STRATEGIC ACTION PLAN

2020

Lower Columbia River Watersheds

Final Draft

Developed by Lower Columbia River Watershed Council

I. INTRODUCTION

The Lower Columbia River Watershed Council (LCRWC) produced this Strategic Action Plan (SAP) as the basis for future restoration planning and implementation in Lower Columbia Watersheds (LCW) for the next 5-10 years. Lower Columbia watershed boundaries are defined by the drainages from the northern edge of the City of Saint Helens to Clatsop Crest just past the Clatsop-Columbia County line (Figure 1). The SAP is informed by watershed assessments, salmon recovery plans, stream surveys, restoration projects completed, and lessons learned over the last 20 years. State and federal recovery plans have been completed that define limiting factors to watershed health and threatened and endangered salmonid populations.

The Strategic Action Plan (SAP) highlights a list of strategies to address limiting factors and existing uncertainties including anticipated impacts associated with climate change. High-value restoration and protection opportunities are identified using a spatially explicit approach informed by the information available to date. Accompanying the SAP is an outreach strategy (Appendix C) that outlines activities to ensure restoration actions are aligned with the values and input of stakeholders and community groups.

II. PURPOSE

This document intends to provide the LCRWC and partners a tool to support the identification, planning and development of high priority restoration and protection projects. The SAP also serves as a mechanism for reaching out to landowners, communities, and stakeholders as a platform for innovative partnership building. The SAP takes a landscape view of restoration project types for the entire gradient of habitats encompassing upland hillslopes, stream corridors, low gradient floodplain areas, to tidal-estuarine areas of Columbia River Estuary.

III. BACKGROUND

Since its formation in 1996 the LCRWC serves as a resource to the local communities of Columbia County to facilitate collaborative solutions to improving watershed health. To date the LCRWC and its partners have achieved restoration success for improved fish passage, riparian enhancement, in-stream complexity, and streambank protection. The Council has also completed technically challenging projects to reconnect low-gradient floodplain side channels and levee removal in tidal-estuarine areas of Clatskanie Flats. Recently the LCRWC council has revamped its internal organizational structure with new board members, renewed governance, and targeted outreach to established community entities. This document represents a natural extension of the Council's evolution providing the focus for future restoration investments.

The SAP intends to build a vision for a sustainable future as its communities continue to change from demographic shifts. Over the last few years the pace of socio-economic changes has increased rapidly throughout the Lower Columbia region. The Lower Columbia watersheds historically expressed a rural character with small municipalities flecked along the Highway 30 corridor. The influx of new populations to the City of Portland and surrounding metro areas are transforming the watershed area into a more ex-urban environment, witnessed by increased traffic numbers and expanded footprint of Columbia County cities. Tourism trends will continue to contribute more interest to destination coastal communities such as Astoria. Shifts in demographics increase demand for housing to accommodate retirees and telecommuting professionals to the area.

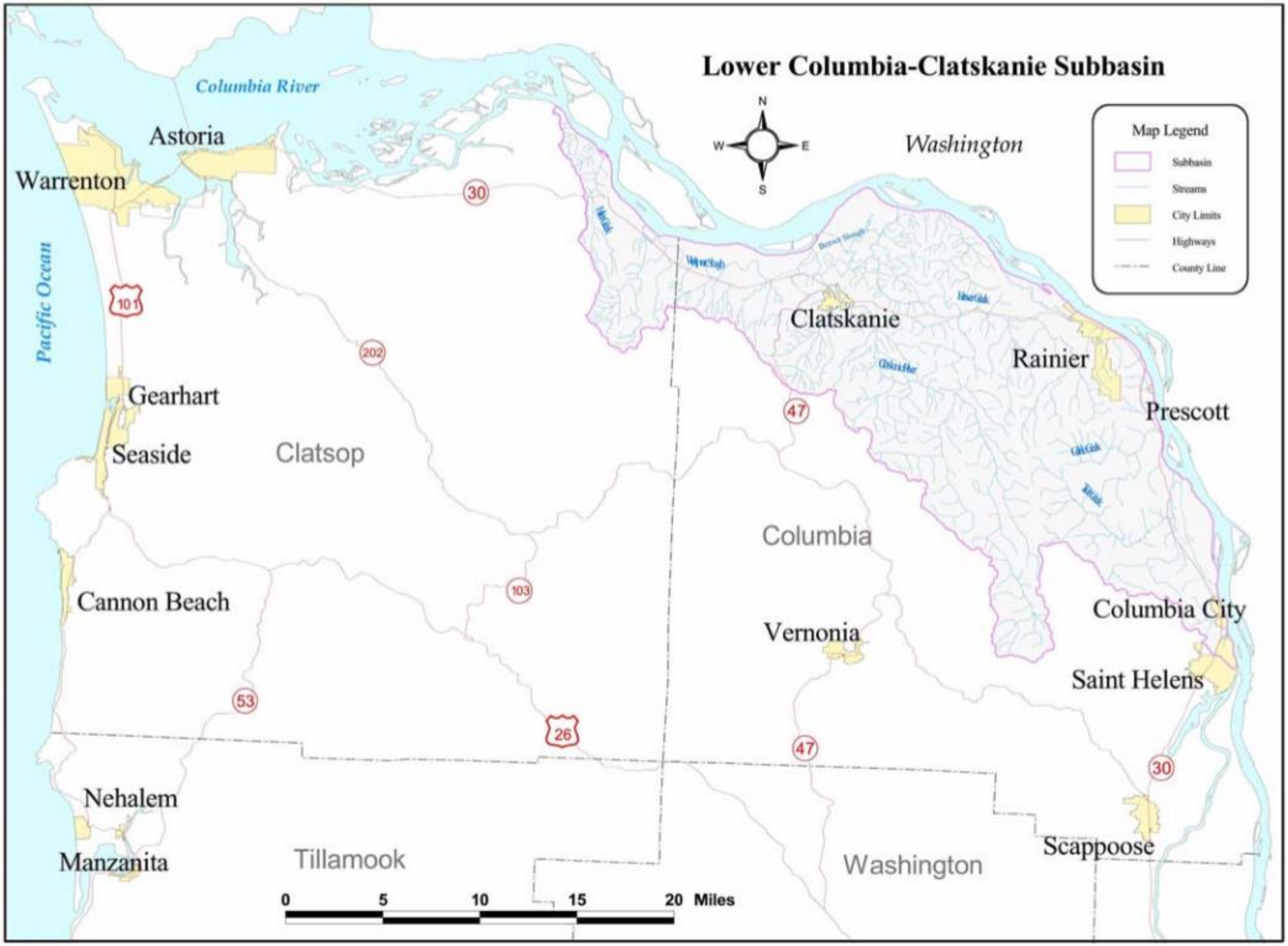


FIGURE 1: LOWER COLUMBIA WATERSHEDS

IV. ACTION PLANNING BASIS

Completed studies guide the identification of high-value restoration projects. They point to limiting factors and constraints to improving watershed health. This plan utilizes these documents as the basis for identifying project opportunity areas and evaluating their potential ecological benefit. Combined with spatial-database inquiries, these plans also identify areas in the watershed previously not explored. These areas with proper outreach and technical approach, present additional ecological restoration potential for medium and longer-range planning horizons.

A. Watershed Assessment (2001)

This seminal document was important to the early understanding of existing watershed conditions. Base maps and narratives were developed to form a common understanding of watershed processes and features based on available information. The assessment summarized physical and biological characteristics that help frame the range of restoration actions for a given watershed area. Stream habitat types developed during the assessment process are used in conjunction with other GIS-based layers (see Intrinsic Potential below) to focus restoration planning at discrete areas of the watershed.

B. Lower Columbia River Recovery Plan (2010)

Completed in 2010, the Lower Columbia Recovery Plan covers a broad territory of watersheds defining limiting factors and threats affecting threatened and endangered salmon at the population level. The plan's domain includes all Columbia River tributary streams and their fish populations from Hood River downstream to the mouth of the Columbia River. This includes the lower Willamette River and tributaries located below Willamette Falls. The plan also outlines limiting factors of the Columbia River estuary common to all of Oregon's lower Columbia watersheds.

The plan is a comprehensive document that defines recovery goals, delisting criteria, lists recovery strategies and management actions to address limiting factors and threats. Figure 2 summarizes limiting factors and threats relevant to Lower Columbia watersheds, with the Clatskanie river being highlighted as a key watershed to meet recovery goals. As the table shows, there are limiting factors that are beyond the scope of the Watershed Council and its partners. They are related to broader basin constraints affecting the Columbia River Estuary and rearing habitat. Limiting factors relevant to Watershed Councils mission are highlighted with an asterisk (*) and will be used as a platform for restoration measure development unique to the Lower Columbia watersheds.

Figure 2: Summary of Limiting Factors affecting Lower Columbia Watersheds (* indicates areas LCRWC can address)

Key Limiting Factors	Limiting Factors Description	Habitat Type	Threat Description	Speices
Physical Habitat Quality*	Imparied complexity and diversity Access to off-channel habitats	Tributary	Past, current land uses	Junvenile Coho, Chinook, Steelhead
Foodweb*	Reduced Macrodetrital Inputs	Estuary	Hydrosystem, revetments, dredged material	All juvenile salmonids
Water Quantity	Hydrosystem impacts, access to offchannel habitats	Estuary		Junvenile Coho, Chinook
Harvest Management	Consumptive, targeted fishery			Adult Coho, Chinook
Hatchery Management	Stray hatchery fish interbreeding with wild fish			Adult Chinook only
Secondary Limiting Factors	**Limiting Factors Description**	**Habitat Type**	**Threat Description**	**Speices**
Water quantity*	Upslope Land Uses	Tributary	Shifts in local hydrographs from ag and forestry practices	All juvenile salmonids
Physical Habitat Quality*	Excessive fine sediment, loss of habitat complexity and diversity; access to off-channel habitats	Tributary	Rural roads and Land Use	All juvenile salmonids
Water Quality*	Elevated water temperature	Tributary	Excessive fine sediment, loss of habitat complexity and diversity, access to off-channel habitats	Junvenile Coho, Steelhead
Competition	Hatchery Fish	Estuary	Smolts from all Columbia Basin hatcheries	Junvenile Coho only
Physical Habitat Quality	Excessive fine sediment, loss of habitat complexity and diversity; access to off-channel habitats	Estuary	Channelization, diking, navigation channel	All juvenile salmonids
Water Quality	Elevated water temperature	Estuary	Flow regulation, reservoirs	All juvenile salmonids
Water Quality	Toxins from agricultural practices	Estuary	Upper basin impacts from pesticides	All juvenile salmonids
Water Quality	Toxins from urban and industrial sources	Estuary	Upper basin impacts from trace metals, PCBs, PAHs	All juvenile salmonids
Predation	Avian species (Caspian terns, cormorants)	Estuary		All juvenile salmonids

C. Water Quality Monitoring (2017)

Lead by the Columbia SWCD and Lower Columbia Estuary Partnership, the study intends to establish a network of monitoring stations in the Clatskanie and Beaver Creek watersheds. The investigation focused on establishing baseline conditions for temperature, turbidity, and bacteria during the months of June-October. Now in its second year of implementation, the data summaries provide the basis for watershed health trends and patterns useful for engaging new partners. This helps provide additional spatial precision of areas to target for future restoration measure development. At the time of writing this plan, it is anticipated this effort will continue as will the LCRWC presence to inform sampling design, data analysis, and relevance to SAP.

D. Stream Surveys/Aquatic Inventories (2011)

In 2009/2010 stream surveys were conducted by Boswell Consultants to characterize the existing condition of stream corridors and opportunities for restoration. Using established ODFW stream survey protocols reaches were identified for LWD placement, riparian enhancement, and fish barrier removal. Desired habitat parameters were outlined and largely focused on habitat requirements for Coho salmon. The surveys intended to investigate areas where no data exists and complement previous efforts conducted by ODFW. Outcomes of the survey includes reach characterizations, data summaries, and mapping products to spatially depict habitat condition and restoration potential. Survey information assisted in validating limiting factors identified in the Recovery Plan document described above.

E. ODFW Chum Salmon Spawning Habitat Report (November 2017)

Summarizes stream surveys with attention to habitat needs of chum salmon. Surveys targeted low gradient streams and assessed substrate conditions, cold water patches, and barriers. Reaches coalesced with 2011 stream surveys and helped ground truth Intrinsic Potential mapping described below. Data is also being examined for strategic planning efforts for the North Coast Watershed Association. Chum salmon are sensitive to sediment loads and their effect on spawning habitat. Because of that a watershed approach is being considered for SAP planning efforts that examine upslope processes as well as its response in the lower reaches. Appendix D highlights stream reaches having “Chum Potential” when at least one of the criteria for substrate and/or cold-water patches were identified.

F. Intrinsic Potential Mapping (2008)

NOAA fisheries generated maps that depict high-value areas for salmon and steelhead for the watersheds. These are based on physical characteristics of the stream such as gradient, stream widths, valley constraint, and discharge. Spatial datasets were made available for SAP needs so that spatial rules could be generated using Geographic Information Systems (GIS). Paired with other datasets such as the stream surveys above they provide insight into finer resolution stream conditions at the reach and sub-reach scale. Examples of this application are shown and explained in section VIII.

G. Other Documents (Estuary-related, Reach C)

Substantial research has been conducted in the Columbia River Estuary which includes diked areas such as Clatskanie Bottoms, Westport Slough, and intact mid-channel island areas like Wallace Island. Below is a sample of research useful to restoration planning in tidally influenced areas of the Lower Columbia River watersheds.

1. USGS Columbia River Ecosystem Classification System

Spatially explicit database the inventoried important landforms and estuarine habitat types at multiple spatial scales. Paired with LIDAR, information can be used to generate maps useful for depicting flood profiles and generating metrics useful for characterizing estuarine habitat from Bonneville Dam to the mouth of the Columbia River.

2. Pacific Northwest National Laboratory Reference Site Study

Investigations have been completed in Westport Slough and Wallace Island area that measure elevations, vegetation communities, and sediment accretion rates at functioning, intact estuarine habitats. Information derived from these surveys is important for establishing design criteria for estuarine restoration projects in the area.

3. Design Guidelines for Enhancement and Creation of Estuarine habitats

Another resource for developing restoration design criteria for estuary projects with special emphasis on areas affected by dredged material. Guidelines offer practitioners elevations for establishing proper estuary channel development and vegetation-elevation patterns.

4. ACOE Climate Change Study

Summarizes vulnerability assessments related to sea-level rise, shifting hydrologic patterns, and temperature. Identifies response variables likely affected by these key drivers of habitat conditions. Test cases are provided that can be used to develop adaptation strategies.

V. WATERSHED AREA CHARACTERIZATION

Lower Columbia watersheds express a diversity of shapes, sizes, and configurations. This is due in part to its formative processes shaped by its geologic past. Landforms borne from broader scale stochastic and localized events serve as the basis of hydrologic patterns and habitat-forming processes. This section characterizes the structure of these processes across all the watersheds to create a common understanding of strategic and sustainable action planning. The assumption being that not all restoration actions will be suitable or sustainable for a given watershed. A summary of the area's geology is provided along with the stream habitat types for six (6) sub-areas. The sub-areas will then serve as the proper context for desired project types so that they align with unique geomorphic processes, stream channel form, and sediment source.

A. Geologic History

The LCR watersheds are shaped by the blending of geologic and stochastic events. Figure 2 shows the distribution of geologic units across the Lower Columbia watersheds. This includes historical rising and falling sea levels 50 million years ago that build up ocean-derived sediments. Volcanic events both and in the region originating from the Coastal and Cascades mountains contribute to large swaths of basalt formations to form the backbone of some of the Lower Columbia watersheds. This includes vast lava flows extending across the lower Columbia floodplain originating from Oregon-Idaho border 17-15 million years ago. Parts of LCR watersheds express landforms from large scale flooding from melting glaciers and ice dams 15,000-17,000 years ago. This includes lower floodplain areas of Clatskanie Flats and Deer Island. Relics of these geomorphic features serve to influence hydrologic and sediment transport processes for the contemporary flow regime of the Lower Columbia.

Today LCR watersheds respond to these seminal geologic features coupled with contemporary events such as flooding and landslide events. Precipitation patterns dominated by Pacific Ocean climate fluctuations contribute to regular flooding events that reshape stream corridors. Localized erosion and fluvial deposition are common as they respond to available sediment supply. The spatial distribution of these alluvial deposits affects the type of riparian vegetation communities that colonize the floodplain. Figure 4 also shows areas susceptible to mass wasting events in the form of landslides that reset watershed processes and sediment source witnessed by head scarps and slope failures.

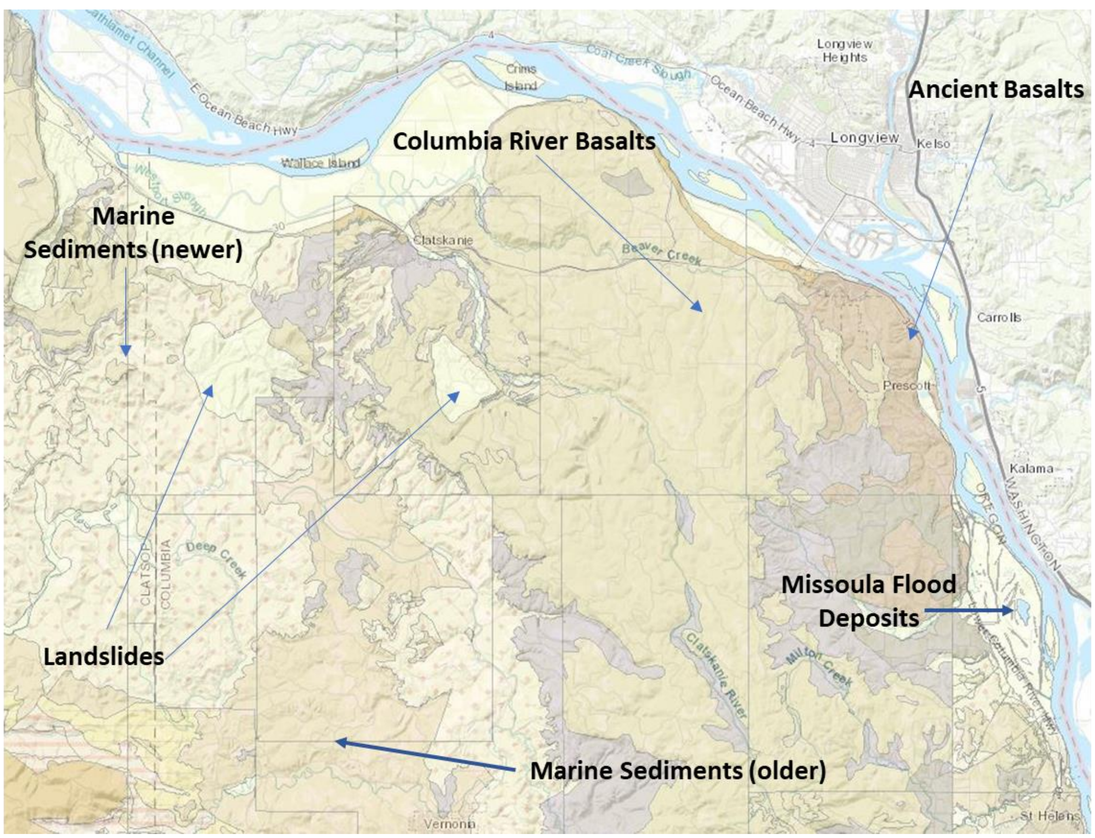


Figure 4: Geologic Units of LCR Watershed Area

B. Strategic Action Plan Subareas

Formative geologic processes described above affect the shape, size, and orientation of the Lower Columbia watersheds. These are used as the platform to delineate subareas and the frame range of restoration actions for restoration planning and project development. Stream habitat classes developed from the watershed assessment (figure 5) provides insight into the dominant types of stream types that can help in formulating project ideas so that they are aligned with existing geomorphology. Descriptions for each subarea and its contributing waterbodies are listed in figure 6.

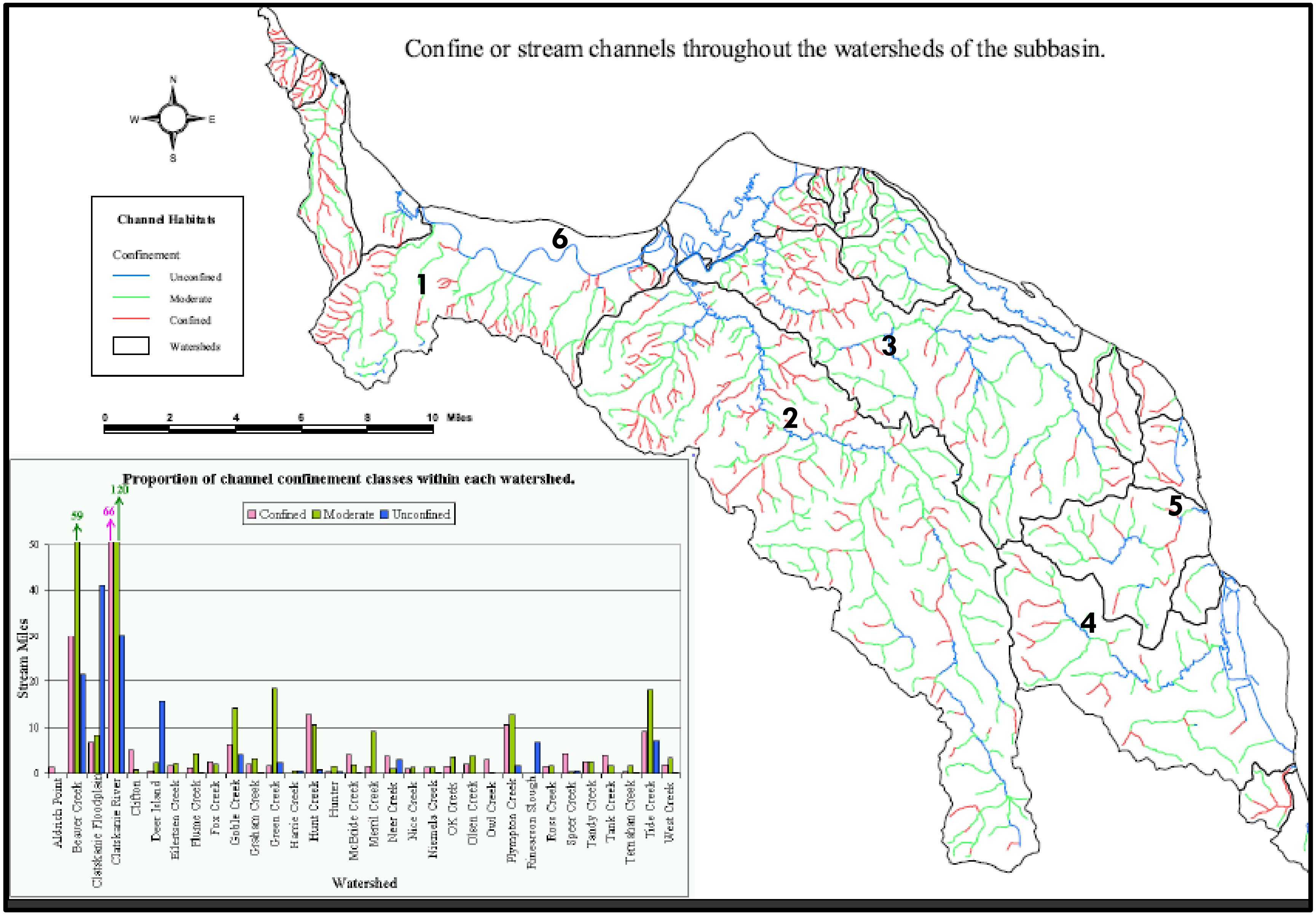


Figure 5. LCRWCs Channel Habitat Types and SAP Sub Areas

Subarea #	Subarea Name	Contributing Streams	Description
1	West Side Tributaries	Hunt,Driscoll Slough, Plympton, West, Ross, Olsen, Ellersten, Tandy, Graham	These smaller drainages near the Clatsop-Columbia county line are bounded by Nikolai mountain to the west and Skunk Cabbage ridge to the east. Highway 30 transects all these drainages. The sharp gradient and dominant geology make this area particularly sensitive to slope failures and episodic landslide events.
2	Clatskanie Area	Fall Cr.,Conyers Cr.,Merril Cr., Perkins Cr., Keystone Cr.,Miller Cr., Page Cr.,Carcus Cr., North Fork, Little Clatskanie, Buck Cr.	The largest subarea of the Lower Columbia watersheds, the Clatskanie River is dominated by basalt geology with moderate expressions of marine sedimentary substrate in tributaries such as Conyers Creek. The Clatskanie river sub-area is bounded to the south by Bunker Hill and abuts the Beaver creek drainage to the east. The sub-area also expresses the largest unconfined floodplain expanding over a 15% of the basin's acres. Clatskanie river receives significant flow contributions from Page Creek, Carcus, Conyers, and Little Clatskanie tributary systems
3	Beaver Creek/Stewart Creek	Beaver Cr., Stewart Cr.,Palm Cr.,Lost Creek, Tank Cr., Flume Cr., Green Creek	The second largest subarea is Beaver Creek which has predominately basalt bedrock as its foundation. Sub-area southern boundary is Fern Hill which measures about 1000 feet at its peak. The subarea has a slightly larger floodplain area than the Clatskanie basin in proportion to its watershed size. Beaver Creek falls is an iconic, natural fish barrier for anadromous species. Smaller drainages sharing the same geologic unit drain direct north to the Columbia river
4	Deer Island Area	Tide Cr., Merrill Cr.,McBride Cr., Deer Island, Sandy Island, Goat Island	Deer Island is a discrete subarea formed in the Lower Columbia floodplain. It is bisected by a large slough channel that historically used to be connected to tidal and fluvial innundation patterns. Much of its topography are bar and scroll landforms shaping wetland back swamps in lower areas. This type of landform is developed from overbank flood events from the Columbia river before the federal hydropower system was put in place. Current Deer Island hydrology is sourced primarily from Tide and Merrill Creek drainage areas that have been rerouted from their former channels to facilitate agricultural development on the island.
5	Eastside Tributaries	Nice Cr., Fox Cr., Owl Cr.,Goble Cr.	A geologically unique area representing the intersection of older basalt groups (~50 mya) as well as alluvium from Missoula flood events. Watersheds are smaller to medium size with predominantly steep slopes apart from Goble Creek. Goble creek is the largest sub watershed of this group with the highest proportion of unconfined floodplain. Fox Creek is unique in its location within the urban area of Rainier.
6	Estuary Zone	Westport Slough, Beaver Slough, Randa Slough, Kelli Slough, Larson Slough, McLean Slough, Carr Slough, Wallace Island, Cooper Island, Crims Island,Gull Island, Lord Island, Walker Island, Rinearson Slough, Diblee Point	This subarea captures most of the lower portions of the watersheds under tidal influence. The largest expanse of these areas is Clatskanie Flats, north of the City of Clatskanie. Clatskanie Flats area is drained by the Westport and Beaver Slough channels. Area also includes emergent marsh fringes along Columbia river shoreline and large mid-channel islands such as Wallace and Lord Island. Some of these islands have been shaped by the disposal of dredge material to maintain the federal navigation channel. Additional areas included in this area are Carr Slough near Prescott and Dibblee Beach. ost of the estuarine areas have been fragmented by flood control and road building activities shifting drainage patterns.

VI. ACTION PLAN GOALS

Goals were vetted and refined members of the LCRWC and Technical Advisory Committee. They are summarized below with the understanding that they can be revised during engagement with community groups and stakeholders. Most of the Council's projects to date have centered around their benefit to endangered salmon species. At the time of writing this plan emerging information is forthcoming on additional species including lamprey and sensitive species such as Lower Columbia Chum. Their habitat needs along with other species relevant to restoration planning are listed in Appendix A (Sensitive Species of LCR Watersheds).

A. Vision Statement

Improve watershed function through the implementation of a diversity of restoration projects for recovery and sustainability of native fish populations and community resiliency.

B. Watershed Restoration Goals

1. **Increase access to spawning habitat to maximize reproduction capacity of adult salmon**
2. **Improve riparian and adjacent wetland condition to increase the extent and diversity of native plant communities**
3. **Increase stream complexity through strategic placement of LWD**
4. **Increase habitat connectivity between side-channel/confluence areas**
5. **Improve estuary rearing capacity for needs of juvenile salmonids**
6. **Protect/enhance watershed processes through the support of sustainable forest management practices and road decommissioning.**
7. **Improve water quality in degraded reaches for bacteria and temperature**

C. Organizational Goals

1. **LCRWC governance-Strengthen agreements and project management roles with local partners through regular project coordination meetings**
2. **Outreach-Increase diversity of community partners through formal and informal activities outlined in the outreach plan.**
3. **Board Recruitment-Increase board membership to represent the diversity of the broader lower Columbia community.**
4. **Expand environmental education opportunities in collaboration with local schools.**

D. Community Goals

1. **Sustainability-Support natural resource managers in the timber and agricultural community to apply new technologies that promote sustainable natural resource practices.**
2. **Resiliency-Serve as a resource to municipalities and community interest to design projects for existing vulnerabilities to climate change (i.e. coastal storminess/flooding, temperatures, sea level rise)**

VII. ACTION PLAN STRATEGIES

This section outlines actions intended to meet the goals identified above. The approach entails identifying a subset of the limiting factors that can be addressed through LCR Watershed Council's collective capacity with its partners. Strategies are identified for each threat as described in the Lower Columbia Recovery Plan. Strategies can be used as an initial screening of project opportunities to ensure it meets ecological needs documented in the existing literature. Additional strategies are provided to capture existing uncertainties including a characterization of known vulnerabilities related to climate change. Figure 7 shows a depicts the approach used for the intersection of project opportunities, limiting factors, and strategies as a platform for project prioritization.

Figure 7: Conceptual Basis for Strategic Action Planning

A. Strategies to Address Physical Habitat Quality

Threat Description: Past and current land use have impaired physical habitat quality, which includes habitat complexity and diversity as well as access to off-channel habitats. Land use can also increase sediment source contribution to streams through road building and land clearing activities.

List of <u>Strategies</u> Include:

- Using guidelines from State of Oregon standards to strategically place woody debris in floodplain areas, riparian corridor, and stream channel to improve habitat complexity for rearing and spawning salmonid needs.
- Engage landowners adjacent to a stream corridor to encourage the removal of invasive plants and develop riparian buffer zones with native plant community species.
- Identify candidate sites for road decommissioning to reduce sediment source inputs to the stream corridor.
- Identify floodplain reconnection opportunities that activate off-channel rearing areas.
- Work with willing landowners to promote natural stream complexing associated with beaver activity without increasing flooding risk.

B. Strategies to Address Estuarine Food Web Productivity

Threat Description: Loss of estuarine habitat from diking and impoundments from upper river dams have shifted food-web productivity from a macro-detrital to a micro-detrital system.

List of Strategies include:

- Increase connectivity of estuarine habitats through undersized culvert/tidegate and/or dike removal to passive initiate marsh development patterns important for estuarine food web productivity and improved nutrient exchange processes.
- Reduce the infestation of invasive species in tidal areas using established Design Guidelines and through reference site investigations to understand elevations optimal for developing native estuarine plant diversity.
- Improve restoration potential of subsided areas by importing material to elevations optimal for propagation and colonization of desired estuarine plant communities.

C. Strategies to Address Water Quality

Threat Description: Land use practices have impacted the quality and diversity of riparian/wetland habitats. This can lead to increased exposure to direct solar radiation of the water column and elevate stream temperatures to lethal levels for salmonids. The lack of adequate stream buffers in sections of stream channels can accelerate runoff events that flush artificial contaminants into the stream area that adversely affect salmonid capacity for egg production, juvenile survival, and rearing.

List of Strategies include:

- Close gaps of exposed stream corridor with native riparian plantings using nearby functioning riparian zones as a guide.
- Revegetate stream buffers to expand buffers of existing riparian areas.
- Investigate the applicability of tax incentive programs at the County and State levels to protect both forested and wetland areas.

D. Adaptation Strategies for Climate Change

Threat Description: Initial results from vulnerability assessments identify a multitude of variables affected by climate change. Three of these variables are identified here that directly affect restoration planning in the Lower Columbia watersheds. They are selected because these variables can be addressed at the watershed scale through proactive resiliency planning. For each variable a list of guidance statements is provided to help in developing an approach for adaptation strategy development.

1. Coastal Storminess

Increased storminess will change the amplitude, timing, and intensity of hydrologic patterns. As a result, without adequate resiliency planning, community risk to flooding events will increase. Completed restoration projects designed with conventional flood profiles have the potential of endangering project goals. Successful resiliency planning will need to take a broader view of a project and put it in the proper landscape context. Here are some general principles for developing adaptation strategies for a sustainable restoration project that also contributes to community resiliency to flooding.

- During restoration planning examine transitional areas between floodplain area and uplands to increase buffer areas during high flows.
- In addition to habitat benefits floodplain reconnection projects can reduce excessive streambank erosion and channel migration by spreading floodwaters across floodplain dissipating stream velocity energy.
- Design channel profiles with larger geometry to accommodate higher intensity flooding events.
- Leverage resources to acquire private property at high risk of flooding and repurpose for public use (i.e. floodplain park).

2. Sea Level Rise

Sea level rise predictions are readily available for community and resiliency planning in low elevation areas. This is especially relevant in the diked area of Clatskanie Bottoms where infrastructure is antiquated, and a large expanse of interior agricultural areas are experiencing subsidence. Figure 8 depicts a range of sea-level rise predictions for the Astoria area.

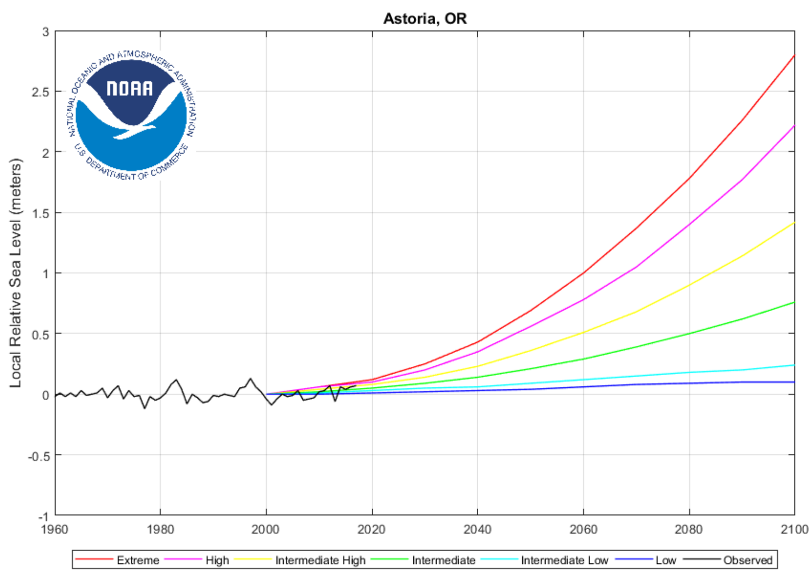


Figure 8: Sea Level Rise Predictions-Astoria, Oregon
(source: http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html)

These predictions are also important for restoration planning in the tidal-estuarine area of the Lower Columbia. Several guidelines are outlined here for developing adaptations strategies in the tidally influenced areas of LCR watersheds:

- Broaden the scope of the project area to examine upslope transitional areas for buffers as marshes migrate upslope from sea level rise.
- For diked areas that are substantially subsided consider importing material to raise elevations desirable for jump-starting marsh development patterns.
- Experiment with designing levees at gradual slopes (i.e. horizontal levees) to emulate natural levee forms and soften impacts from sea-level rise.

3. Stream Temperature

Stream temperature is a primary indicator of watershed health. Cold water-dependent species who experience elevated temperatures lose their swimming, foraging capacity, and overall ability to survive. It also shifts food web patterns and associated biota of the water column. Figure 9 is a snapshot of predicted stream temperature changes to lower reaches of the Clatskanie river showing high levels (16-18 Centigrade in orange) during August. This has direct implications for any restoration activities locally and upstream. Many of the strategies identified above can have a direct benefit in lowering temperature levels. For resiliency planning purposes, additional resources may be necessary to off-set impacts for this climate change variable.

- Increase shade through riparian planting projects
- Protect areas of cold water refugia in areas of groundwater contributions or other known sources
- Consider expanding riparian protection buffers to protect transitional areas to upland

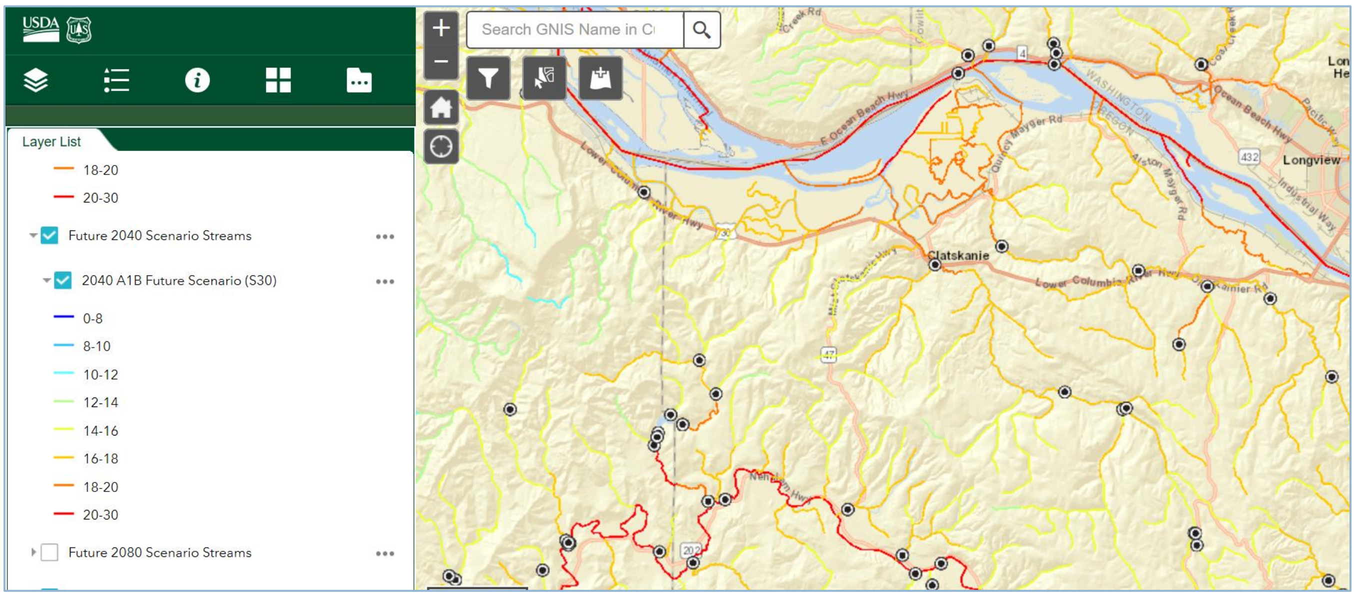


Figure 9: Stream Temperature Predictions, Lower Clatskanie River

E. Action Items for Addressing Uncertainties/Closing Data Gaps

A variety of information gaps are identified that offer insight into watershed processes and functions. This section captures information needs that with additional resources could help fill these gaps. It can serve as the basis for future proposal writing and help refine strategies as needed to address watershed limiting factors described.

1. Productivity

Questions have been raised in the watershed community about the overall capacity of Lower Columbia rivers to meet the foraging needs of native aquatic species. Fish populations declines may contribute to reduced levels of nutrients needed for primary and secondary aquatic food web productivity. Another contributing factor may be the reduction of macro-detrital inputs from estuarine habitats that are currently disconnected from the system due to flood control structures put in place in tidally influenced areas. Proposals have been developed to collect additional stream survey data to validate this assumption and estimate current fish densities and distribution Additional biological surveys in the form of fish densities and macroinvertebrates can be used as a window to better address this working hypothesis of the Lower Columbia watershed systems.

2. Flood Profiles/Gage Data

Flooding is a regularly occurring phenomenon of the watersheds of the Lower Columbia area. Sparse data exist on flood frequency, magnitude, and timing. Resources that provide for regular data collection of water surface elevations would be a resource useful for restoration planning and flood hazard mitigation in the area.

3. Side Channel Inventory

The combination of spatial datasets and local knowledge positions the Watershed Council to identify side channel areas important for the needs of aquatic species. Stream channel habitat types developed during the watershed assessment can be ground-truthed efficiently with emerging LIDAR datasets for a comprehensive inventory of existing side channels. This can be used to expand restoration project opportunities and broader reach scale investigations for restoration potential.

4. Road Inventory

Additional information to confirm the assumed limiting factor of excessive sediment load impacts to stream may be useful for tracking source and future patterns. Updating current road databases paired with existing information on soils, slope, and hydrology can be useful for existing projects and provide a window to opportunities in watershed upland areas.

F. Organization/Programmatic Actions

1. Outreach and Education

Effective implementation of the Outreach Plan in Appendix C will forward the watershed council mission to serve as a resource to landowners and community groups. Watershed Council goals can only be achieved through strong relationships with groups identified in the plan and development of innovative partnerships. This includes bolstering local environmental education programs with local schools. LCRWC will continue to serve as a convener of experts on watershed science to bolster knowledge of watershed in light changing demographics and land ownership.

2. Board Recruitment and Development

Internal governance of the LCRWC will need to reflect changes in the communities and expanded diversity of interests. Regular meetings with Board members in the form of an Executive Committee will work to make regular updates to LCR Watershed Council Charter and Mission. This committee will also oversee making changes as needed to existing agreements with project partners and new ones as they emerge.

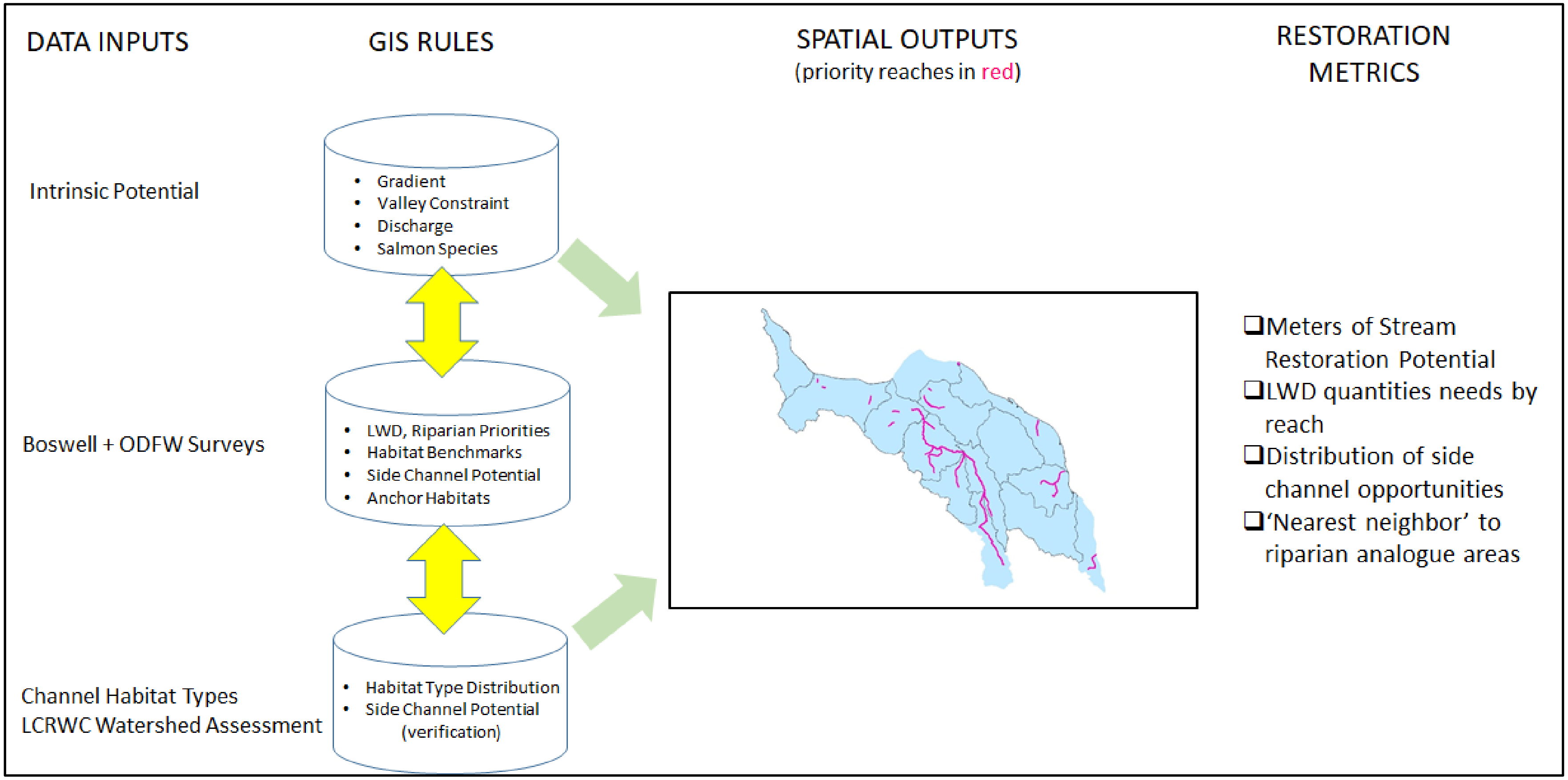
VIII. ACTION PLAN PROJECT AREA PRIORITIES

Applying existing information from watershed assessments, completed stream surveys, and Intrinsic Potential spatial datasets, high-value restoration priorities are identified. Figure 10 is a schematic of the approach used for screening stream reaches in the Lower Columbia River watersheds. The left side of the figure is summary information for informing restoration project opportunities. GIS rules were developed to select attributes from stream survey geodatabase. These rules query the following attributes from available geodatabases:

- Need for Large Woody Debris
- Side Channel Development Potential
- Riparian Need
- Intrinsic Potential (>=2 or more species)
- Chum Salmon Potential

Metrics were then generated to summarize restoration area characteristics that include LWD potential using ODFW stream habitat benchmarks of 3 “key” pieces (>60cm diameter >10m long) of LWD/100 meters. These areas are summarized by reach where project sponsors can begin the project development process for social feasibility with landowners and site-level constraints to implementation (i.e. access logistics, flood risk). All the data input used in the model are summarized in Appendix D.

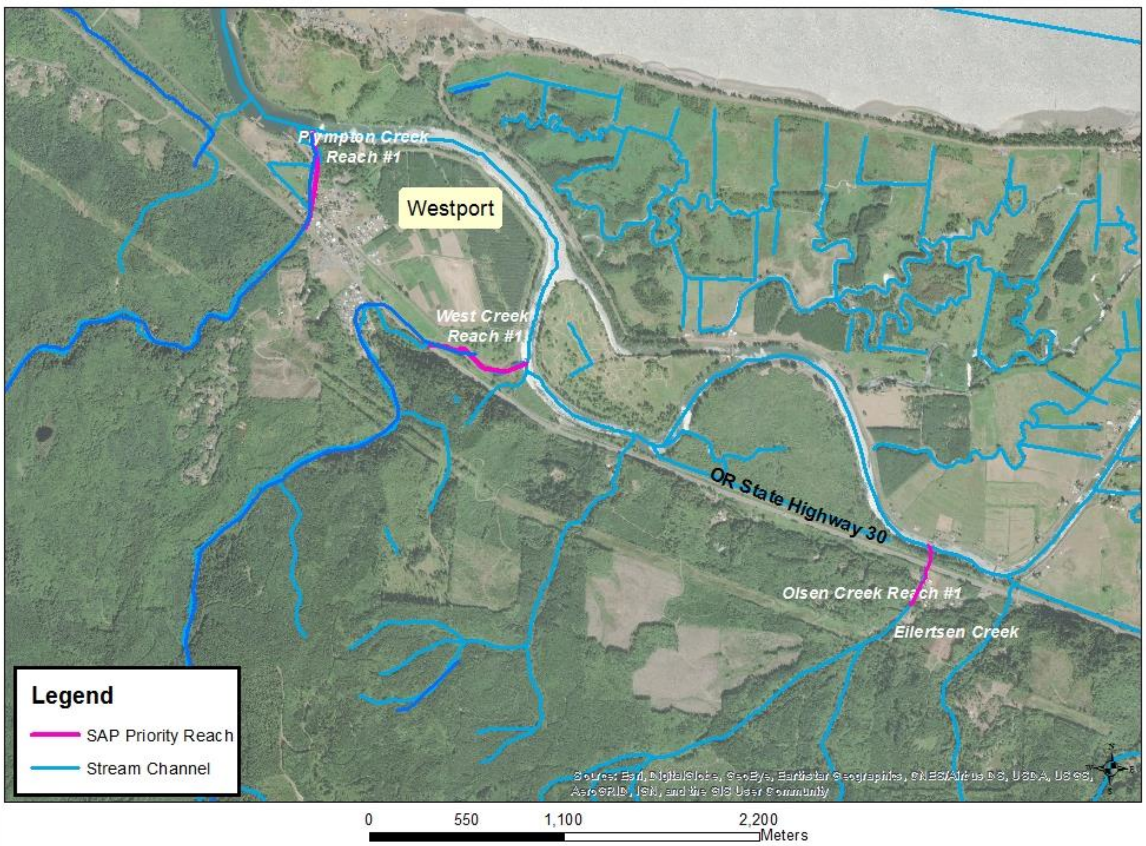
Figure 10: LCRW Project Priorities Workflow Model



A. Subarea 1 Priorities: West Side Tributaries

Subarea 1 has three opportunities in lower sections of Plympton, West, and Graham Creek systems. All three are near their confluence with Westport Slough. Any restoration design concepts will need to consider these areas as response reaches to upper watershed processes that are particularly susceptible to slope failures. Surveys completed do not identify these areas as reaches that have side-channel development potential consistent with the subareas geomorphic structure. While these projects area priorities are smaller in scale, their position is important to head of tide transition areas that may elevate their ecological significance for migrating juveniles as they adapt to Columbia River estuary conditions. Eilerston Creek underwent channel enhancement activities from ODOT to improve conveyance through highway 30 right of way. This may represent an opportunity to develop complementary enhancement activities to bolster stream habitat as the site adjusts to re-established hydrology patterns and improve physical habitat quality.

West Side Tributaries Priorities (Plympton #1, West #1, Olsen #1)



West Side Tributary Area Summary

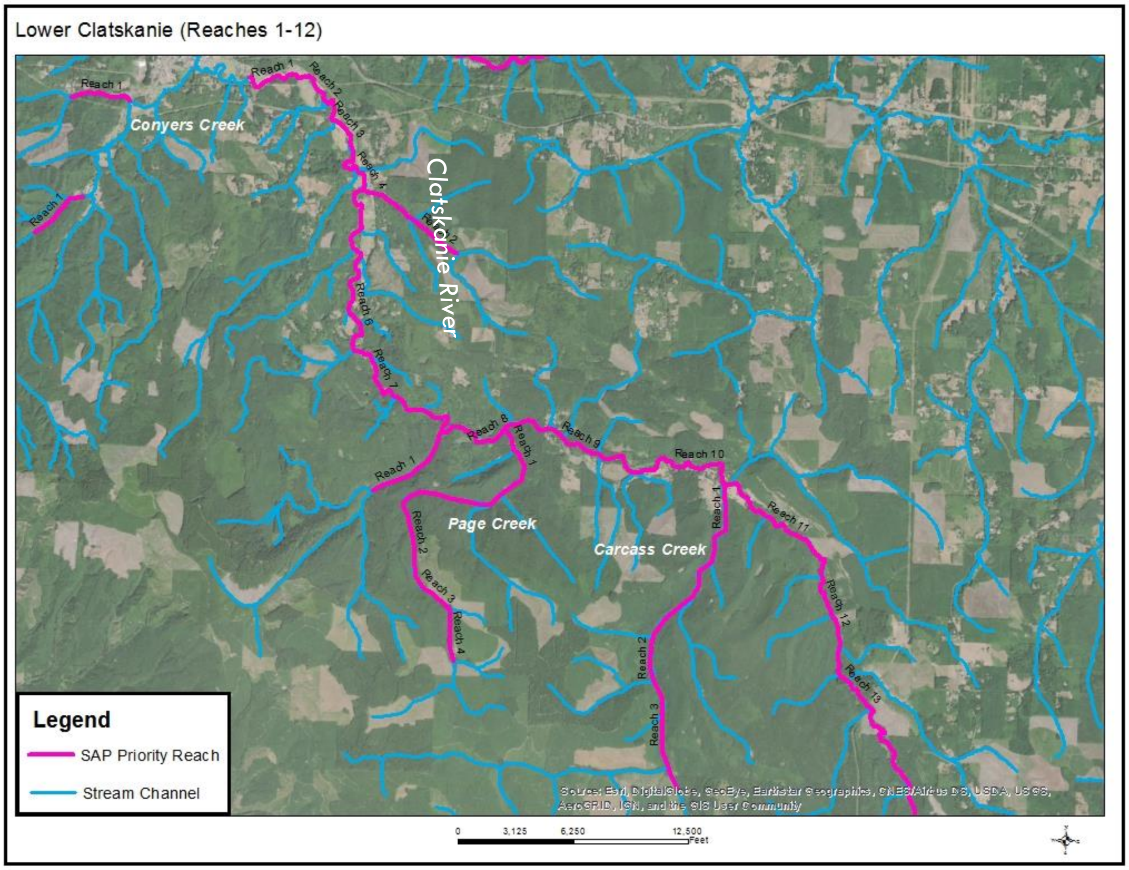
Reach #	Reach Length (m)	LWD Need (anchor pieces/100m)	Side Channel Potential	Riparian Need
Plympton #1	468	3	No	Yes
West Creek #1	442	3	No	Yes
Olsen Creek #1	484	3	No	Yes

B. Subarea 2 Priorities: Clatskanie River (lower reaches 1-12)

This area represents substantial restoration opportunities both in mainstem Clatskanie river floodplain areas and large tributary systems of Conyers, Page, and Carcus Creek. Highlighted areas are reaches where significant deficits exist for LWD anchor pieces and the likelihood of side-channel development (Reach #4, Reach #8). With a few exceptions many fish barriers have been removed or are being planned for removal. Floodplain habitats and instream complexity, therefore, are priority strategies in this subarea to provide rearing areas for needs of juvenile salmonid species and pools for resting adults as they move to upstream spawning areas.

A large floodplain restoration project is near completion at River Mile 2 that can be used to inform the development of similar projects elsewhere in this subarea. The project involved reconnecting side-channel based on predicted flood events from the Clatskanie River. The site continues to evolve as the re-established hydrology adjusts side channels and the wetland plant community evolves. Monitoring this site over time will provide insight into optimal channel invert and plant-elevation relationships useful for reducing the level of uncertainty associated with this project type. Collaboration for this monitoring effort with ODFW is underway in the form of sharing fish, water level, and temperature data.

Plans have been developed for LWD placement in Reach 10 to increase stream complexity and facilitate side-channel development to help meet the habitat needs of this reach. The success of the project could be instrumental in getting landowner support in adjacent reaches to meet the broader needs of this subarea.



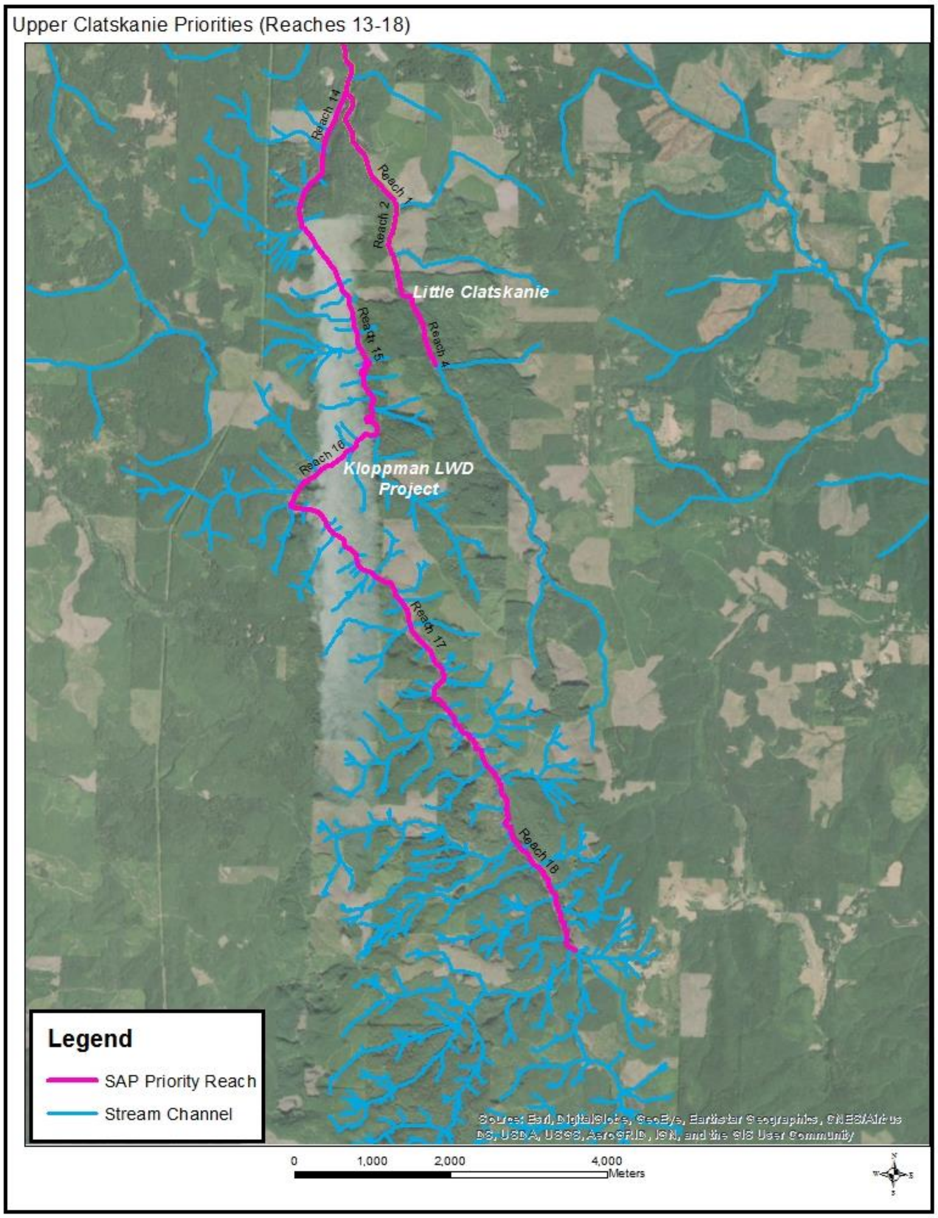
Lower Clatskanie Priority Area Summary

Reach #	Length (m)	LWD Need (anchor pieces/ 100m)	Side Channel Potential	Riparian Need
1	841	2.2	Yes	Yes
2	1462	2.0	Yes	Yes
3	1301	1.5	Yes	Yes
4	603	2.8	Yes	Yes
5	1338	0.4	Yes	Yes
6	1544	1.8	Yes	Yes
7	2470	1.8	Yes	Yes
8	1459	2.0	Yes	Yes
9	1917	2.9	Yes	No
10	2827	2.3	Yes	No
11	1917	2.5	Yes	No
12	2528	2.4	No	Yes
Conyers #1-5*	N/A	N/A	Yes	Yes
Conyers Trib A	1053	2.8	Yes	Yes
Conyers Trib West A	173	2.7	Yes	Yes
Conyers Trib West Cr	987	2.8	Yes	Yes
Carcus Creek #1-3*			Yes	Yes
Page Creek #1-4*			Yes	Yes

*** ODFW Survey Recommendation, Field Data requested**

C. Subarea 2 Priorities: Clatskanie River (upper reaches 12-18)

Limiting factors in this sub-area are similar to Lower Clatskanie and validated from completed surveys. In general, the amount of LWD deficit in these sections is broader in extent. The density of landowners is also lower, improving the chances for project support investigations by community members. Projects completed at Kloppman property represent example projects with high-level improvements with minimal risk to the needs of property owners. Logs were positioned in a variety of ways to recruit additional wood passively for low flow and high flow scenarios. Tracking the diversity of designs and flood profiles used at this site will inform cost-effective approaches elsewhere in this reach. Resources are needed to conduct reach level habitat changes from completed surveys and viability of side-channel activation in alignment with current land use of this area.

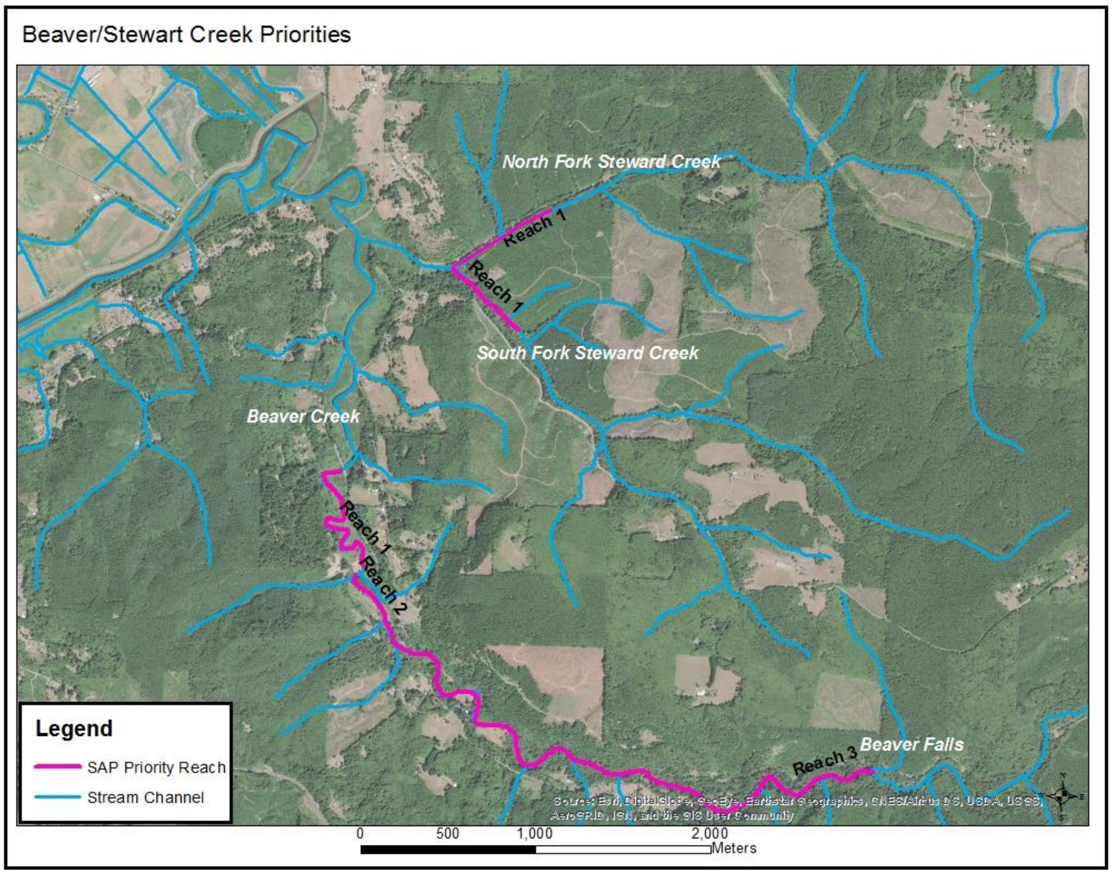


Upper Clatskanie Priority Area Summary

Reach #	Length (m)	LWD Need (anchor pieces/100m)	Side Channel Potential	Riparian Need
13	2528	2.2	Yes	Yes
14	2825	2.8	Yes	Yes
15	2828	3.0	Yes	Yes
16	2500	3.0	TBD	Yes
17	3151	2.9	Yes	Yes
18	2519	3.0	Yes	Yes
Little Clatskanie Reach 1	1439	2.3	Yes	Yes
Little Clatskanie Reach 2	569	1.2	Yes	Yes
Little Clatskanie Reach 3	654	2.5	Yes	Yes
Little Clatskanie Reach 4	601	2.7	Yes	Yes

D. Sub Area 3 Priorities: Beaver Creek/Stewart Creek

Sub-area represents a large expanse of area unexplored for restoration planning and investigations until recently. Restoration planning is occurring in lower, tidally influenced sections of Stewart creek for fish passage and wetland enhancement. Lower North and South fork of Stewart creek are important transitional areas for juveniles as they adapt to tidal fringe habitat conditions. Water quality data analyzed points to elevated bacteria levels in Beaver Creek whose source has yet to be determined. Water quality sampling effort will continue to verify seasonal trends and add rigor to its initial findings This is important context for priority restoration reaches to ensure these risks to watershed health are managed appropriately to maximize ecological benefit.

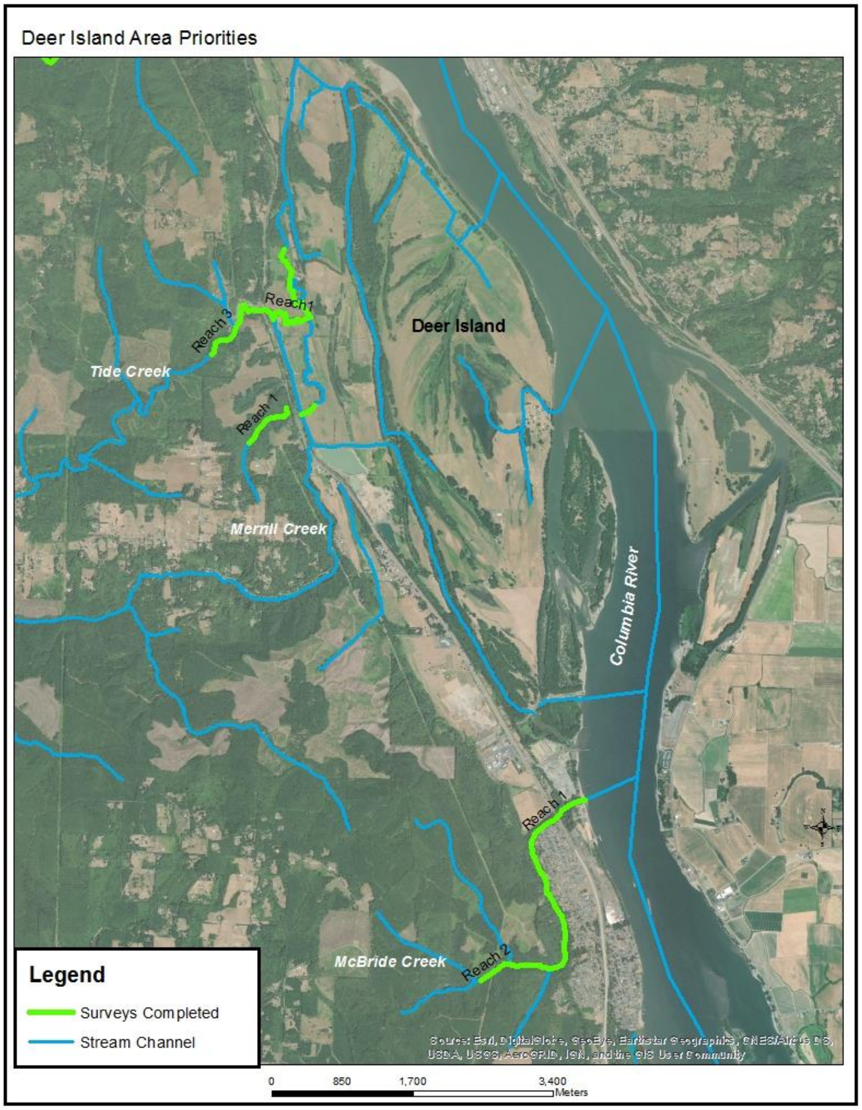


Beaver/Steward Creek Priority Area Summary

Reach #	Length (m)	LWD Need (anchor pieces/100m)	Side Channel Potential	Riparian Need
Beaver Creek 1	1085	2.9	Yes	Yes
Beaver Creek 2	2200	2.9	Yes	No
Beaver Creek 3	2259	2.7	Yes	No
NF-Steward Creek	639	2.6	TBD	No
SF-Steward Creek	486	2.9	Yes	Yes

E. Subarea 4 Priorities: Deer Island Area

Deer Island's historical connection to the Columbia River is fragmented due to flood control measures in the form of levee, tide gate, and drainage ditch network. Columbia Land Trust recently purchased sections of the island for habitat protection. Merrill Creek and Tide Creek tributaries have limited access for anadromous species because of its hydrologic connection to Deer Island. At the time of this writing, no management plan was available to understand the scope of restoration measure being planned and its impact on Deer Island and contributing tributary system. McBride Creek just upstream of Deer Island area has not been examined for restoration opportunities or potential constraints. More information would be useful to validate this tributary as a priority.

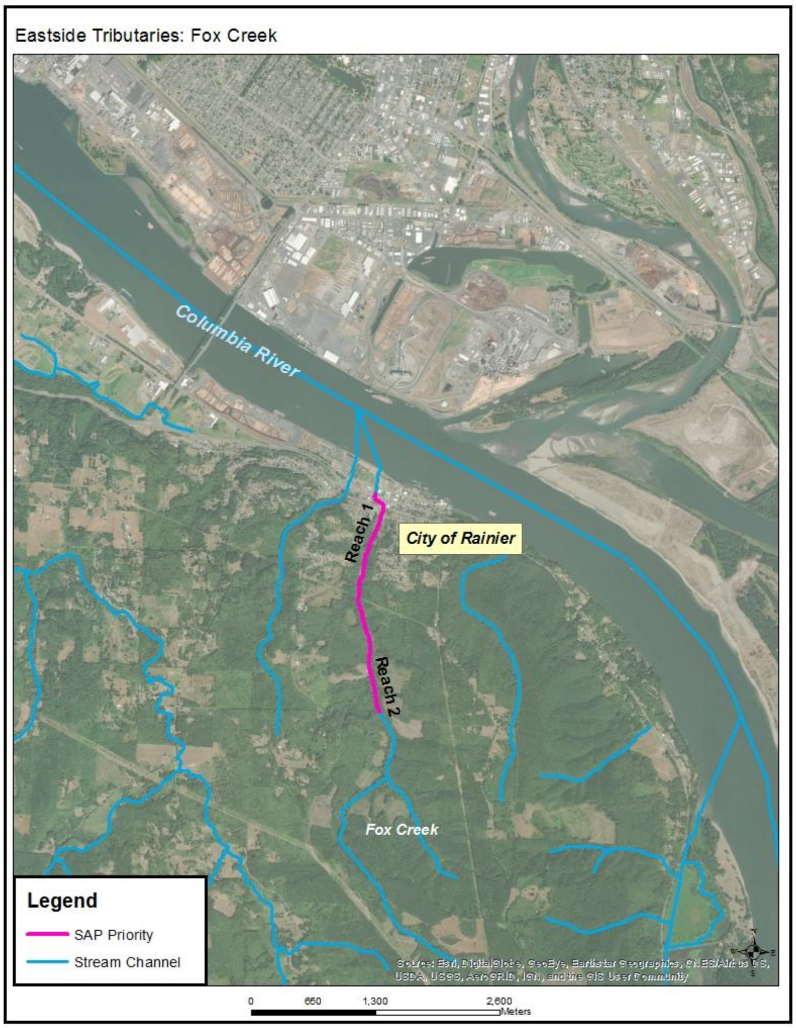


Deer Island Area Priority Area Summary

Reach #	Length (m)	LWD Need (anchor pieces/100m)	Side Channel Potential	Riparian Need
Tide Creek 1	2182	2.7	Yes	Yes
Tide Creek 2	1833	2.8	Yes	Yes
Tide Creek 3	1310	3	Yes	Yes
Merrill Creek 1	2182	2.7	Yes	Yes
Merrill Creek 2	1833	2.8	Yes	Yes
Merrill Creek 3	1310	3.0	Yes	Yes
McBride Creek 1	2182	2.7	Yes	Yes
McBride Creek 2	1833	2.8	Yes	Yes
McBride Creek 3	1310	3.0	Yes	Yes

F. Subarea 5 Priorities: Eastside Tributaries

This subarea has the least amount of data available to determine adequate priorities. Goble Creek and Fox Creek both have constraints in the form of undersized culverts and antiquated fish ladders that merit additional investigations. Friends of Fox Creek are working with the City of Rainier and other partners in scoping formal feasibility for fish passage and flood hazard mitigation needs at Fox Creek. LCRWC plays a supportive role in this endeavor and is ready to provide facilitation and technical assistance as needed to ensure project goals are met for the fish and needs of the community.



Reach #	Length (m)	LWD Need (anchor pieces/100m)	Side Channel Potential	Riparian Need
Fox Creek 1	1274	3.0	Yes	Yes
Fox Creek 2	1168	3.0	Yes	Yes

G. Subarea 6 Priorities: Estuary Zone (insert estuary map here)

Survey data wasn't collected for the estuarine sections of LC watersheds. Therefore, priorities weren't determined from the GIS model described above. Several restoration projects have been completed in this area through the removal and/or manipulation of levee material to re-establish tidal-estuarine hydrologic patterns. Consideration should be given to several criteria to screen a range of estuarine opportunities in this area. They are listed here with descriptions as prioritization guidelines as estuary project opportunities are identified:

Size

Size is always a factor in determining priorities from several fronts. In simple terms, the larger the size the greater the capacity to support more fish and a variety of other species' needs. The broader the expanse of the potential habitat "patch" the more likely it can support a diversity of habitat types and diverse channel structures. Larger size habitats are general more resilient to bigger events such as storms, landslides, and flooding.

Proximity to the tributary confluence area

Areas near transitional boundaries such as the confluence area serve as important patches as aquatic species make their transition from freshwater stream systems to estuarine environments. Depending on flow conditions from the estuary these areas may serve as cold-water refugia from surrounding warmer water.

Proximity to reference site or completed restoration project

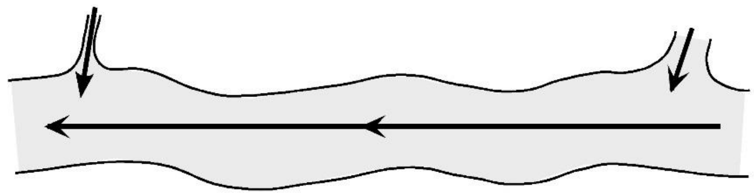
Distance to functioning habitats may provide a synergistic effect in the availability of nutrients and resources to jump-start food web productivity for the foraging needs of salmon and other aquatic species. An argument can also be made to developing a restoration project where there is no surrounding habitat, establish "steppingstones" to meet basic survival needs. The availability of these patches reduces stress and predation risk during estuary migration. (Figure 11 below).

Potential habitat diversity

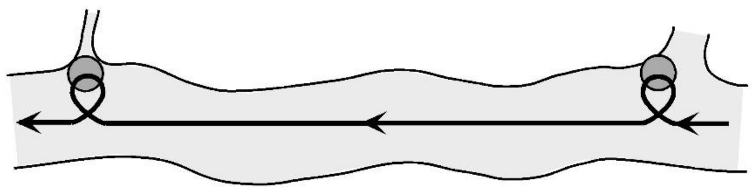
A site that has a variety of elevations may be considered high priority so that direct and indirect habitat patches can be made available for a variety of water level conditions. This can also bolster plant diversity that can facilitate prey resources available during different times of the year for a range of juvenile salmonid life histories.

Figure 11: Conceptual Model Application of Estuary Habitat Proximity Criteria

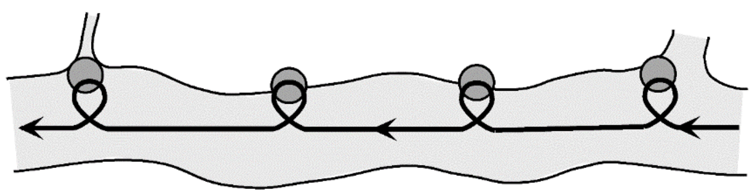
1. Initial condition--no habitat: short residence; low feeding opportunity; high predation, phsyiological stress, mortality.



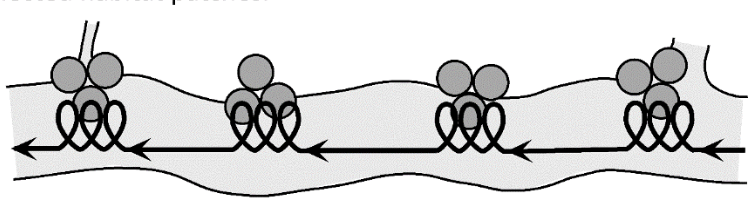
2. Initial priority--restoration at tributary junctions: some habitat; some residence, feeding, refuge; use by multiple stocks; high fish density due to proximity to tributary population sources.



3. Stepping stone corridor: some residence, feeding, refuge in each stepping stone; long residence in system of stepping stones; reduced travel time and mortality risk between stepping stone refuges.



4 Mature system restoration--large, well-connected habitat patches: long residence in large habitat patches, long residence in stepping stone corridor; low stress and mortality within and between large, well-connected habitat patches.



IX. APPENDIX A: LIFE HISTORIES OF FOCAL FISH SPECIES AND SENSITIVE SPECIES OF LCR WATERSHEDS

A. **Lower Columbia Coho Salmon**
B. **Lower Columbia Chinook Salmon**
C. **Lower Columbia Steelhead Salmon**
D. **Lower Columbia Chum Salmon**
E. **Sea-Run Cutthroat Trout**
F. **Resident Cutthroat Trout**
G. **Pacific Lamprey**
H. **Brook Lamprey**
I. **X Salamander**
J. **Columbia White-tailed Deer**

X. APPENDIX B: ADDITIONAL THREATS TO HABITATS

A. Plants

1. Reed Canary Grass
2. False Indigo
3. Japanese Knotweed
4. Yellow Iris
5. Purple Loosestrife
6. Elodea
7. Milfoil
8. Ludwigia

B. Animals

1. Piscivorous Fish
2. Piscivorous Mammals

XI. APPENDIX C: LCRWC STRATEGIC OUTREACH PLAN

XII. APPENDIX D GIS OUTPUT TABLE SUMMARIES

Subarea	Reach	Length (m)	Intrinsic Potential			Chum Potential	LWD Need (anchor pieces/100m)	Side Channel Potential?	Riparian Need?
			Chinook	Coho	Steelhead				
West Side Tributaries									
	Plympton #1	468		x			3.0	No	Yes
	West Creek #1	442					3.0	No	Yes
	Olsen Creek #1	484		x			3.0	No	Yes
Lower Clatskanie									
	1	841	x	x	x		2.2	Yes	Yes
	2	1462	x	x		x	2.0	Yes	Yes
	3	1301	x	x		x	1.5	Yes	Yes
	4	603	x	x		x	2.8	Yes	Yes
	5	1338	x	x		x	0.4	Yes	Yes
	6	1544	x	x	x		1.8	Yes	Yes
	7	2470	x	x	x	x	1.8	Yes	Yes
	8	1459	x	x	x	x	2.0	Yes	Yes
	9	1917	x	x		x	2.9	Yes	No
	10	2827	x	x		x	2.3	Yes	No
	11	1917	x	x		No Data	2.5	No	No
	12	2528	x	x	x	No Data	2.4	Yes	Yes
	Conyers #1-5	N/A					N/A	Yes	Yes
	Conyers Trib A	1053					2.8	Yes	Yes
	Conyers Trib West A	173					2.7	Yes	Yes
	Conyers Trib West Creek	987					2.8	Yes	Yes
	Carcus Creek #1-3		x	x	x			Yes	Yes
	Page Creek #1-4		x	x	x			Yes	Yes
Upper Clatskanie									
	13	2528	x	x		No Data	2.2	Yes	Yes
	14	2825		x	x	No Data	2.8	Yes	Yes
	15	2828	x	x	x	No Data	3.0	Yes	Yes
	16	2500	x			No Data	3.0	TBD	Yes
	17	3151	x		x	No Data	2.9	Yes	Yes
	18	2519	x			No Data	3.0	Yes	Yes
Little Clatskanie									
	1	1439	x		x	No Data	2.3	Yes	Yes
	2	569	x			No Data	1.2	Yes	Yes
	3	654	x			No Data	2.5	Yes	Yes
	4	601	x			No Data	2.7	Yes	Yes

Subarea	Reach	Length (m)	Intrinsic Potential			Chum Potential	LWD Need (anchor pieces/100m)	Side Channel Potential?	Riparian Need?
Beaver Creek/Stewart Creek									
	Beaver Creek 1	1085	x	x		x	2.9	Yes	Yes
	Beaver Creek 2	2200	x	x	x	x	2.9	Yes	No
	Beaver Creek 3	2259	x	x	x	x	2.7	Yes	No
	NF-Steward Creek	639		x		x	2.6	TBD	No
	SF-Steward Creek	486		x	x	x	2.9	Yes	Yes
Deer Island									
	Tide Creek 1	2182	x	x			2.7	Yes	Yes
	Tide Creek 2	1833	x	x			2.8	Yes	Yes
	Tide Creek 3	1310	x	x	x		3.0	Yes	Yes
	Merrill Creek 1	2182				x	2.7	Yes	Yes
	Merrill Creek 2	1833					2.8	Yes	Yes
	Merrill Creek 3	1310					3.0	Yes	Yes
East Side Tributaries									
	Fox Creek 1	1274		x			3.0	Yes	Yes
	Fox Creek 2	1168		x	x		3.0	Yes	Yes