of habitat.
- Projects that incorporate “more landscape-based approaches, such as merging with existing restoration sites, linking to upland drainages, development of tidal channels and sloughs, and addition of natural estuarine wetland attributes, such as large woody debris” are preferable (Simenstad et al., 2005).
- The habitat feature *most needed* in the Duwamish below RM 5.5 from a salmonid perspective is mudflat within the entire intertidal range between -4 and +12 ft. Mean Lower Low Water (MLLW), with an emphasis on mudflats in the low intertidal between -4 to +4 ft. MLLW. These mudflats would ideally have a relatively shallow grade of less than 5% (20:1), a silt/clay to fine sand substrate, and be unvegetated. Elevations of planned habitat features should be determined by surveying elevations of existing mudflats and marsh as close to the project site as possible.
- The habitat feature *most needed* in the Duwamish above RM 5.5 from a salmonid perspective is shallow-water, off-channel habitats where juvenile salmonids can shelter, hold in low-salinity water, and feed (Ruggerone et al. 2006). Ideally, these habitats would feature a relatively shallow grade, a silt/clay to fine sand substrate, and be ringed with emergent vegetation and mixed riparian in the uplands.
- Larger and/or multiple openings to the main channel may be preferable to smaller/single openings (Cordell et al. 2011). This design feature will need to be balanced against the need to protect the habitat from wave and/or current energy.
- Projects should be sited where the water is more brackish than saline (Cordell et al. 2011), and where there are freshwater inputs to provide small-scale habitats of mixed salinity within the larger estuarine ecosystem.
- Habitat improvements may be obtained by linear treatments of the river bank.
- In a few circumstances, it may be possible to connect the project with upland habitats to expand the project size and/or benefit other aquatic and terrestrial wildlife.
- Projects should be revegetated using appropriate soil preparation, native plantings, maintenance and monitoring to ensure successful development of trans-successional states stages of intertidal, riparian and terrestrial habitat as appropriate for the site (Appendix C).
- Trees should be planted across the Duwamish subwatershed, targeting residential neighborhoods and areas where people work. Trees in the urban landscape can help clean

runoff by reducing the amount and temperature of runoff, and capturing airborne pollutants. They also have social benefits, including improving health (Donovan et al. 2011 and 2013) and reducing crime rates (Donovan and Prestoman 2012).

This Blueprint does not evaluate or rank potential projects because of the need to act when one of the limited opportunity areas becomes available. Projects can be evaluated in the future if there are two or more projects that need conceptual development or full funding.

Implementation Strategy

To move forward with creating the habitat projects listed in this Blueprint, the partners should adopt the following strategy:

1. Pursue all habitat opportunities located on publicly-owned properties. The project list (Appendix A) includes potential, in progress, and completed projects. All potential projects on the list are not likely to be completed, and likewise, other opportunities for habitat may arise that are not on the list.
2. Encourage partnering to leverage resources and maximize the size of restoration sites.
3. Identify privately-owned properties that offer the greatest potential.
4. Contact private property owners. This could be done by governmental agencies, a non-profit, or WRIA staff.
5. Develop conceptual design and budget for selected properties.
6. Work to arrange funding in advance to allow timely purchase when properties desired for habitat projects come onto the market.
7. Stewardship, maintenance, and monitoring and adaptive management should be prioritized to maintain quality habitat, track project implementation and effectiveness, and improve future efforts. Stakeholders should consider meeting on a regular basis to facilitate collaboration and coordination.

Key Recommendations

- Streamline permitting processes for habitat restoration.
- Track project implementation and the areas of shallow water and native riparian vegetation in the transition zone to make sure there is a net gain over time.
- Pursue new funding sources to allow timely purchase when transition zone parcels are for sale.
- Prioritize purchase, design and construction funds for the largest potential properties.
- Determine whether Chinook fry voluntarily migrate to the lower Duwamish estuary; whether the size of the opening to the main river influences fish use of off-channel habitats; and how much juvenile fish rely on the area between river miles 8.5 and 11 for smoltification;
- Research whether pass-through or flow-through channels vs. blind channels (channels that don't connect back to the river) are more beneficial to juvenile salmonids.
- Hire a part-time Duwamish Basin Steward to speed up and track Duwamish habitat improvements.
- Monitor projects to determine whether they are functioning as intended. Adjust habitat approaches as needed and share with project sponsors.



Duwamish Blueprint: Salmon Habitat in the Duwamish Transition Zone

Purpose and Scope

The purpose of the Duwamish transition zone Blueprint (Blueprint) is to provide guidance for improving “transition zone” habitat in the Duwamish, where juvenile salmonids:

- feed,
- shelter from predators and high flows, and
- osmoregulate

as they transition from being freshwater fish to saltwater fish. The most important habitat types for these young fish are intertidal mudflats and marsh, also known as “shallow water” habitat. These habitat types are highly productive, and young fish apparently seek out these slow water areas to eat, rest and grow. Improving the quantity and quality of this habitat is expected to increase juvenile salmonid growth, which in turn improves their survival in Puget Sound, thus increasing the number of adults returning to spawn.

The Blueprint is developed in accord with Policy MS1 and Program D-3 from the “WRIA 9 Salmon Habitat Plan: Making Our Watershed Fit for a King” (WRIA 9 Steering Committee, 2005), which provides guidance on where to focus initial efforts to recover Chinook salmon in Water Resource Inventory Area 9, the Green/Duwamish and Central Puget Sound Watershed.

Specifically, Policy MS1 (page 5-16) states that the highest priority for habitat projects is in the Duwamish transition zone, with funding for habitat projects to be allocated as follows: 40% to Duwamish transition zone rearing habitat, 30% to rearing habitat in the remainder of the watershed, and 30% to spawning habitat in the Middle and Lower Green subwatersheds. This document implements Program D-3 (page 7-82), to develop a blueprint that determines the boundary of the transition zone based on the most recent science and identifies habitat projects for implementation in coordination with Natural Resources Damages Assessment (WRIA 9 Steering Committee, 2005).

Uses of the Blueprint

This Blueprint intends to provide guidance to governments, businesses, and citizen groups as they improve the aquatic ecosystem of the Duwamish estuary for the benefit of salmonids.

The geographic focus is on the area between river miles 10-1, generally from Tukwila, near the Interstate 5/599 interchange, downstream/north to almost Harbor Island and the West Seattle Bridge. The Blueprint is a working document because the answers to key questions will evolve over time and because opportunities to act to improve habitat will change in response

to economic activity, regulatory requirements, and cleanup efforts as part of the Lower Duwamish Superfund project and other cleanup and mitigation efforts.

This document is an effort to bridge the gap between science and policy. It interprets the body of scientific assessment of juvenile salmonid use of the Duwamish. It attempts to influence private and public development to include elements that could benefit salmon recovery during the 2014-2025 timeframe.

The Blueprint ideally will be used by and for:

- Habitat restoration and/or acquisition projects undertaken explicitly for Puget Sound salmon habitat recovery (projects sponsored by WRIA 9 Forum of Local Governments);
- Natural Resource Trustees and land owners seeking restoration and mitigation opportunities; and
- Citizen groups seeking habitat stewardship projects.

Projects specifically identified in this document will be eligible for funding. In addition, other proposed projects within the transition zone which meet guidelines will be considered.

Background and the Duwamish Blueprint Working Group

The Green/Duwamish and Central Puget Sound Watershed (WRIA 9) Forum of Local Governments (Forum) created the Duwamish Blueprint Working Group and asked its members to update and revise the 2006 draft Duwamish Transition Zone Blueprint (Blueprint) so that it can be adopted as a consensus document among the major entities involved in Chinook salmon habitat restoration and/or creation in the Duwamish River subwatershed. This effort is part of WRIA 9's 2005 Salmon Habitat Plan, and will become part of the 2015 recovery plan update.

Superfund Cleanup actions and habitat improvements required for Natural Resources Damage Assessments (NRDA) were largely unknown at the time of the writing of the 2006 draft Blueprint. The publication of the Final Lower Duwamish River NRDA Restoration Plan (NOAA 2013) and the Draft Superfund Cleanup Plan (EPA 2013) provided more certainty and gave stakeholders impetus to think about how cooperation could contribute to the success of Chinook habitat restoration. The working group's members are stakeholders in WRIA 9 salmon recovery, and have expertise in habitat restoration and/or familiarity with the Duwamish River. The members of the working group are:

Laura Arber	WA Dept. of Fish & Wildlife
Brian Anderson	The Boeing Company
Andrea Cummins, Ryan Larson and Sandra Whiting	City of Tukwila
George Blomberg and Jon Sloan	Port of Seattle
Rebecca Hoff	NOAA
Liz Johnston	Forterra
Kathy Minsch	City of Seattle
Elissa Ostergaard	WRIA 9
Jeff Stern	King County

Glen St. Amant from the Muckleshoot Indian Tribe was also consulted on the Blueprint. Experts were called upon to assist with important topics including the determination of the transition zone, climate change and tree planting. The US Forest Service Pacific Northwest Research Station provided funding for planning and facilitation of the working group as part of the Urban Waters Federal Partnership (UWFP). The Duwamish was named one of the eighteen UWFP partner locations in the country in 2013.

The working group sought to have the Blueprint represent the best current information for planning potential habitat improvements in the Duwamish; the projects and recommendations in this document are provided as guidance. The individual members were selected based on their agency/company's involvement in Chinook habitat restoration or their regulation of activities along the Duwamish River.

From January through October 2014, the working group met on a monthly basis and reviewed the 2006 draft. Meeting summaries can be found in Appendix D. Through a process of collaboration and redrafting, the working group agreed by consensus on this revised Blueprint. It should be noted that the consensus agreement of the working group does not constitute commitments by the entities that had representation on the group. Their participation and agreement on the contents of the document point to new opportunities to coordinate and achieve more profound habitat recovery through combined efforts.

Importance of the Duwamish Estuary for Salmonids and People

As the estuary for the Green River, the Duwamish provides critical habitat for Chinook salmon. Chinook, along with chum, are the salmonid species most dependent on healthy estuarine habitat. The Duwamish estuary begins at river mile 11, at the confluence of the Black River remnant with the Green River, and extends downstream to Elliott Bay (river mile 0 at the southwest corner of Harbor Island).

The Duwamish Estuary is the part of WRIA 9 most dramatically transformed by the last 130 years of development. The majority of the Duwamish Estuary Subwatershed lies in the cities of Seattle and Tukwila. The upper portion of the Duwamish – above the Turning Basin at river mile 5.3 – has been diked and revetted, while the lower Duwamish was extensively dredged and filled. The lower Duwamish estuary that meandered for a length of 9.3 miles now takes a direct route of only 5.3 miles (Kerwin and Nelson (Eds.) 2000). In addition, seventy percent of the river flow was diverted away, and currently, flows are managed by the operation of the Howard Hanson Dam flood control project. These alterations have pushed the salt wedge farther upstream than would have been the case historically. As a result of development and land use, the Duwamish has lost 97% of the habitat it provided 150 years ago (**Error! Reference source not found.**). The Duwamish also suffers from decades of industrial pollution that have resulted in the lower five miles of the river becoming a Superfund cleanup site.

Industrial (43%) and residential (39%) development are the primary land uses. The Duwamish is an economic powerhouse for King County, home to 8% of the jobs in the county while making up less than 1% of the land area. The industrial lands surrounding the transition zone

represents 80% of Seattle's industrial area. It will remain important for people to use the river as a resource, and it is likewise important to improve habitat to the greatest extent possible, both for the benefit of the natural environment and the people who live, work and recreate there.

Scientific assessment work for this Plan suggests that this loss, degradation, and fragmentation of estuarine habitat in the Duwamish – particularly transition zone habitat – is a limiting habitat factor for the Chinook populations of the watershed. Specifically, juvenile Chinook migrating from upriver to Puget Sound need shallow water habitat, including intertidal mudflats and marsh, with low gradients, fine substrates, and clean sediments that will produce and collect invertebrates and other aquatic organisms that they can eat in order to grow as quickly as possible. Large woody debris also provides necessary cover, harbors edible organisms, and creates areas of slow water for fish to rest. Healthy riparian areas provide shade, edible organisms, and over time, large woody debris that promote fish growth. Growth at this early stage of life in these protected, scarce habitats is the key to improving the overall survival rates of Chinook salmon. Investments in the Middle and Lower Green subwatersheds to improve spawning and rearing habitat will only be worthwhile if those juvenile fish have enough habitat for rearing when they reach the Duwamish.

There is extensive scientific information on the Duwamish that was summarized for the WRIA 9 Salmon Habitat Plan and WRIA 9 Strategic Assessment Report. This information is referenced and partially reproduced in Appendix B.

Transition Zone

For the purpose of this Blueprint, the transition zone is defined as the area most important for juvenile fish making the physiological transition from freshwater to salt water as they migrate to Puget Sound from upriver. The location of the transition zone is the river area extending from river mile 9 (the Interstate 5 crossing of the Duwamish) at the upstream end, to river mile 1 (downstream of Kellogg Island) at the downstream end (Figure 2).*

This definition is based on information available to date and the conclusions of the majority of participants who provided input in 2006 and 2014 (Appendix D). The transition zone encompasses areas that, with additional habitat, should support increased juvenile salmon survival and life history diversity. The habitat type most needed is mudflats, because these are where juvenile salmonids rest and feed. Adjacent tidal marshes produce food for fish, and are also needed; next in order of importance are riparian trees and other diverse plants. The transition zone location is primarily based on the most current research on the location of

* River mile marking systems vary for the Duwamish. River miles in this document are based on those in the WRIA 9 Strategic Assessment (WRIA 9 Technical Committee, 2005) and Salmon Habitat Plan (WRIA 9 Steering Committee, 2005), as updated based on a more accurate measurement of the river distances.

juvenile salmonids (especially Chinook) in the Duwamish (Appendix B). Secondary considerations include:

- intertidal and subtidal habitat, and
- the location of the interface between fresh and salt water (known as the salt wedge or salinity gradient).



Figure 1. Historic photo of the Duwamish River, date unknown.

Specifically, the transition zone was expanded from the 2005 designated area (RM

4.7-7.0) because of data that showed differential use of different habitat areas by different Chinook life history types. The data show that:

- smaller juveniles (fry) predominantly use the lower estuary (RM 1-3.5) during early spring, from February through March;
- fry and larger juveniles predominantly use middle portion of the river (RM 4.7-6.5) from February through May; and
- larger juveniles use the upper Duwamish (RM 6.8-8.5) in higher numbers later in the year, between May and July.

A major tenet of the Salmon Habitat Plan is to increase Chinook life history diversity in order to reduce the overall risk to the population. This expanded transition zone attempts to support all known juvenile life history types so that if survival of one type is reduced in a particular year, the population could rebound due to the better survival of the other type(s).

Additional information and/or further analysis may lead to different conclusions in the future. Because of the importance of the transition zone and the high cost and complexity of improving habitat in the Duwamish, it should be a goal of monitoring and adaptive management to further refine our understanding of the scope and nature of the transition zone, so that habitat work can be targeted in the areas where it will have the most benefit to outmigrating salmonids. In particular, studies of the following would help further refine the ideal boundaries of the transition zone:

- juvenile salmonid use of RM 0-1 and 8.5-11;
- the physiological state of juveniles captured;
- survival of fry vs. parr to return as adults; and
- the salinity of water relative to the location of juvenile salmonids of different sizes.



Figure 2. The Duwamish transition zone, the area most critical for migrating juvenile salmonids, is located between River Miles 1 and 10, from just downstream of Kellogg Island to just upstream of the I-5 crossing.

Significant Activities and Programs Affecting Salmon Habitat Recovery

There are multiple activities and programs in the Duwamish that have connections and implications for efforts to improve transition zone habitat for salmonids:

1. Superfund and other cleanups of sediment and stormwater¹

Years of industrial pollution in the Lower Duwamish, below River Mile 5.5, have resulted in contaminated sediments. The Environmental Protection Agency issued a proposed cleanup plan in 2013 for the cleanup of the lower Duwamish, and is still in the process of responding to public comments; the final extent of the cleanup has yet to be determined. While cleanup will reduce contamination in the Duwamish and the estuarine food web, areas that are cleaned up are not required to be restored to improve fish or wildlife habitat. However, the many cleanup actions may create or remove opportunities for restoration.

2. Natural Resource Damage Assessments (NRDA)

Trustees work with parties responsible for damaging aquatic resources and habitat from pollutants released into the Duwamish to create or improve habitat for a suite of aquatic species, including juvenile salmonids. The “habitat focus area” is the lower Duwamish; see chapter 6 of the [Final Lower Duwamish River NRDA Restoration Plan and Programmatic Environmental Impact Statement](#) (2013). These actions will potentially create opportunities to collaborate to increase the amount and/or quality of habitat.

3. Dredging operations by the U.S. Army Corps of Engineers to maintain the shipping channel

The Corps of Engineers dredges the turning basin (RM 5.3) every one to three years to remove accumulated sediments to allow large boats to access the shipping channel. Removing sediments in this area prevents some sediment from accumulating downstream, and limits the area that needs to be regularly dredged. However, dredging directly impacts the estuarine ecology of the shallow water mudflats, where Chinook juveniles have been found in high densities relative to other locations in the Duwamish. The Corps wrote an Environmental Assessment for dredging from 2012-2019. Dredging occurs only between November 1 and February 15 to minimize effects on outmigrating salmonids.

4. Shoreline Master Plan Updates by the City of Seattle, City of Tukwila and King County

As shoreline landowners develop or redevelop their properties, they will be held to new rules under the shoreline master programs of the three jurisdictions in the subwatershed (Table 1**Error! Reference source not found.**), which has potential to influence salmon habitat along the Duwamish transition zone.

5. [Duwamish community vision](#) process and map, 2009

¹ For recent information on the Duwamish Superfund Cleanup on the Web:

<http://yosemite.epa.gov/r10/cleanup.nsf/sites/lduwamish> and

http://www.ecy.wa.gov/programs/tcp/sites_brochure/lower_duwamish/lower_duwamish_hp.html

The Duwamish River Cleanup Coalition hosted a series of community workshops, interviews and surveys with over 500 Duwamish valley residents, workers, business owners, industrial leaders, youth, elders, recreational visitors, fishermen and homeless. The focus area is south Seattle along the Duwamish, between RM 0 and about RM 6.0.

6. Equity and Social Justice initiatives

Tukwila has the most diverse school district in the nation (New York Times 2014), and Duwamish neighborhoods are among the most diverse in Seattle. King County and Seattle have adopted equity and social justice policies, and other jurisdictions are developing similar policies to improve access and services for these communities. EPA published an environmental Justice analysis for the Lower Duwamish Waterway Superfund in 2013: http://www.epa.gov/region10/pdf/sites/ldw/pp/ej_analysis_ldw_feb_2013.pdf

7. Port of Seattle's [century agenda](#) and [Lower Duwamish River Habitat Restoration Plan](#) (2009)

The Port of Seattle plans to convert or restore 40 acres in the Duwamish and Elliott Bay to habitat between 2011 and 2036, along with its 2009 plan noting specific locations for habitat opportunities for linear corridors along the shoreline, habitat hubs, and other projects are expected to help meet salmon recovery goals.

8. Urban Waters Federal Partnership (UWFP)

This program seeks to help communities, particularly in underserved areas, improve and benefit from their urban waters. The Green/Duwamish watershed was designated under the program in 2013. The UWFP ambassador works with local groups and federal agencies to improve collaboration and provide limited funding to conservation projects in order to “put people first.”

9. Mitigation Reserve Program

King County's In Lieu Fee mitigation program provides a means by which permittees creating unavoidable impacts to aquatic resources can pay a fee to satisfy their mitigation obligations, thereby transferring the responsibility for fulfilling mitigation requirements to King County.

10. Green/Duwamish Ecosystem Restoration Project (ERP)

In 2000, the U.S. Congress authorized the ERP, which consists of 45 habitat improvement projects along the Green/Duwamish River. Projects receive 65% of their funding from the Army Corps of Engineers and 35% from local project sponsors. Three projects are located in the transition zone: Riverton, North Wind's Weir (completed in 2010), and Codiga Park (completed in 2007).

11. Cascade Agenda

Guided by the 100 year Cascade Agenda, Forterra partners with stakeholders along the Duwamish toward a common objective – a sustainable, livable region. Since 2001, Forterra has partnered with cities, communities, tribes, businesses, and volunteers to create the culturally and ecologically significant park preserve, Duwamish Hill, and has engaged local

businesses in the restoration of their shoreline properties through the Restore the Duwamish Shoreline Challenge.

12. Green/Duwamish Watershed Strategy

This new effort intends to geographically link existing programs and projects with the desired outcomes for improved public health, cleaner air and water, and a better economy to ensure that the region is focused on a common vision and set of priorities. It will use the Regional Open Space Strategy model created by the Green Futures Lab at the University of Washington and the Bullitt Foundation to identify the most significant gaps and resources needed to implement the vision. The process will identify measures to enhance open space systems and contribute to the ecological, economic, recreational, cultural and aesthetic vitality of the watershed.

13. Green River System-wide Improvement Framework (SWIF)

The King County Flood Control District and other stakeholders are developing a management plan for the Lower Green River. This U.S. Army Corps of Engineers approach aims to improve flood protection while also protecting habitat, increasing floodplain area, and accommodating recreation and productive agriculture. Decisions made about the Lower Green River have potential to influence flood risks as well as the numbers of juvenile fish reaching the Duwamish to rear, and the outcomes of the process will be finalized in 2015.

14. Seattle's Shoreline Street Ends

Seattle Department of Transportation (SDOT) has 149 designated shoreline street ends—streets that end at navigable water bodies—on Lake Washington, Lake Union, the Ship Canal, Puget Sound, and the Duwamish River, where there are 28. These shoreline street ends have been designated as a special type of public space, with opportunities for public access and use as well as shoreline habitat enhancements. SDOT has a small designated funding source to improve and maintain the street ends, and the program is actively seeking partnership opportunities and community stewards for the sites.

Table 1. Shoreline Master Program Elements – King County, City of Tukwila, and City of Seattle. Note the Shoreline Jurisdiction is 200 feet from the edge of the river, per state guidelines.

	King County	Tukwila	Seattle
Location	“Sliver on the River” – narrow area of unincorporated KC in South Park; Left Bank RM 3.7-5.2	Above/upstream of Turning Basin 3, RM 3.7 (right bank) and 5.2 (left bank)	Downstream/north of RM 3.7
Aquatic Buffer Width	115 feet; buffer reduction possible through critical areas alteration exception, subject to specific criteria and compensatory mitigation	Buffers based on zoning: Residential 50 feet; High Intensity 100 feet; Urban Conservancy 100 feet. 50% buffer reduction allowed if bank resloped to 3:1 and heavily replanted with natives in high intensity; 2.5:1 in others.	35 feet for non-water dependent uses; 15 feet for water-dependent uses, with lots of exceptions
Land Use Types	Residential and High Intensity (industrial)	Aquatic, Residential, High Intensity and Urban Conservancy	Urban Industrial
Habitat Restoration criteria	Modification of vegetation, removal of nonnative/invasive plants, shoreline stabilization, installation of LWD, dredging & filling may be allowed as part of restoring the natural character & ecological function of the site	Adopted WRIA 9 recovery plan’s restoration projects, and some other small projects.	Incorporates other plans in restoration plan, Table 16; opportunities
Emphasis	Water dependent, water enjoyment, water oriented and water related uses. Seeks to achieve no net loss of shoreline ecological functions.	Existing uses okay, significant development requires buffer enhancement and other mitigation to prevent loss of shoreline function	Balance water-dependent uses with no net loss and restoration plan
Web site	General: http://www.kingcounty.gov/environment/waterandland/shorelines.aspx Code Title 21A.25: Title_21A.pdf">http://your.kingcounty.gov/mkcc/clerk/code/24-30>Title_21A.pdf SMP Chapter 5 Comp Plan: http://www.kingcounty.gov/property/permits/codes/growth/CompPlan/2012Adopted.aspx	SMP: http://www.tukwilawa.gov/dcd/shoreline.html Code: http://records.tukwilawa.gov/WebLink8/1/doc/56618/Electronic.aspx	http://www.seattle.gov/dpd/codesrules/changestocode/shorelineupdate/whatwhy/default.htm

Significantly, the activities listed above are informed by and will influence the plans and hopes of thousands of individuals, businesses, and other organization that work and reside in and around the Duwamish.

Challenges and Opportunities

The Duwamish estuary, located as it is in the heart of an industrial, commercial, and residential area, yet home to a wide variety of fish and wildlife, provides many things for many people. The many challenges and demands also present opportunities for habitat improvement, as detailed in Table 2.

The experience of those who have built habitat projects highlights some important barriers that need to be addressed. Permitting at the local, state, and federal levels is very complex and costly, and can take many years. Some cleanup sites (Superfund and others with EPA oversight) can be converted to habitat under NRDA, but doing so requires advance planning and staging, and permit requirements of the various federal regulations are vastly different. The time and expense needed to meet permit requirements discourages landowners who might otherwise create habitat, not only as part of a cleanup project, but also as a stand-alone habitat project. Substantial efforts are needed to simplify and streamline these requirements.

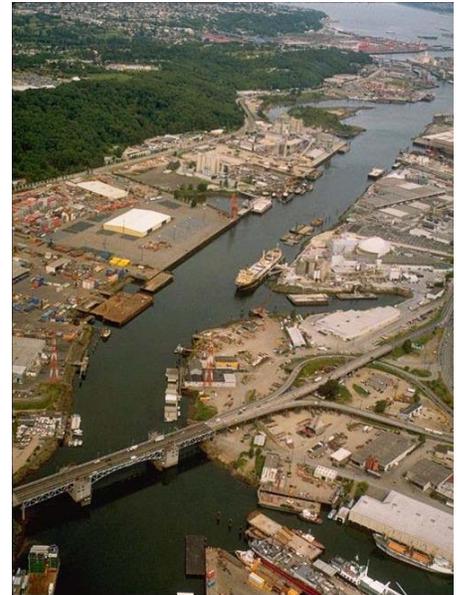


Figure 3. The Duwamish estuary as it appears today, as seen from the air. The First Ave. S. bridge is in the foreground, and Elliott Bay is on the upper right.

Table 2. Challenges & Opportunities for habitat restoration along the Duwamish transition zone.

Challenges	Implications for Restoration	Opportunities for Habitat Improvement
Structural/Physical Challenges		
Shoreline armoring, overwater structures (piers, docks, boathouses, piling), buried utilities, marine debris	Difficulty and high cost of laying back shoreline that is armored, and of restoring vegetation or other kinds of habitat	Identify places to reduce or remove armoring and overwater structures.
Sediment and upland contamination, clean-up impacts to potential restoration projects or existing habitat	Increased costs for restoration (studies, clean-up, long range monitoring); limitations on restoration (ex. capped areas); need to wait for cleanup before restoration can happen	NRDA projects; leverage mitigation funds to prepare sites for restoration.

Challenges	Implications for Restoration	Opportunities for Habitat Improvement
Slope stability/oversteepened banks	Erosion potential, difficult to re-vegetate, high temperatures	Lay back banks – will also mitigate sea level rise. Plant with willow and dogwood stakes.
Significant invasive vegetation	Several years of control (especially knotweed) prior to any vegetation restoration. Difficulty removing invasives from ripped areas. Difficulty obtaining permission from property owners	Long-term plan & strategy for bank revegetation and maintenance needed. King County noxious weed program – engage on regular basis. Duwamish Alive and other stewardship opportunities need consistent source of funding.
Channel shape and dredging/infrastructure affect bathymetry, compatibility with river hydrodynamics, sediment movement/processes, vessel wake impacts	Limits main channel restoration opportunities. Lack of innovative restoration design techniques	Lay back banks so less steep. Reduce dredging where possible.
Recontamination of sediments and water from upstream	Polluted water, high temperatures stress fish	Source control, tree planting, and green stormwater infrastructure should be encouraged in the entire Green/Duwamish watershed.
Creosote piles, derelict structures and vessels, fill	Ongoing source of pollution, make restoration more difficult; disposal expensive	Continue working with PSP and DNR to prioritize removal of piles and derelict vessels.
Resource/Planning Challenges		
Existing land uses and zoning, conflicting land uses	Port and local government interests in preserving industrial and water dependent uses	Setting targets for salmon recovery and measuring outcomes will help determine amount of habitat needed. Evaluating the economic impacts of conversion to restored lands could help decision-makers.

Habitat Goal

The habitat goal for the Duwamish Blueprint is to improve productivity of habitat for juvenile salmonids. Improvements in the estuarine ecosystem of the Duwamish are vital to improve the productivity of the Chinook salmon population of the Green/Duwamish watershed. This is important because increasing productivity of the Chinook population is a key priority for WRIA 9. (Productivity is defined as a measure of how well the population is “performing” in its

habitat, or the growth rate of the population.) While improved ecosystem health is the general goal, priority will be given to projects that explicitly benefit Chinook salmon and other estuarine-dependent salmonids.

Improvements in the productivity of estuarine environments of the Duwamish should be informed by the [conservation hypotheses](#)² developed as part of the Strategic Assessment (WRIA 9 Technical Committee, 2005), the scientific foundation for the WRIA 9 Salmon Habitat Plan. Conservation hypotheses are a “best estimate” of how improvements in habitat conditions and processes will lead to improvements in the four salmon parameters critical to viability. There are six [conservation hypotheses](#) specific to the Duwamish (Duw-1 through Duw-6), and another seven that pertain to the entire watershed: All-1 through All-6, from the 2005 Salmon Habitat Plan, and All-7, which was added in 2013 to address water temperature. Again, owing to the provisional nature of this information, the implementation of habitat projects should be accompanied by monitoring designed to test the conservation hypotheses.

Habitat Project Design and Approach

Based on the goals delineated above and informed by input from a variety of scientists and informed planning and technical staff, recommendations for habitat improvements in the Duwamish transition zone are:

- The creation of at least 40 acres of new habitat that supports transition zone functions by 2025. Habitat potential is further specified for five different reaches in the transition zone (Appendix A, Table 1). For context, approximately 31 acres of habitat were created in the Duwamish transition zone between about 1988 and 2014 (WRIA 9 Implementation Technical Committee 2012 and unpublished data).
- Larger projects – that is, two acres in size or greater – are highest priority because they are more likely to support a diverse ecosystem and because of the economies of scale associated with design, permitting, construction, maintenance, and monitoring. However, smaller projects are still welcome as much needed incremental additions of habitat.
- Projects that incorporate “more landscape-based approaches, such as merging with existing restoration sites, linking to upland drainages, development of tidal channels and sloughs, and addition of natural estuarine wetland attributes, such as large woody debris” are preferable (Simenstad et al., 2005).
- The habitat feature *most needed* in the Duwamish below RM 5.5 from a salmonid perspective is mudflat within the entire intertidal range between -4 and +12 ft. Mean Lower Low Water (MLLW), with an emphasis on mudflats in the low intertidal between -4 to +4 ft. MLLW (based on fish use of habitats in the Lower Duwamish, see Appendix B). These mudflats would ideally have a relatively shallow grade of less than 5% (20:1), a silt/clay to fine sand substrate, and be unvegetated. Mudflats should make up between 50

² WRIA 9 conservation hypotheses can be found at <http://www.govlink.org/watersheds/9/pdf/tieredCH.pdf>

and 75% of the project area in situations where the mudflat is being excavated from upland. In such situations, complementing mudflats would be, in priority order:

- 1) low marsh, potentially from +7.5 to +10.0 ft. MLLW, vegetated with aquatic vascular plants, and
 - 2) high marsh, potentially from +8.0 to +12.0 ft. MLLW, vegetated with aquatic vascular plants and terrestrial plants (the mix of high marsh plants will vary considerably by location/soil conditions) (in part from Steinhoff, 2005).
- Elevations of planned habitat features should be determined by surveying elevations of existing mudflats and marsh as close to the project site as possible, since elevations of these habitat types can change with location and over time.
 - The habitat feature *most needed* in the Duwamish above RM 5.5 from a salmonid perspective is shallow-water, off-channel habitats where juvenile salmonids can shelter, hold in low-salinity water, and feed (Ruggerone et al. 2006). Ideally, these habitats would feature a relatively shallow grade, a silt/clay to fine sand substrate, and be ringed with emergent vegetation and mixed riparian in the uplands.
 - Larger and/or multiple openings to the main channel may be preferable to smaller/single openings (Cordell et al. 2011). This design feature will need to be balanced against the need to protect the habitat from wave and/or current energy.
 - Projects should be sited where the water is more brackish than saline (Cordell et al. 2011), and where there are freshwater inputs to provide small-scale habitats of mixed salinity within the larger estuarine ecosystem. Such areas could include Hamm Creek (RM 4.8) and the First Ave. S. wetlands (RM 2.6). Other areas with significant freshwater inputs include Riverton Creek (RM 6.6), Southgate Creek (RM 7.9), and Puget Creek (RM 1.3). The Black River (RM 11) also contributes fresh water, but is outside the current transition zone boundary.
 - Habitat improvements may be obtained by linear treatments of the river bank. For example, such projects could include replacing invasive vegetation with diverse native plants, including perennials, trees and shrubs; bank laybacks, sculpting the bank so it is less steep; or the creation of benches or terraces increasing the amount of intertidal habitat. Linear treatments also would be conducive to the creation of emergent marsh vegetation, which is notably lacking in the Lower Duwamish.
 - Projects should be sited to improve connectivity and facilitate both the vertical and horizontal movement of juvenile salmonids as they respond to freshwater flow, tides, prey availability, predator avoidance, and the physiological demands of osmoregulation. This suggests the following areas to concentrate rehabilitation projects:
 - In the Foster reach, RM 10-8:
 - Rendering Plant on the right bank (privately owned)
 - In the North Wind reach, between RM 5.5 and 7, which includes:
 - Chinook Wind (privately owned)
 - the Boeing Oxbow (privately owned)

- Duwamish Revival Street End Project (Environmental Coalition of South Seattle 2001 – multiple owners)
- In the Lower Duwamish reach, between RM 5.5 and 1.6, which includes:
 - Hamm Creek (Seattle City Light, King County)
 - 1st Ave S. and T-117 Remediation/Rehabilitation (WSDOT, Port of Seattle and King County)
- In the Kellogg Island reach, RM 1-1.6, Kellogg Island and the surrounding areas (Port of Seattle).
- In a few circumstances, it may be possible to connect the project with upland habitats to expand the project size and/or benefit other aquatic and terrestrial wildlife. Examples include the possible setback of S. 115th at Duwamish Riverbend Hill Park; the Port of Seattle parking lot southwest of Kellogg Island; and the WSDOT parcel between the 1st Ave. S. bridge and T-115.
- Projects should be revegetated using appropriate soil preparation, native plantings, maintenance, and monitoring to ensure successful development of trans-successional stages of intertidal, riparian and terrestrial habitat as appropriate for the site. Revegetation recommendations are presented in Appendix C.
- Trees should be planted across the Duwamish subwatershed, targeting residential neighborhoods and areas where people work. Trees in the urban landscape can help improve water quality by reducing the quantity of runoff, capturing airborne pollutants, and ameliorating high temperatures. They also have social benefits, including improving health (Donovan et al. 2011 and 2013) and reducing crime rates (Donovan and Prestoman 2012).

Climate Change

Climate change impacts on the Duwamish are expected to include sea level rise, resulting in increased areas of inundation and higher storm surges, but there is uncertainty about the timing and extent (see Appendix D for meeting notes regarding climate change from March 2013). One potential scenario predicts a mean increase of 6.5 inches by the year 2050 (National Research Council 2012). Other changes include transition from snow in the mountains to rain only, increased rainfall in winter, lower flows in summer, and higher water temperatures (Battin et al. 2007). Restoring rearing habitat at low elevations for juvenile Chinook is recommended to offset impacts at high elevations. Other recommendations for reducing climate change impacts to Chinook include:

- Create transition zone rearing habitat at the largest sites possible with diverse elevations at different sites;
- Slope banks at a low gradient to reduce erosion and accommodate higher water;
- Establish monitoring stations to track change in elevations of different habitat types over time;

- Add large wood and allow trees to remain where they fall in the river to create pools and shade for adult and juvenile salmon;
- Offset higher water temperatures by increasing groundwater inputs where contamination is not an issue, planting trees, reducing paved and impervious surfaces, reducing shoreline armoring, and restoring floodplain connectivity (Beechie et al. 2012);
- Promote landowner education and incentives to reduce shoreline armoring, in conjunction with King Conservation District and the King County Public Benefit Rating System program; and
- Convert low-lying areas, susceptible to inundation, to habitat.

The habitat recommendations above are based on optimal conditions and resources. Given site constraints, it likely will be necessary to favor some design objectives over others.

Innovative Approaches

The high costs and few opportunities to rehabilitate/substitute habitat, particularly downstream of RM 5.5, requires consideration of innovative approaches. (The term “innovative” rather than “experimental” is used because all rehabilitation/substitution projects in the Duwamish should be viewed as experiments that should be intensively studied to create knowledge that can be used in adaptive management.) The need for innovative approaches will be heightened if there prove to be few opportunities to do the projects described above, either due to lack of money or lack of suitable properties.

Those innovative ideas/techniques that offer the greatest potential benefit when compared to the cost/drawbacks should be carried out and monitored. Results – positive and negative – should be shared with others around Puget Sound. Similarly, the experiences of people working in other Pacific Northwest estuaries should be reviewed for possible ideas.

Another idea for further consideration includes:

- Plant emergent vegetation in areas where no other restoration is presently possible, regardless of wave energy. Planting of sedges (e.g., *Carex lyngbyei*) in enclosures at suitable elevations may result in successful revegetation, including volunteer recruitment. A scarcity of emergent vegetation is thought to contribute to a lower proportion of some insects in the diet of juvenile Chinook in the Lower Duwamish (Cordell et al. 2001).

Implementation Strategy

To meet the challenge of improving habitat in the Duwamish, the following strategy should be employed:

1. Pursue all potential habitat opportunities located on publicly-owned properties. These properties include:
 - Codiga retrofit

- S.115th/Riverbend Hill
 - Cecil Moses Park
 - Riverton Creek
 - Duwamish dredging
 - T-115
 - First Ave. S./SR509 wetlands retrofit
 - Kellogg Island
 - Projects on Port property along the waterway
 - Hamm Creek/City Light North
 - Shoreline street ends
2. Encourage partnering to leverage resources and maximize the size of restoration sites.
 3. Identify privately-owned properties that offer the greatest potential.
 4. Contact private property owners. This could be done by the government agencies, a non-profit, or WRIA staff.
 5. Develop conceptual design and associated project budget for selected properties.

Coordination and Collaboration

An important role for WRIA 9 staff on the lead entity team for Chinook recovery is to help facilitate or encourage restoration, including acquiring or combining parcels to make projects as large as possible, and collaborating on funding, permitting, and removing barriers to project implementation. To facilitate future collaboration, the Duwamish Blueprint Working Group and other potential project sponsors should consider meeting regularly.

It is recommended that WRIA 9 or one of its stakeholders designate a part-time Duwamish Basin Steward to track these efforts, reduce barriers to habitat improvements, simplify permit requirements, encourage NRDA and Superfund coordination, and help potential project sponsors coordinate early in project development. The Basin Steward recommendation is described in Program WW-10, page 7-9 (WRIA 9 Steering Committee 2005).

Habitat Projects: Schedule and Funding

The schedule for carrying out these projects is not defined at present. In general, the schedule for implementation will be influenced/driven by the following factors:

1. Projects providing transition zone habitat will be viewed favorably for funding at the WRIA level. Because the lack of transition zone habitat is thought to be the primary habitat limiting factor for juvenile Chinook salmonids, the WRIA 9 policy MS-1 states that forty percent of funding over the first ten years of the plan (2006-2015) should be devoted to projects in the transition zone (WRIA 9 Steering Committee 2005). WRIA 9 may want to consider increasing this percentage due to the lack of progress towards previous habitat goals in the Duwamish, and to compensate for spending less than 40 percent of its recovery dollars on Duwamish transition zone projects in the first ten years of plan implementation.

2. The schedule for project implementation will be driven in large part by the availability of money to purchase private (and some public) lands and carry out restoration projects. Most shallow-water habitat projects will require fee-simple purchase (rather than easements) to allow the extensive excavation required. Property ownership turnover appears to be relatively low among most Duwamish waterfront properties. This means that there probably will be few opportunities to acquire the needed acreage, making it particularly important that a funding mechanism be created to allow the swift purchase of properties when they become available. Owing to the high monetary value of land in the Duwamish, it is difficult to obtain the necessary funding for acquisition from one or two sources only. Cobbling together sufficient funding from multiple sources requires time, which is not often available when a party wishes to sell. Duwamish projects often do not compete well for regional or national funds because of the high cost of land. This makes it difficult to obtain properties that come on the market. Property values sometimes continue to increase during the time required to obtain the funding from several sources, although public entities cannot pay more than the appraised value for property.

This cumbersome approach to property acquisition is a significant obstacle to the success of habitat recovery in the Duwamish. One way to overcome this obstacle is through an improved funding mechanism at the local, Puget Sound and/or state levels. New funding strategies should be considered, including public/private partnerships, corporate sponsorships, and a regional funding reserve to provide money for fee-simple purchase of properties that will be used for habitat. This would allow the purchase of property when it comes on the market. Once the property is acquired, the funding could be reimbursed by obtaining grants from the same local, state, and federal sources that typically fund such efforts. This approach would require policy changes by those funders who do not presently award grants to fund projects retroactively. A benefactor or other source for the funding reserve needs to be identified. Mitigation banking programs are a welcome source of funds for restoration, but it will be important not to count mitigation projects towards overall habitat improvement goals. There are many grant sources, and potential project sponsors are invited to come forward and pursue funding.

3. The schedule will also be shaped by the willingness of private parties to sell property. Such purchases will be on a voluntary basis only because eminent domain is not applicable or desirable.

Habitat Projects

A list of habitat projects is presented in Appendix A. Projects are categorized as potential, in progress, or completed. Potential projects on this list are considered opportunity areas; at the same time, this is not an exhaustive list of all opportunity areas where habitat might be improved or created, nor does inclusion on the project list mean that a particular site will be converted into a habitat project. Projects are listed in order moving downstream, and New Project ID numbers correspond with River Miles. The right bank is on the east side of the river and the left bank is on the west side. In some cases, possible project sponsors are listed, but for potential projects, this may not have been confirmed.

The potential habitat projects listed in the Blueprint are drawn from the experience of members of the Duwamish Blueprint working group convened in 2014, as well as various efforts over the years to identify where to construct or improve aquatic habitat in the Duwamish, including:

- A River of Green (King County and Jones & Jones, 1979 (est.))
- Potential Intertidal Habitat Restoration Sites in the Duwamish River Estuary (Tanner, 1991)
- Elliott Bay/Duwamish Restoration Program Concept Document (King County, 1994)
- Lower Duwamish Community Plan (Green-Duwamish Watershed Alliance, 1998)
- Inventory of Shoreline Habitat and Riparian Conditions in the Green/Duwamish River Within the City of Tukwila (draft) (Houghton, 2003)
- Seattle's Urban Blueprint for Habitat Protection and Restoration (Seattle, 2003)
- WRIA 9 Salmon Habitat Plan: Making Our Watershed Fit for a King (WRIA 9 Steering Committee, 2005)
- Lower Duwamish River Habitat Restoration Plan: An Inventory of Port of Seattle Properties (Seaport Planning Group, AHBL, 2009)
- Duwamish Valley Vision Project (Duwamish River Cleanup Coalition, 2009)
- Seattle Street Ends Fact Sheet (Seattle Department of Transportation, 2009)

No effort has been made to prioritize the potential projects. Some projects are more defined than others. Some projects will probably remain conceptual until specific properties are identified.

Criteria for Assessing Potential Projects

This Blueprint does not evaluate potential projects because of the need to act when one of the limited opportunity areas becomes available. Projects can be evaluated in the future if there are two or more projects that need conceptual development (using a subset of the criteria) or full funding (using all the criteria).

These criteria are taken directly from "*Appendix H: SRFB Review Panel Evaluation Criteria, Manual 18*, with some exceptions. For projects seeking funding from other grant programs, criteria specific to the funding source should be used to maximize the likelihood that the priority projects will score well in Puget Sound-wide evaluations and thus receive regional funding.

- Watershed Processes and Habitat Features
 - Addresses high priority habitat features and/or watershed processes that significantly protect or limit salmonid productivity in the area.

- Crucial to understanding watershed processes, is directly relevant to project development or sequencing, and will clearly lead to new projects in high priority areas.
- Areas, Actions, and Design
 - Is a high priority action within high priority geographical area.
 - Acquisition feasibility / Project area availability.
 - Appropriate project scale (area and cost) to habitat benefit.
 - Utilizes adaptive management strategies.
 - Form cooperative partnerships to increase project support (resources: financial, expertise, etc.)
 - Clearly stated goals and objectives
 - Clearly stated implementation strategy and timeline
 - Stewardship plan
 - Scientific monitoring
 - Outreach and Education
 - Policy considerations addressed
- Process-driven design with stacked functionality:
 - Diversity and complexity of habitat for fish and wildlife.
 - Project is activated at all tide levels
 - Anticipates sea level rise
 - Improves water quality and temperature.
 - Natural drainage solutions (for upland areas)
 - Riparian vegetation, Large Woody Debris
 - Site specific public access where appropriate.
- Scientific
 - Is identified through a documented habitat assessment.
- Species
 - Addresses multiple species; or unique populations of salmonids essential for recovery; or Endangered Species Act listed fish species; or non-listed populations primarily supported by natural spawning. Fish use has been documented.
 - Addresses an important life history stage or habitat type that limits the productivity of the salmonid species in the area or project addresses multiple life history requirements.
- Costs
 - Has reasonable cost relative to the predicted benefits for the project type in that location.

Stewardship, Maintenance and Monitoring

Successful habitat rehabilitation/substitution depends on building community support for the work, ongoing maintenance, and learning from past experiences so that others may make improvements. Lack of funding is a major barrier to accomplishing these, and so it should be a

priority in WRIA 9 to seek out and dedicate funding to stewardship, monitoring, and maintenance to the extent possible.

Stewardship:

Community involvement in restoration and stewardship of restored areas is critical to gaining support for additional restoration and keeping project sites free of trash, invasive weeds, and other problems. Involving the community in restoration educates people about what is needed, and gives them a meaningful way to contribute to the health and beauty of their community. Community grants for small, local projects, and Duwamish Alive!, a consortium of nonprofits, businesses and agencies that promote volunteer events at restoration sites, should continue to be supported and encouraged.

Maintenance:

Beyond the three-year maintenance period that is customary with habitat projects, sponsors and/or landowners should plan for on-going maintenance, particularly with regard to control of invasive plant species. Without regular, on-going maintenance, the habitat value of riparian vegetation at habitat projects will degrade. Maintenance is also required on exclusion devices used to protect emergent marsh vegetation from grazing by Canada geese. While efforts in recent years to grow the number of volunteers working on Duwamish habitat projects have been successful, it is unwise to assume that these efforts will suffice to provide maintenance for an ever-growing acreage of restored uplands. Project sponsors/landowners should design projects to facilitate maintenance and budget for on-going efforts. Alternatively, an initial investment could be made that would generate income from interest to pay for a group or groups to manage sites with volunteers or professional crews, as appropriate for each site.

Monitoring and Adaptive Management:

Monitoring the implementation and effectiveness of Duwamish habitat projects is highly recommended. There are several efforts at the state and Puget Sound level to make recommendations about the type of monitoring for such habitat projects. In addition, the WRIA 9 Steering Committee approved recommendations for WRIA 9 monitoring in the winter of 2007 (see the Implementation Guidance for the WRIA 9 Salmon Habitat Plan). An updated draft WRIA 9 Monitoring and Adaptive Management Plan was approved by the WRIA 9 Watershed Ecosystem Forum in 2013.

Monitoring implementation would include tracking properties for sale, acquisitions, and the area of habitat types. The overall goal is to increase shallow water habitat and native riparian vegetation, which means that habitat area cannot be simultaneously lost while habitat restoration is occurring at great expense. A Duwamish Basin Steward could be responsible for tracking habitat areas. Project-specific monitoring should be planned during project design.

Additional recommendations include:

- Small-scale studies indicated that off-channel habitat with larger openings to the main river were used more by juvenile salmonids than areas with small openings, but sampling was limited to only two sites. Study more sites among the areas above and below RM 5.3 to determine the relative importance of location and size of opening.

- Conduct research into whether pass-through or flow-through channels vs. blind channels (channels that don't connect back to the river) are more beneficial to juvenile salmonids; different research says different things.
- Map shallow water habitat and native riparian vegetation in the transition zone, and track the area over time.
- Convene regular meetings of the working group and other Duwamish project sponsors and stakeholders to continue adaptive management.

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