Wind River Habitat Restoration Strategy

SUBMITTED TO
Lower Columbia Fish Recovery Board

FEBRUARY 27, 2017

Wind River Habitat Restoration Strategy

SUBMITTED TO
Lower Columbia Fish Recovery Board
2127 8th Avenue
Longview, WA 98632
(360) 425-1555

PREPARED BY
Inter-Fluve, Inc., Underwood Conservation District, and Lower Columbia Fish Recovery Board in collaboration with the Wind River Work Group.

FEBRUARY 27, 2017

ACKNOWLEDGEMENTS

The authors of this report would like to thank all of the Wind River Work Group participants that contributed to the development of this habitat strategy. In addition, key technical information related to the EDT Analysis was provided by Dan Rawding of Washington Department of Fish and Wildlife. Numerous private landowners throughout the watershed provided permission to access their properties in order for field data to be collected. All of the staff at Lower Columbia Fish Recovery Board were instrumental in this project's origination and completion, including Jeff Breckel, Steve Manlow, Melody Tereski, Karen Adams, Amelia Johnson, and Lorie Clark. Funding for the project was provided by the Washington Salmon Recovery Funding Board, grant #14-1392.

Table of Contents

1. Introduction and Background

1.1 OVERVIEW

This habitat restoration strategy is intended to guide aquatic habitat restoration activities for salmon and steelhead in the Wind River watershed. The strategy builds on previous work of the Lower Columbia Fish Recovery Board's (LCFRB) Salmon Recovery and Fish and Wildlife Subbasin Plan (Recovery Plan) (LCFRB 2010). The strategy identifies reach-specific habitat conditions and limiting factors, identifies site-specific restoration projects, and prioritizes those projects based on biological benefits, cost, and certainty of success.

The Wind River subbasin is the first major Columbia River tributary in Washington upstream of Bonneville Dam. The subbasin historically supported abundant fall Chinook, summer and winter steelhead, chum, and coho. These fish populations are components of Lower Columbia Evolutionarily Significant Units (ESUs) that have been listed as Threatened under the Endangered Species Act (ESA). In response to these ESA listings, the LCFRB developed the Recovery Plan, which encompasses the Wind River subbasin. The Recovery Plan describes fish population status, trends, and goals for recovery, and outlines limiting factors and key habitat priorities necessary for recovery. The nine Key Priorities identified in the Wind River subbasin are:

1. Reduce Passage Mortality at Bonneville Dam and Mitigate for Effects of Reservoir Inundation
2. Protect Intact Forests in Headwater Basins
3. Manage Forest Lands to Protect and Restore Watershed Processes
4. Manage Growth and Development to Protect Watershed Processes and Habitat Conditions
5. Restore Floodplain Function, Riparian Function and Stream Habitat Diversity
6. Evaluate and Address Passage Issues at Hemlock Dam and Lake and Other Barriers
7. Align Hatchery Priorities with Conservation Objectives
8. Manage Fishery Impacts so they do not Impede Progress Toward Recovery
9. Reduce Out-of-Subbasin Impacts so that the Benefits of In-Basin Actions can be Realized

This effort focusses primarily on #5 above. Other priorities are being addressed as part of other programs or regulations, or have already been conducted. Although the Recovery Plan outlines general limiting factors and priorities for habitat work, it does not define site-specific actions that will contribute to species recovery. This habitat restoration strategy defines those site-specific actions, and provides the technical basis for restoration projects to move forward in the Wind River subbasin. The strategy is based on a technical assessment that included synthesizing existing information, performing field surveys, and soliciting input from community stakeholders. The assessment identified a suite of potential projects and prioritized those using methods consistent with the LCFRB's regional Habitat Strategy. Two of the top-priority projects were further developed to the preliminary design stage; the documentation for these design projects has been compiled separately. Information provided in this report is intended to be used as a foundation for cooperative restoration implementation in the Wind River watershed for the benefit of fish and the local community. This habitat restoration strategy is incorporated into the LCFRB 6-year Habitat Work Schedule (LCFRB 2010).

1.2 WIND RIVER WORKGROUP

The Wind River subbasin has benefitted from many years of collaborative watershed research and restoration. In response to the ESA listing of fish species in the 1990s, several entities joined together to better understand the wild steelhead population of the Wind River and support its recovery. During this time a Bonneville Power Administration-funded steelhead restoration project was initiated to support the research, monitoring and restoration efforts of four partners: U.S. Geologic Survey Columbia River Research Laboratory (USGS), Washington Department of Fish and Wildlife (WDFW), U.S. Forest Service Gifford Pinchot National Forest (USFS), and Underwood Conservation District (UCD). As part of this effort, the Wind River Watershed Council was formed, which involved multiple community members and landowners as well as watershed professionals in the region. Other stakeholder planning efforts developed, including the Watershed Resource Inventory Area (WRIA 29 and WRIA 29A) planning processes and the South Gifford Pinchot Collaborative Group. Funding support for the watershed council ended, and over time the Wind River Watershed Council became inactive.

The initiation of this habitat restoration strategy provided an opportunity to form the Wind River Work Group (WRWG) in 2015. The partners involved in the WRWG include a variety of federal, state, tribal, and private interests. Thus far facilitated by the LCFRB, the WRWG provides a collaborative process that builds upon existing partnerships and encourages new relationships.

During the first few meetings, which are always open to the public, community interests and concerns were identified and defined in order to guide restoration priorities. The Vision and Goals of this group were formalized early in the process, and are described below, in Section 1.4.

Throughout the development of the habitat restoration strategy, WRWG members contributed significant input, especially with regard to existing publications and data in the watershed, the geographic scope, project and reach prioritization, and project design alternatives.

WRWG members include:

- Eli Asher, Cowlitz Indian Tribe
- Brian Bair, US Forest Service TEAMS Enterprise and Bair LLC
- Thomas Buehrens, Washington Department of Fish and Wildlife
- Jeanette Burkhardt, Yakama Nation Fisheries Program
- Stephanie Caballero, U.S. Forest Service Gifford Pinchot National Forest
- Lee Carlson, Yakama Nation Fisheries Program
- Bengt Coffin, U.S. Forest Service Gifford Pinchot National Forest
- Pat Connolly, U.S. Geological Survey Columbia River Research Laboratory

- Dan Gundersen, Wind River landowner
- Shiloh Halsey, Gifford Pinchot Task Force
- Bob Hamlin, Skamania County Commissioner
- Tom Hausmann, NOAA Fisheries
- Dave Howe, Washington Department of Fish and Wildlife
- Ian Jezorek, U.S. Geological Survey Columbia River Research Laboratory
- Amelia Johnson, Lower Columbia Fish Recovery Board (position previously held by Karen Adams)
- Sam Kolb, Washington Department of Fish and Wildlife
- Tom Linde, Wind River landowner and LCFRB Chair
- Steve Manlow, Lower Columbia Fish Recovery Board (position previously held by Jeff Breckel)
- Margaret Neuman, Mid-Columbia Fisheries Enhancement Group
- Jan Thomas, Underwood Conservation District
- Tova Tillinghast, Underwood Conservation District
- Nate Ulrich, Columbia Land Trust
- Del Wilson, Wind River landowner
- Larry Zeigenfuss, US Fish and Wildlife Service - Carson National Fish Hatchery

1.3 THE PUBLIC AS A PARTNER IN RESTORATION

This habitat restoration strategy is not a regulatory document and does not require compliance or implementation from any entity or individual. Instead, it relies solely on the willing cooperation and support of public jurisdictions, private landowners, local interest groups, and the community within the subbasin. In addition, public and stakeholder involvement strengthens the implementation and long-term stewardship of restoration efforts. While the WRWG provides one forum for engaging the public on the habitat restoration plan and specific projects, there have been several additional efforts to reach out to the community. Regular WRWG public meetings were held in Carson, Stevenson, and Hemlock, with two additional web-based meetings. The meeting dates are listed below:

September 16, 2015
October 20, 2015
November 17, 2015
December 16, 2015
January 19, 2016
February 16, 2016
March 15, 2016
April 19, 2016
May 17, 2016
June 21, 2016 - public workshop at USFS Training Center in Hemlock
August 16, 2016
September 20, 2016 - public workshop at USFS Training Center in Hemlock
October 18, 2016
December 19, 2016 - via web
January 17, 2017 - via web
February 21, 2017 – via web (pending)

At its December 16, 2015 meeting, the WRWG finalized an outreach plan for this effort, shown in Appendix A. The objectives of the outreach plan are:

1. Listen to better understand community interests and concerns;

2. Inform the public on how well things have worked so far, current activities, and how the habitat strategy development is voluntary and non-regulatory; and
3. Develop partnerships to obtain community and landowner support for doing projects.

Additional public outreach efforts included press releases to the Skamania Pioneer newspaper, meeting with the Stabler Community Council, posting up-to-date information on the LCFRB and UCD websites and other social media, and holding informational interviews with community leaders. Individual letters and requests for permission were sent to private landowners adjacent to waterways within the geographic scope to allow for the field data gathering. Numerous individual conversations followed the landowner outreach so as to further develop specific habitat projects. Projects that are located on private land have only been moved forward into the design phase with landowner consent, and it will be necessary for project sponsors to secure landowner permission prior to seeking implementation funding.

1.4 VISION AND GOALS

The following Vision and Goals for the Wind River Restoration Strategy Development were discussed, revised and agreed upon at two Wind River Work Group meetings on Nov. 17, 2015 and Dec. 16, 2015.

1.4.1 Vision

Create a restoration strategy that maintains and improves fish habitat and habitat-forming processes while maintaining support of community values

1.4.2 Goals

- Sustain and restore water quality, water quantity, and watershed function
- Restore and enhance fish habitat and habitat-forming processes with an emphasis on wild steelhead
- Recommend monitoring and evaluation efforts to assess achievements toward these goals. Communicate findings to stakeholders.
- Incorporate local input and knowledge to inform watershed enhancement activities
- Promote the vision and goals of the Wind River strategy through community involvement and outreach
- Respect the local culture, economic interests, property rights, and other community values.

1.5 GEOGRAPHIC SCOPE

The proposed study segments were determined through input from members of the Wind River Work Group and additional staff from the WA Dept of Fish & Wildlife. Various factors were considered in determining the study segments, including the importance of the reach for fish, the potential for meaningful restoration, and whether or not streams were part of recent US Forest Service restoration planning efforts. These considerations led to the first cut at a prioritization of the stream segments by the WRWG. The final selected stream segments were further filtered based on where landowner permissions were obtained, access considerations, and achieving a target of 20 total survey miles. Figure 1 shows the final geographic scope of the survey effort, with the Trout and Trapper Creek Basins highlighted as being part of recent USFS restoration planning efforts (public lands only). Table 1 lists the study segments and includes the evaluation results and rationale for selection.

The final geographic scope for this study incorporated 20.5 stream miles, and included portions of the Little Wind River, Lower Trout Creek, Paradise Creek, Middle Wind (Stabler to Hatchery), Upper Wind (Above the Hatchery), and Dry Creek.

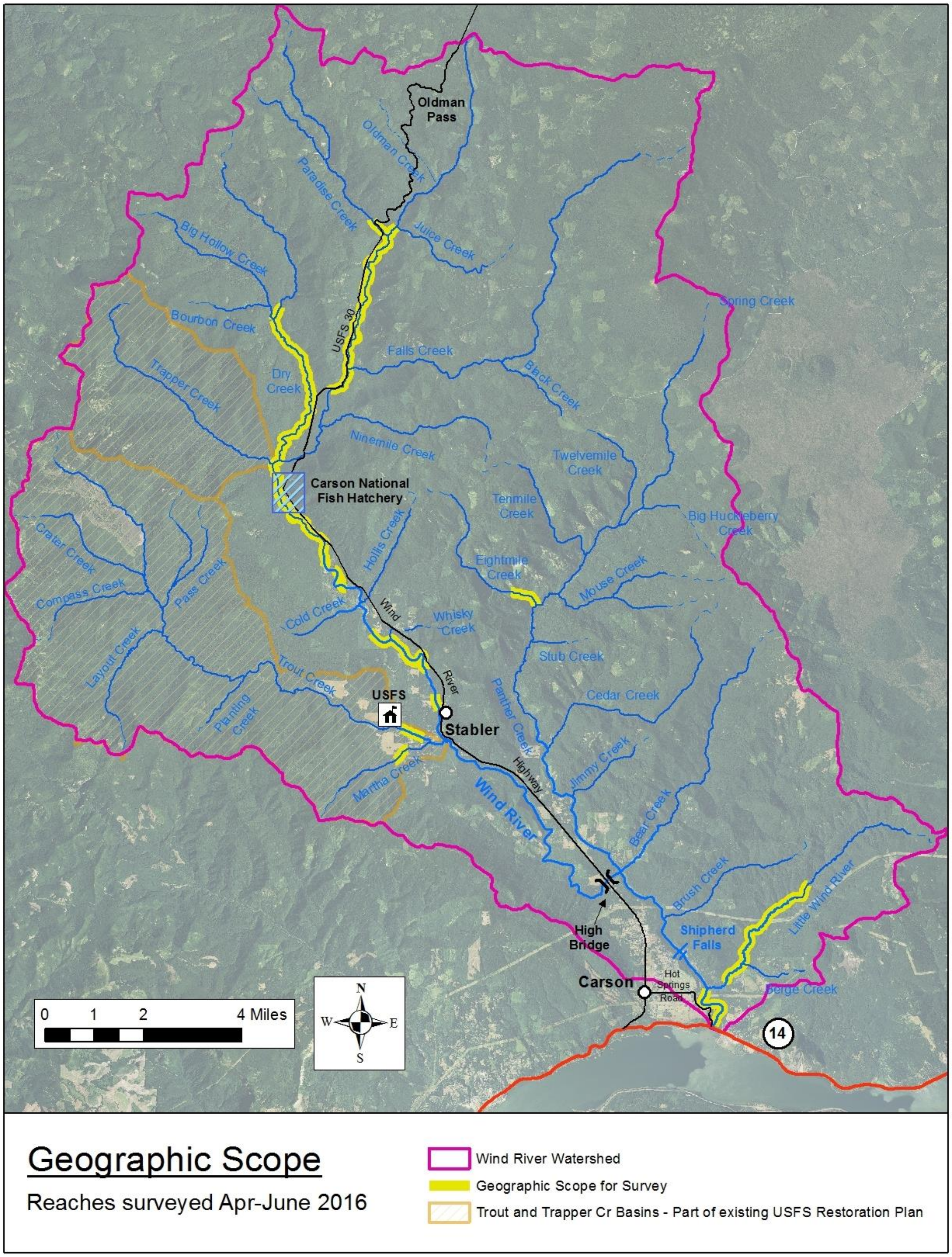

Figure 1. Map of geographic scope of reaches included in the assessment.

Table 1. Selection of stream segments for geographic scope of the survey and project identification effort.

Stream or Segment	WRWG Rank October 20th	WDFW Rank of top 22 miles	Total Anad. Miles	LCFRB Tier	USFS Land? (Y/N)	Covered in USFS Restoration Plan? (Y/N)	Inclusion in Survey Scope? (Y/N)	Final Survey Miles	Notes
Little Wind	H	3	3.1	1	Y&N	N	Y	3.1	Lower 0.5 mile already treated
Eightmile	H	6	1.5	not tiered	Y	N	Y	0.6	Includes first 0.6 miles affected by recent harvest. Upper portion in good shape and challenging access
Layout	H	4	3	4	Y	Y	N		Already covered in USFS Restoration Plan
Upper Trout	H	2	7	4	Y	Y	N		Already covered in USFS Restoration Plan
Lower Trout (PCT to the mouth)	H	M	4.3	1,4,2	Y&N	Y&N	Y	0.8	Martha to FS bdry. Lower Canyon not included. Remainder already covered in USFS Restoration Plan
Lower Trapper (Lower 2 Miles)	H	5	2	4	Y	Y	N		Already covered in USFS Restoration Plan
Paradise	H	L	2.4	4	Y	N	Y	0.5	Includes lower portion along road and campground. Upper portion in good shape.
Hollis	H	L	1.2	not tiered	Y	N	N		Barrier culvert at WR Hwy 0.2 mi up. 1.2 mi to a barrier falls. Surveyed by UCD 2015. Access challenges.
Cold	H	L	0.1	not tiered	N	N	N		No landowner permissions
Middle Wind (Stabler to Hatchery)	H	1	7.2	2,4	Y&N	N	Y	4.6	Included where landowner permissions allowed.
Martha Creek	H	M	2.1	2	Y&N	Y&N	Y	0.3	Includes lower private portion where permissions granted. Upstream covered in USFS Restoration Plan
Upper Wind (Above Hatchery)	H	M	10.6	1,2,4	Y	N	Y	5.4	Includes hatchery to Dry Cr; along WR Hwy dwnstrm of Falls Cr; Mining Reach; along Paradise CG
Cedar	M	M	2	4	Y&N	N	N		Not included. Not high priority from either ranking
Trout (Canyon)	M	L	2	2	Y	Y	N		Already covered in USFS Restoration Plan
Lower Planting	M	L	1.5	not tiered	Y	Y	N		Already covered in USFS Restoration Plan
Crater	M	7	1.6	4	Y	Y	N		Already covered in USFS Restoration Plan
Cannavina/Whiskey (lower 0.5 mi of each)	M	M	1	not tiered	N	N	N		Not included. Not high priority from either ranking
Lower Wind (Below Shipherd)	M	M	3	2	Y&N	N	Y	1.2	Includes lower 1.2 miles (Little Wind to Hwy 14) based on discussion at Dec 16 2015 WRWG meeting
Panther	L	L	11.4	1,2,4	Y&N	N	N		Not included. Not high priority from either ranking
Compass	L	M	2.1	4	Y	Y	N		Already covered in USFS Restoration Plan
Pass	L	L	1.7	not tiered	Y	Y	N		Not included. Not high priority from either ranking
EF Trout	L	L	1.1	4	Y	Y	N		Not included. Not high priority from either ranking
Dry	L	8	4.7	4	Y	N	Y	4.0	Mouth to road crossing/culvert (above Big Hollow)
Ninemile	L	L	2.3	4	Y	N	N		Not included. Not high priority from either ranking
Lower Oldman	L	L	0.5	not tiered	Y	N	N		Not included. Not high priority from either ranking
Lower Youngman	L	L	0.3	not tiered	Y	N	N		Not included. Not high priority from either ranking
Canyon Reach Wind	L	L	6.3	1	Y&N	N	N		Not included. Not high priority from either ranking for restoration. However, preservation value acknowledged.
Falls Creek	L	L	1.7	4	Y	N	N		Not included. Not high priority from either ranking
						Total survey mileage		**20.5**	

2. Watershed Conditions

This section provides an overview of the geomorphology, hydrology, and habitat condition of the Wind River, Skamania County, Washington. Ecologic processes are integrated with the geomorphologic and hydrologic assessment for a holistic understanding of the historic, current, and potential functioning condition of the study site. Conditions and trends are evaluated herein to identify, prioritize, and develop various restoration projects throughout the Wind River watershed. To complete this assessment, existing datasets and studies were analyzed and field work surveys were performed by Inter-Fluve, Inc., (IFI) and Underwood Conservation District (UCD) staff. An emphasis was placed on identifying site-specific aquatic habitat and geomorphic conditions in order to inform the identification and prioritization of potential habitat restoration actions.

The purpose of this assessment is to document and evaluate geomorphic processes, hydrologic processes, and aquatic and riparian habitat conditions in the Wind River watershed and to present a comprehensive restoration strategy.

2.1 GEOLOGY

The Wind River subbasin occupies about 224 mi^2 within the south-central portion of the South Cascades geologic province. The province is a complex mosaic of terranes, dominated by extrusive volcanics, resulting from approximately 40 million years of volcanism within the Cascade Volcanic Arc (WADNR 2015). Modern topography and hydrography is influenced by the location and orientation of faults and folds in the Wind River subbasin (Czajkowski et al. 2014). The surficial geology of the Wind River subbasin include intrusive and extrusive volcanics, marine and riverine sedimentary rocks, and unconsolidated alluvium and colluvium (Figure 2).

During the lower Eocene, subduction of basaltic Farallon lithosphere beneath the North American continent formed extensive accretionary terranes in modern-day western Washington and Oregon (Wells et al. 2014). Volcanism associated with the subduction of this material extruded primarily mafic lavas, such as basalt, during this early period of Cascade volcanism (WADNR 2015). Ongoing subduction continued to drive regional volcanic activity throughout the Oligocene, depositing alternating layers of lava, ash, and volcaniclastic rocks. The Ohanapecosh Formation, composed of andesite lava flows, tuff-breccias, and debris-flow tuffs, covers a large portion of the Wind River basin and was deposited approximately 35 to 29 million years ago (Berri and Korosec 1983).

During the middle Miocene, flood basalts sourced from the Columbia Plateau flowed across the southeast portion of the Wind River subbasin. The majority of extruded material during these episodes occurred between 17 and 14 million years ago (Tolan et al. 2009). Noteworthy flood basalt members traversing the lower Wind River subbasin include the Grande Ronde (15.6 million years ago), Frenchman Springs (15.3 myo), Priest Rapids (15 myo), Asotin (13 myo), and Pomona (12 myo; WADNR 2015). Two additional andesite flows erupted through the Ohanapecosh Formation during this period in the vicinity of Big Butte, Warren Ridge, and Stevenson Ridge. Numerous additional basaltic and andesitic dikes were emplaced throughout the lower Wind River subbasin during this period (Czajkowski et al. 2014). Regional tectonism during the period concurrent and immediately prior to the eruption of the Columbia Flood Basalt Group resulted in folding, faulting, and tilting of Eocene and Oligocene deposits of the South Cascades province, as well as older units of flood basalts (Berri and Korosec 1984).

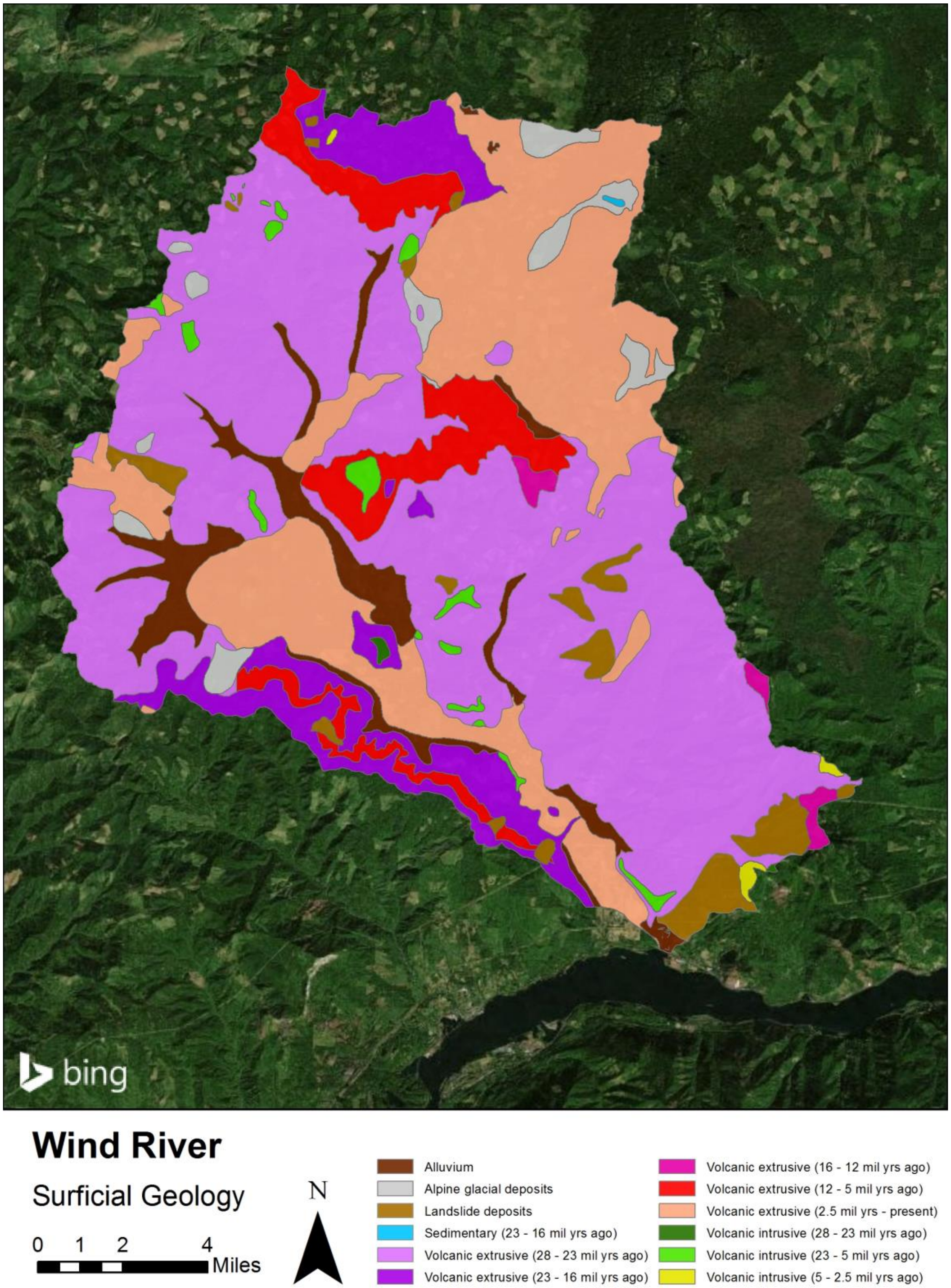

Figure 2: Surficial geology of the Wind RiverBasin study area with approximate age of origin.

Local volcanism accelerated during the Pliocene and Quaternary periods, dominated by mafic basalt eruptions from numerous centers (Berri and Korosec 1984). Eruptive centers within or near to the Wind River subasin include Trout Creek Hill, Cedar Creek, and the various cones of the Indian Heaven plateau. The eruption of the Trout Creek Hill volcano sent basalt down-valley to the Columbia River (Czajkowski et al. 2014). Ash and tuff deposits from regional andesitic stratovolcanoes, including Mount Hood, Mount St. Helens, and Mount Rainier, are present within the Wind River subbasin. Hypabyssal intrusives of late Oligocene to Pliocene age are present throughout the Wind River subbasin. Diorite and intrusive andesite in the Trapper Creek watershed are members of the Miocene Silver Star Pluton. Gabbro is evident in the vicinity of Bunker Hill and Warren Ridge. Tertiary and Pliocene quartz diorite plutons are present in the lower Wind River valley, with Wind Mountain being the most prominent example.

Analysis of geothermal resource potential in the lower Wind River Valley identified a series of northeast-trending faults of Pliocene to Quaternary age, including the Bear Creek, Brush Creek, and Little Wind River faults (Czajkowski et al. 2014). Evidence of tectonic shear was observed in the vicinity of the Brush Creek confluence with the Wind River. The St. Martins and Shipherd's hot springs occur between the Little Wind River and Brush Creek faults, and lie within the proposed Shipherd Fault Zone. This deformation episode represents a combination of crustal response to subsurface intrusion and regional tectonic forces. The combined effects of faulting and folding, bedrock stratigraphy, weathering patterns, and sporadic large earthquakes render the Wind River subbasin prone to extensive landsliding. A significant portion of the watershed is composed of alluvium/colluvium landslide deposits (Figure 2).

2.2 GEOMORPHOLOGY

2.2.1 Valley Geomorphology

The Wind River valley rests within the high-relief mountainous landscape of the western Cascade Range. Elevation within the basin ranges from 80 feet at the confluence with the Columbia River to 5,366 feet at Gifford Peak. The contemporary aspect of the valley is governed by regional fault zones that have imposed both hydrographic and topographic influences on the drainage basin for millennia. The main valley (downstream from the Trapper Creek confluence) trends northwest to southeast, reflecting the direction of the dominant regional tectonic forces and running parallel to Miocene-age faults and folds. Younger faults in the lower basin run southwest to northeast, including those occupied by Bear Creek, Brush Creek, and the Little Wind River. The Wind River – Bear Creek confluence occurs along one of these faults. The steep, timbered drainages of the Wind River basin are the result of fluvial incision, due to the watershed's relatively low elevation and occurrence within the rain-on-snow climatic zone. However, small alpine glaciers were present during the most recent ice ages, between 20,000 and 9.500 years ago (late Pleistocene to early Holocene). Multiple locations within the headwaters and tributaries of the Wind River valley were formed or influenced by glacial processes, creating small cirques and deposits of glacial drift. Glacial landscape features are most prevalent in the vicinity of Mowich Butte, West Crater, Soda Peaks, and the Indian Heaven plateau.

In the Cascade Range, retreating continental and alpine glaciers at the close of the last ice age resulted in increased discharge and sediment loads to mountainous river systems. This resulted in deposition of glacial outwash deposits along valley bottoms throughout the range. As glaciation in the Wind River subbasin was limited to small alpine ice bodies, and corresponding outwash deposits are only visible in the present day towards the headwaters of the Wind River and its tributaries (Figure 2). Glacial outwash likely traversed beyond the headwaters but became obscured by Quaternary alluvial fill in the vicinity of the Trout Creek Hill Volcano (TCHV). The TCHV erupted approximately 340,000 years ago, sourcing basalt flows that progressed through the lower Wind River Valley and into the Columbia River (Berri and Korosec 1984). The basalt infilling of the Wind River Valley resulted in locally changed base levels for the upper Wind River and its tributaries, causing gravel and sand deposition. These deposits are still visible in the upper reaches of Trout Creek (west of the TCHV) and in the Wind River valley near the Carson Fish Hatchery. As incision progressed through the newly-deposited basalt, further alluvial deposits were stranded as terraces along Panther, Bear, and other tributaries entering the Wind River from the east (Berri and Korosec 1984).

The geomorphology of the modern Wind River Valley is dictated by patterns of regional volcanism and superimposed on by modern discharge and sediment regimes. While glacial influences in the basin are limited to small cirques and outwash deposits at higher elevations, increased discharge and sediment supply corresponding to alpine glacier retreat resulted at the end of the last ice age (~10,000 years ago). Upstream of Stabler (~RM 11.5), the Wind River occupies an alluvial floodplain forced by the valley filling behind TCHV basalt. Much of the sediment transported during glacial retreat and more recent time contributed to the alluvial fill here and west of Trout Creek Hill, an area known as "Trout Creek Flats". Sediment delivered from adjacent hillslopes and tributaries is deposited on the valley floor, which varies from 0.3 to 1.5 miles wide. Quaternary basalt and andesite filled the valley between the Dry Creek (RM 19) and Falls Creek (RM 22) confluences and forced a wider valley bottom with incising bedrock channels. Downstream of Stabler, the valley narrows as the Wind River incises into TCHV basalt infilling. Various tributaries of the lower Wind River incise into THCV basalt along existing faults (e.g. Bear Creek, Brush Creek, and the Little Wind River). Landslide and debris flow deposits in the lower valley tend to strand along the valley toes at the margins of TCHV fill and isolated from the Wind River itself. This is different from the upper valley, where the river is able to move across a wider lateral area to incorporate recent deposits from hillslopes.

Landsliding is a common and significant disturbance event in the Wind River subbasin, due to the combined influences of climate, geology, and land-use history in the watershed. While undercutting of hillslope deposits is a significant driver of landslides in the watershed, locations underlain by Miocene-age and older volcaniclastics are especially at-risk, being tilted and prone to weathering into silts and clays (Rawding 2000). Glacial outburst flooding and corresponding alluvial deposits in the lower watershed are also prone to failure. Though relatively uncommon compared to drier areas of the Cascade Range, wildfire serves as a geomorphic agent in the basin and promotes mass-wasting via vegetative removal. The Wind River Valley was partially burned by the Siouxan and Yacolt Burns of 1902.

2.2.2 Channel Geomorphology

The Wind River is unregulated and influenced by the geologic history described previously. The modern channel occupies an alluvial valley floor and is inset beneath landslide deposits, alluvial fans, and gravel terraces corresponding to glacial retreat. As discharge and sediment flux reduced with warming climate during the Holocene, the glacial outwash deposits were incised into and stranded along the valley margins in the upper portion of the watershed. This is a classic example of Schumm et al.'s channel evolution process (1986), where incision follows alterations to discharge and sediment regimes and forms a new inset, active floodplain within the abandoned terraces. This evolutionary track is not visible in the bedrock-confined lower Wind River, though some terraces are visible there as well. These deposits are the result of adjusted base levels and forced deposition of tributary sediment following the eruption of the TCHV. As the river incised through the TCHV basalts these deposits were stranded along Panther Creek and other eastern tributaries of the lower Wind River (Berri and Korosec 1984).

Trends in basin hydrology and sediment supply in the last 150 years have been dominated by anthropogenic activity on the landscape. Vegetation clearing, road and bridge building, log rafting, and other logging-related activities have resulted in increased sediment supplied to the mainstem Wind River and its tributaries. This was the dominant historical economic activity in the basin, occurring throughout lands managed by federal (89% of basin area), state (2%), and private timber groups (6%; Rawding, 2000). Despite a reduction in timber extraction in recent decades, the legacy of large-scale logging persists – approximately 20% of the Wind River subbasin is categorized as containing early-seral vegetative cover (LCFRB 2010) and logging continues within the middle and upper portions of the basin. A gold mine is present downstream of the Paradise Creek confluence at approximately RM 24. These activities are correlated with accelerated soil erosion and reduced stability on hillslopes, as well as increased turbidity and reduced channel stability in the channel itself. In the lower Wind River Valley, bank armoring and water withdrawal associated with urban development at Carson (RM 2) and Stabler (RM 7) affect flow timing, discharge, and temperature as well as the ability of the Wind River to laterally migrate across its floodplain.

Sediment is presently contributed to the channel from tributaries, mass-wasting processes, near-channel banks, and hillslopes. Tributaries in the basin are highly connected to adjacent hillslopes and prone to flashy discharges following rain-on-snow events, spring snowmelt, and fall storms. Large-scale development of logging roads and systematic vegetation removal in the basin has increased the sediment load within these tributaries. The width of the Wind River valley precludes direct incorporation of alluvial deposits at valley toes, especially where the river is laterally confined by bedrock canyons. Where it exists, floodplain surfaces act as both source and sink for sediment progressing through the system. Activation typically occurs through overbank scour, lateral bank erosion, channel avulsion, and side-channel reactivation. During high flow events, additional sediment is sourced from the channel bed. There are significant point-sources of sediment within the watershed as well, including the Wind River Mine (RM 24), recent landslide deposits on the lower Wind River and Little Wind River, and a highly-erosive gully created by runoff from golf course in Carson (RM 1; LCFRB 2010).

Excessive sedimentation of the Wind River Subbasin due to forestry practices has caused concerns related to bank stability by federal and state land agencies. A majority of surveyed streams in the basin have above-average to excessive in-stream sediment levels, with Dry Creek, Youngman Creek, and the upper Wind River having the highest percentages of fines (LCFRB 2010). High width-to-depth ratios have been documented in the middle Wind (RM 12-19), Eightmile Creek, and Cedar Creek (LCFRB 2010). This section resides in alluvial fill behind TCHV basalts and experiences rapid channel migration and avulsions during high flow events. Bank stability concerns have also surfaced in the Trout Creek watershed, to the west of the middle and lower Wind River. Incision through valley-filling alluvium has resulted in weakened banks and overall unstable channels.

Little information exists regarding floodplain connectivity and riparian condition within the Wind River basin. Large trees in the riparian zone comprise about 33% of surveyed areas (LCFRB 2010), and past removal of mature riparian vegetation has contributed to the overall lack of large woody debris observed in the fluvial system. Floodplain connectivity is noticeably impinged by FS 30, the Carson Fish Hatchery, and various residential developments in the middle Wind River.

2.3 HYDROLOGY

The Wind River is a 5th order stream emptying into the Columbia River at RM 154.5 near Carson, WA. The river is approximately 31 mi. long, and the basin drains approximately 225 sq. mi. The maritime climate produces cool, wet winters and hot, dry summers. The basin has a mean annual precipitation of 110 inches, with the highest precipitation occurring between November and April, and summer months having very little precipitation (LCFRB 2010).

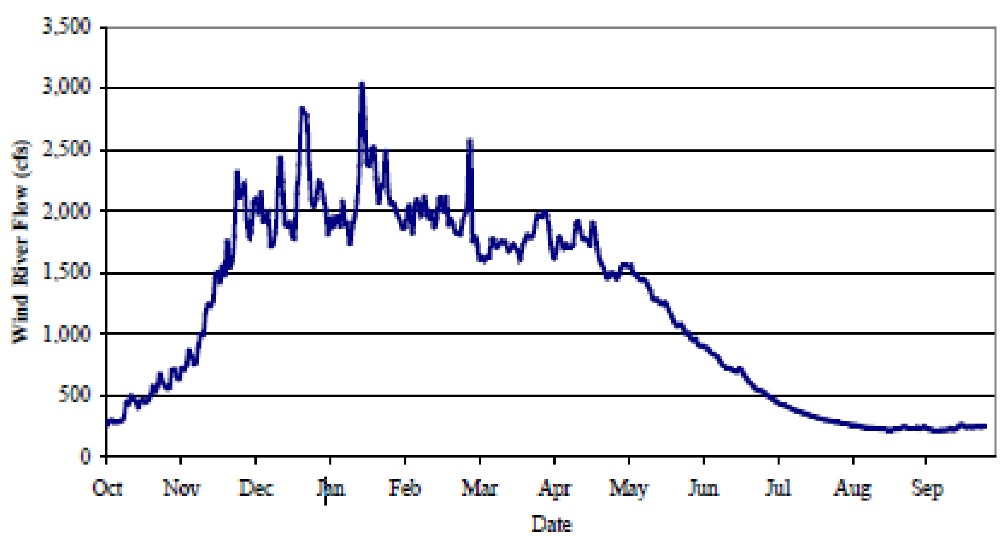

Figure 3. Wind River hydrograph (1934-1980), source LCFRB 2010. Peak flows occur in the winter and spring months, with the lowest flows occurring in August and September.

Mean flows range from 236 cfs in the late summer months to 2,168 cfs in the winter months (USFS 2001). The general pattern of the annual hydrograph is depicted in Figure 3. Summer flows are driven primarily by groundwater and snowmelt, and several tributaries (Martha Creek, Dry Creek, and portions of Trout Creek) regularly go subsurface in the summer months. Winter flows are primarily precipitation driven; with rain and rain-on-snow events creating peak flows. Areas of early-seral vegetation, combined with moderate-to-high road densities are also believed to affect peak flow timing and magnitude (LCFRB 2010). The peak flow of record occurred in February 1996, when flows reached an estimated 53,600 cfs. The 1996 event was estimated by the US Geological Survey (USGS) to be a 125-year event (USFS 2001).

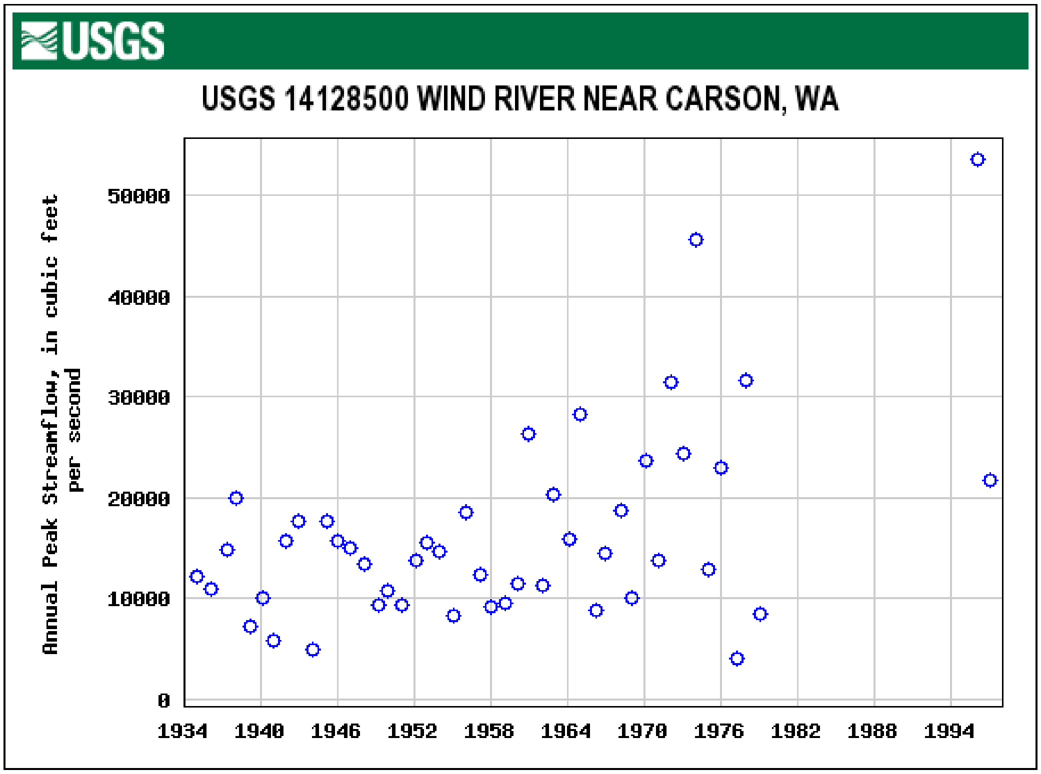

Figure 4. Annual peak flows from 1934 through 1997. The rain-on-snow event in February 1996 triggered peak flows of more than 50,000 cfs.

2.4 RIPARIAN CONDITIONS

Riparian conditions vary throughout the Wind River subbasin, but show a general trend of moderately impaired to impaired conditions (LCFRB 2010). Past timber harvest practices as well as residential, agricultural, and transportation corridors have all impacted riparian forests in the watershed (LCFRB 2010). These land-uses have led to reduced stream canopy cover, reduced bank stability, and reduced wood recruitment – all identified in the Wind River basin as habitat limiting factors (LCFRB 2015). Reaches with the highest level of impairment are the upper middle Wind and lower and middle Trout Creek (LCFRB 2010).

3. Fish Populations and Limiting Factors

3.1 FOCAL FISH POPULATIONS

Focal fish populations in the Wind River subbasin include summer and winter steelhead, and fall Chinook, chum, and coho salmon. Current population numbers for these focal species fall well below historical levels, and all are listed under the ESA as Threatened. It is estimated that between 30 - 90% of historical fish habitat has been lost (LCFRB 2015). Historical timber harvest practices, hydropower infrastructure, and rural development have all contributed to the loss of fish habitat in the subbasin.

Summer steelhead have the largest distribution of the focal species and are found throughout the subbasin, both in the mainstem and tributaries. Winter steelhead are distributed throughout the lower mainstem and in lower Trout Creek. Coho are primarily found in the Little Wind River, and in the mainstem below Shipherd Falls. Fall Chinook are distributed as far upstream as the Carson National Fish Hatchery (NFH), but are primarily found in the mainstem below Shipherd Falls and in the Little Wind River. Chum distribution is unknown; potential spawning habitat exists in the Wind River below Shipherd Falls and in the Little Wind River (LCFRB 2010), but numbers are believed to be very low. Table 2 shows current and historical abundance of focal salmon and steelhead populations.

Table 2. Status of focal salmonid and steelhead populations in the Wind River subbasin (reproduced from LCFRB 2010).

Species	Population	Recovery priority[1]	Viability Status[2]	Viability Obj.[3]	Improve-ment[4]	Abundance Historic[5]	Abundance Current[6]	Abundance Target[7]
Fall Chinook (Tule)	Upper Gorge	Contributing	VL	M	>500%	n/a[8]	<50	1,200
Chum	Upper Gorge	Contributing	VL	M	>500%	11,000	<50	900
Winter Steelhead	Upper Gorge	Stabilizing	L	L	0%[9]	n/a[8]	200	200
Summer Steelhead	Wind	Primary	H	VH	0%[9]	n/a[8]	1,000	1,000
Coho	Upper Gorge	Primary	VL	H	400%	n/a[8]	<50	1,900

[1] Primary, Contributing, and Stabilizing designations reflect the relative contribution of a population to major population group recovery goals.
[2] Baseline viability is based on Technical Recovery Team viability rating approach.
[3] Viability objective is based on the scenario contribution.
[4] Improvement is the relative increase in population production required to reach the prescribed viability goal
[5] Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NMFS back-of-envelope calculations.
[6] Approximate current annual range in number of naturally-produced fish returning to the watershed.
[7] Abundance target were estimated by population viability simulations based on viability goals.
[8] Historical abundance and recovery goal information is not available at this time due to a lack of information regarding population dynamics.
[9] Improvement increments are based on abundance and productivity, however, this population will require improvements in spatial structure or diversity to meet recovery objectives.

3.2 FISH LIFE HISTORY AND USE

3.2.1 Steelhead

Winter steelhead are found in low numbers throughout the mainstem Wind River below RM11, in Trout Creek, and in the Little Wind River. Historically, winter steelhead were limited in distribution by Shipherd falls; however, the addition of a fish ladder there in 1956 allowed passage, and winter steelhead spawning is now observed as far upstream as the Carson NFH at RM 11. Winter steelhead return to the Wind River subbasin between December and April, and spawning occurs between March and early June. Fry emerge between March and May. Juveniles rear for 1-2 years, emigrating between April and May, with a peak in early May (LCFRB 2010).

Summer steelhead are distributed throughout the basin, in the mainstem and tributaries. Historically, they were the only salmonid species found above Shipherd Falls. Summer steelhead return to the Wind River from May through November, with spawning occurring early March through May. Fry emerge between April and May. Juveniles rear for 1-2 years, emigrating between April and May, with a peak in early May (LCFRB 2010). The majority of Wind River juveniles spend one year in their natal stream before moving down the mainstem to the canyon reaches, where they will rear for another year before emigrating. Alternatively, some juveniles spend several years in their natal streams, with no stop in the canyon reaches as they emigrate (personal communication with WRWG members 2016).

The Mining Reach (Falls Creek to Paradise Creek) has higher numbers of rearing juveniles as compared to the middle reaches (Carson NFH to Stabler Bend). This is presumed to be due to higher habitat complexity in the Mining Reach. Some parr also move in the fall, perhaps when the Mining Reach is beginning to reach capacity, potentially driving some movement to the middle Wind reach (personal communication with WRWG members 2016). The middle Wind is an important spawning reach, but rearing numbers are lower than expected. This is presumably due to the lack of habitat complexity and cover found in the middle Wind. Temperature is not thought to be a limiting factor to rearing, because although it is an alluvial reach, there are many cold water inputs (personal communication with WRWG members 2016). Rearing habitat is thought to be the primary limiting factor in the middle Wind, due to the following issues:

- Simplification of habitat
- Lack of large woody debris
- Floodplain disconnection
- Lack of sinuosity
- Little or no cover, pool habitat
- Little or no off-channel habitat, such as side-channels, oxbows, wetlands

Overall, spawning habitat is not thought to be a limiting factor, although some redd scour could be occurring, but in general the channel-forming flows do not occur when redds are present (personal communication with WRWG members 2016).

Both winter steelhead, as well as low numbers of summer steelhead, also use the Little Wind River for spawning and rearing (personal communication with WRWG members 2016).

3.2.2 Coho

Coho are present in low numbers in the Wind subbasin. Their distribution includes the mainstem below Shipherd Falls, although their primary use is in the Little Wind River. Coho return in late summer and fall, with spawning occurring in the fall and winter. Fry emerge in the spring, and smolts emigrate between March and May of their second year (LCFRB 2010).

3.2.3 Fall Chinook

Fall Chinook historically were not found above Shipherd Falls, although they are now found in small numbers as far upstream as the Carson NFH. The heaviest spawning of fall chinook is found in the mainstem Wind below Shipherd falls. There is some use of the Little Wind River for spawning as well (LCFRB 2010, personal communication with WRWG members 2016).

Tule fall Chinook return to the Wind in September, with spawning also occurring in September. Fry emerge January through March, with juveniles rearing near and downstream of spawning areas and emigrating in spring and early summer as sub-yearlings (LCFRB 2010). Mid-Columbia bright fall Chinook return to the Wind River in late September to October, spawning from late October through November. Fry emerge in the spring, with emigration in spring and early summer as sub-yearlings (LCFRB 2010).

3.2.4 Chum

Very low numbers of chum are assumed in the Wind River; very few fish are counted (less than 150) over Bonneville Dam each year. Inundation of spawning and rearing habitat at the mouth of the Wind River is thought to significantly impact chum numbers as well. Adult chum migrate from mid-October through November, with spawning occurring in late November. Fry emerge in early spring, with emigration occurring shortly thereafter (LCFRB 2010).

3.3 HABITAT LIMITING FACTORS

3.3.1 Overview of Limiting Factors

Habitat limiting factors at the basin-scale are provided below. These were obtained from existing sources including the Recovery Plan (LCFRB), the Limiting Factors Analysis (WACC 1999), and surveys performed as part of this strategy. These are defined in greater detail at the reach-scale in Section 4.3.

Temperature – High summer temperatures in Bear, Eightmile, Trout Creek, Lower Wind, Middle Wind, and others. High temperatures are caused by high width-to-depth, lack of riparian shade, and water withdrawals.

Sediment – High turbidity in Panther, Trout, Wind. Likely from road density, historical timber harvest, golf course, landslides, and bank erosion.

Pools – Quantity and quality are low, including percent pool, pools/mi, pool depth, pool cover

Large Wood – Low numbers and small sizes due harvest, lack of recruitment, and lack of retention.

Channel Stability – Low large wood numbers, high width-to-depth ratios, excessive sediment inputs, mass wasting in lower basin, riparian clearing, and human infrastructure

Riparian Function – Riparian clearing due to harvest, roads, residential development. Many riparian zones are in early seral stage or cleared. Impaired conditions affect bank stability, hydraulic roughness, shade, large wood recruitment, and nutrients.

Floodplain and Channel Migration Zone Function – Impaired floodplain and CMZ connectivity due to civil infrastructure (e.g roads and bridges), floodplain clearing/development, bank armoring, levees, and stream channel incision.

Side- and Off-Channel Habitat – Lack of habitat availability and quality due to floodplain/CMZ impairment, lack of large wood, and riparian impairment.

3.3.2 Species Life Stage Limiting Factors

The species- and life stage-specific limiting factors presented here (Table 3) are from the Recovery Plan (2010) and are based primarily on the EDT model.

Table 3. Species life-stage factors table.

Species and Lifestage		*Primary factors*	*Secondary factors*	*Tertiary factors*
Wind Fall Chinook				
most critical	Egg incubation	sediment	channel stability, key habitat	harassment, pathogens, temperature
second	Fry colonization	habitat diversity, predation	channel stability, food	flow, competition (other spp), pathogens
third	Spawning	habitat diversity, harassment	key habitat, pathogens	flow, sediment, predation
Wind Chum				
most critical	Prespawning holding	habitat diversity, harassment	pathogens	flow, temperature
second	Egg incubation	sediment	channel stability, key habitat, harassment	pathogens
third	Spawning	habitat diversity, harassment	flow, pathogens, temperature	
Wind Coho				
most critical	Egg incubation	key habitat	sediment	channel stability
second	0-age summer rearing	key habitat	habitat diversity, temperature	competition (hatchery), food, predation
third	Fry colonization	key habitat	flow, food, habitat diversity	channel stability, predation
Wind Summer Steelhead				
most critical	Egg incubation	sediment	temperature	key habitat

Species and Lifestage		Primary factors	Secondary factors	Tertiary factors
second	0-age active rearing	habitat diversity, pathogens	flow, temperature, competition (hatchery), predation	
third	1-age active rearing	competition (hatchery)	flow, habitat diversity	pathogens, predation, temperature
Wind Winter Steelhead				
most critical	0-age summer rearing	competition (hatchery), habitat diversity, pathogens, temperature	predation	flow, food
second	Egg incubation	sediment, temperature	key habitat	channel stability, harassment, pathogens
third	0,1-age active rearing	flow	channel stability, food, habitat diversity	

4. Restoration Strategy

4.1 OVERVIEW

The restoration strategy is intended to guide effective and efficient restoration for the Wind River study area. The restoration strategy is the final product of two efforts: (1) identification of potential projects, and (2) subsequent prioritization of the importance of those projects. The project types and prioritization have been guided by the existing body of knowledge (see Annotated Bibliography – Appendix B), habitat objectives, technical evaluation by the project partners (Wind River Work Group), and by field and analytical work conducted as part of this effort. This section describes the methods for identifying and prioritizing projects and presents the project list and results of the prioritization.

4.2 HABITAT RESTORATION GOALS AND STRATEGIES

Habitat restoration goals and strategies at the subbasin-scale are listed here (Table 4). These were obtained from existing sources and modified by the WRWG at the Nov 17, 2015 WRWG meeting.

Table 4. Basin-scale habitat restoration goals and strategies.

Goal and Strategies	Applicability to this Effort
Protect/restore hillslope processes	
Management of forest practices (being addressed as part of other efforts, e.g. USFS management plans)	Low
Address road/residential/golf course runoff issues	Moderate
Protect stream corridor structure and function	
Identify well-functioning areas that may be at risk	High
Restore floodplain function and channel migration processes	
Set-back, breach, or remove artificial confinement structures (e.g. levees)	High
Remove/modify bank armoring to restore channel migration and margin habitat	High
Enhance availability, connectivity, and habitat within floodplain wetlands	High
Restore floodplain vegetation conditions	High
Restore riparian conditions	
Restore the natural riparian plant community	High
Control invasive plant species	High
Restore degraded water quality with emphasis on temperature and sediment	
Increase riparian shading	High
Decrease channel width-to-depth ratios	High
Address leaking septic systems	Low
Ensure adequate instream flow	Low
Address fish passage issues	
Restore access to isolated habitats blocked by culverts, dams, or other barriers	High
Restore channel structure and stability	
Place large woody debris (LWD) to enhance cover, pool formation, bank stability, and sediment sorting	High
Use LWD jams to enhance lateral channel dynamics, channel aggradation, split-flow, etc to restore geomorphic processes and long-term habitat formation	High
Structurally modify channel morphology to create suitable habitat	High
Restore natural rates of erosion and mass wasting within river corridors	High
Create/restore off-channel and side-channel habitat	
Restore historical off-channel and side-channel habitats where they have been eliminated or impaired	High
Create new off-channel habitats for juvenile rearing	High
Create new off-channel spawning habitats (e.g. for chum in lower basin)	Moderate
Provide for adequate instream flows during critical periods	
Protection and restoration of instream flows (being addressed as part of other efforts, e.g. WRIA planning)	Low

4.3 HABITAT ASSESSMENT METHODS AND RESULTS

Existing and target habitat conditions were identified for each reach within the geographic scope (the reach definitions used for this assessment are the same as used in the Recovery Plan). This task helped to inform the specific habitat attributes that should be targeted for restoration and also helped with populating the metrics used for project scoring and prioritization. Use of consistent habitat attributes among the study reaches also allows for useful comparisons between reaches.

The list of attributes and their definitions are included in Appendix C. Each reach is given a “good”, “fair”, or “poor” rating for each attribute. The attributes and their definitions are a derivation of other similar lists used by resource agencies and restoration practitioners in the Pacific Northwest, such as the NMFS Matrix of Pathways and Indicators (NMFS 1996) and the Reach-Based Ecosystem Indicators (REI, e.g. US Bureau of Reclamation 2009). The target condition is represented by the definition for the “good” rating, except where unique reach conditions justify an alternate target.

For the reaches in this assessment, the ratings were developed by consulting existing information and through collection of new data during the field surveys. Existing information used for these ratings primarily came from existing recent US Forest Service Level II stream habitat inventories. Recent data, within the last 5 years, were available for various reaches, including much of the middle mainstem Wind River and Dry Creek. For reaches where habitat surveys have not been performed, or where the data were very old (e.g. greater than 10 years old), new data were collected during the field surveys using a Rapid Habitat Assessment method, described below. For some attributes, including the riparian attribute and floodplain connectivity attribute, aerial photographs and LiDAR data were used to help determine the ratings. The final ratings for each reach in this study are included in Appendix D.

As described above, a rapid habitat assessment was performed during the field surveys to fill in data gaps in habitat information needed to develop the habitat attribute ratings. The rapid assessment protocol included recording both qualitative and quantitative data on stream attributes. Rapid assessment attributes included riparian condition (buffer width, canopy closure, riparian disturbance, stand age), floodplain connectivity (connectivity, disturbance and road density within the floodplain), bank condition (hydromodifications and anthropogenic erosion), vertical channel stability (anthropogenic aggradation or incision), pools (total number, depth, and cover), large wood (>24 in diameter, 50 ft long) and log jam counts, habitat complexity (total number of habitat units), off-channel habitat (presence and abundance), man-made fish passage barriers (total count), and percentage of fine sediment (visual estimates). Site conditions for each attribute were recorded approximately every 1,000 feet throughout the reach, with the exception of pools, habitat units, and LWD/log jams which were counted continuously throughout the entire reach; and canopy closure and road density, which were defined in the office using LiDAR and aerial photos. See Appendix E for a blank field data sheet.

4.4 PROJECT IDENTIFICATION

Potential projects were identified based on multiple considerations, including: 1) previous studies, 2) professional experience and knowledge of design team and WRWG members, 3) new analyses and field surveys conducted as part of this effort, 4) evaluation of previous projects in the area, 5) a comparison of existing and target fish use and habitat conditions, and 6) current site conditions and human uses. Processes operating both at the watershed- and reach-scales were considered when identifying potential projects. At the watershed-scale, the influence and condition of the hydrologic, sediment, wood, and temperature regimes were taken into account when developing project recommendations. The conditions of these processes were obtained from the existing literature, the investigators' knowledge of the subbasin, and from input from the WRWG.

Field data collection occurred from late April through June 2016, in conjunction with the rapid habitat surveys described previously. Teams from UCD and IFI surveyed the 20 stream miles within the geographic scope. Potential habitat enhancement project sites were documented with GPS coordinates, photos showing general site conditions, extent of the proposed project, and notes outlining the scope, presumed site access, any additional opportunities or challenges, and the overall potential gain or effect of the project.

4.5 PROJECTS

The suite of identified project types includes floodplain reconnection, off-channel habitat enhancement, riparian restoration, instream large wood placement, and protection. The scope and scale of project types varies depending on the particular habitat conditions, land uses, and geomorphic context of the site. The individual project descriptions and site maps are provided in Appendix F. Figure 5 below shows the general distribution of projects at the subbasin-scale. The projects are listed in priority order in Section 4.6.2.

It is important to note that other planning efforts in the basin have also identified projects. These include the USFS Restoration Action Plans for the Trout and Trapper Creek Basins and the UCD's on-going project opportunity list. The geographic scope for this current effort purposefully did not include high priority reaches in the Trout Basin specifically because of the USFS effort that had recently been performed there. The project lists from the USFS Trout and Trapper Creek plans are included in Appendix G and the UCD project list is included in Appendix H.

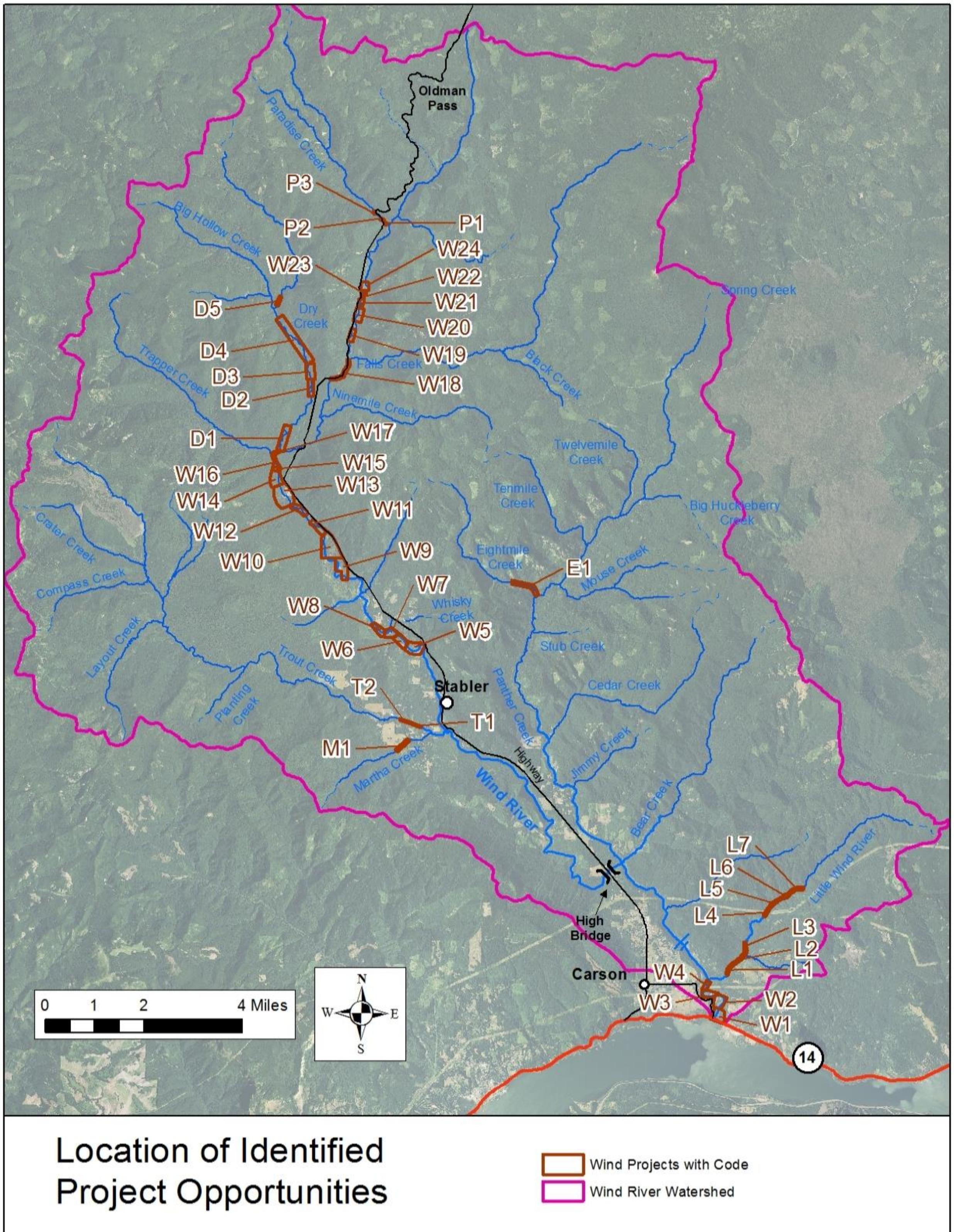

Figure 5. Location of projects identified as part of the restoration strategy. Project codes are included in the project list in Table 6. Detailed project descriptions and concept maps are included in Appendix F.

4.6 PROJECT PRIORITIZATION

4.6.1 Project Prioritization Methods

Projects identified as part of this effort were prioritized using a methodology consistent with the LCFRB methods used to score project proposals for funding in the LCFRB Lead Entity region. The LCFRB method has 3 primary components to the scoring: 1) Benefits to Fish (BTF), 2) Certainty of Success (COS), and 3) Cost. For the purposes of this Wind River Restoration Strategy, we have incorporated only the first two components – benefits to fish and certainty of success – for scoring and ranking of projects. Although we have identified the approximate cost range for each project, we have not used cost for scoring since 1) costs are very preliminary at this point, and 2) the cost of a project ends up very much depending on how a particular sponsor proposes to accomplish it. These considerations also apply somewhat to the COS ratings, albeit less so, and so the COS score should be considered preliminary at this stage of project development. The methods for assigning the BTF and COS scores are included in the sections below, as well as a description of how we addressed project costs.

The BTF score utilizes quantitative reach-scale fish and habitat information from the Recovery Plan. For the purposes of project scoring in this assessment, we have made some modifications to how the BTF scoring is performed in the Wind River. These modifications, and the rationale behind them, are described below.

It should be recognized that a project that is brought forward for a SRFB application submitted to the LCFRB could differ substantially from the scale and scope of the projects identified here, especially given that project details frequently change once landowners and stakeholders become engaged in the early stages of project planning. Projects submitted for SRFB funding therefore could receive different scores than in this assessment. For these reasons, the scoring applied here should be viewed as a means to provide a relative ranking of projects in the Wind River, and is not meant to imply that a project would necessarily receive the same scoring during the official grant round. It should also be recognized that other projects in the Wind River not identified in this assessment, such as ones outside of the geographic scope of this effort, could potentially score highly during the grant round if they satisfy the key LCFRB scoring criteria.

Benefits to Fish

The Wind River project prioritization framework follows the 'Benefits to Fish' score methodology used by the LCFRB Technical Advisory Committee (TAC) (LCFRB 2016). The BTF score incorporates the following:

1. Population/Reach Rating (H, M, L) and Score (100 pt max)
2. Protection/Access/Restoration (PAR) Rating (H, M, L) and Score (100 pt max)
3. Overall Rating (H, M, L) and Score (200 pt max)

The Population/Reach Rating and Score are based on the Reach Tier and the species- and reach-specific Species Reach Potential (SRP) developed as part of the Recovery Plan. For the

Protection/Access/Restoration Rating and Score, we have only applied the restoration component, since all of the projects included in the strategy are primarily restoration focused. The Restoration Score indicates the extent to which a project is anticipated to address the targeted restoration need for the reach, and incorporates considerations of project scope and scale. For additional detail of how these scores are derived, we refer the reader to the LCFRB document "Lower Columbia Fish Recovery Board Project Evaluation Criteria" (LCFRB 2016).

Certainty of Success

The COS rating and score evaluate how likely a project is to achieve proposed outcomes or benefits. The COS receives equal weight as the BTF score, with a total possible score of 200 points. Additional details on the factors considered in scoring these categories can be found in the LCFRB Habitat Project Application Evaluation Questions (LCFRB 2017). For purposes of scoring within this strategy, COS ratings were qualitatively assigned based on staff, consultant and WRWG feedback. Considerations included, but were not limited to, field survey information and data, landowner willingness, and infrastructure and logistical constraints.

Cost

Although cost was not used as a scoring component for this assessment, we made an effort to provide approximate cost ranges for each project. This is based on the investigators experience with similar project types in the region. This is for informational purposes and for general guidance to project sponsors to assist in project planning.

Modifications to SRP and Tiering for Project Scoring Purposes

The unique character of the Wind River warrants reconsideration of some of the measures that underlie the LCFRB scoring methodology. The first proposed modification is re-evaluation of a reach's SRP, which affects the reach tier ratings and scores. The SRP is a reflection of how important a particular reach is to the fish population of interest. The SRP is based both on the reach's restoration ***and*** preservation values produced from the EDT model. For each reach, the EDT model predicts how population-scale abundance, productivity, and spatial diversity would be expected to change under two scenarios: 1) restoration of habitat in the reach, and 2) hypothetical degradation of habitat within the reach (the inverse of which is preservation). These analyses result in six model output values – change in abundance, productivity, and diversity for both the restoration and preservation scenarios. For the purposes of determining SRP, these six values are summed for each reach and then all reaches are ranked and are binned into the 3 SRP categories (High, Medium, or Low). These SRPs, which also affect the Reach Tier designations, are used in the LCFRB ranking as described previously.

Compared to other basins throughout the lower Columbia recovery planning region, the Wind River watershed is unique in that a few reaches (high functioning canyon reaches in the mainstem Wind River, lower Trout Creek, and Panther Creek) have such high preservation values that the reaches with high restoration value end up receiving lower SRP ratings.

Due to this unique condition, in order to evaluate the potential restoration importance, and to accurately prioritize restoration projects, we have modified the way that the SRP is calculated, using only the restoration value and not the preservation value. This is done for every summer steelhead reach in the basin, not just the reaches that are part of the geographic scope of the restoration strategy. These modified reach tier ratings and supporting rationales will be presented to the LCFRB TAC for consideration in future project scoring in the Wind River basin, but will not re-define existing reach tiers in the Recovery Plan. Performing this analysis for the basin results in the following reaches moving from a 'Medium' to a 'High' SRP (and thus Tier 1 for prioritization purposes): Martha, Wind 5b, and Wind 5c. Reach Wind 5a moves from a 'Low' to 'High'. Only one reach, Panther 1c, moves from an SRP of 'Low' to 'Medium', and is thus prioritized as if it were Tier 2. We assume that reaches that would move down in value (e.g. from 'High' to 'Medium' SRP) are left as is for prioritization purposes. Results are summarized in Table 5.

A second modification was to the SRP rating for reach Wind 5d. This reach lies just above the hatchery on the middle Wind River. It extends from the tributary Tyee Springs upstream to Trapper Creek. In the process of this assessment, this reach was found to have an error in the most recent EDT run that resulted in an erroneous 'Low' SRP value. The SRP calculation was therefore performed using an older run result, which moved this reach into the 'High' SRP category. The same error was found with reach Trapper Creek, but the corrected calculation did not result in a shift in SRP value (i.e. it remained 'Low').

The WRWG also considered the potential modification of SRPs for reaches in the Trout Creek basin that lie above the former Hemlock Dam site. This could have affected scoring for projects in the Trout Creek basin identified as part of US Forest Service restoration planning efforts. The rationale was based on the idea that removal of Hemlock Dam in 2009 may have increased the potential fish benefit of restoration in these reaches – a condition that would not have been represented in the 2005-2006 running of the EDT model. However, after careful consideration and input from multiple agency fish biologists that have worked in the basin for years, it was decided that it is too early to tell if the SRPs for these reaches should be altered or not.

Table 5. Revised SRP and Tiering for Wind River subbasin reaches. Changes that resulted in a lower SRP or tier are not included. Note that these changes are performed only for the purposes of scoring of projects as part of this restoration strategy and do not affect the SRPs or Reach Tiers in the Recovery Plan.

Reach	Former Steelhead SRP rating	Former Tier	Revised Steelhead SRP rating	Revised Tier
Wind 1	Low	2	Med	No revision (already med SRP for chum)
Martha	Med	2	High	1
Wind 5a	Low	4	High	1
Wind 5b	Med	2	High	1
Wind 5c	Med	2	High	1
Wind 5d	Low	4	High	1
Panther 1c	Low	4	Med	2

4.6.2 Prioritized Project List

A total of 43 potential projects were identified during the course of this assessment. Eight projects ranked 'high' (H/H) for both Benefits to Fish (BTF) and Certainty of Success (COS) during initial scoring. Eighteen projects ranked 'high/medium' (H/M) with a 'high' score in either BTF or COS, and a 'medium' score in the other. Three projects ranked 'medium' (M/M) for both BTF and COS. The remaining 14 projects scored a 'low' in either BTF, COS, or both. The projects and rankings are shown in the table below.

The Hatchery Reach Project (W13) and the Beaver Campground Project (W10) were rated very high for BTF. However, the WRWG recognized that these are large and complex projects with many stakeholder considerations that need to be addressed prior to moving forward with restoration design work. For these reasons, these projects were ranked lower for COS at this time. The WRWG believes these are nevertheless highly beneficial projects, and it is recommended that additional feasibility and planning work be pursued at these sites in order to advance the projects further towards design and implementation.

Table 6. Prioritized project list with rankings.

Project Name -- Code	Stream Reach	BTF #	BTF rank	BTF rank group	COS rank	COS #	BTF/ COS group	BTF+ COS #	Updated Ranking within groups
Stabler Bend -- W5	Wind 5a	95	7	H	High	190	H/H	285	**1**
Little Wind River Phase IV -- L1	Little Wind 1	59	15	H	High	190	H/H	249	**2**
Big Butte -- W12	Wind 5c	77	10	H	High	170	H/H	247	**3**
Lower Headwater Flats -- L5	Little Wind 1	61	13	H	High	170	H/H	231	**4**
Berge Confluence -- L2	Little Wind 1	58	17	H	High	170	H/H	228	**5**
Powerline -- L4	Little Wind 1	55	19	H	High	170	H/H	225	**6**
Martha -- M1	Martha	49	23	H	High	170	H/H	219	**7**
Wind River bel Trapper Cr Confluence -- W16	Wind 5d	44	25	H	High	170	H/H	214	**8**
Hatchery Reach -- W13	Wind 5c & 5d	129	1	H	Med	105	H/M	234	**1**
Beaver Campground -- W10	Wind 5c	122	3	H	Med	105	H/M	227	**2**
Mining Middle Road Contact -- W20	Wind 6d	51	22	M	High	170	H/M	221	**3**
Mining Downstream Road Contact -- W19	Wind 6d	49	24	M	High	170	H/M	219	**4**
Middle Butte Fan -- W21	Wind 6d	41	26	M	High	170	H/M	211	**5**
Wind River bel Dry Cr confluence -- W17	Wind 6a	30	34	M	High	170	H/M	200	**6**
Mining Upstream Road Contact -- W22	Wind 6d	29	35	M	High	170	H/M	199	**7**
Mineral Springs Bridge Reach -- W14	Wind 5d	82	8	H	Med	105	H/M	187	**8**
Beaver North -- W11	Wind 5c	80	9	H	Med	105	H/M	185	**9**
Stump House -- W9	Wind 5c	77	11	H	Med	105	H/M	182	**10**
Upper Headwater Flats -- L7	Little Wind 1	66	12	H	Med	105	H/M	171	**11**
Middle Headwater Flats -- L6	Little Wind 1	61	14	H	Med	105	H/M	166	**12**
Whisky --W7	Wind 5a	59	16	H	Med	105	H/M	164	**13**
Dillon -- L3	Little Wind 1	57	18	H	Med	105	H/M	162	**14**
Stabler North --W6	Wind 5a	55	20	H	Med	105	H/M	160	**15**

Project Name -- Code	Stream Reach	BTF #	BTF rank	BTF rank group	COS rank	COS #	BTF/ COS group	BTF+ COS #	Updated Ranking within groups
Middle Mining Large Wood -- W24	Wind 6d	38	27	M	High	105	H/M	143	**16**
650 Road Fill -- W23	Wind 6d	38	28	M	High	105	H/M	143	**16**
Mineral Springs Road Bridge -- W15	Wind 5d	37	29	H	Med	70	H/M	107	**18**
Indian Cabin Road Reach -- W4	Wind 2	119	4	M	Med	105	M/M	224	**1**
In-Lieu Bend -- W3	Wind 2	117	6	M	Med	105	M/M	222	**2**
Falls Confluence Highway Slope -- W18	Wind 6c	31	31	M	Med	70	M/M	101	**3**
Lower Dry Creek -- D1	Dry Creek 1	32	30	L	High	170	H/L	202	**1**
Spoil Bank -- D3	Dry Creek 1	31	32	L	High	170	H/L	201	**2**
Forest Road 64 Crossing-- D5	Dry Creek 2	26	38	L	High	170	H/L	196	**3**
Dry Creek Upper Bedrock Channel -- D2	Dry Creek 1	24	39	L	High	170	H/L	194	**4**
Paradise Creek Large wood -- P3	Paradise 1	21	42	L	High	170	H/L	191	**5**
Upper Dry Cr Key Piece Supplementation -- D4	Dry Creek 1	30	33	L	Med	137.5	M/L	167	**6**
Log Dump Bend -- W2	Wind 2	126	2	M	Low	35	M/L	161	**7**
Paradise Cmpgrnd Off-Channel Enhance -- P1	Paradise 1	20	43	L	Med	137.5	M/L	157	**8**
Wind River Confluence -- W1	Wind 1 & Wind 2	119	5	M	Low	35	M/L	154	**9**
Meadow Crest -- T1	Trout 1b	28	36	L	Med	105	M/L	133	**10**
Summer's End -- T2	Trout 1b	27	37	L	Med	105	M/L	132.5	**11**
Eightmile -- E1	Eightmile	24	40	L	Med	105	M/L	129	**12**
Paradise Bridge -- P2	Paradise 1	22	41	L	Med	70	M/L	92	**13**
Cannavina -- W8	Wind 5a	53	21	H	Low	35	H/L	88	**14**

5. References

Berri, D.A. and M.A. Korosec. 1983. Geological and geothermal investigation of the lower Wind River valley, southwestern Washington Cascade Range: Washington Division of Geology and Earth Resources Open File Report 83-5, 48 p., 2 plates. [http://www.dnr.wa.gov/publications/ger_ofr83-5_wind_river_geology_24k.pdf].

Czajkowski, J.L., J.D.Bowman, L.A. Fusso, and D.E. Boschmann. 2014. Geologic mapping and geothermal assessment of the Wind River valley, Skamania County, Washington: Washington Division of Geology and Earth Resources Open File Report 2014-01, 30 p., 1 pl., scale 1:24,000. [http://www.dnr.wa.gov/publications/ger_ofr2014-1_wind_river_geothermal.pdf].

Inter-Fluve and Cramer Fish Sciences. 2009. Lower East Fork Lewis River Habitat Restoration Plan. Prepared for Lower Columbia Fish Recovery Board with oversight by the East Fork Lewis Working Group. LCFRB, Longview, WA.

Lower Columbia Fish Recovery Board. 2010. Washington Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Longview, WA.

Lower Columbia Fish Recovery Board. 2015. WRIA 29A Watershed Planning Detailed Implementation Plan. 185 electronic pages.

Lower Columbia Fish Recovery Board. 2016. Lower Columbia Fish Recovery Board Project Evaluation Criteria. Longview, WA.

National Marine Fisheries Service (NMFS). 1996. Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale. Lacey, Washington, National Marine Fisheries Service, Environmental and Technical Services Division, Habitat Conservation Branch.

Rawding, D. 2000. Draft Wind River subbasin summary. Prepared for the Northwest Power Planning Council. Dan Rawding – Subbasin Team Leader.

Schumm, A., C. Watson, and M. Harvey. 1986. Incised Channels, Morphology, Dynamics and Controls. Water Resources Publications, Littelton, CO. 200pp.

Tolan, T.L., B.S. Martin, S.P. Riedel, J.L. Anderson, K.A. Lindsey, and W. Burt. 2009. An introduction to stratigraphy, structural geology, and hydrogeology of the Columbia River Flood-Basalt Province—A primer for the GSA Columbia River Basalt Group field trips, in O'Connor, J.E., Dorsey, R.J., and Madin, I.P., eds., Volcanoes to vineyards—Geologic field trips through the dynamic landscape of the Pacific Northwest: Geological Society of America Field Guide 15, p. 599–643.

US Bureau of Reclamation (USBR). 2009. Preston Reach Assessment – Entiat River, Chelan County, WA. USBR Pacific Northwest Region, Boise, ID, US Department of the Interior.

US Forest Service (USFS). 2001. Wind River Watershed Analysis (Second Iteration). United States Forest Service--Mt. Adams Ranger District/Gifford Pinchot National Forest.

Washington Conservation Commission (WACC). 1999. WRIA 29 Salmonid Habitat Limiting Factors Analysis Report. Olympia, WA.

Washington Department of Natural Resources (WADNR). 2015. Geology of Washington – Southern Cascades.

Wells, R., D. Bukry, R. Friedman, D. Pyle, R. Duncan, P. Haeussler, and J. Wooden. 2014. Geologic history of Siletzia, a large igneous province in the Oregon and Washington Coast Range: Correlation to the geomagnetic polarity time scale and implications for a long-lived Yellowstone hotspot. Geosphere, 10 (4), 692-719. doi:10.1130/GES01018.1.