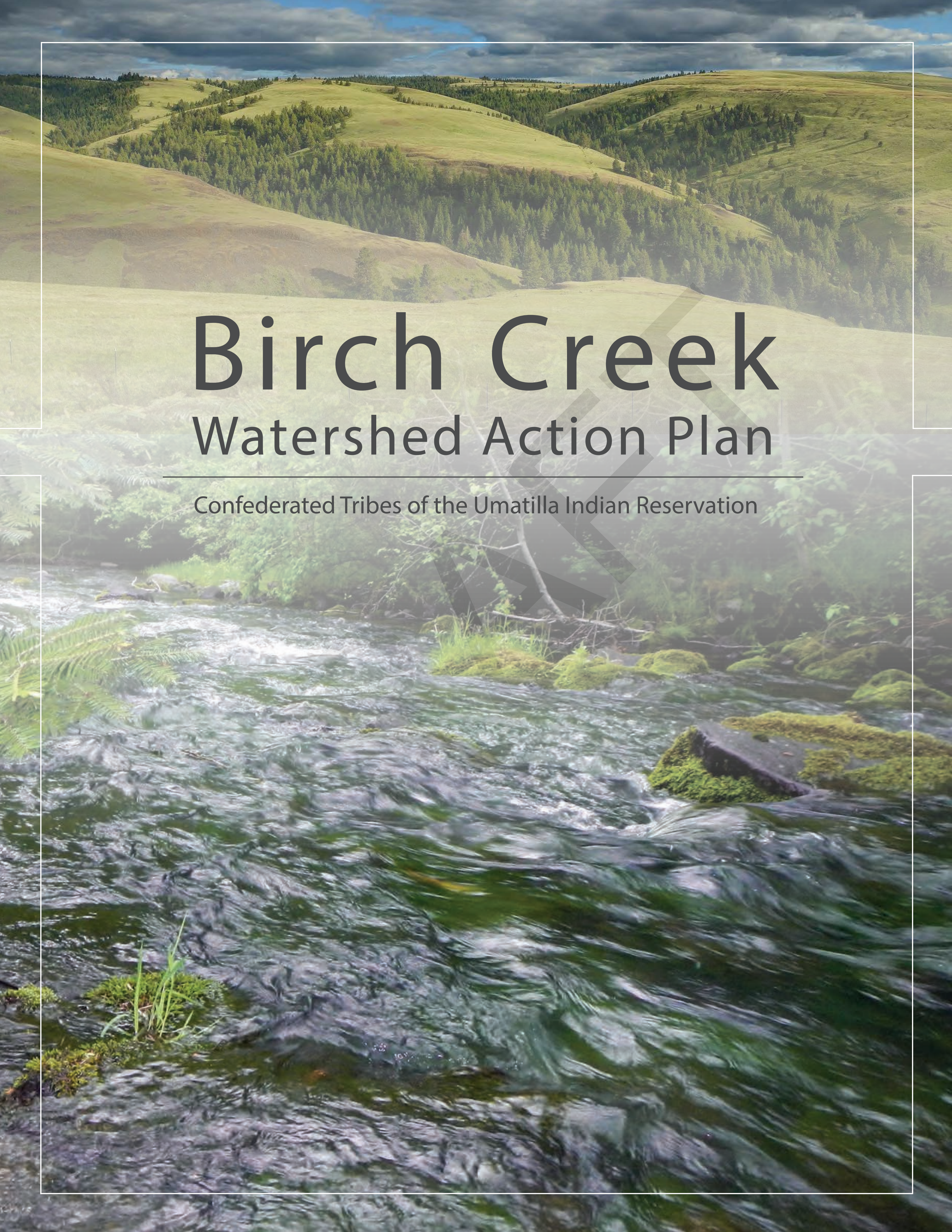

Birch Creek

Watershed Action Plan

Confederated Tribes of the Umatilla Indian Reservation

Confederated Tribes of the
Umatilla Indian Reservation
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Birch Creek Watershed Action Plan

Acknowledgements

Confederated Tribes of the Umatilla Indian Reservation

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) is a federally recognized union of the Cayuse, Umatilla, and Walla Walla tribes established through the 1855 Treaty of Walla Walla. At the signing of the treaty with the United States, the Tribes ceded 6.4 million acres of homeland located on the Columbia River Plateau in what is now northeastern Oregon and southeastern Washington. For thousands of years the Tribal economy was based on subsistence as people traveled throughout the homeland to harvest and gather food. Tribal people maintain a strong connection to the traditional culture of fishing, hunting, and gathering foods important to the tribal community, which is emphasized with their adoption of the First Foods mission and application of the Umatilla River Vision (Jones et. al., 2008). Birch Creek, a tributary to the Umatilla River, flows from a watershed that supports and provides these important First Foods and is a priority area for protection and enhancement of water and fisheries resources.

Contributors

A collaborative approach was taken to incorporate ecological and fisheries recovery goals with local land management and use. The common goal was to create an action plan for improving salmonid habitat conditions and natural riverine processes in the Birch Creek Watershed. Contributions to the assessment and planning process were provided through a technical and scientific level of input and review led by the CTUIR and organized as the Birch Creek Technical Team (BCTT). A set of technical meetings were regularly held during plan development with the BCTT and specialized sub-committees to make informed decisions about the approach and strategy. Additionally, input and involvement was garnered from the Birch Creek Community and other key stakeholders through an organized public outreach effort led by the Umatilla Basin Watershed Council (UBWC) and the Umatilla County Soil and Water Conservation District (SWCD). Contributions by the relatively diverse group of involved public, private and non-profit partners is important for making this an applicable implementation plan. Personal acknowledgements are listed in the back of this strategy.

Birch Creek Watershed -Pearson Creek

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Action Plan Organization

This Action Plan document begins with an Introduction that describes the background for this effort, the entities involved, and the Vision, Goals and Objectives of the BCTT that shaped this Plan. The Environmental Setting section provides a general overview of the Birch Creek Watershed (Figure 1). The Approach and Process section describes the restoration planning framework along with a summary of analyses methodologies, which included watershed- and reach-scale assessments of physical characteristics and fish productivity. The results of these assessments are summarized in the Watershed Assessment and Sub-Basin Assessment sections, which identify the restoration needs throughout the Birch Creek Watershed. The Strategy section provides a path for implementing restoration actions, including a prioritization of reaches and identification of actions that would best address the restoration needs. As the Action Plan gets applied during the next several decades, the effectiveness of restoration projects can be evaluated with the approaches described in the Monitoring and Adaptive Management section.

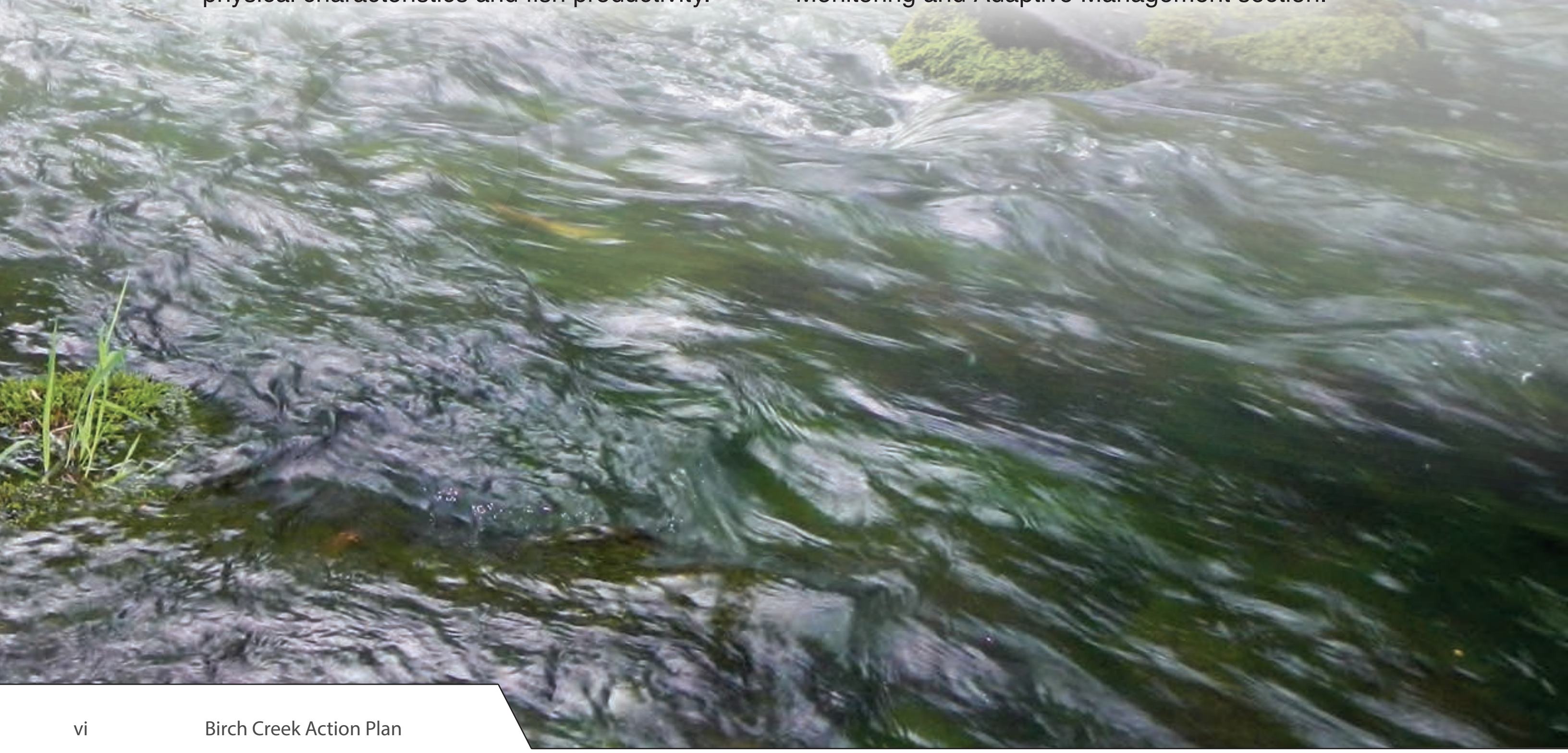
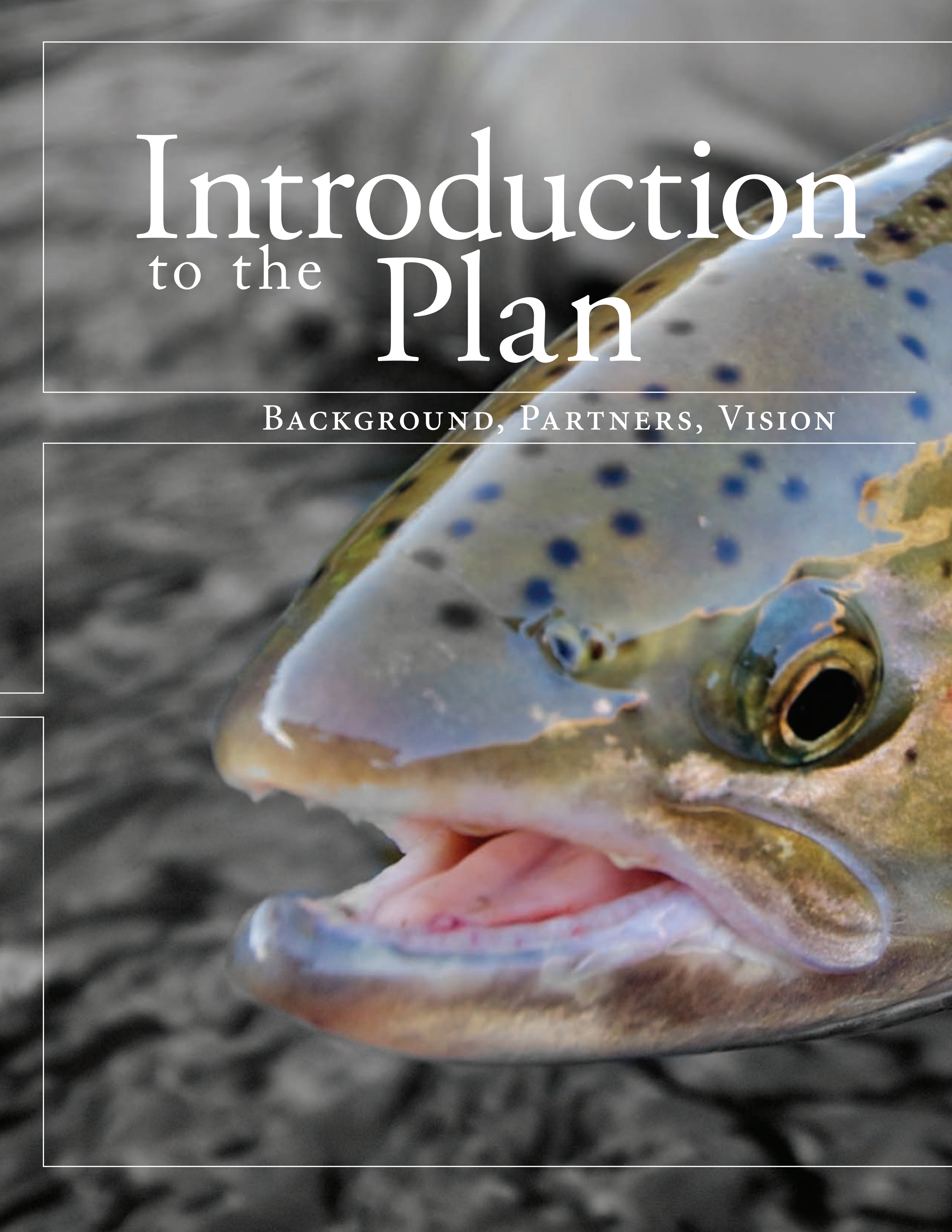
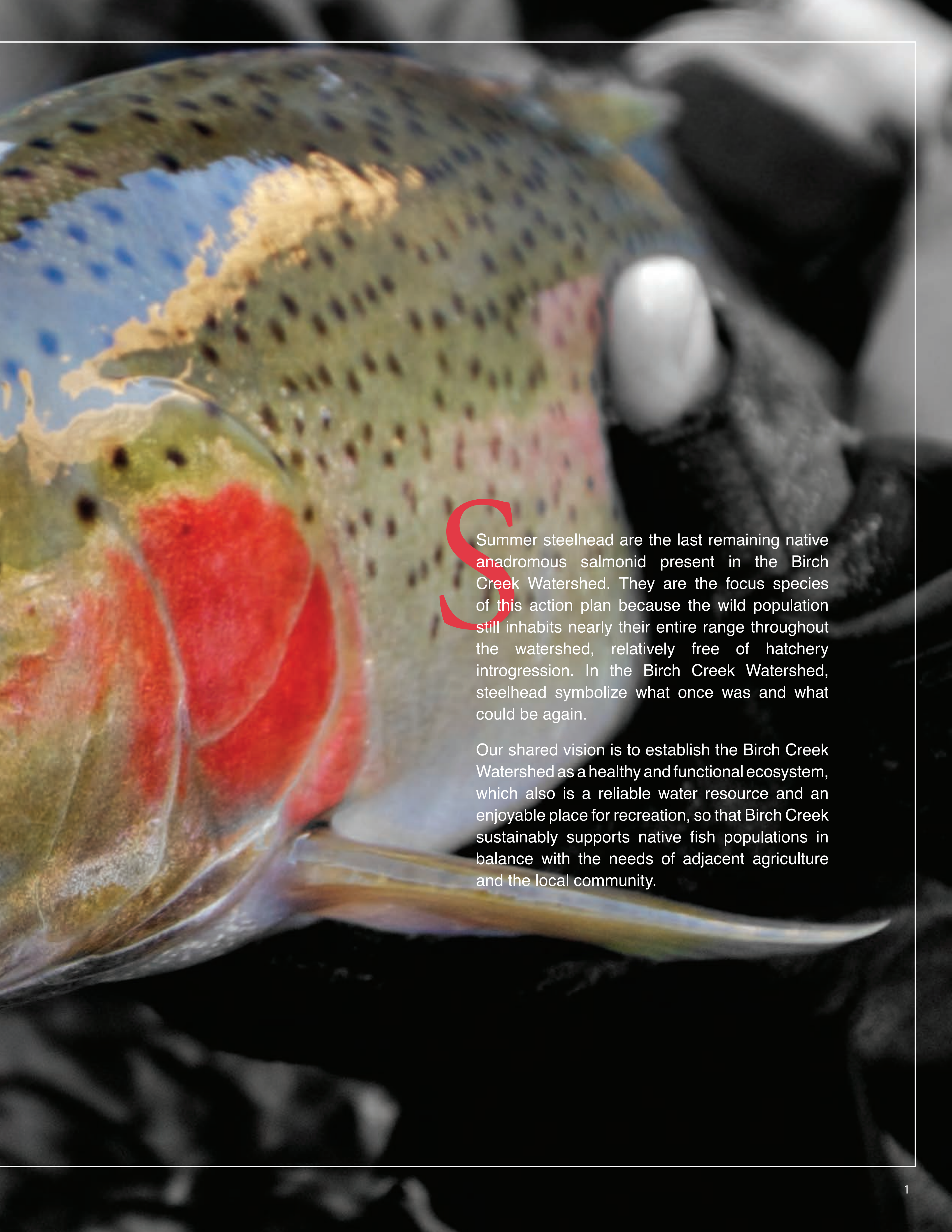


Figure 1. Map of the major sub-basins within the Birch Creek Watershed

Introduction to the Plan

Background, Partners, Vision





Summer steelhead are the last remaining native anadromous salmonid present in the Birch Creek Watershed. They are the focus species of this action plan because the wild population still inhabits nearly their entire range throughout the watershed, relatively free of hatchery introgression. In the Birch Creek Watershed, steelhead symbolize what once was and what could be again.

Our shared vision is to establish the Birch Creek Watershed as a healthy and functional ecosystem, which also is a reliable water resource and an enjoyable place for recreation, so that Birch Creek sustainably supports native fish populations in balance with the needs of adjacent agriculture and the local community.

The Birch Creek Watershed is a physically diverse landscape containing a variety of land forms and natural resources that support a wide range of valuable land uses and fish and wildlife populations.

Birch Creek is a primary tributary to the Umatilla River and provides important habitat for salmonids and other aquatic species. Summer steelhead (*Oncorhynchus mykiss*) are the focal species. Improving habitats that support spawning and juvenile rearing was the emphasis for this assessment and Action Plan strategy. The Action Plan identifies objectives and actions aimed at restoring a self-sustaining riverine system through a process-based approach. Through the assessment, the technical partners of the BCTT gained specific knowledge about geomorphic, hydrologic, and biological functionality. Then a collaborative and interactive process was used to develop watershed conditions that support healthy and functional ecosystem processes in balance with the needs of the Birch Creek Community and in support of the local economy.

The forested headwaters, located along the western face of the Blue Mountains, contain timber resources along with complex wildlife habitats. The lower and western portion of the watershed consists of grasslands, upland pasture, and moderately wide and fertile floodplains along Birch Creek and its tributaries that provide farming and ranching opportunities.

The Birch Creek Watershed has been part of the homeland for the three tribes of the Confederated Tribes of the Umatilla Indian Reservation, Cayuse, Umatilla, and Walla Walla, since time immemorial. The Tribes moved across the Columbia Plateau in an annual cycle of travel from areas of hunting, fishing, and gathering to celebration and trading camps. They would hunt, fish and gather roots and berries in various areas and seasons based

River Vision Touchstones

Riparian Vegetation - Native vegetation in the riparian area and floodplain influence system stability, water quality and provide habitat in several ways. Live trees and shrubs that depend on water for growth and nutrients can provide shade and stability to the channel. Large woody material can be an important structural feature for habitat complexity and cover.

Aquatic Biota - The aquatic food web includes a range of biota from primary production organisms to a variety of fish species at higher trophic levels. The health and persistence of biota respond to the functionality of physical characteristics in the watershed and can be viewed as the result of the riverine and floodplain conditions.

Connectivity - A functional river and floodplain is supported by connectivity of surface water and shallow groundwater. The movement of nutrients, sediment, and biota is dependent on connected flowpaths in the surface and subsurface environments.

Hydrology - Clean, cold water of adequate quantity is not only a First Food, but is required to support Salmon and other native aquatic species.

Geomorphology - Channel and floodplain form are shaped as a balance between water flow and sediment with influences from other physical characteristics, such as valley width and slope. Diverse and complex floodplain forms provide the platform for functional floodplain processes and healthy fish habitat.

on availability. This cycle would take them to the lower watershed areas and along the Columbia and Snake rivers in the winter and spring and to the headwaters along the foothills of the Blue Mountains and far beyond in the summer and fall. Birch Creek provided a conduit for travel, and the diverse resources of the watershed were available for subsistence hunting, fishing and gathering.

Beginning in the 1800's, Euro-American explorers and traders arrived in the Columbia River Basin in search of the plentiful furs and other natural resources. The Oregon Trail was established through the tribes' homeland and the United States government encouraged settlers to move to the developing Oregon Territory. By the 1850's tension between immigrants and Tribes had escalated to a level that the government pursued the development of a treaties. After much negotiation, the Treaty of June 9, 1955 was signed between the United States and members of the Walla Walla, Cayuse, and Umatilla tribes and ratified in 1859. The Umatilla Indian Reservation was created at that time and 6.4 million acres of land were ceded to the United States. The Confederated Tribes of the Umatilla Indian Reservation was eventually formed and rights were reserved for fishing, hunting, gathering foods and medicine, and grazing livestock in the ceded area.

European settlers continued to move into the Umatilla River Subbasin through the late 1800's as they found the area to be productive and accessible land for ranching and farming. The area along the floodplain of Birch Creek and its tributaries provided accessible and fertile land for ranching and agriculture. A majority of the Watershed was eventually claimed as privately owned land and the only municipality of Pilot Rock, Oregon was incorporated in 1911. The area continues to be a rural setting offering a productive environment that supports natural resources, economic value, and recreational opportunities.

Purpose

Land management activities have taken a toll on ecological conditions and natural geomorphic processes. Over the past 150 years, activities such as grazing, timber harvest, conversion of land to agricultural production and floodplain and stream channel manipulation have had detrimental effects on habitat. Over the years reductions in habitat quality and quantity has resulted in impacts to key fish species, including the extirpation of spring chinook (*O. tshawytscha*) and coho salmon (*O. kisutch*). In an attempt to improve and restore habitat conditions, activities have been planned and implemented for decades, but generally in isolated and opportunistic ways. The purpose of this project is to better understand existing conditions in the Birch Creek Watershed, identify areas for improvement and to restore functional conditions that effect aquatic habitat and biota.

The Oregon Department of Fish and Wildlife (ODFW) Fish Habitat Program and the CTUIR Fisheries Habitat Program convened in 2006 to create an action plan for habitat improvement projects in the Umatilla River Subbasin (ODFW and CTUIR, 2006). This five-year plan was intended to coordinate projects implemented by ODFW and the CTUIR with Bonneville Power Administration (BPA) funds on private and Tribal lands and was correlated with priorities identified in the 2004 Umatilla/Willow Subbasin Plan. Although the five-year action plan provides a good list of actions, the prioritization method did not fully consider important physical and ecological parameters. Limiting factor conditions were refined and not all actions identified for Birch Creek Watershed were completed, given other habitat restoration priorities in the Umatilla River subbasin and funding limitations.

Resource managers and stakeholders identified the need for scientifically-based, holistic and coordinated strategy for restoring natural riverine processes in support of aquatic habitat. This approach should relate to ecological concerns and needs as identified at larger scales (Barnas et.al. 2015). Resource and land managers, regulatory agencies, and scientific reviews (Independent Science Review Panel [ISRP]) have noted that to complete this task effectively, understanding of geomorphic processes, hydrologic conditions, and aquatic habitat quality and quantity, within the Birch Creek Watershed, should be a prerequisite to developing habitat restoration plans. As issues and concerns related to flood risk and damage, channel erosion, bedload deposition and aquatic habitat quality have emerged, the lack of knowledge about the physical setting and processes, and how they interact with land use and management has become apparent. By combining existing information with newly acquired data, a more complete understanding of the Watershed informs the development of a prioritized action plan.

Funding and Regulatory Setting

The summer steelhead population throughout the Umatilla River Subbasin is part of the Middle-Columbia Distinct Population Segment (DPS), which was listed as Threatened under the Endangered Species Act (ESA) on March 25, 1999. In 2008, the CTUIR was one of three Columbia Basin treaty tribes that entered into a 10-year Columbia Basin Fish Accords (Accords) Memorandum of Agreement (MOA) with the Federal Columbia River Power System (FCRPS) Action Agencies (US Army Corps of Engineers [USACE], US Bureau of Reclamation [BOR], and the Bonneville Power Administration [BPA]). One purpose of the Accords MOA was to provide stable funding to implement projects for the benefit ESA-listed anadromous fish species affected by the FCRPS (3 Treaty Tribes-Action Agencies 2008). Funding for the development of this Action Plan was provided, in part, through the Accords MOA for the benefit of ESA-listed steelhead.

Projects funded through the Accords are part of the Northwest Power and Conservation Council's (Council) Fish and Wildlife Program (Program). To maintain consistency within the Council's program, an Independent Science Review Panel (ISRP) reviews projects at the subbasin-scale to ensure scientific credibility and that project objectives are being met.

Other regulatory drivers in the watershed is the FCRPS Biological Opinion (BiOp) (NOAA Fisheries 2014), and two other Biological Opinions (NMFS 2013 and USFWS 2013) related to BPA's Habitat Improvement Program (HIP III). The general purpose of these BiOp's is to evaluate the likely effects of actions on ESA-listed species and to apply the statutory standards set forth in Section 7(a)(2) of the ESA. With the HIP III, BPA has formed an internal Restoration Review Team (RRT) that is comprised of technical experts from federal agencies with the purpose of providing design review of medium to high-risk projects throughout their development. Clearance from all member agencies, represented in the RRT, must be achieved prior to implementation.

Implementation of restoration actions in the Birch Creek Watershed is expected to be collaborative because this Action Plan was developed in partnership with many agencies, stakeholders and the local community. Accords funds are not directly available to the collaborative entities so it is expected that other funding sources will be sought throughout the plan's implementation. Development of this collaborative assessment and strategy provides a holistic and scientifically supported basis for solicitation of broader funding sources through granting agencies focused on resource-based restoration. Applicable and expected sources for restoration funding might include the Oregon Watershed Enhancement Board (OWEB), Pacific Coastal Salmon Recovery Fund (PCSRF), the ODFW Restoration and Enhancement Program (R&E), the Natural Resources Conservation Service (NRCS), Oregon Department of Environmental Quality (DEQ) programs such as nonpoint source Clean Water Act 319 grants, and others.

Partners and Stakeholders

The Birch Creek Watershed is important to CTUIR, the people that inhabit and live in the local community, and others with a stake and interest in the valuable resources. The CTUIR have a long history of living in the Columbia River Plateau and prioritize the area for its cultural and traditional values. Private landowners and managers make their living with the goods and services provided through forestry, farming and ranching. Others that live in the watershed and the city of Pilot Rock, Oregon, appreciate the lifestyle of a small, tightly knit community in a rural environment. While other stakeholders also value the area in a larger context and how it contributes to conditions in the Columbia River Basin. For this plan to be successfully implemented, it is imperative that the intent be clearly communicated and the many interests and concerns be considered.

Technical Team

General project oversight was accomplished through the formation of a group of cooperating entities and agencies that was defined as the Birch Creek Technical Team (BCTT). The BCTT was led by the CTUIR Department of Natural Resources Fisheries Habitat Program and consisted of members with interests and responsibilities in fisheries and watershed management as well as general land management and watershed health. Since the assessment and action plan focus on water resources and fisheries issues, members include natural resource and fisheries professionals from ODFW, UBWC, SWCD, and the Umatilla National Forest (UNF).

Each member of the BCTT and consulting assessment team brought an individual set of knowledge and experience to the team. To take advantage of the expertise, working subgroups were organized, based on scientific discipline, to address the various topics and tasks of the project. The following sub-groups were formed and team members were assigned:

- Project Management—Rick Christian (CTUIR) and Jason Scott and Jim Webster (GeoEngineers)
- Fisheries—Bill Duke, Joe Smietana, and Jacquelyn DeAngelo (ODFW); Mark Lacy, Olin Anderson, Rick Christian, Ethan Green, Mike Lambert, and Craig Contor (CTUIR); Jesse Schwartz (Portland Fish Company); Jason Scott (GeoEngineers)
- Geomorphology—Scott O'Daniel (CTUIR); Katherine Ramsey and Joy Archuleta (USFS); Tim Hanrahan (GeoEngineers)
- Outreach—Jonathan Staldine and Patricia Jones (UBWC); Tom Demianew, Shanna Hamilton, and Kyle Waggoner (SWCD); Bill Duke (ODFW)

A common theme between BCTT members has been a mission to protect, enhance and restore water resources, fish and wildlife habitat and the supporting ecological processes. Each mission may focus on different details or parts of the landscape, but they coincide well and can synthesize into effective overall outcomes.

CTUIR River Vision and Touchstones

The Tribes have a traditional and cultural connection to the foods provided by the earth. This is supported through ceremonial meals in the Tribal Longhouse and is further ingrained through the First Foods mission. The Umatilla River Vision was developed as an application of the Umatilla Tribes First Foods mission focusing on water and water quality management. The Vision provides management context to maintain the minimum ecological requirements for the First Foods of water and salmon and requires a river that is dynamic and shaped by physical and biological processes and interaction between those processes. The vision describes the desired ecological characteristics based on fundamental touchstones that include hydrology, geomorphology, connectivity, native riparian vegetation, and native aquatic biota. As a basis for this action plan, organizing ecological processes by touchstone provides a way to categorize and identify functional metrics and relates well to limiting factors for important species. Although this vision is developed by the CTUIR to support the First Foods mission and is directed at the Umatilla River, it is consistent with other natural resource management agency goals and is applicable to other riverine systems.

ODFW

The Oregon Department of Fish and Wildlife (ODFW) is mandated to protect and manage fish in the state of Oregon and are a co-manager with the CTUIR in the Umatilla River Subbasin, including Birch Creek. As part of their mission to protect and enhance fish and wildlife and their habitats for the use and enjoyment by present and future generations, ODFW has planned and implemented habitat improvement projects in Birch Creek through a fisheries habitat program since the 1980's. Their approach to project identification and prioritization will benefit from the development of this strategy based on a holistic assessment, thereby providing justification to funding agencies.

UBWC

The Umatilla Basin Watershed Council (UBWC) is a grass-roots organization that focuses on protecting and improving water resources and watershed conditions in the Umatilla River Subbasin. The UBWC has been a key partner by leading outreach. Both the Executive Director and a board member have participated as members of the BCTT and provided input.

The UBWC has played a specific role in watershed management and restoration by monitoring and evaluating water quality, coordinating with landowners to improve management approaches and implementing floodplain and fisheries enhancement projects.

SWCD

The Umatilla County Soil and Water Conservation District (SWCD) assists private property owners, land managers, agencies and organizations with a mission to conserve, protect and develop soil, water, and other natural resources for the economic and environmental benefit of the Umatilla County. As an active member of the BCTT, they have assisted the UBWC with public outreach and garnering support and input through several public meetings. The focus of the SWCD has been on projects in the outer floodplains and uplands that improve conditions for natural vegetation, protect water quality and improve land management practices. The action plan will provide technical support in planning and prioritization for future project development.

U.S. Forest Service

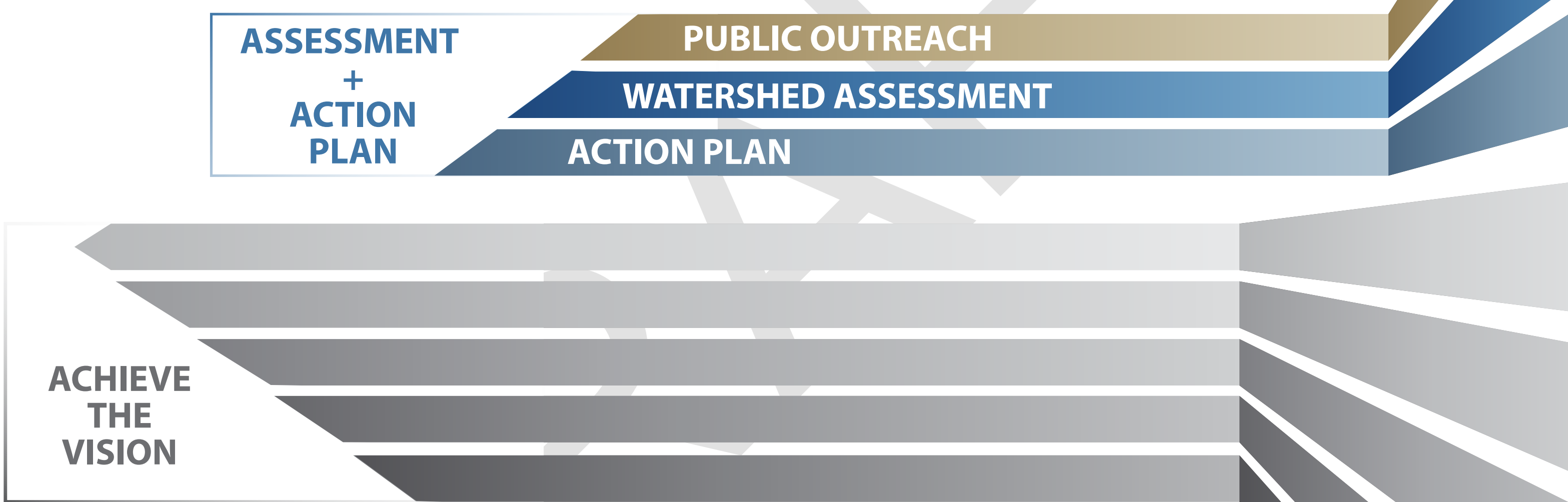
The U.S. Forest Service, Umatilla National Forest (UNF) manages the upper headwaters and southern portion of the Watershed with restoration in mind. The U.S. Forest Service applies a strategic approach for watershed restoration to promote healthy, sustainable watersheds fundamental to functioning ecosystems. Although the Birch Creek watershed is not a priority area, this action plan and strategy will support restoration efforts consistent with forest goals and objectives.

"I wonder if the ground has anything to say? I wonder if the ground is listening to what is said? I wonder if the ground would come alive and what is on it? Though I hear what the ground says. The ground says, it is the great spirit that placed me here. The great spirit tells me to take care of the Indians, to feed them alright. The great spirit appointed the roots to feed the Indians on. The water says the same thing. The great spirit directs me, feed the Indians well. The ground, water and grass say, the great spirit has given us our names. We have these names and hold these names. The ground says, the great spirit has placed me here to produce all that grows on me, trees and fruit. The same way the ground says, it was from me man was made. The great spirit, in placing men on the earth, desired them to take good care of the ground and to do each other no harm..."

Young Chief
1855 Treaty Council

VISION

Our shared vision is to reestablish Birch Creek as a healthy and functional ecosystem, which also is a reliable water resource and an enjoyable place for recreation, so that Birch Creek sustainably supports native fish populations, in balance with the needs of adjacent agriculture and the local community.



STRATEGY

Our strategy is to reach this vision for Birch Creek in two steps, and to do so with effective and cooperative collaboration between concerned agencies and members of the community, with a watershed perspective. First, we assessed baseline watershed conditions, factors limiting fish success, and processes of stream formation and floodplain function. Second, we used this assessment to inform the development of the action plan to identify and prioritize various land conservation and habitat restoration treatments to provide a template for creating and maintaining natural habitats for fish while also supporting a thriving community and strong economy. The intent is to promote a sustainable Birch Creek by linking the larger concerns with potential solutions—supporting the needs of all—from people living on the land to steelhead living in the creek.

GOALS	OBJECTIVES
BUILD COMMUNITY TRUST AND COLLABORATION	Create strong and lasting partnerships to address complex natural resources issues. Improve stakeholder awareness of watershed issues. Increase citizen interest in habitat restoration and protection actions.
UNDERSTAND CURRENT WATERSHED CONDITIONS AND PROCESSES	Develop a comprehensive Birch Creek Geomorphic Assessment document.
PLAN FOR HABITAT RESTORATION AND STREAM MANAGEMENT ACTIONS	Based on knowledge gained in the assessment, develop a comprehensive Birch Creek Action Plan document that supports the needs of fish and the community.
PROMOTE A HEALTHY WATERSHED	Find ways to increase floodplain connectivity to accommodate flood flows without regular destructive flooding and erosion. Provide information to promote sustainable upland forest and grassland management to improve infiltration, provide diverse habitat, reduce soil erosion, and deliver clean water into streams.
PROMOTE A RELIABLE WATER SUPPLY	Find potential opportunities to ensure adequate instream flow needs for fish species needs at all life cycles while supporting sustainable agricultural practices. Suggest avenues to resolve water supply issues.
PROMOTE WATER QUALITY IMPROVEMENTS	Identify causes of poor water quality and explore possible ways to improve conditions to support native aquatic species.
PROMOTE IMPROVED RIPARIAN PLANT COMMUNITY HEALTH	Illustrate the value of maintaining riparian corridors with a dense, healthy native plant community that regenerates naturally, that provides wood recruitment, that shades the stream, and that cycles nutrients . Develop ways to expand riparian corridors as possible by studying the combined opportunities of landowner needs, stream site conditions, and financial resources.
PROMOTE A HEALTHY FISH COMMUNITY	Assess fish passage barriers that affect critical migration cycles. Identify solutions that could remediate all fish passage barriers. Determine needs and solutions to improve habitat conditions that would increase fish capacity and productivity in Birch Creek.

NEAR TERM (first three goals)

LONG TERM (remaining goals)

Birch Creek Watershed

Environmental Setting

The Umatilla River Subbasin, including the Birch Creek watershed, is one of 10 subbasins located in the Columbia Plateau Ecological Province. Birch Creek is a large drainage that, like others in the Umatilla River watershed, begins in forested land cover and descends through a variety of rangelands and irrigated fields before flowing into the Umatilla River near the town of Rieth, Oregon.

The Birch Creek Watershed study area encompasses approximately 284 square miles and approximately 110 stream miles. Elevations range from approximately 900 feet at the confluence with the Umatilla River to 5,000 feet at the headwaters in the Blue Mountains (Figure 2).

Geology

The headwaters of the Birch Creek watershed are in the Blue Mountains geologic province, which is characterized by deeply incised upland surfaces and ramp-like slopes (USACE 1947). The flat-topped ridges and steep stair-stepped valley walls of the Blue Mountains were formed by thousands of feet of Miocene basalt flows, which are part of a regionally widespread series of flows that form the Columbia Basin basalts. As the mountains uplifted and horizontal basalt layers warped into a series of folds, streams carved canyons through basalt layers and created a highly dissected landscape (NPCC 2005).

As channels transition from the canyons of the Blue Mountains, they cross a wide expanse of plains and terraces into the Umatilla Plain geologic province. This province is characterized by tertiary and quaternary loess, alluvium, glacio-fluvial, and lacustrine sediment deposits, which mantle the Columbia River basalts (Newcomb 1965). Tertiary ancestral streams washed the oldest of the valley sedimentary deposits down from the canyons of the Blue Mountains and deposited them along the mountain front (Gonthier and Bolke 1993). Quaternary deposits of wind-borne silt or loess blanket much of the tertiary deposits and basalt flows.

Soils

Soils characteristic of the headwater areas in the Blue Mountains and their foothills were formed in a variety of parent materials including volcanic ash, residuum, loess, and colluvium (Johnson and Makinson 988). In general, these soils are relatively shallow, coarse and well drained. General land use associated with these soil types are rangeland agriculture and timber production. Soils in the mid and lower-range of the watershed (generally between the Blue Mountain foothills and the confluence with the Umatilla River) are moderately deep, well drained loess soils underlain by hardpan and basalt on the terraces. Land uses typical of these soil types are small grain-fallow cropping and rangeland. Deeper silt loam soils occur in the floodplains and are often used for irrigated crops such as alfalfa hay and small grains.

Climate

The Birch Creek watershed falls within Oregon's North Central Climatic Zone (Zone 6). The major influence on the regional climate is the Cascade Mountains to the west (Figure 2), which form a barrier against warm, moist fronts

River Vision Touchstones

Riparian Vegetation - Aquatic habitat in the coniferous forest headwater channels benefit from inputs of large woody material. Riparian vegetation in lower reaches historically dominated by native trees and shrubs, has been impacted by floodplain development and introduction of non-native species.

Aquatic Biota - Birch Creek summer steelhead, a component of the ESA-listed Umatilla River population, are the focal species for habitat assessment and restoration planning. Over half the production of a highly viable Umatilla population is expected from Birch Creek.

Connectivity - Channelization and floodplain constriction in the lower mainstem reaches has constrained overbank flows and resulted in limited connectivity between the main surface channels and floodplains. Several obstructions to fish migration at various life stages exist within the watershed.

Hydrology - A snowmelt dominated flow regime with occasional rain-on-snow events result in late winter and spring peakflows and naturally low summer flows with the potential for high water temperatures.

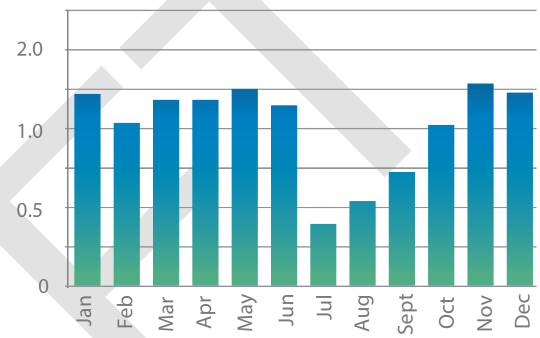
Geomorphology - Steep, naturally confined headwater channels transition to lower gradient channels in moderately confined and unconfined valleys. Upper channel forms consist of straight, riffle-pool sequences while lower channels flow through wider valleys with floodplains that have been converted to agricultural use.

Climate Data

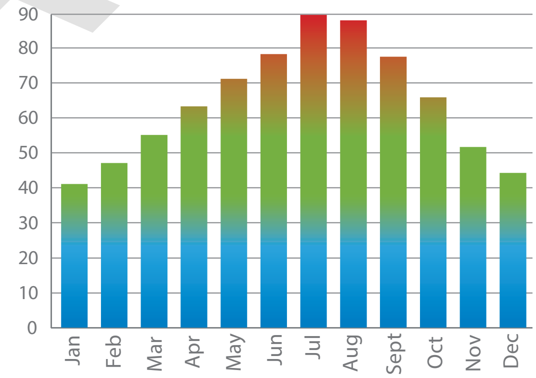
Western Regional Climate Center.
Data for Pilot Rock, OR. Period of Record 1908-2016

1680' Elevation | **14"** Annual Rainfall

Avgerage Precipitation (in.)



Avgerage Temperature (F)



Avgerrage Snowfall (in.)

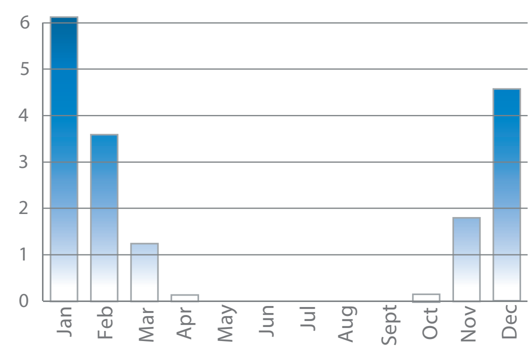
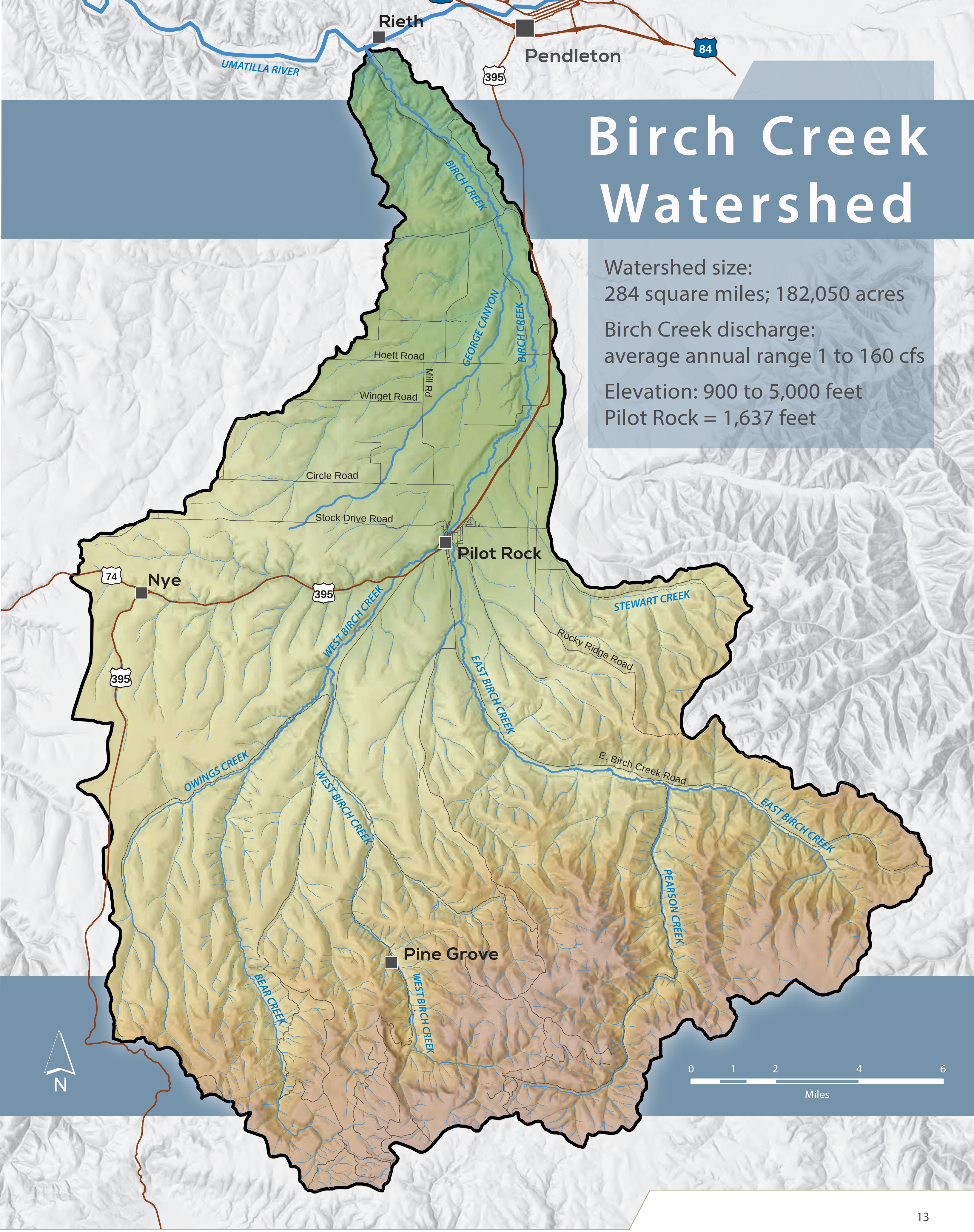


Figure 2. Map of the Birch Creek Watershed study area and summary of the associated climate data

Birch Creek Watershed



Watershed size:
284 square miles; 182,050 acres

Birch Creek discharge:
average annual range 1 to 160 cfs

Elevation: 900 to 5,000 feet
Pilot Rock = 1,637 feet

from the Pacific Ocean. However, the Columbia Gorge provides a break, which occasionally allows moisture laden marine air to penetrate into the northern Blue Mountains (Johnson and Clausnitzer 1992). The climate within the Birch Creek watershed experiences strong seasonal fluctuation in both temperature and precipitation and is strongly influenced by elevation. Precipitation ranges between nine inches in the lower elevation areas, falling mostly as rain, to 30 inches in the headwater areas, which falls mostly as snow. Watershed-wide, the annual average rainfall is 13.8 inches and the average annual snowfall is 18 inches. At Pilot Rock, Oregon (1,637 feet), the annual average high temperature is 64.8°F, the annual average low is 38.4°F and the annual average temperature is 52°F.

Land Cover/Land Use

The Birch Creek watershed is a very rural area with Pilot Rock, Oregon being the only municipal development. Approximately 87 percent of the watershed area is privately owned and largely managed for agriculture production. Approximately 13 percent is publicly owned, most of which is managed by the US Forest Service (USFS) in the headwater areas of the Blue Mountains. Other public ownership in the watershed includes the US Bureau of Land Management (BLM), US Fish and Wildlife Service (USFWS) and State of Oregon (Table 1). From the headwater areas to the mouth, the watershed is comprised of a diverse mix of land cover types that is heavily dominated by shrub/scrub (including grassland) cover type followed by evergreen forest and crop land (Table 2).

Fish Use, Abundance and Distribution

Salmonid fish populations present in the Birch Creek Watershed include spring Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O.kisutch*) and summer steelhead (*O.mykiss*). Spring Chinook populations historically were present in about the lower three miles of Birch Creek (ODFW 2016) but were driven to extinction in the early 20th Century, largely due to habitat degradation and compromised fish passage associated with diversion dams (NPCC 2005). Hatchery fish were reintroduced into the Umatilla watershed starting in 1986 and are currently known to be present in about the lower 1.5 miles of Birch Creek.

Like spring Chinook, coho salmon were extirpated from the Umatilla watershed in the

- *Table 1: Birch Creek watershed land ownership*

Ownership	Acres	Percent Area
BLM	308	0.17%
USFWS	10	0.01%
USFS	22,620	12.42%
State of Oregon	40	0.02%
Private	159,187	87.39%

- *Table 2: Birch Creek watershed land cover types*

Land Cover	Acres	Percent Area
Open Water	14	0.01%
Developed, Open Space	2,737	1.50%
Developed, Low Intensity	264	0.15%
Developed, Medium Intensity	80	0.04%
Developed, High Intensity	9	0.01%
Barren Land	3	0.00%
Deciduous Forest	1	0.00%
Evergreen Forest	36,461	20.03%
Mixed Forest	9	0.01%
Shrub/Scrub	109,388	60.09%
Herbaceous	5,923	3.25%
Hay/Pasture	5,888	3.23%
Cultivated Crops	20,747	11.40%
Woody Wetlands	2	0.00%
Emergent Herbaceous Wetlands	529	0.29%

early 20th century. However, ODFW (2016) suggests they were not likely present in Birch Creek historically. Hatchery introductions of coho occurred in the late 1960's and are now known to occur in the lower 15 miles of Birch Creek (ODFW 2016).

Birch Creek summer steelhead are part of the Middle Columbia River Steelhead Distinct Population Segment (DPS) and are the primary focus species of this plan. The Middle Columbia DPS was listed as threatened under the Endangered Species Act (ESA) in 1998. Currently, steelhead occupy most of their historic range throughout the watershed, albeit at lower levels than historic abundance (NPCC 2005, Carmichael and Taylor 2010). The recovery plan for the Middle Columbia Steelhead DPS requires the Umatilla population to be highly viable, with more than half of the production expected to come from Birch Creek (Carmichael and Taylor 2010). Birch Creek steelhead are predominantly of natural origin, and the watershed is managed in part to preserve endemic wild steelhead genetics that are somewhat free from the influence of neighboring hatchery programs.

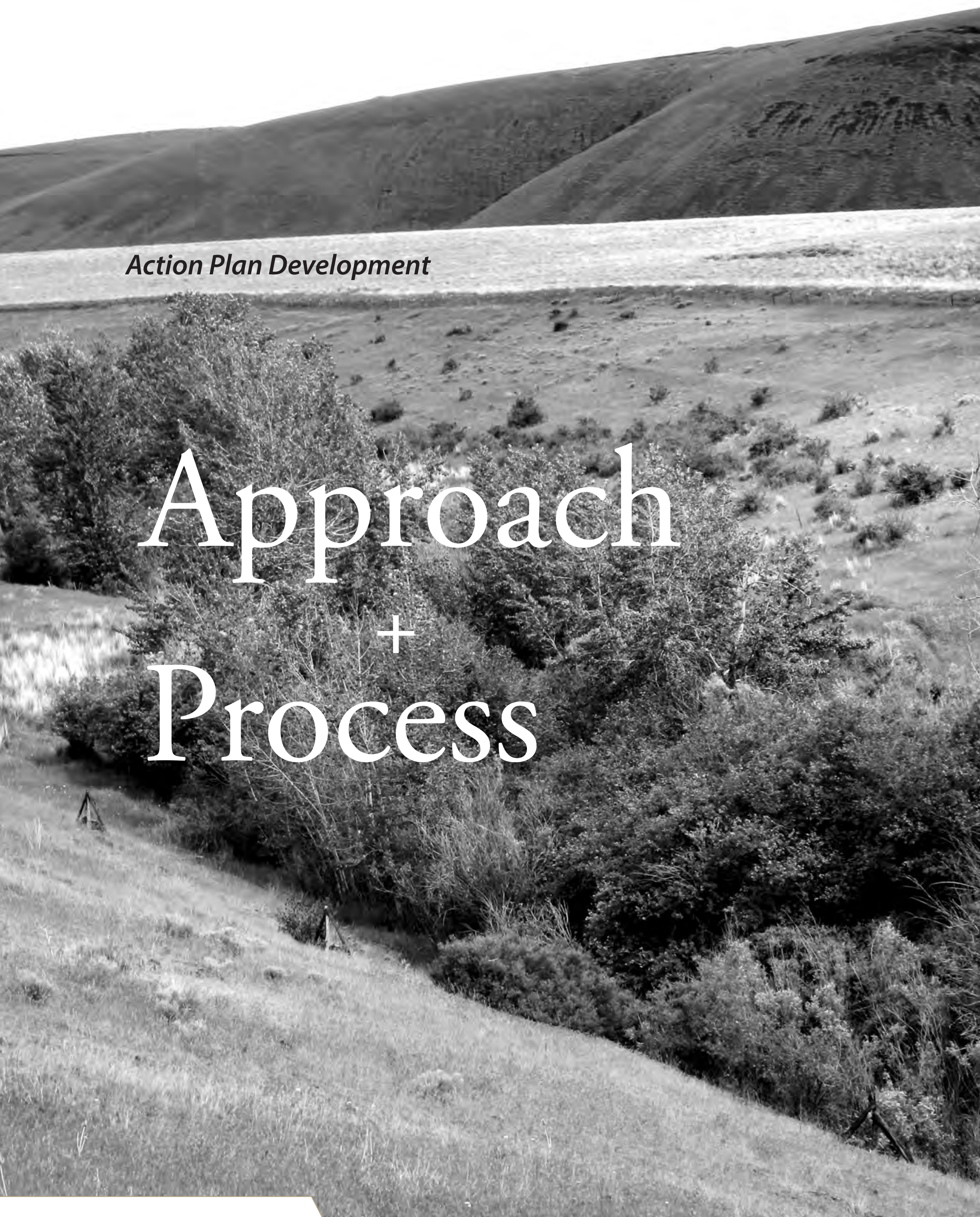
Between 1982 and 2011, as many as 2,600 steelhead are estimated to have returned to Birch Creek. During portions of the 1980's and 1990's as few as 300 fish may have returned. During this time frame, abundance has varied greatly within those bounds, and has averaged 1,117 spawners. Recruitment per spawned productivity (the number of adults that return from a single year of spawning), has ranged from as low as 0.3 (2002) to as high as 5.1 (1982), and is highly density-dependent. This highly density-dependent productivity reinforces the need to improve habitat conditions throughout the watershed in a manner that increases spatial distribution and overall watershed carrying capacity.

Spawning can begin as early as February 1 in lower Birch Creek, and may continue into late June. Steelhead will spawn throughout Birch Creek, but successful spawning is dependent on suitable habitat availability. Egg incubation time is temperature dependent and can be as long as seven weeks in the colder headwater areas. Juveniles rear in Birch Creek and the Umatilla River for one to three years, with the majority of fish rearing for two years. Outmigration of smolts occurs in small numbers from late November through June, but the largest numbers of fish leave the system in April and May. These smolts will spend one to three years in the ocean before returning, with the majority of fish spending two years at sea. Approximately 10% of the smolts emigrating from Birch Creek will return to the Umatilla River as adult migrants to repeat the life cycle.

Demographics

The environmental setting of the Birch Creek Watershed has shaped historic and contemporary land uses. For centuries, Native Americans used the watershed for harvesting fish, wildlife and other foods. After the Indian treaties of 1855, homesteads and ranches were established by European settlers along the fertile bottomlands of the stream corridors where water was available for irrigated agriculture and livestock grazing. During the mid-19th century the upper watershed experienced an increase in timber harvesting and livestock grazing, with an accompanying expansion of rural community development along the stream corridors.

Despite these land uses and rural development, the watershed remains sparsely populated. Pilot Rock, the only incorporated population center in the watershed, had a population of 1,505 in 2013, which had decreased from a population of 1,630 in 1980. The main industry in the Pilot Rock area is a lumber and pole mill. The surrounding farms and ranches contribute a modest amount of agricultural products to the economy. The manufacturing, service and government sectors in nearby city of Pendleton, Oregon, provide jobs to many residents of Pilot Rock and the surrounding area (Oregon State Archives, 2016).



Action Plan Development

Approach + Process

The Action Plan approach is based on the ecological processes across the range of spatial and temporal scales, as well as the disturbances affecting those processes.

The BCTT worked collaboratively to develop the approach to this Action Plan. In this strategy, resource managers were seeking to identify restoration opportunities that protect, restore and enhance natural processes that result in productive salmonid habitat. This included identifying opportunities to address disturbances of ecological processes ranging from the watershed scale to the individual habitat unit scale. At larger scales this included efforts to restore stream flow and sediment balances in multiple reaches and sub-basins, while at smaller scales this included reconnecting the river with its floodplain, increasing fish habitat complexity, and planting native riparian vegetation. A holistic approach of implementing restoration actions at a range of spatial scales and processes was viewed by the resource managers as a fundamental principle to increasing salmonid productivity in the Birch Creek Watershed. Implementation of these actions will be done in parallel, based on both prioritization and opportunity. Although the emphasis of this strategy is to provide a scientifically supported priority for implementation actions, assessment results also inform specific opportunities to work with the local community and landowners.

River Vision Touchstones

Riparian Vegetation - Vegetative cover and type is estimated at the reach scale within riparian areas. Channel shading by vegetation is estimated in the field and from orthophotos. Large woody material providing structure and cover is documented.

Aquatic Biota - Fish-habitat analysis for summer steelhead is completed through fish habitat condition modeling and comparisons of functional and existing conditions using updated environmental attributes.

Connectivity -Flow duration and inundation of floodplains was evaluated with one-dimensional model results and compared with floodplain and valley topography. Physical obstructions in the channel system are documented and evaluated for impacts to fish migration and accessibility of habitat.

Hydrology - Flow dynamics and magnitude are evaluated through an analysis of discharge measurements and one-dimensional model results. Stream temperature data is evaluated as an attribute effecting fish distribution and production.

Geomorphology - Geology and soils information provide the basic foundation for channel and floodplain potential. Continuous field survey provides details of channel characteristics and habitat features.

■ *Birch Creek Watershed - A dense riparian corridor of vegetation is associated with many of the tributaries.*

While many factors were considered in prioritizing the implementation of restoration actions, the Action Plan generally follows the principles of process-based restoration (Roni et al., 2002; Beechie et al, 2008; Beechie et al., 2010). The ecological processes across spatial and temporal scales were evaluated, and the causes of disturbance that reduce habitat quantity and quality were addressed. This framework includes the following elements, some of which are a higher priority because of their effectiveness at addressing the fundamental ecological processes responsible for creating and maintaining high functioning habitat:

- Protection. The highest priority is protecting areas where the ecological processes are highly functioning across the range of spatial and temporal scales. Areas of particularly important biological productivity, such as spawning and rearing areas, are also candidates for protection. Protection could also be afforded to those areas with the greatest potential for restoring ecological processes, regardless of their present condition.
- Conservation. This element is focused on maintaining and improving sustainable resource management practices that affect the ecological processes across the range of spatial and temporal scales. This includes efforts to protect, enhance and restore stream flows and high water quality.
- Reconnection. Connectivity of both biological and physical processes is an important component for restoring salmon productivity. Biological connectivity includes links among habitat types within stream reaches—connectivity among diverse habitat types such as main channel and side channel—and among migration routes by removing passage barriers. Physical process connectivity targets the restoration of flow, sediment, wood, and nutrients upstream to downstream, and among the primary river channel, floodplain and side channels, by removing barriers to these exchange processes.
- Restoration. Active modifications of rivers and floodplains can be characterized as a continuum of actions ranging from full restoration of processes to habitat creation and local treatments:
    - Full restoration: restore watershed, stream and reach ecological processes responsible for creating and maintaining salmonid habitat
    - Partial restoration: enhance or restore selected ecological processes at limited spatial or temporal scales
    - Habitat creation: increase local habitat quantity or quality through treatments that are focused on the symptoms of degradation rather than the fundamental ecological processes

Application of the Action Plan

The Action Plan is an approach to protecting and restoring the health of the Birch Creek watershed and river corridors for the benefit of native salmonids and other native fish species of concern, as well as general ecosystem function. Central to this strategy is the fundamental principle to determine what needs to be done and where in order to protect high quality habitat and restore habitat to a more productive condition. The Action Plan is applied around determining:

- The tributary habitat limiting factors that are impacting the health of steelhead and other native fish (Table 3)—Watershed and Sub-Basin Assessments

■ *Table 3. Primary Limiting factors (as stated in 2008 Accords), NOAA Ecological Concerns, River Vision Touchstones, and Reach Functionality Categories and Parameters.*

Primary Limiting Factors[1]	NOAA Ecological Concerns[2]	River Vision Touchstone[3]	Functional Category	Functional Parameters
In-channel characteristics	Bed and Channel Form Instream Structural Complexity	Primary: Geomorphology Secondary: Aquatic Biota	Geomorphology Hydraulic	LWD transport and storage Bank migration / lateral stability Bed form diversity Bed material characterization
Passage/ Entrainment	Anthropogenic Barriers	Primary: Connectivity Secondary : Aquatic Biota	Biology Hydraulic Geomorphology	Flow duration Physical longitudinal connectivity (barriers)
Riparian/ Floodplain	Riparian Vegetation LWD Recruitment Floodplain Condition	Primary: Riparian Vegetation Secondary: Connectivity Tertiary: Geomorphology	Biology, physicochemical Geomorphology Hydraulics	Riparian vegetation Floodplain connectivity Water quality - temperature
Sediment	Increased Sediment Quantity	Primary: Geomorphology Secondary: Aquatic Biota	Hydraulic Geomorphology	Bed material characterization Bank migration / lateral stability
Water Quality - Temperature	Temperature Decreased Water Quantity	Primary: Geomorphology Secondary: Riparian Vegetation Tertiary: Aquatic Biota	Physicochemical Hydrology Geomorphology	Riparian vegetation Bedform diversity

1 Primary Limiting Factors as defined in the 2008 Fish Accords
2 NOAA Ecological Concerns Sub-Category Definitions
3 Touchstones as defined in the Umatilla River Vision

- The priority of tributary improvement actions that provide the most benefit to steelhead and other native fish, while accommodating practical implementation among many stakeholders—Sub-basin Assessments and Watershed Action Strategy
- The effectiveness of tributary improvement actions at providing benefits to steelhead and other native fish, as well as to floodplain ecological response—Monitoring and Management

The Action Plan is based on the scientific principle of a hierarchy of ecological processes, whereby processes operating at the watershed scale (and over long time periods) create the form and function of the river corridor at smaller scales (and shorter time periods). In this hierarchical concept, watershed scale geology, climate and land cover control the form and function of the river corridor at the valley scale, which includes such elements as stream flow, floodplain inundation, channel migration, sediment transport, and water temperature. Both the watershed and valley scale controlling factors are responsible for shaping the river

Table 4. Functional assessment categories/definitions

Functional Category	Functional Parameter	Function Definition
Hydrology	flow duration	transport of water from the watershed to the channel
Hydraulic	floodplain connectivity	transport of water in the channel, on the floodplain, and through sediments
	flow dynamics	
Geomorphology	sediment transport competency	transport of wood and sediment to create diverse bed forms and dynamic equilibrium
	LWD transport and storage	
	bank migration/ lateral stability	
	bed form diversity	
	bed material characterization	
Physicochemical	water quality - temperature	temperature and oxygen regulation; processing of organic matter and nutrients

corridor characteristics at the smaller spatial scale of the river reach and individual habitat units. The reach and habitat unit elements include such things as channel size and shape, substrate composition, large wood material, bank stability, riparian vegetation—these conditions have been commonly referred to as habitat limiting factors.

Restoration planning for the 2008 Columbia Basin Fish Accords settlement identified primary habitat limiting factors for the Birch Creek Watershed (Table 3). Each of the limiting factors can be correlated with one or more descriptors used for current and future restoration planning in the Birch Creek Watershed, including NOAA Ecological Concerns (Hamm, 2012) and CTUIR River Vision Touchstones (Jones et al., 2008). In keeping with the principles of process-based restoration for the Birch Creek Watershed Action Plan, a functional approach to identifying habitat limiting factors was applied through watershed- and reach-scale assessments. Stream function assessments are commonly used to determine aquatic habitat conditions and restoration opportunities (Somerville, 2010; Palmer et al., 2014).

The functional approach used for the Birch Creek Watershed Action Plan was based on an adaptation of the concepts developed for a range of physical settings (Fischenich, 2006; Sear et al., 2009; Somerville, 2010; Cluer and Thorne, 2014), and generally followed the framework proposed by Harman et al. (2012).

The Action Plan evaluated functions in four primary categories: Hydrology, Hydraulic, Geomorphology and Physicochemical (Table 4). These functional categories represent the primary watershed- and reach-scale processes responsible for determining the health of stream ecosystems. Each category is comprised of one or more functional parameters that are used to quantify or describe the status of each functional category. The functional parameters are evaluated through the use of functional metrics that were calculated from available data, measured in accessible reaches, or modeled at the watershed and reach scales. The metrics are quantifiable attributes that were associated with one or more functional parameter, and used to directly or indirectly evaluate the status and trend of stream function. Within this functional framework, fish abundance, distribution, habitat use, and productivity (biota/biology) were considered in terms of their response to changes in the primary watershed- and reach-scale functional parameters.

Watershed Assessment

This assessment focused on characterizing the physiography of the watershed, and how the controlling factors at this scale affect the development of river attributes at the valley and reach scales. The objective was to identify major geologic, hydrologic, and hydraulic processes active within the valley segments, and to delineate geomorphic reaches within the valley segments that share similar physical processes and conditions. The relationships between these physical characteristics and summer steelhead distribution were used to evaluate fish population responses to environmental conditions. The following summarizes the approach used for the assessments, with more detailed methods provided in Appendix A.

The ODFW Natural Resources Information Management Program was used to acquire the most recent information on the distribution of summer steelhead in streams throughout the Birch Creek watershed. The existing Birch Creek/Umatilla Ecosystem Diagnosis and Treatment (EDT) model developed during the Subbasin planning process (NPCC, 2005) was used to setup the initial fish-habitat analysis framework.

The fish habitat conditions model was updated with environmental attributes acquired from the watershed and reach assessments described in this document. Fish habitat analysis was completed by comparing existing condition with historic condition parameters (productivity, capacity, abundance and diversity). These parameters are derived from simulation based on species habitat relationships and estimates of habitat productivity, habitat capacity, habitat abundance and life history diversity of steelhead (McElhany et al., 2000; Caswell, 2000; Board, 2006; Good et al., 2007). Resulting values were aggregated at the watershed-, tributary-, and reach-scales.

The watershed-scale geomorphic assessment was based on analysis and summary of empirical data and model results. The geologic controls in the Birch Creek watershed were identified by GIS mapping and description of lithology and surficial geology with data compiled from the Oregon Department of Geology and Mineral Industries (DOGAMI). Soils data were acquired from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) and State Soil Geographic (STATSGO) data sets. Elevation data throughout the watershed were acquired from the 10 meter digital elevation model (DEM) in the National Elevation Database available from the U.S. Geological Survey (USGS). Additional, high-resolution elevation data along the primary stream corridors in the watershed were available from a 2013 Light Detection and Ranging (LiDAR) dataset, which also included high resolution orthophotographs. Land use and land cover data from the years 1992 and 2011 were available from the USGS National Land Cover Database (NLCD).

The watershed hydrologic regime was characterized through an analysis of available stream flow gage data and estimates of stream flow for ungaged reaches. The Oregon Water Resources Department (OWRD) gage 14025000 near the mouth of Birch Creek at Rieth provided 92 years of discharge data for estimates of peak discharge and low flow statistics. OWRD gages on East Birch Creek (14024200, 14024300) and West Birch Creek (14024100) provided approximately seven years of discharge data for similar analysis. To compensate for limited data throughout the streams in the watershed, empirical regression equations were used to generate peak discharge and low-flow statistics. The equations were developed by OWRD specifically for ungaged streams in eastern Oregon.

The hydraulic characteristics and associated sediment transport dynamics in the primary stream channels were estimated with the application of the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center River Analysis System (HEC-RAS). The one-dimensional model (v. 4.1.0) was setup based on closely spaced cross-sections (varying from approximately 100 feet to 1000 feet apart) extracted from the 2013 LiDAR elevation data. Channel and floodplain roughness values were determined from field observations. The model was calibrated to water surface elevations from the Flood Insurance Study for Umatilla County, Oregon (FEMA, 2010). Modeled discharges corresponded to the 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals.

Watershed sediment yield models were used to estimate the potential sediment delivery from hillslopes and roads to the streams. The ArcGIS version of the Soil and Water Assessment Tool (ArcSWAT, v. 2012.10.18) was used to model hillslope erosion for the land cover and land use represented in the 1992 and 2011 data sets. Other inputs to the model included the elevation, slope and soils data. Potential sediment delivery from primary and secondary roads was estimated with the road version of the Watershed Erosion Prediction Project model (WEPP:road). Road characteristics were developed from field surveys and elevation data in the GIS database. Both models were run for 50 years of simulated climate, based on data from nearby weather stations, including in Pilot Rock, OR.

The spatial extent for assessment, data analysis and development of restoration strategies was defined using a tiered approach based on summer steelhead distribution, available data, and hydrology in the watershed. Tier 1 streams encompass steelhead distribution, are included in the 2013 LiDAR data extent, and are primary tributaries within the 12-digit Hydrologic Unit Code (HUC12) sub-watershed (Figure 3). Tier 2 streams encompass steelhead distribution, are included in the 2013 LiDAR data extent, and are secondary or minor tributaries in the HUC12 sub-watershed. Tier 3 streams may encompass steelhead distribution (but not in Tier 1 or Tier 2); or they may not be currently identified in the steelhead distribution, but may be significant contributors to maintaining water quality or quantity to downstream stream reaches. Five Tier 1 streams were identified in the Birch Creek watershed, with assessments and restoration strategies completed for each of the following: Lower Birch Creek, East Birch Creek, Pearson Creek, West Birch Creek, and Bear Creek.

The Tier 1 and Tier 2 streams in the Birch Creek watershed were delineated into distinct reaches based on their geomorphic characteristics. Reaches were delineated based on geomorphic process domains in order to guide the sampling, interpretation and identification of restoration strategies within similar physical-ecological systems at the reach scale (Montgomery, 1999; Fryirs and Brierley, 2013). Reaches were delineated based on valley confinement, geology of the valley floor and walls, slope, and tributary confluence locations. There were 32 geomorphic reaches delineated among the five Tier 1 streams.

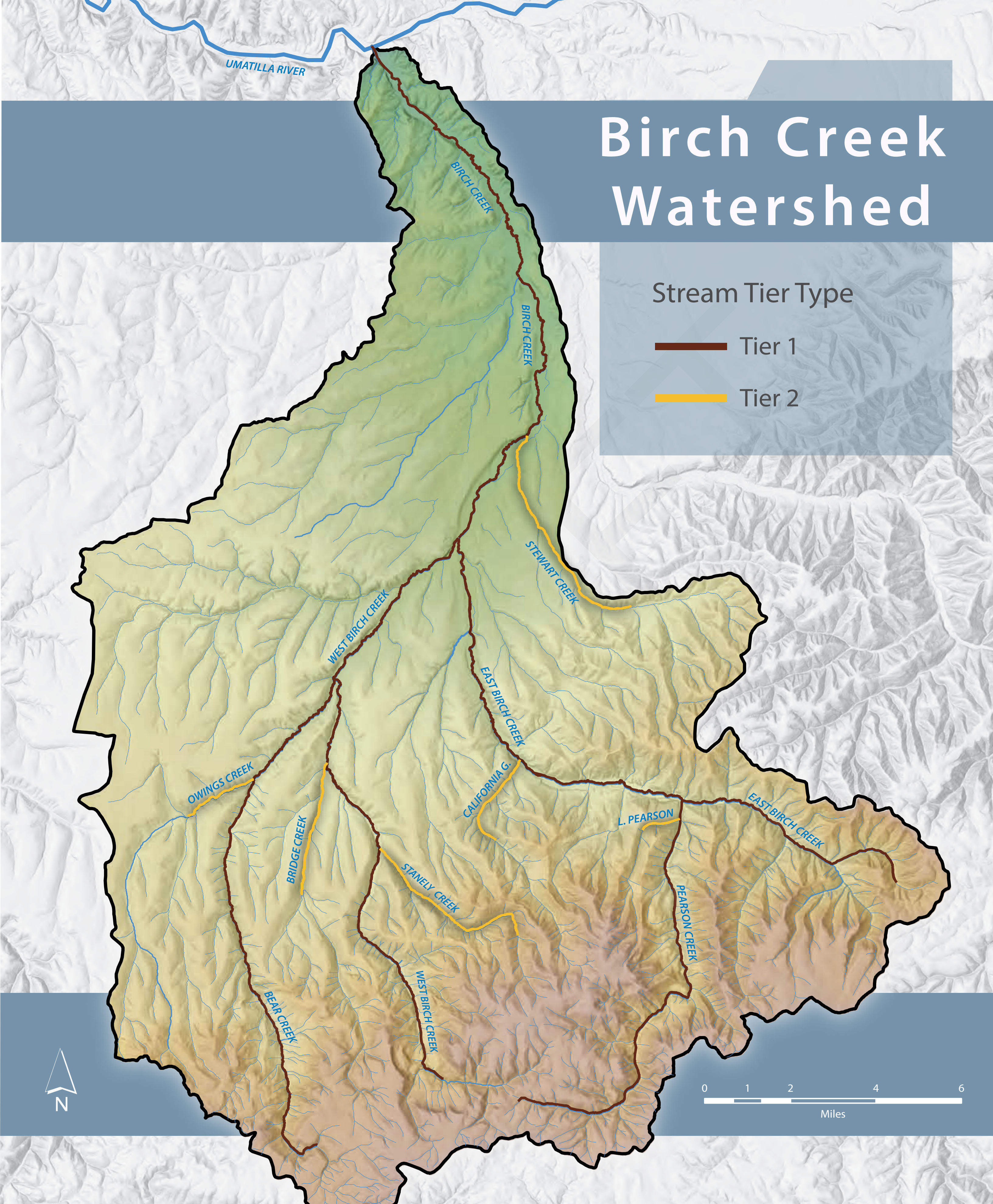


Figure 3. Map of Tier 1 and Tier 2 streams in the Birch Creek Watershed

Reach Assessment

This assessment focused on characterizing each geomorphic reach in terms of the Functional Categories of Hydrology, Hydraulic, Geomorphology and Physicochemical. Each of these categories is described by one or more Functional Parameters, which in turn are quantified by one or more Functional Metrics (Appendix B). For all Tier 1 reaches, Functional Metrics were calculated from available data, measured in accessible reaches, or modeled within the Birch Creek watershed. For reaches that were inaccessible due to restricted access (Appendix A), Functional Metrics were modeled or derived from similar geomorphic reaches. The metrics were summarized at the reach scale for all Tier 1 reaches.

Fish passage was assessed in each reach using information identified during Subbasin Planning (NPPC, 2005), LiDAR data analysis and/or field data collected in 2015. Fish passage criteria, used to evaluate barrier conditions, were based largely on Robison et al. (1999) (Table 5). However, in reaches where access for field assessments was not available, only LiDAR data and other spatial data were used to estimate passage conditions. Barrier locations and potential passage issues determines the amount of the population that is exposed to the barrier and helps define its relative importance at the watershed-scale. This information was used to calculate the approximate equilibrium abundance of steelhead above each barrier. Based on barrier conditions, relative location in the watershed and equilibrium abundance, a risk determination was made and each barrier was given a weight of low, moderate or high.

Modeled Data

Information from the Watershed Assessment was used to quantify Functional Metrics for all reaches. The reach-based specific peak discharge was calculated as selected peak discharges (e.g., 2-yr, 100-yr) divided by the reach valley/floodplain area (Olden and Poff, 2003). This metric is useful for comparing relative channel sizes (hydrologically), in order to evaluate relative habitat availability in the tributaries (e.g., production potential based on channel size), relative quantity of water available for management actions, and relative influence on downstream channel processes (e.g., wood transport, sediment transport, temperature/ water quality).

Floodplain connectivity was evaluated with top-width ratios and inundated area ratios using hydraulic model results (Table 6; Steger et al., 1998; Hall et al., 2007; Benda et al., 2011; Schenk et al., 2013; Nagel et al., 2014). These metrics are intended to describe the significance of channel incision/entrenchment (5-yr:2-yr top-width ratio), relative to the available valley/ floodplain width (i.e., the scale and physical controls of the valley).

Flow dynamics and sediment transport competency were evaluated with shear stress outputs from hydraulic modeling (Nanson and Crooke, 1992; Pitlick, 1992; Knighton, 1998; Parker, 2008; USFS, 2008; Fryirs and Brierley, 2013). The shear stress ratio (Channel:Total) is an indicator of the hydraulic diversity within a reach. The transport stage ratio (Applied:Critical shear stress) is an indicator of sediment transport competency and streambed stability.

Table 5. Passage criteria for adult and juvenile steelhead

Parameter	Definition	Age Class	100% Passage	90% Passage (some concern)	50% Passage (uncertain passage)	10% Passage (limited passage)
Inlet Depth	Depth of water at structure inlet	Adult	7 inches or greater	5-7 inches	1-5 inches	dewatering
		juveniles	4 inches or greater	3-4 inches	1-3 inches	1 inch or less
Outlet Depth	Depth of water at outfall	Adult	Full backwatering	7-6 inches	6-1 inches	dewatering
		juveniles	Full backwatering	4-3 inches	3-1 inches	1 inch or less
Minimum Channel Depth	Depth of water in structure channel	Adult	7 inches or greater	5-7 inches	1-5 inches	dewatering
		juveniles	4 inches or greater	3-4 inches	1-3 inches	1 inch or less
Entrance Jump	Distance of jump relative to pool depth at 20 degrees Celsius	Adult	Less than 1 foot	1-3 feet	3-6 feet	6-12 feet
		juveniles	Less than 6 inches	6-12 inches	1-2 feet	2-6 feet
Channel Gradient	Gradient along wetted channel through structure	Adult	Less than 0.5%	0.5-2%	2-4%	4-8%
		juveniles	Less than 0.5%	0.5-1%	1-3%	3-6%
Jump Pool	Pool depth at jump position	Adult	1.5 times jump height or 2 ft at 1 foot from Outlet	1.5 times jump height or 2 ft at less then 3 ft from Outlet	Less than 1.5 times jump height or but less than 1.5 times jump height distance from Outlet	Less than 2ft and greater than 1.5 times jump height from Outlet
		juveniles	1.5 times jump height at 6 inches from Outlet	1.5 times jump height at less than 1 ft from Outlet	Less than 1.5 times jump height or an 1 ft from Outlet	Less than 1 times jump height and more than 1 times jump height from Outlet

Field Data

Geomorphic and habitat surveys of the reaches were completed in July and August of 2015. The following summarizes the approach used for the surveys, with more detailed methods provided in Appendix A.

The number of individual pieces of large wood and accumulations of large wood were enumerated (Table 6; Roni et al., 2005; ISEMP, 2012; Archer et al., 2014). Bank conditions were evaluated by identifying the length of unstable banks and the presence of bank revetments (Peck et al., 2001; USFS, 2013; Archer et al., 2014; ODFW, 2014). Bedform diversity was evaluated by identifying distinct bank-to-bank geomorphic units (pool, riffle, run, step, cascade) along the longitudinal channel profile (Peck et al., 2001; ISEMP, 2012; Fryirs and Brierley, 2013; Archer et al., 2014; ODFW, 2014). These estimates were supplemented by enumerating the number of secondary pool features created by localized structures (large wood, boulders, undercut banks) within primary geomorphic units (Stevenson and Bain, 1999; Peck et al., 2001), and the number of local habitat cover elements (large wood, vegetation, boulders, undercut banks) within primary geomorphic units (Stevenson and Bain, 1999; Peck et al., 2001; ISEMP, 2012; ODFW, 2014). Characterization of riverbed material included estimates of grain- size distribution from field measurements, visual observations, and digital photographs (Buffington and Montgomery, 1999; Bunte and Abt, 2001; Graham et al., 2005; USFS, 2013; ODFW, 2014). As primary controls on stream temperature, estimates of channel shading by the riparian vegetation and topography were completed with field surveys (USFS, 2013; ODFW, 2014) and from analysis of the 2013 orthophotos acquired during the LiDAR survey.

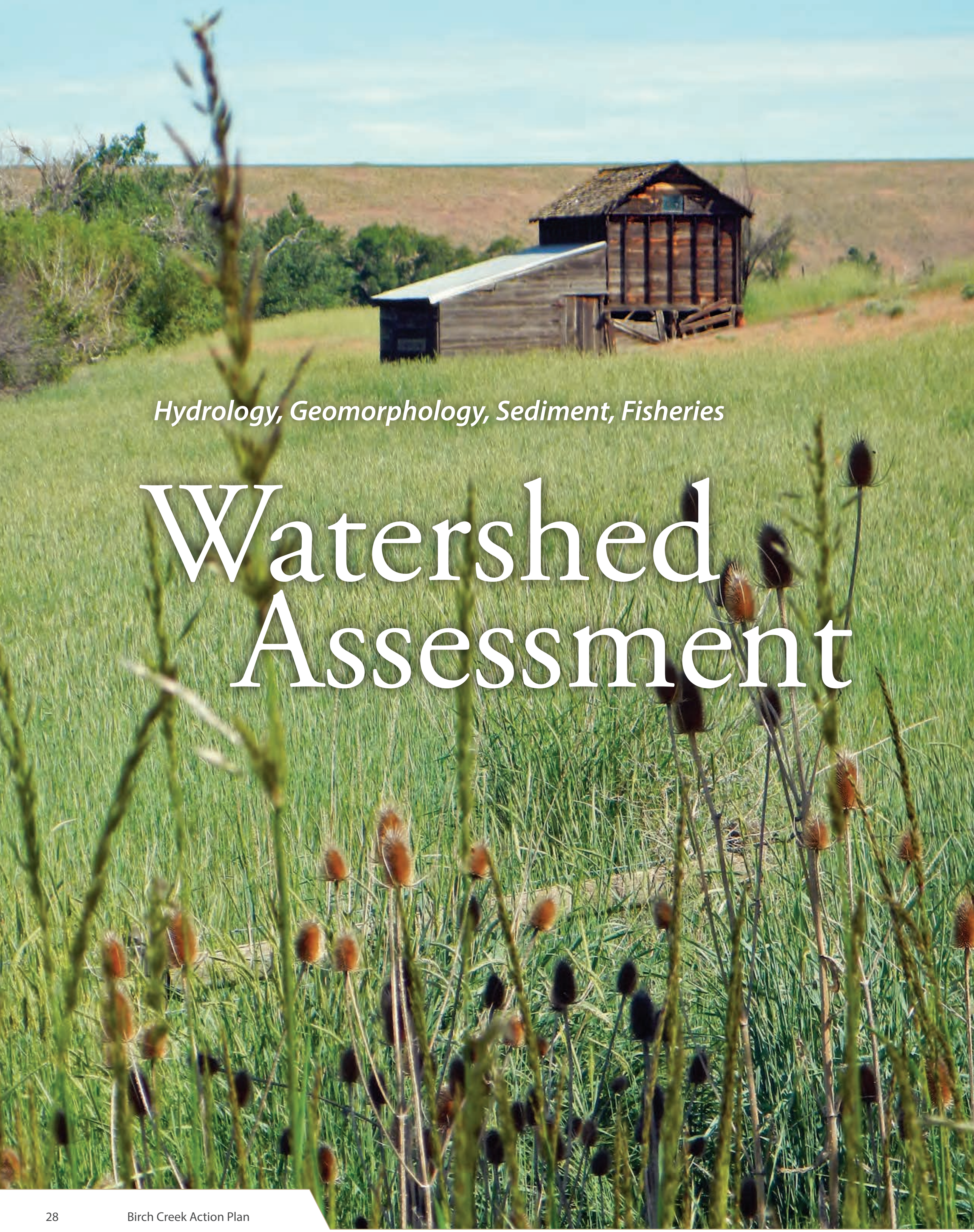
Functional Scoring

Functional assessments of the Tier 1 reaches were used to determine aquatic habitat conditions and restoration opportunities within the Birch Creek watershed. Information from the Watershed and Reach Assessments was used to score the Functional Metrics on a continuous scale from 0.0 (absent/non-functional) to 1.0 (abundant/ fully functional). The data were evaluated relative to performance standards based on regional benchmarks (ODFW, 2014), properly functioning conditions defined for salmon recovery planning in the Columbia River Basin (Hillman and Giorgi, 2002), or literature values (Appendix B). For many environmental attributes in general, performance standards are nonexistent, ambiguous, and not applicable to the spatial scale of interest; therefore, literature values and professional judgment are commonly used to score the relative functionality of stream conditions (Hillman and Giorgi, 2002; Fischenich, 2006; Sear et al., 2009; Somerville, 2010; Harman et al., 2012; Cluer and Thorne, 2014; Palmer et al., 2014). Functional Parameter values were calculated as the average Functional Metric scores, Functional Category values were calculated as the average Functional Parameter scores, and overall reach functionality was estimated as the average of Functional Category scores. This approach helps identify the fundamental drivers of overall reach functionality, and fosters comparability of functionality among reaches (Langhans et al., 2013).

Table 6. Functional Metric Definitions

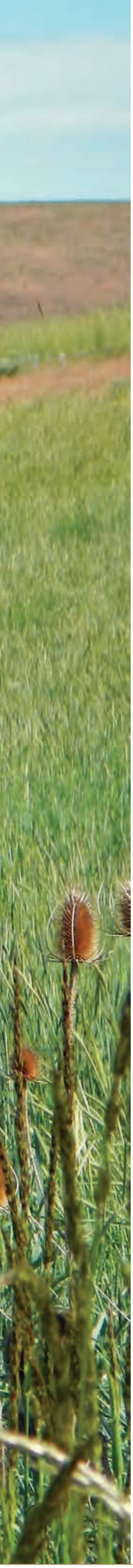
Functional Parameter	Functional Metric	Functional Metric Definition
flow duration	percent of reach dewatered during summer low flow	The percent length of the reach without surface water flow during the field survey period of July-August.
floodplain connectivity	top-width ratios	Ratios of the channel top width for selected flood discharges relative to the top width for the 2-yr recurrence interval discharge (e.g., 5-yr:2-yr), and valley width relative to the 2-yr channel top width.
flow dynamics	shear stress ratios (channel:total)	Ratios of the in-channel shear stress to the total cross-section shear stress for selected flood discharges (e.g., 2-yr, 100-yr).
sediment transport competency	incipient motion (transport stage)	For the 2-yr discharge, ratios of the shear stress applied by the flow relative to the critical shear stress required to mobilize selected grain sizes (e.g., D50, D84).
LWD transport and storage	jams per 100 m	The number of large wood accumulations (five or more individual pieces of large wood > 10 cm diameter and > 1.0 m length) per 100 m of channel length.
	logs/log-rootwads per 100 m	The number of individual pieces of large wood (> 10 cm diameter and > 1.0 m length) per 100 m of channel length.
bed form diversity	percent of reach length comprised of pools	The percent of reach length comprised of primary, bank-to-bank, pool geomorphic units along the longitudinal channel profile.
	pool frequency (bankfull channel widths between pools)	The distance (in number of channel widths) along the longitudinal channel profile between primary, bank-to-bank, pool geomorphic units.
bed material characterization	gravel % in riffles	The percent surface area of riffle geomorphic units comprised of gravel (2 - 62 mm b-axis diameter).
	percent fines in riffles	The percent surface area of riffle geomorphic units comprised of sand and smaller material (< 2 mm b-axis diameter).
water quality - temperature	riparian % shade	The percent of channel width shaded by riparian vegetation or topography, measured at > 10% of the geomorphic units in a reach.

The 12 Functional Metrics defined in this table correspond to the summary metrics presented for all Tier 1 reaches in the Sub-basin Assessment chapter of this Action Plan. The definitions for all 23 Functional Metrics are provided in Appendix B.



Hydrology, Geomorphology, Sediment, Fisheries

Watershed Assessment



The Birch Creek Watershed Assessment area included 110 stream miles that were divided into 42 distinct geomorphic reaches. In each reach, assessments of hydrology, geomorphology, sediment, and fisheries were conducted to gain a more thorough understanding of the current conditions.

While the Birch Creek watershed is relatively small at approximately 284 square miles, the variability in physical characteristics and fish distribution throughout the watershed is remarkable.

The nine HUC12 subbasins within the watershed—Coombs Peak, Stewart Creek, George Canyon, Jack Canyon, West Birch Creek, Bear Creek, Lower East Birch Creek, Upper East Birch Creek, and Pearson Creek—encompass a broad range of hydrologic regimes, hydraulic conditions, land uses and land cover types, geology, and topography. These watershedscale characteristics combine to form a template of distinct geomorphic reaches that control the types of riverine ecosystems and habitats that can develop along the stream corridors. Each of the nine subbasins and their geomorphic reaches are important to native salmonids at different times throughout the year as these fish complete the freshwater stage of their life history.

An understanding of the hydrology, sediment regime and geomorphology within the nine HUC12 subbasins will help to identify restoration strategies that range from protection of important areas to improved resource management practices and instream-floodplain habitat creation.

River Vision Touchstones

Riparian Vegetation - Vegetation species type, density and growth is dependent on the availability of water and soil conditions and varies throughout the watershed. Much of the area with supportive water and soil conditions are also prime agricultural production areas that have been modified.

Aquatic Biota -Steelhead migration into Birch Creek peaks during the spring with an average of 1,117 adults spawning from February through June.

Connectivity - Several obstructions in the watershed, such as road crossing structures and irrigation water diversions, limit or block fish passage to important spawning and rearing habitat. Channel simplification and floodplain development in certain reaches has limited hydraulic connectivity.

Hydrology -The upper watershed contains cool, clean water that diminishes in the summer to continuous flow only in the major tributaries. Several reaches of intermittent and subsurface flow exist throughout the watershed with isolated pools in the upper reaches that provide limited habitat for juvenile fish.

Geomorphology - Sediment yield is dominated by upland sources with a few key areas where road contribution is also high. Sediment transport in channels is impacted and results in specific areas of channel aggradation and degradation outside an expected range of conditions.

■ *Birch Creek Watershed has a long history of farming and ranching*

Watershed Assessment

Hydrology

Annual peak discharge data indicate that 2,200 cubic feet per second (cfs) was the maximum discharge during the 87-year period of record at the stream flow gage near Rieth, Oregon (Figure 4). This discharge is less than the estimated 50-year peak discharge of approximately 2,400 cfs, which is also known as the flow with a 2% chance of occurring in any year. In general, the lower magnitude 2-yr to 10-yr peak discharges have occurred at the expected frequency in the historic record. The East Birch Creek sub watershed contributes more flow per unit area than West Birch Creek and the Birch Creek watershed as a whole (Figure 5). In East Birch Creek the mean monthly discharge normalized by drainage area is approximately twice as large as that in West Birch Creek and at the mouth of Birch Creek. This finding indicates that the hydrologic regime of East Birch Creek provides a relatively larger surface water supply that is important for river ecosystem function, including the hydraulics, geomorphology and riparian zone characteristics of perennial stream channels within this subwatershed. The mean monthly discharge throughout the watershed is highest in April and lowest in August (Figure 6). Low flows naturally occur in July, August and September, however these conditions have been exacerbated by surface water withdrawals for irrigation. The long-term mean annual discharge has remained consistent over the period of record (Figure 7). In recent years, stream flow gaging records indicate that there is typically less than 1.0 cfs in lower Birch Creek during the months of August and September, with many days of zero flow (Figure 8).

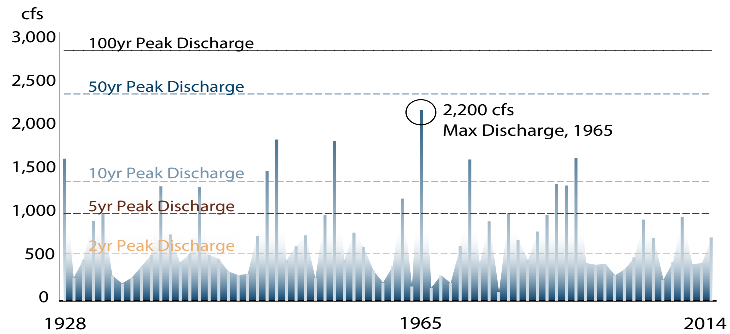


Figure 4. Peak Discharge 1928-2014, Rieth, OR

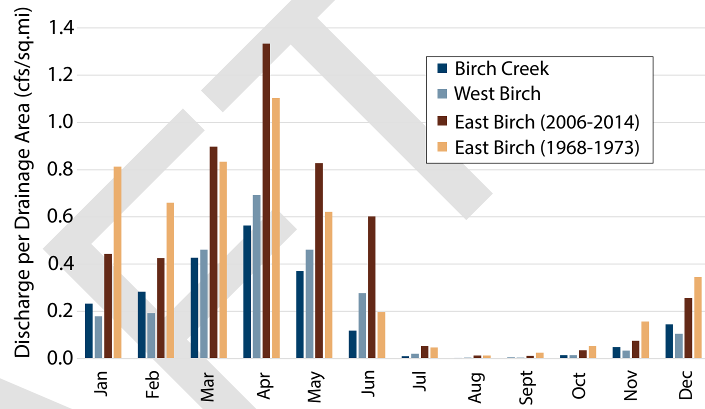


Figure 5. Mean Monthly Discharge Normalized by Drainage Area

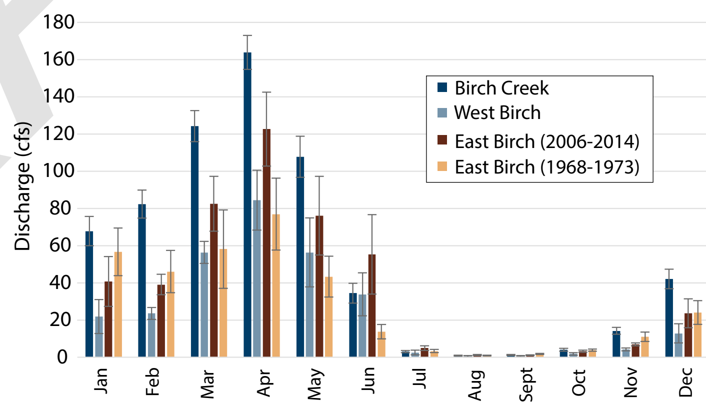


Figure 6. Average Mean Monthly Discharge (with Standard Error Bars)

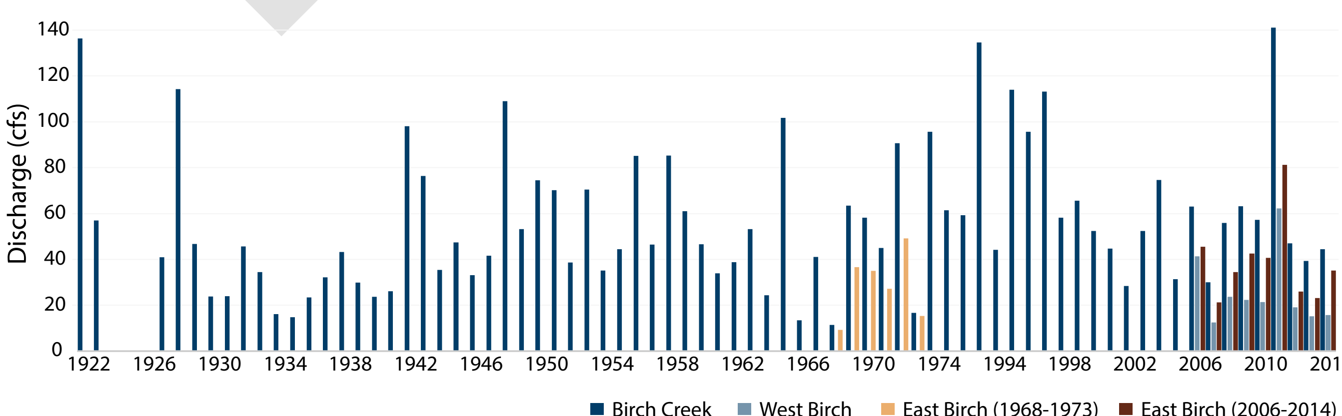
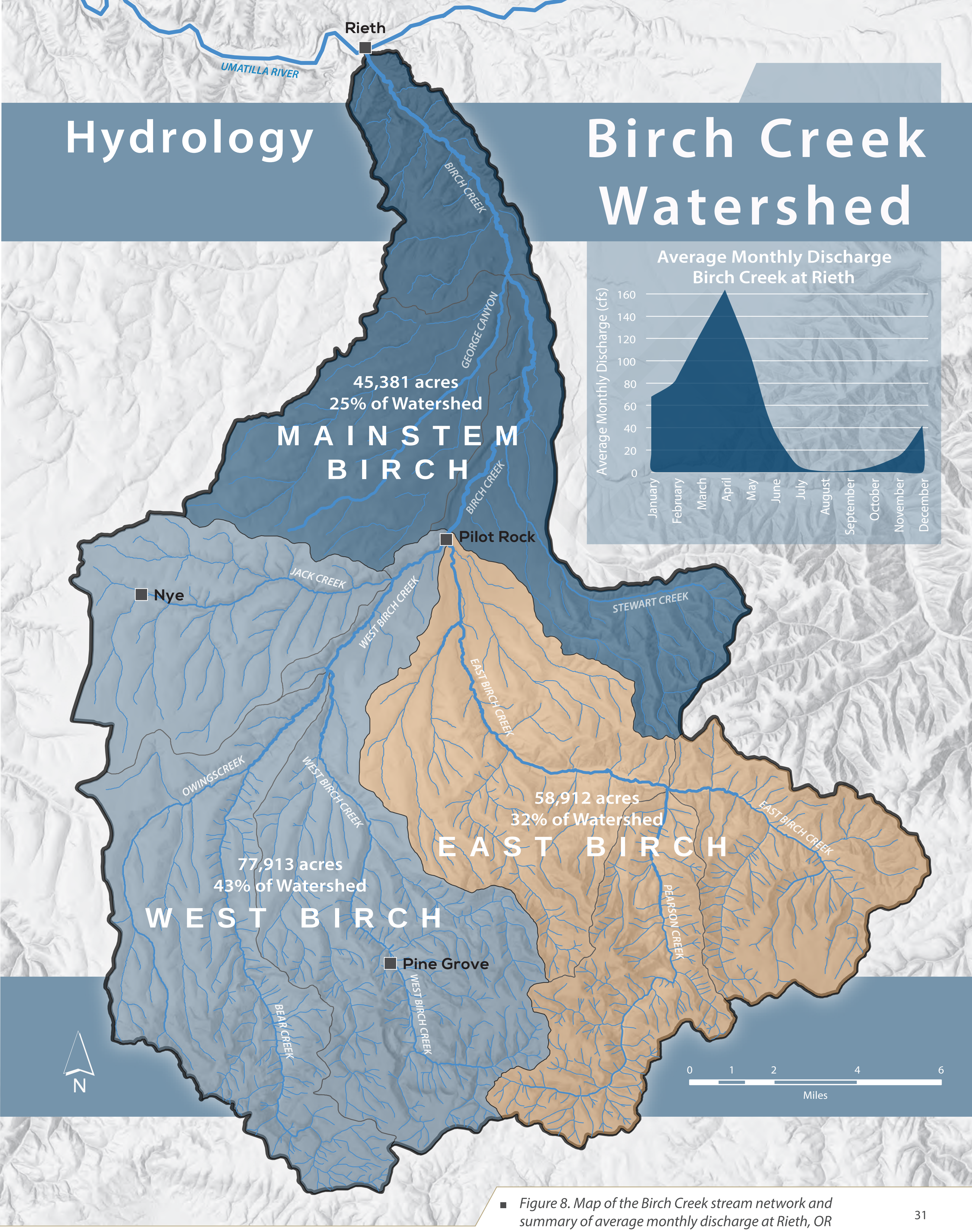


Figure 7. Mean Annual Discharge 1922-2014

Hydrology

Birch Creek Watershed



■ *Figure 8. Map of the Birch Creek stream network and summary of average monthly discharge at Rieth, OR*

Sediment

The estimated hillslope sediment erosion varies among the nine HUC12 subbasins within the Birch Creek watershed. The average annual total sediment loading to stream channels within the subbasins is lowest in Pearson Creek and highest in George Canyon (Figure 9). These sediment loading estimates have remained consistent in most subbasins between the years 1992 and 2011, with the exception of George Canyon and Stewart Creek. In both of these subbasins, the increase in estimated sediment loading is attributed to a change in the predominant agriculture land use from wheat and pasture to row crops and hay. Of the total estimated sediment delivered to stream channels within the subbasins, the proportion transported to the outlet of each subbasin is lowest in the lower elevation subbasins – Coombs Peak, George Canyon, Jack Canyon and Stewart Creek – and highest in the upper elevation subbasins – Pearson Creek, Upper East Birch, Lower East Birch, Bear Creek and West Birch Creek. In lower elevations of the watershed, the hydrologic conditions (drier climate, ephemeral stream channels) and lower topographic relief result in approximately 1% to 9% of the total average annual sediment load being delivered to the outlet of the subbasin streams (Figures 9 and 10). In upper elevations of the watershed, the hydrologic conditions (wetter climate, perennial streams) and larger topographic relief result in 13% to 79% of the total average annual sediment load being delivered to the

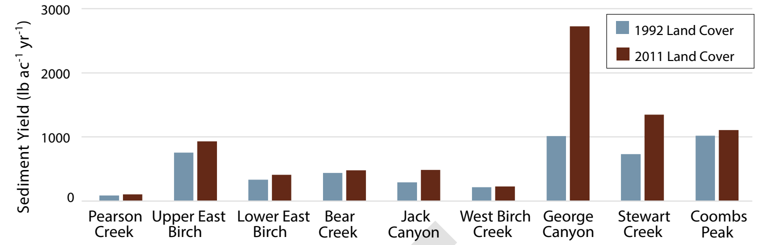


Figure 9. Average Annual Total Sediment Loading to Streams

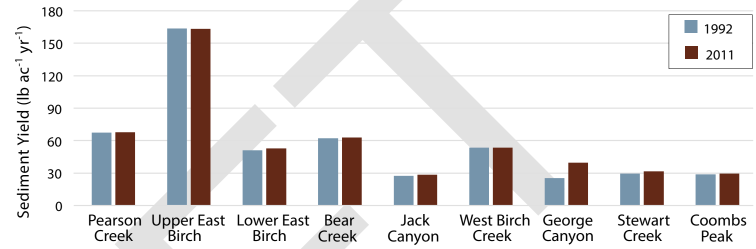


Figure 10. Average Annual Sediment Yield at Subbasin Outlet

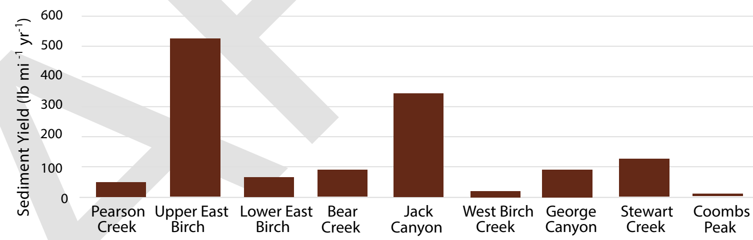


Figure 12. Potential Average Annual Sediment Delivery from Roads to Streams

outlet of the subbasin streams (Figures 9 and 10). Among all nine subbasins within the Birch Creek Watershed, Upper East Birch Creek contributes the largest amount of sediment to its outlet (Figure 11). The potential average annual sediment delivery from roads to stream channels was estimated to be highest in the Upper East Birch Creek subbasin and lowest in the Coombs Peak subbasin (Figure 12). The potential sediment erosion from roads is minor compared to hillslope erosion. However, the road network can have other negative effects on stream channels, including confinement of the river corridor along the valley bottom and fish passage barriers at stream crossings, both of which can contribute to increased stream bank erosion.

A relatively small proportion of the road network in the subbasins contributes the vast majority of sediment to streams. For example, in Upper East Birch Creek 6% of the road length (0.8 miles) contributes 80% of the potential sediment delivery to streams (Figure 13). These findings are consistent with recent road erosion research, and will help guide restoration treatments applied to the road network (Luce and Black, 1999; Croke and Hairsine, 2006).

Birch Creek Watershed

Sediment

Figure 13. Within each subbasin the (A) % of road length, and (B) length of road (mi.), responsible for 80% of potential sediment delivery to streams within each subbasin.

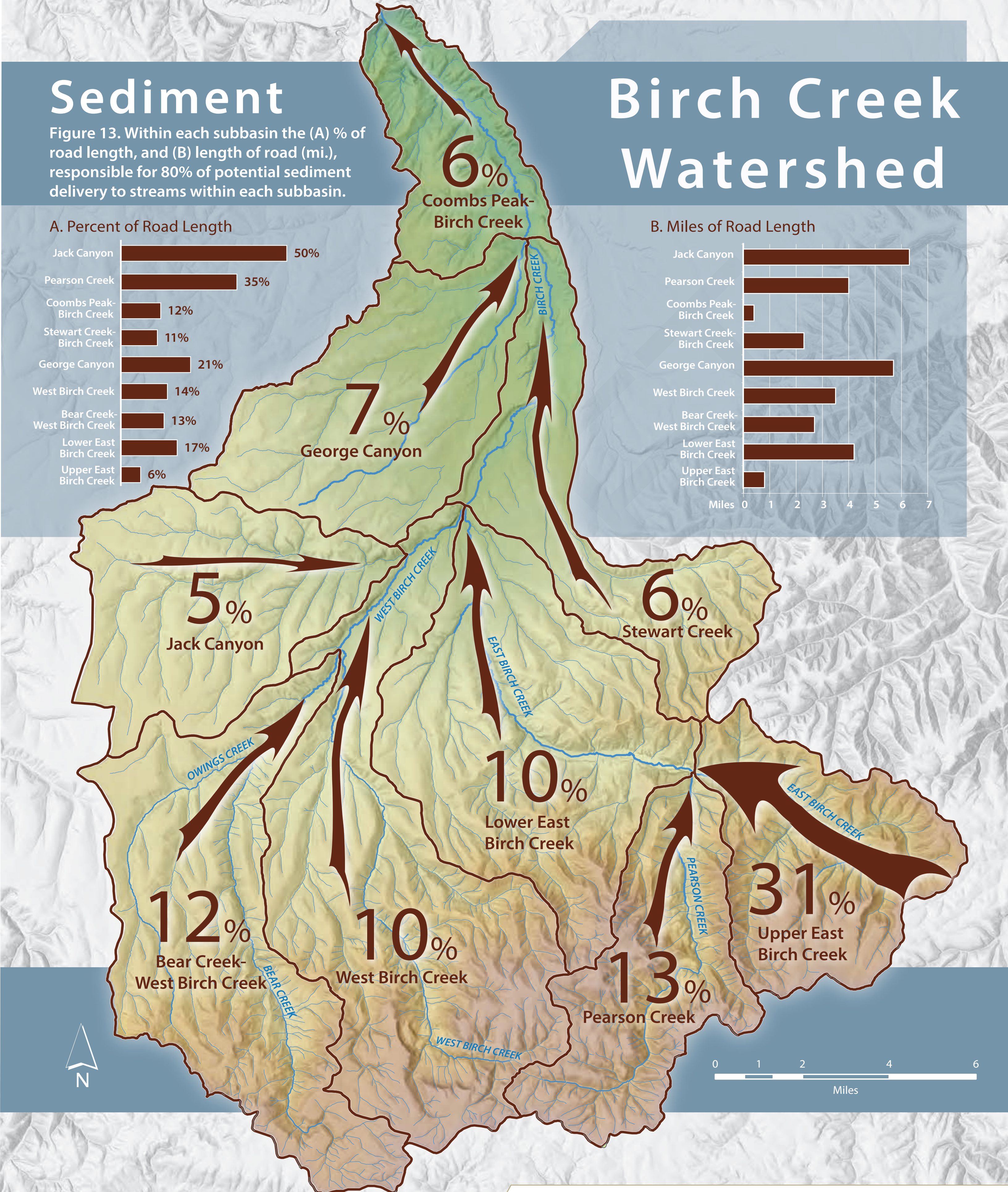


Figure 11. Map of the relative average annual sediment yield (%) among the nine subbasins

Watershed Assessment

Geomorphic Reaches

The physical characteristics of the Tier 1 streams vary significantly from the lower elevations of the Birch Creek watershed to the headwaters (Figures 14-16). Lower Birch Creek is comprised of five distinct geomorphic reaches situated largely in a broad, unconfined valley bottom. The stream flows through unconsolidated alluvial sand, gravel and cobble along the valley floor, while the valley walls are alternately comprised of basalt rocks and sedimentary rocks (Figure 14). All five geomorphic reaches have a slope of less than 0.9% with a corresponding pool-riffle channel morphology (Figures 15 and 16).

East Birch Creek is comprised of eight reaches that vary largely by channel slope and valley confinement (Figure 16). The slope along East Birch Creek increases from 1.3% in the downstream most reach (EB1) to 6.8% in the headwater reach (EB8) (Figure 15). The valley confinement alternates between partially confined and unconfined, with reach EB6 being the only confined reach along East Birch Creek. The stream in reaches EB1 through EB6 flows through unconsolidated alluvium along the valley bottom, suggesting these reaches are alluvial or partially-alluvial with pool-riffle and plane-bed channel types (Figure 14). In the higher slope reaches of EB7 and EB8, the channel types transition to step-pool/cascade with the valley bottom being comprised of basalt rocks rather than alluvial material.

Pearson Creek contains five reaches that vary by valley confinement and geology (Figure 16). The two downstream most reaches (P1 and P2) are situated in a confined valley that transitions from basalt rocks on the valley floor (P1) to unconsolidated alluvium (P2) (Figure 14). The slope of these reaches also indicate a transition in channel type from plane-bed (P1) to step-pool (P2) (Figure 15). Reaches P3 through P5 are also step-pool channel types within a partially confined valley comprised of unconsolidated alluvium (P3 and P4) and basalt rocks (P5) in the valley bottom.

The geomorphic characteristics of West Birch Creek change significantly along its course. There are eight distinct reaches (Figure 16) ranging from lower gradient, unconfined valley segments flowing through unconsolidated alluvium (WB1 and WB2) to the higher gradient, partially confined reach WB8 with a valley bottom comprised of landslide rocks (Figure 14). Reaches WB1 through WB6 have alluvial or partially-alluvial characteristics, with channel types transitioning from pool-riffle in lower slope reaches (WB1 and WB2) to plane-bed in higher slope reaches (WB3 – WB6) (Figure 15). The upstream most reaches (WB7 and WB8) are both high gradient streams with step-pool channel morphology.

Bear Creek contains six geomorphic reaches that vary by slope, valley confinement and geology (Figure 16). The downstream most reach (BR1) is a low gradient stream in a partially confined valley comprised of alluvium, with a corresponding pool-riffle channel morphology (Figures 14 and 15). Reaches BR2 through BR4 are situated in a confined valley comprised of alluvium (BR2 and BR4) and basalt rocks (BR3), with all three reaches exhibiting plane-bed channel morphology. Reaches BR5 and BR6 are both step-pool channel types that are contained within a partially confined to confined valley of intrusive rocks.

Geology & Channel Type

Birch Creek Watershed

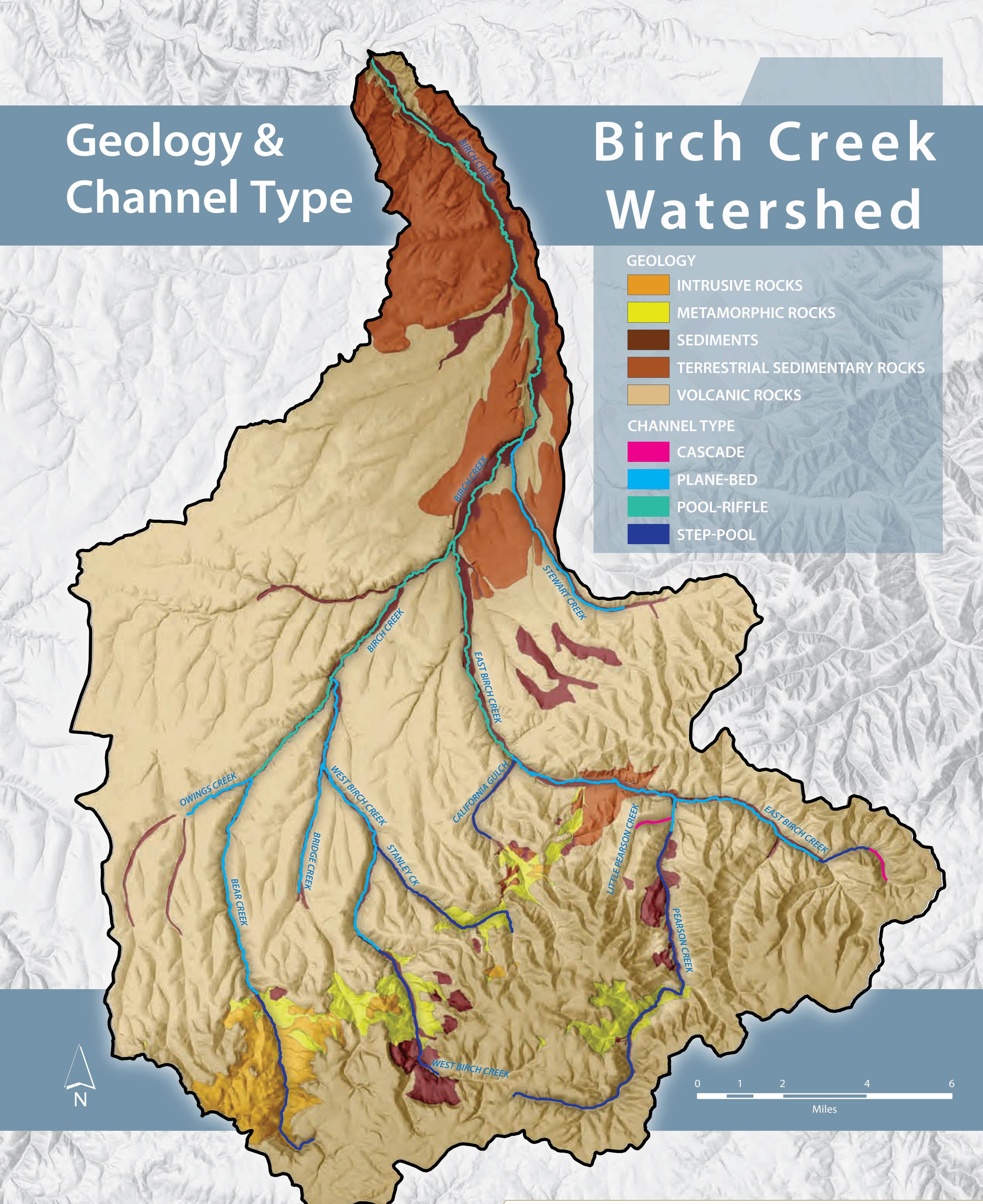
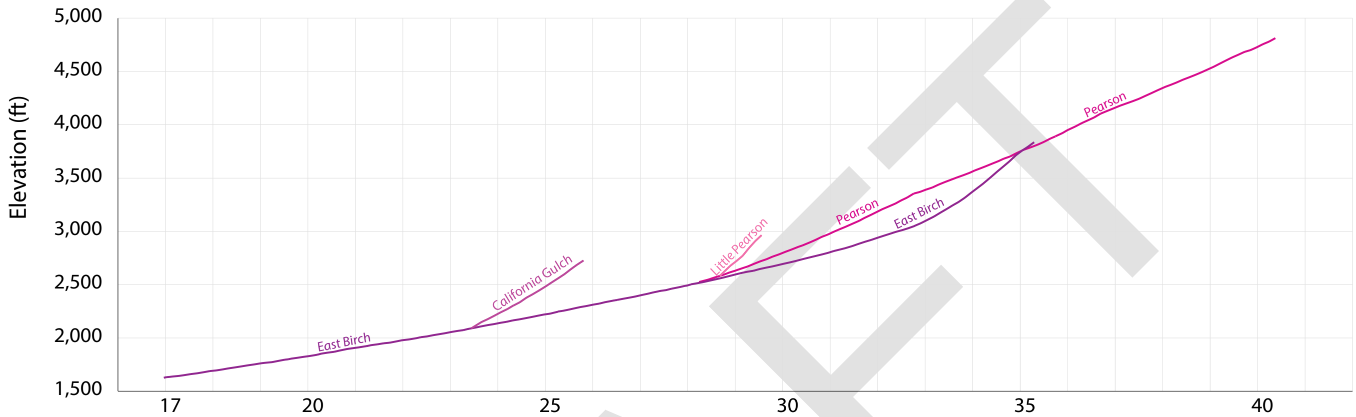


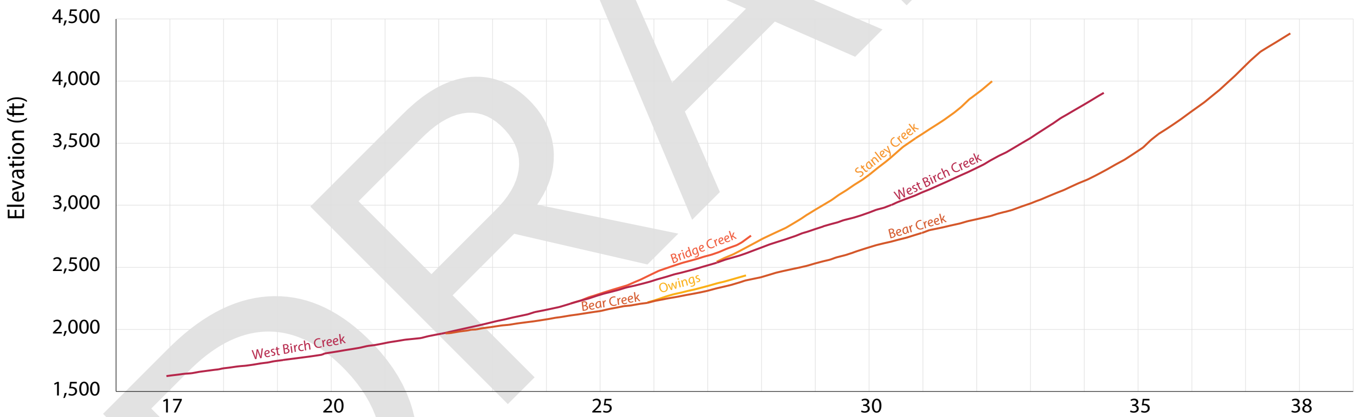
Figure 14. Map of the geology and channel type for geomorphic reaches

Geomorphic Reaches

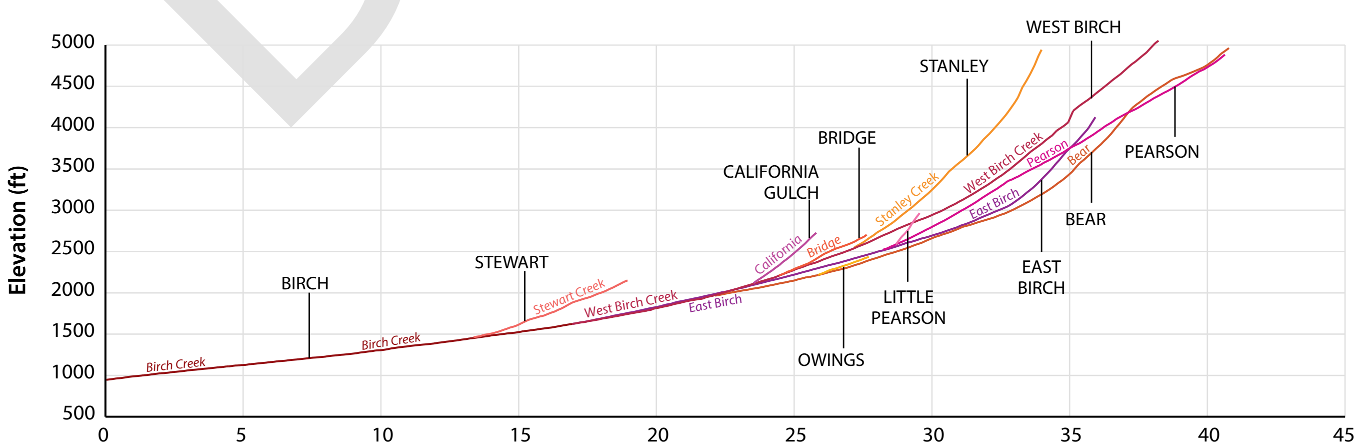
The stream channel gradients vary significantly from the lower elevations of the Birch Creek watershed to the headwaters (Figure 15). The lower gradient reaches in Lower Birch Creek, East Birch Creek and West Birch Creek are characterized by larger floodplains and unconfined valleys. The higher gradient reaches flow through more confined valleys with little to no floodplain area along the stream channels (Figure 16).



■ *A. East Birch Creek Watershed*



■ *B. West Birch Creek Watershed*



■ *C. Birch Creek Watershed*

■ *Figure 15 A,B,C. Geomorphic Reach Elevations Birch Creek Watershed*

Geomorphic Reaches

Birch Creek Watershed

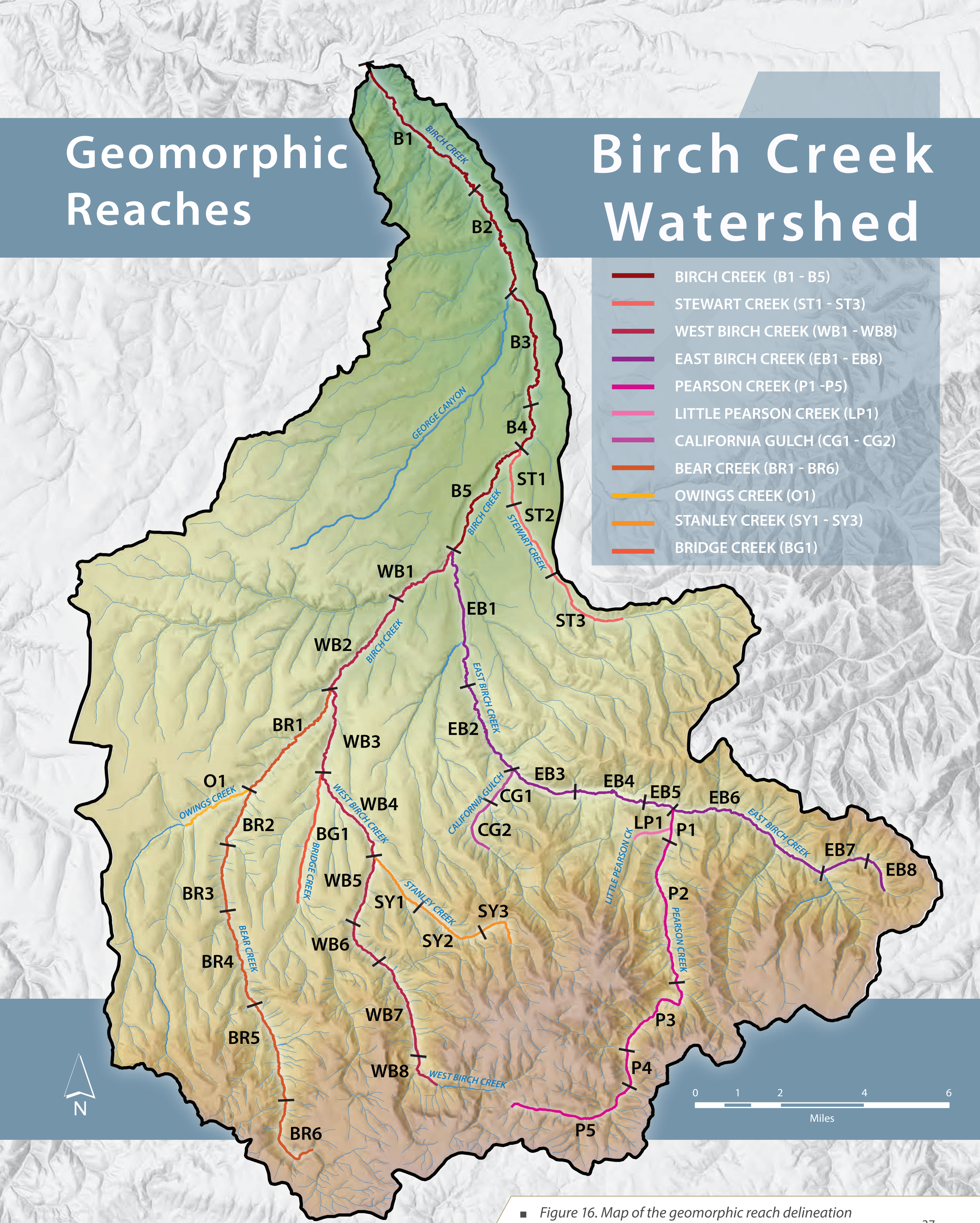


Figure 16. Map of the geomorphic reach delineation within the Birch Creek Watershed

Watershed Assessment

Steelhead Population Summary

Steelhead stock abundance has increased in the Umatilla Subbasin and Birch Creek during the past several decades (Figure 17). Abundance increases are largely attributed to out of subbasin actions such as management of the regional hydrosystem, improved dam passage performance and more reliable adaptive management of ocean and mainstem fisheries. Improvements in adult returns have outpaced habitat capacity in the Birch Creek watershed and consequently resulted in a corresponding decrease in productivity (recruits per spawner) (Figure 17). The decline in Birch Creek's productivity and habitat capacity (Figure 18), relative to the increase in abundance, suggests that habitat conditions are limiting population growth throughout the system.

Birch Creek is limited in terms of the number of spawners and redds it can accommodate, the number of fish it can rear, and the number smolts it can produce.

Current conditions throughout the Birch Creek watershed limit returns and stock sizes in the area of the current equilibrium abundance owing largely to relatively widespread degradation of habitat.

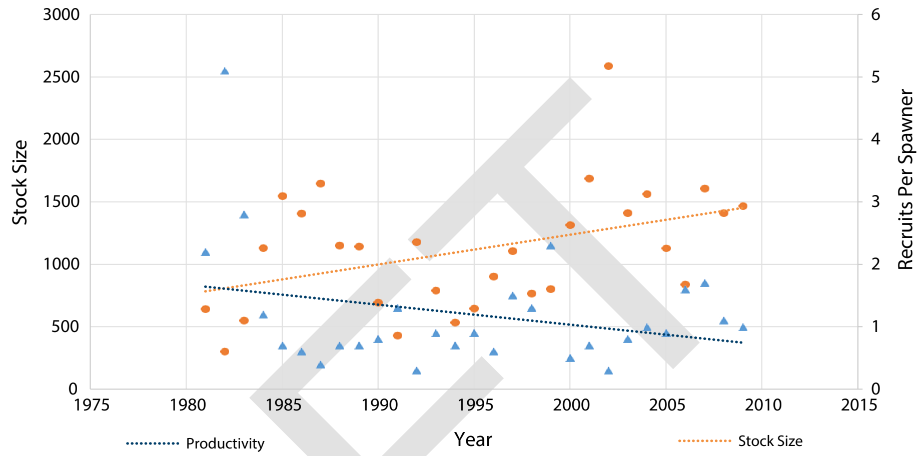


Figure 17. Birch Creek summer steelhead approximate stock size and recruitment per spawner ratios

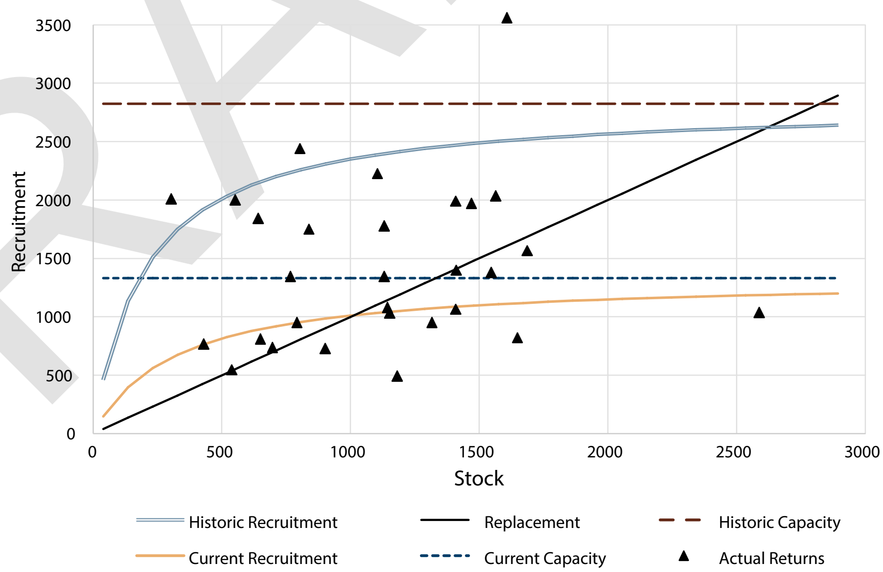
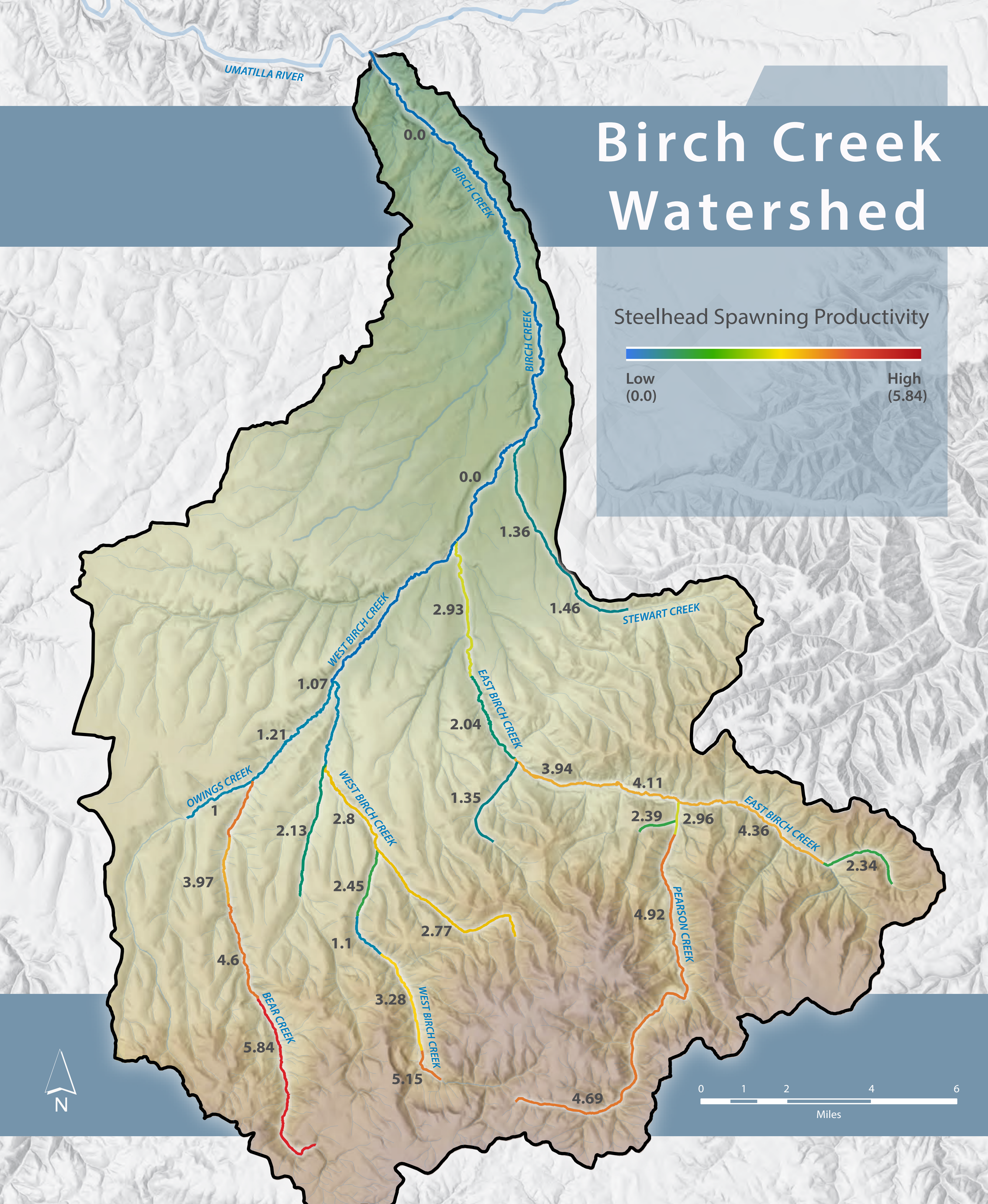


Figure 18. Current and historic steelhead productivity and habitat capacity estimates for the Birch Creek Watershed

Birch Creek Watershed



■ *Figure 19. Modeled steelhead spawning productivity throughout the Birch Creek watershed*

Steelhead Population Summary

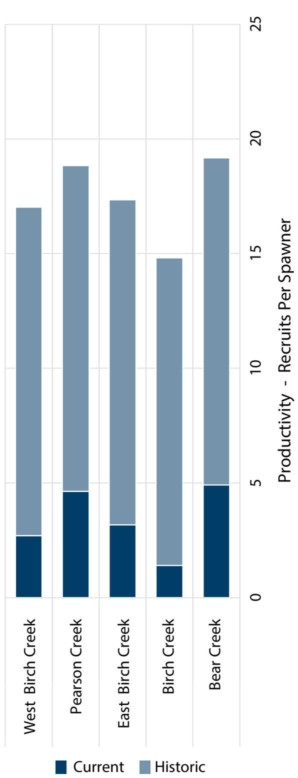
Relatively high steelhead productivity areas, that support the remaining population, are generally located in the upper reaches of the watershed (Figure 19). Improvements in locally limiting conditions can be expected to result in increased productivity and capacity and, in-turn, result in increased recruitment and average stock sizes. In theory, a complete restoration to historic conditions would result in returns and stock near the template equilibrium abundance. Currently an average of approximately 1,117 adult recruits return to the watershed annually, with peak recruitment of approximately 2,600 fish. A fully functional Birch Creek would be expected to return an average of closer to 3,000 fish, with peak recruitment of approximately twice that number of fish.

Each of the distinct geomorphic reaches has a unique hydrology, geomorphology, sediment, and fisheries ecology. The five Tier 1 tributaries in the Birch Creek Watershed – Lower Birch Creek, East Birch Creek, Pearson Creek, West Birch Creek and Bear Creek – include a high diversity of physical characteristics and fish distributions. However, some similarities exist among the reaches of each tributary due to their shared watersheds characteristics. Spatial patterns in environmental attributes, limiting factors, and population performance provide insight into the landscape of Birch Creek "through the eyes of steelhead," and will allow for development of restoration strategies that address limiting factors across the landscape.

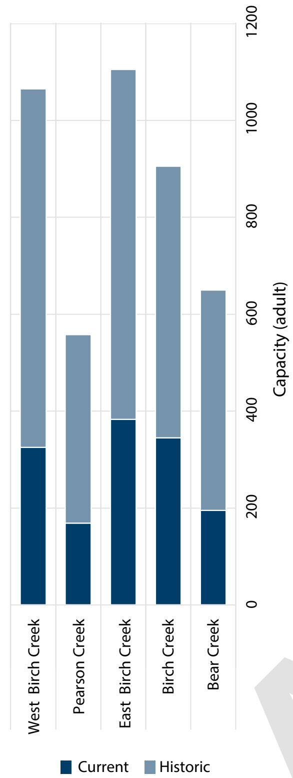
There are similarities between the current and historic estimates of productivity and capacity throughout the watershed. For example; while the current levels of productivity throughout all of the Tier 1 reaches is significantly lower than historic levels, the relative contribution of each tributary is similarly distributed (Figure 20) and generally highest in the upper reaches of the watershed (Bear Creek and Pearson Creek). Likewise, the trend in habitat capacity is similar (Figure 21), however, habitat capacity is generally highest in middle reaches of the watershed (East Birch Creek and West Birch Creek). These results suggest that spawning, egg incubation and early life stage rearing are most successful where they are not subjected to the threats of elevated temperatures and fine sediment, to which those stages are most sensitive. As sensitivity to water quality impairments decreases and density dependence increases, areas of the watershed with more capacity are better suited to support the more advanced rearing stages through smoltification. This similarity in trends between historic and current conditions might, in part, explain why the Birch Creek steelhead population continues to persist, albeit at depressed levels, and is a significant contributor to the larger Umatilla steelhead population.

Watershed-wide, water quality (temperature and sediment) is most limiting to productivity, followed by physical habitat quality and quantity. Temperature and sediment limit summer steelhead performance in Birch Creek, particularly at the spawning through early rearing life stages (Figure 22). Steelhead are highly sensitive to elevated temperatures and fine sediment because they result in direct mortality. Although the treatments to address sediment and temperature will likely include repairs to the riparian zone and the addition of wood, the benefits of these actions to the population will be directly limited by the extent to which they relax the limitations of temperature and sediment.

Bedscour is another primary limiting factor that disrupts egg incubation by directly scouring redds, or by scouring just upstream of redds and burying them below a functional depth of substrate. Bedscour is more limiting to egg incubation than fine sediment, but only marginally impacts other rearing life stages (Figure 22). A related attribute, high flow



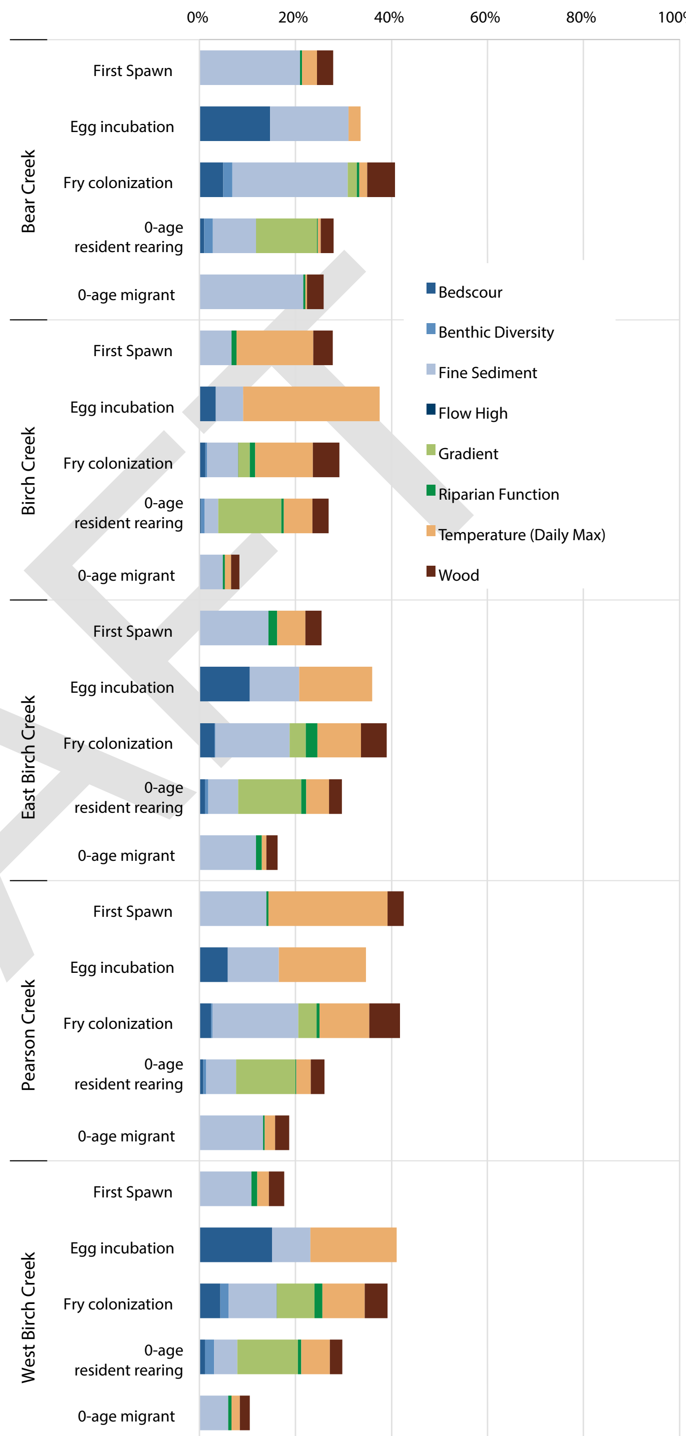
■ *Figure 20. Estimation of current and historic productivity (recruits per spawner) for Tier 1 streams*



■ *Figure 21. Estimation of current and historic capacity for Tier 1 streams*

frequency, is degraded in numerous reaches but has almost no impact on the population. Likewise, Benthos diversity, while important to ecosystem function and the overall health of Birch Creek, is degraded in numerous reaches but has almost no influence on the performance of any life stage.

Gradient is limiting to the productivity of fry and rearing fish in all tributaries (Figure 22). Gradient increases the work requirements needed to secure food, and indirectly reduce survival through decreased growth and survival. Gradient cannot be improved in all cases, and may be related to the natural limitations and natural processes. However, the loss of Beaver Ponds and natural log jams reduces the effective gradient of Birch Creek and limits productivity and capacity for summer steelhead.



■ *Figure 22. Limiting factors for each Tier 1 stream from first spawn through 0 age migrant*

Fish Passage Connectivity

Birch Creek contains a variety of passage barriers that have been constructed using a diversity of techniques and of variable quality. In general, adult steelhead appear to have access to all or the great majority of their historic range throughout the watershed and no critical adult passage issues were identified. However, individually and collectively, the barriers identified are a concern due to the potential for restricting migration between habitats and subsequently reducing the overall productivity of steelhead. A total of 73 potential fish passage barriers were identified through the assessment (Figure 23). Of the 73 potential barriers, 40 are minor risk barriers, 22 are moderate risk barriers and 11 are major risk barriers (Table 7).

Lower Birch Creek includes several barriers that appear to be currently functional but include concrete aprons, weirs, or notches. East Birch Creek, the most productive of the tributaries, includes multiple temporary obstructions such as pushup dams and rock weirs that may be deserving of passage maintenance actions. The lower reaches of West Birch Creek are similarly obstructed by a mixture of concrete and other structures that present some risk to upstream fish passage. In particular, the most downstream reach of West Birch Creek (WB1) includes a series of concrete structures that may limit passage under certain flow conditions.

In addition to barriers created by structures placed in the streams and/or channel modifications, dewatered reaches and/or restrictive channel slope occur throughout the watershed. Most notably are dewaterd reaches in East and West Birch Creek that likely occur in greater frequency then they did historically. These potential seasonal barriers also contribute to overall loss of habitat capacity. Restoration of flows will increase connectivity and increase some of the life history diversity lost due to migration impediments.

Table 7. Summary of potential passage barriers by tributary and risk rating

Stream Name	Minor	Moderate	Major
Birch Creek	4	4	8
Bridge Creek	1	0	0
California Gulch	2	0	0
East Birch Creek	13	8	0
Pearson Creek	10	6	1
Stanley Creek	1	0	0
West Birch Creek	9	4	2
Totals	**40**	**22**	**11**

Fish Passage Barriers

Birch Creek Watershed

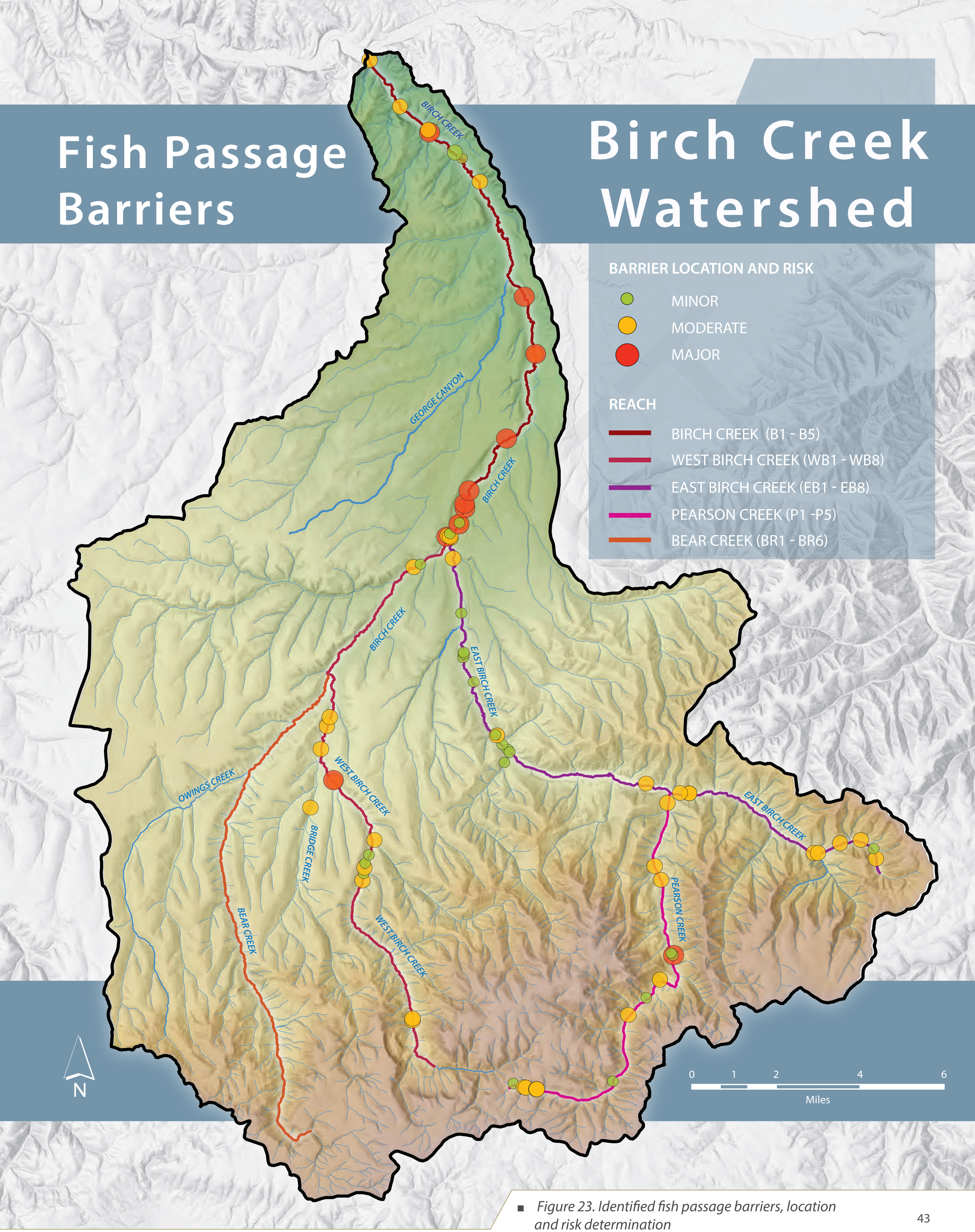


Figure 23. Identified fish passage barriers, location and risk determination

Sub-Basin and Tributary

Sub-Basin Assessments

Birch Creek Watershed was assessed in a tiered approach based on steelhead distribution. The subwatersheds of Mainstem Birch, East Fork Birch, West Fork Birch, Pearson, and Bear Creek were analyzed at a reach scale for physical functional metrics and fish habitat attributes.

The five Tier 1 tributaries in the Birch Creek Watershed—Lower Birch Creek, East Birch Creek, Pearson Creek, West Birch Creek and Bear Creek—comprise a high diversity of physical characteristics and fish distribution. All the unique geomorphic reaches within these streams encompass a broad range of hydrologic regimes, hydraulic conditions, geology, topography and riparian vegetation characteristics.

These reach-scale characteristics combine to form a template of distinct geomorphic reaches that control the types of riverine ecosystems and habitats that can develop along the stream corridors.

Each of the 32 geomorphic reaches are important to native salmonids at different times throughout the year as these fish complete the freshwater stage of their life history.

An understanding of the hydrologic, hydraulic, geomorphic and physicochemical characteristics within the 32 Tier 1 reaches will help to identify restoration strategies that range from protection of important areas to improved resource management practices and instream-floodplain habitat creation.

River Vision Touchstones

Riparian Vegetation - Floodplain development and riparian encroachment from land management activities have reduced or removed native vegetation in specific reaches. Streambank and floodplain stability and channel complexity are reduced.

Aquatic Biota - Although steelhead spawning is distributed broadly throughout the primary and secondary (Tier 1 and 2) stream segments, successful egg incubation is dependent on those reaches with high quality habitat and water temperature.

Connectivity - Channel encroachment and floodplain modification in the specific areas have resulted in entrenched stream reaches and a lack of connectivity with a floodplain.

Hydrology - East Birch Creek contributes a larger quantity of flow per area than West Birch Creek. Low summer flows combined with irrigation water withdrawals in the lower tributaries and mainstem during the warm summer season creates poor conditions for aquatic habitat and migration opportunities for steelhead.

Geomorphology - Large woody material influences habitat formation and channel form mainly in the upper portions of the watershed dominated by coniferous forest. Channel form in lower reaches are highly influenced by land management activities.

Birch Creek - Mainstem

Lower Birch Creek extends approximately 16.8 miles from the Umatilla River upstream to the confluence with East Birch Creek in the City of Pilot Rock (Figure 24). There are five geomorphic reaches along this distance, ranging in length from 1.3 miles (B4) to 4.9 miles (B1). The physical characteristics of these reaches are summarized in Figure 25.

All of the Lower Birch Creek reaches experience extremely low stream flow during the late summer months of July through September. During the field surveys in 2015, there was no surface water flow in portions of all of the reaches. The percentage of reach lengths dewatered ranged from 15% in reach B4 to 47% in reach B3. Based on data from The Freshwater Trust (2010), the amount of surface water rights in all of Lower Birch Creek exceeds the natural stream flow from July through September. These low stream flows contribute to late-summer elevated water temperatures observed in Lower Birch Creek.

Despite being situated within a large, unconfined valley bottom, all of the Lower Birch Creek reaches have been disconnected from the floodplain over the range of low (2-year) to high (100-year) flood discharges. As an indicator of channel straightening, all of the reaches are much less sinuous than expected, with sinuosity ranging from 1.14 (B3 and B4) to 1.33 (B2). In response to channel straightening, reaches B1 through B4 have become incised vertically into the valley bottom, with entrenchment ratios ranging from 2.2 to 2.8. Reach B5 is less incised and better connected to the floodplain, with a larger entrenchment ratio of 6.0. At the larger 100-year flood discharge, the percentage of the valley bottom inundated ranges from 34% (B4) to 55% (B5), indicating significant floodplain disconnection.

The entrenched characteristics of the Lower Birch Creek reaches result in high shear stress being applied within the channel over the range of low to high flood discharges. The channel:total shear stress ratios for the 100-year discharge ranged from 1.82 to 2.82, indicating that much of the available energy from the flow is being applied to the stream channel rather than being distributed across the floodplain.

The hydraulic characteristics for the 2-year discharge result in the estimated transport stage (Φ, ratio of applied shear stress to critical shear stress for a given grain size) indicating mobility of the median grain size (D50) in all reaches except B3. However, the transport stage for the larger D84 grain sizes indicates mobility only in reach B1 where $\Phi = 1.27$; in all other reaches $\Phi < 1.0$. This finding suggests that the bed surface grain sizes in reaches B2 – B5 are larger than what can be mobilized by the 2-year discharge.

The amount of large wood present in all Lower Birch Creek reaches was much less than would be expected, and much less than benchmark values used by resource management agencies. The average number of large wood pieces per 100 meters ranged from 0.2 to 1.1. The average number of log jams per kilometer ranged from 0.4 to 1.9. These low densities of large wood material are likely a result of a low wood supply from the riparian zone and from upstream sources.

■ *Figure 24. Location map and photograph of Lower Birch Creek*

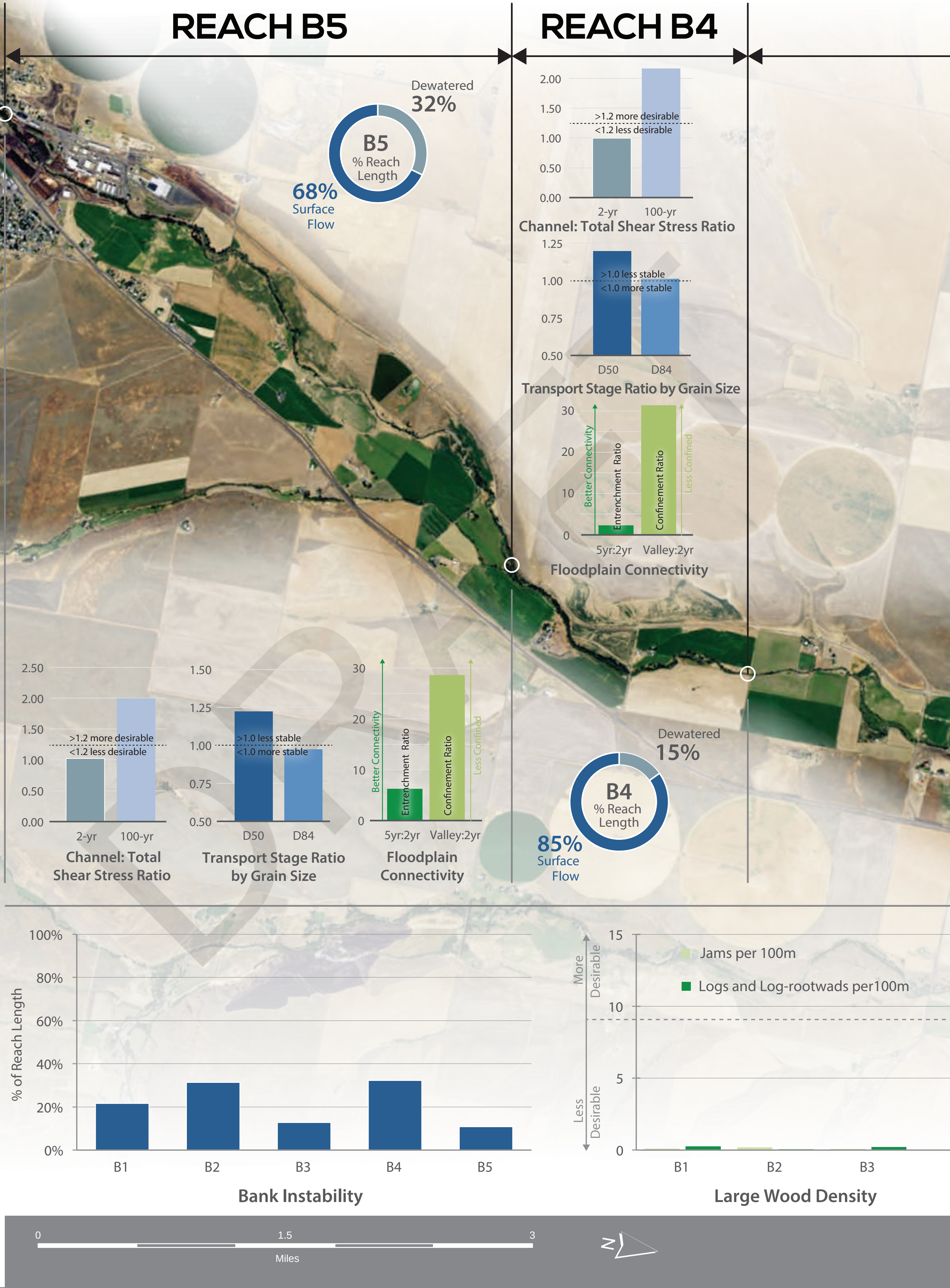
Field surveys from 2015 indicate that streambank instability is a concern in all reaches of Lower Birch Creek. The percentage of bank instability ranged from a low of 11% (B5) to a high of 32% (B4). The bank stability problems are compounded by the placement of bank revetments in all reaches, the vast majority of which were observed to be non-native riprap and large boulders.

All of the Lower Birch Creek reaches contain a large portion of geomorphic units characterized as pools. The average number of pools per kilometer ranged from 10.0 (B5) to 22.6 (B4), hitch is in the high functionality range based on regional performance standards. The average percentage of a reach comprised of pool was also high functioning for all reaches, ranging from 32% (B5) to 60% (B4). However, the pool frequency (channel widths between pools) was lower than expected, ranging from 1.1 (B2) to 5.6 (B5). This short spacing between pools reflects the straightened, entrenched characteristics of most Lower Birch Creek reaches, wherein the local hydraulic conditions result in frequent bed scour.

The sediment mobility characteristics in Lower Birch Creek result in variable substrate habitat quality conditions. The average gravel percentage in riffles was high in reaches B1 (58%) and B2 (63%), while ranging from only 11% to 30% in reaches B3 – B5. The lack of available gravel is a result of many factors, including the hydraulic characteristics caused by entrenchment and the lack of large wood material and other in-channel roughness that is responsible for sorting and storing bed material that is being transported through a reach. The amount of fine sediment in riffles indicates high habitat quality, with the average percent fines in riffles ranging from 5% (B4) to 11% (B2).

Field surveys from 2015 indicate that the lack of mature riparian vegetation plant communities is a concern in all reaches of Lower Birch Creek. The average percent of a stream reach that was shaded by riparian vegetation ranged from 13% (B2) to 29% (B3). In reaches B1 and B2 the riparian vegetation was dominated by shrubs and herbaceous vegetation, while in reaches B3 – B5 trees comprised 40% - 50% of the riparian shade. The entrenched channel conditions in these reaches has likely lowered the water table and reduced the water availability for riparian vegetation. This lack of mature riparian vegetation plant communities contributes to late-summer elevated water temperatures observed in Lower Birch Creek.

Birch Creek - Reach Summary



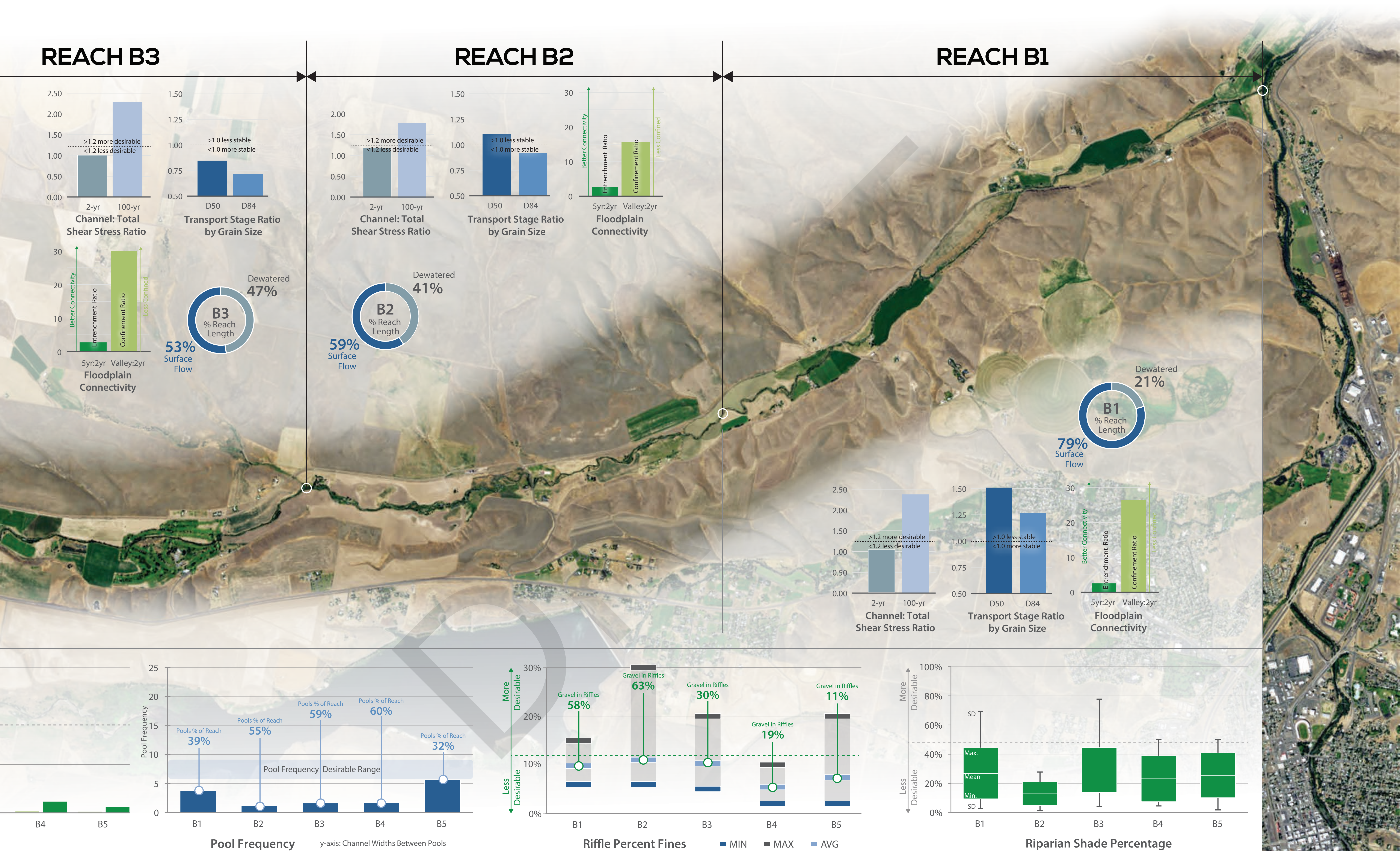


Figure 25. Geomorphic assessment reach summary of Lower Birch Creek

Birch Creek - Reach Function

Results of the watershed and reach assessments indicate a large range of hydrogeomorphic functionality exists among the Lower Birch Creek reaches (Figure 26).

The hydrologic parameter of flow duration is one of the lowest indicators, which is largely driven by the significant surface water withdrawals and dewatering of Lower Birch Creek reaches.

Large wood material transport and storage is another low functioning parameter due to the very low quantities of large wood present in these reaches.

Elevated water temperatures, as a result of low stream flow, the lack of riparian vegetation and a channel that is disconnected from the floodplain, represent a significant water quality concern in Lower Birch Creek.

The overall hydrogeomorphic functionality in Lower Birch Creek ranges from 29% of fully functional (B1) to 44% of fully functional (B5) (Figure 27).

The lowest performing functional categories are hydrology and physicochemical, due to low stream flows and lack of riparian shading.

The highest performing categories are hydraulic and geomorphology, largely due to the streambed material composition and sediment transport characteristics.

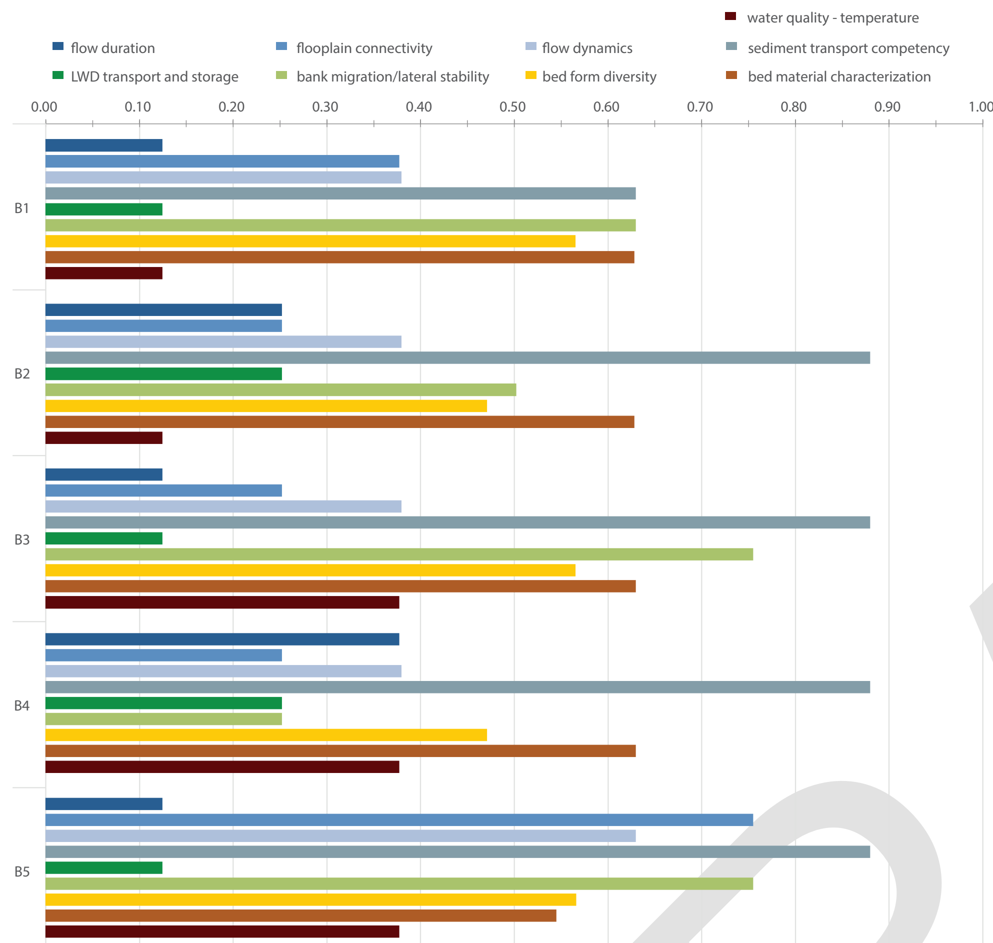


Figure 26. Functional parameter scores by reach in Lower Birch Creek

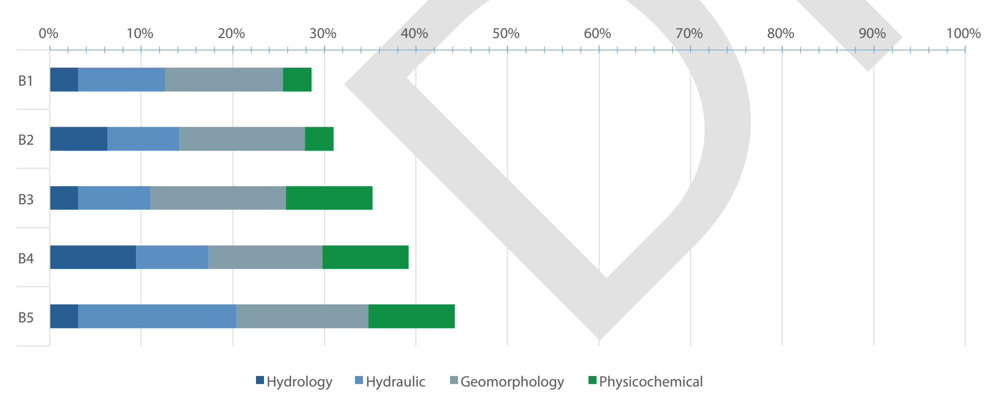


Figure 27. Functional category relative percent of total reach function in Lower Birch Creek

Birch Creek - Reach Fishery

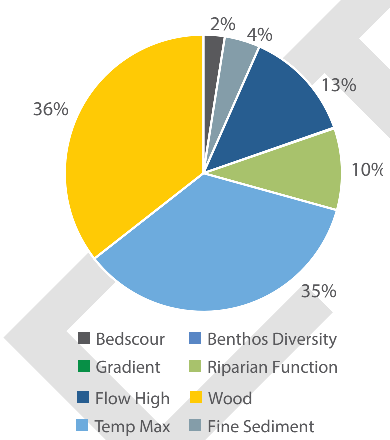


Figure 28. Steelhead limiting factors distribution in Lower Birch Creek

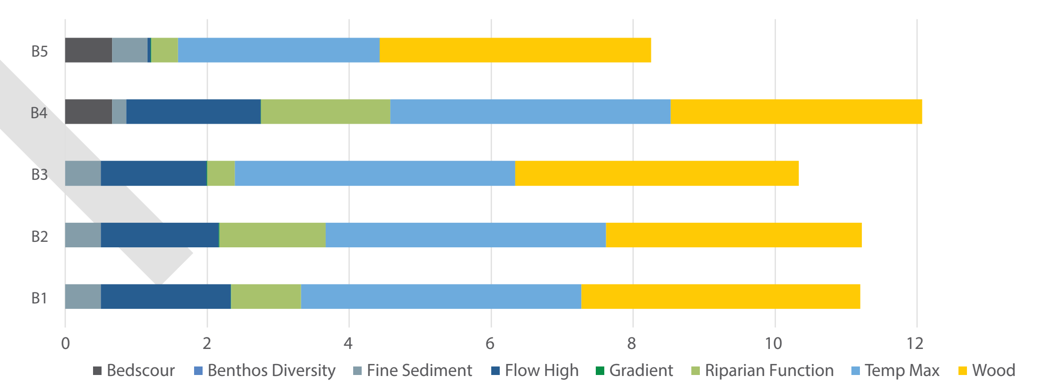


Figure 29. Steelhead limiting factors distribution by reach in Lower Birch Creek

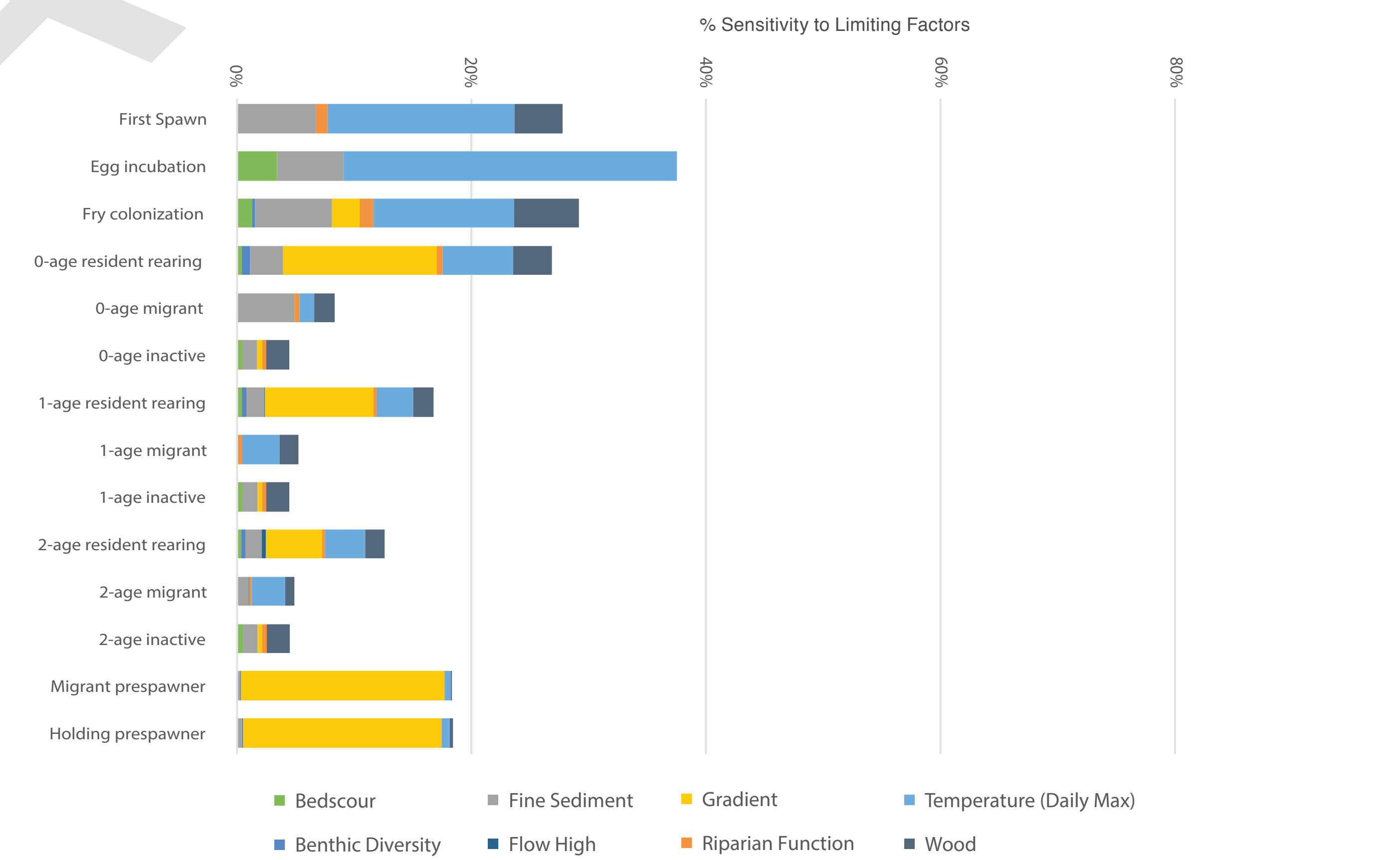


Figure 30. Steelhead sensitivity (%) to limiting factors by life stage in Lower Birch Creek

Birch Creek - Reach Fishery

Steelhead Population and Habitat Limiting Factors

Lower Birch Creek reaches are subjected to cumulative impacts that occur in upstream tributaries throughout the watershed. Daily maximum stream temperature is the primary limiting factor for steelhead in Lower Birch Creek (Figures 28 and 29). The inheritance of water from degraded conditions upstream as well as water withdrawals, have resulted in elevated water temperatures that are unsuitable for steelhead in the summer. Contributing to the elevated temperature is a relatively early successional riparian community that is lacking the canopy necessary to provide buffering shade.

All steelhead life stages are sensitive to elevated temperatures, with spawning, egg incubation, and juvenile rearing stages being the most sensitive (Figure 30). In the case of Lower Birch Creek, temperatures become unsuitable for steelhead early in the season, and therefore impact the earliest life stages first. Specifically, late fall temperatures and early spring temperatures greatly reduce the productivity of the steelhead population.

Historically, Lower Birch Creek reaches were likely among the lowest in productivity (recruits per spawner) throughout the watershed. However, that estimation is more a reflection of the historically highly productive middle and upper reaches rather than depressed mainstem contributions. Conversely, Lower Birch Creek was likely among the highest in terms of habitat capacity, owing largely to the relative size and complexity of these reaches.

Independent of the temperature impacts, the current physical adult habitat capacity in Lower Birch Creek is approximately 62% of historic conditions (Figure 31). However, due to multiple sources of degradation, productivity in Lower Birch Creek is less than 10% of historic (Figure 31). Collectively, the reduction in productivity and capacity, in Lower Birch Creek reaches, has resulted in an equilibrium abundance that is less than 20% of historic, and a population with substantial restoration potential and need.

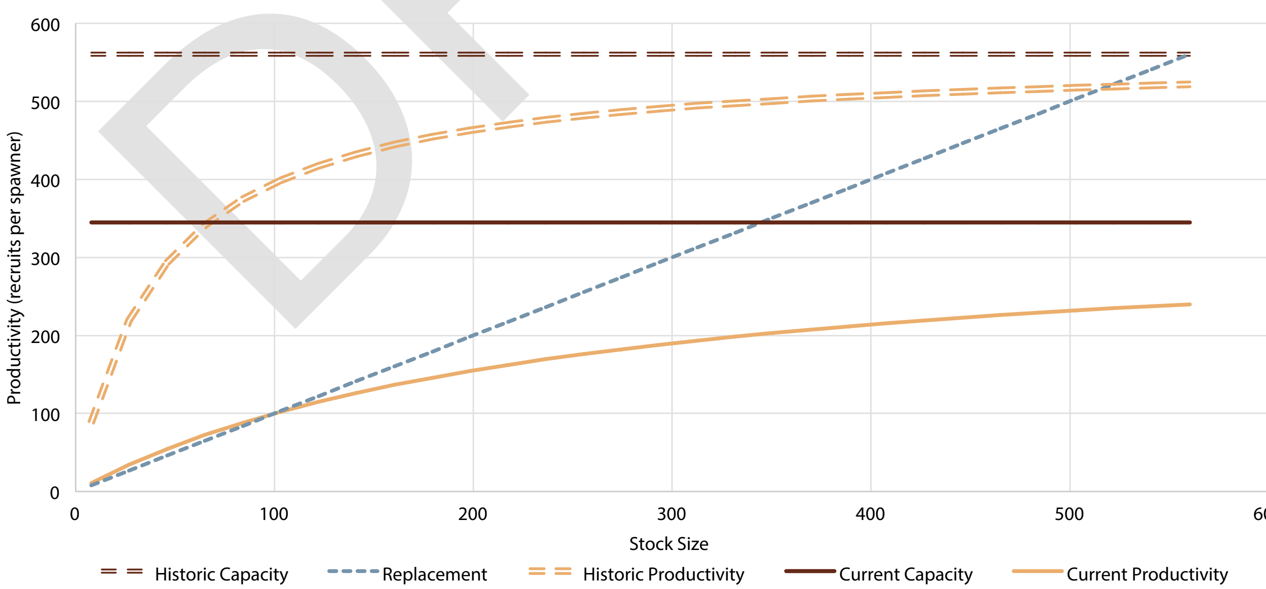


Figure 31. Stock recruitment relationships for the current and historic scenarios based on habitat productivity and capacity in Lower Birch Creek.

East Birch Creek

East Birch Creek extends approximately 19.2 miles from the confluence with Birch Creek in the City of Pilot Rock upstream to the headwaters of the watershed (Figure 32). There are eight geomorphic reaches along this distance, ranging in length from 0.9 miles (EB5) to 4.6 miles (EB6). The physical characteristics of these reaches are summarized in Figure 33.

Several East Birch Creek reaches experience extremely low stream flow during the late summer months of July through September. During the field surveys in 2015, there was no surface water flow in portions of reaches EB1, EB3, and EB4, all of which are downstream from the confluence with Pearson Creek. The percentage of reach lengths dewatered ranged from 16% in reach EB3 to 35% in reach EB4. Based on data from The Freshwater Trust (2010), the amount of surface water rights in East Birch Creek are approximately half of the natural stream flow from July through September. These low stream flows contribute to late-summer elevated water temperatures observed in East Birch Creek.

Despite being situated within unconfined or partially-confined valley bottom, East Birch Creek reaches EB1 through EB3 have been disconnected from the floodplain. As an indicator of channel straightening, all of the reaches are much less sinuous than expected, with sinuosity ranging from 1.10 (EB3) to 1.15 (EB1). In response to channel straightening, reaches EB1 through EB3 have become incised vertically into the valley bottom, with entrenchment ratios ranging from 1.74 to 2.62. Reaches EB4 and EB5 are less incised and better connected to the floodplain, with a larger entrenchment ratio of 2.84 and 2.61, respectively. At the larger 100-year flood discharge, the percentage of the valley bottom inundated ranges from 40% (EB3) to 55% (EB2), indicating significant floodplain disconnection.

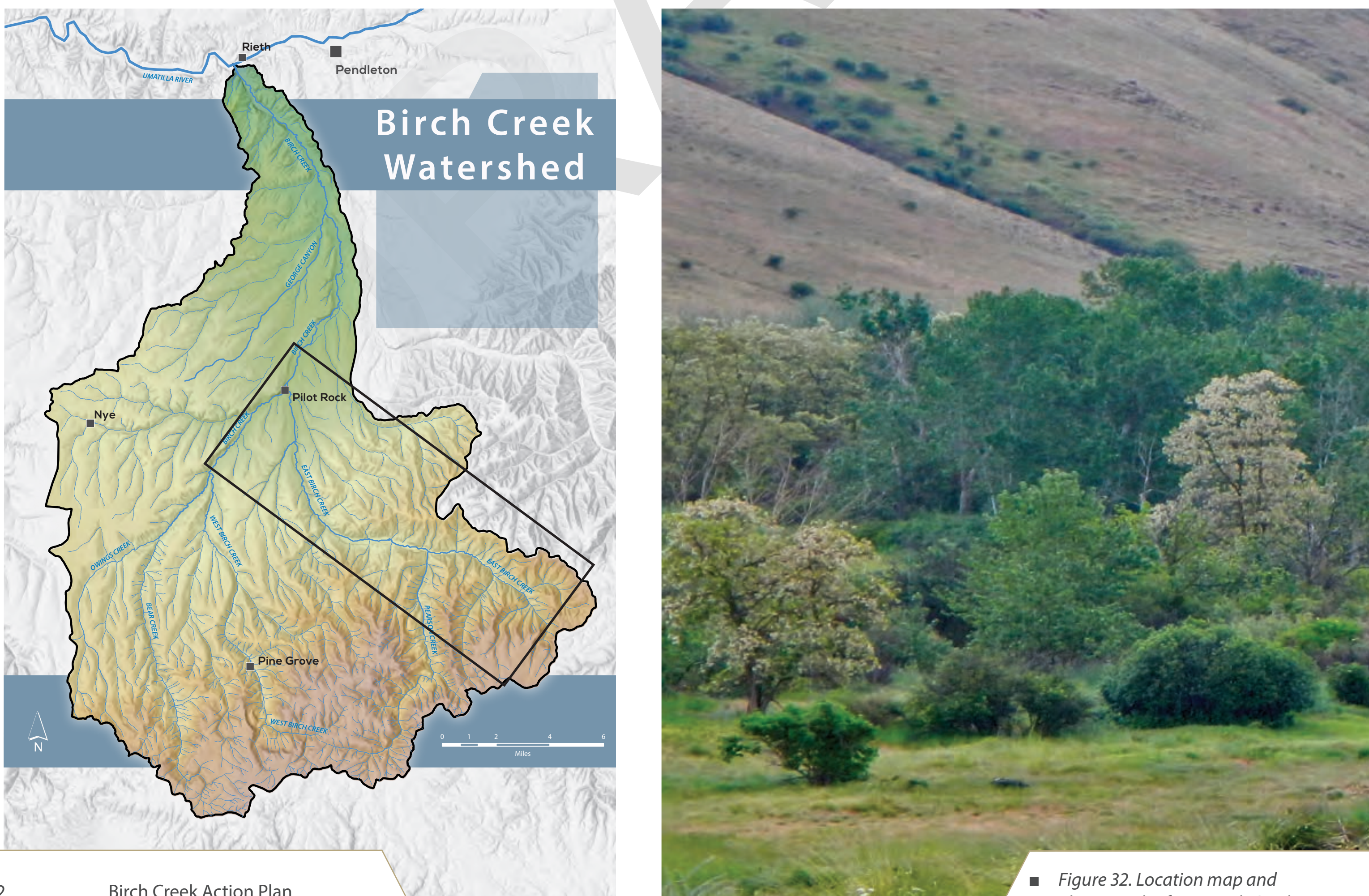
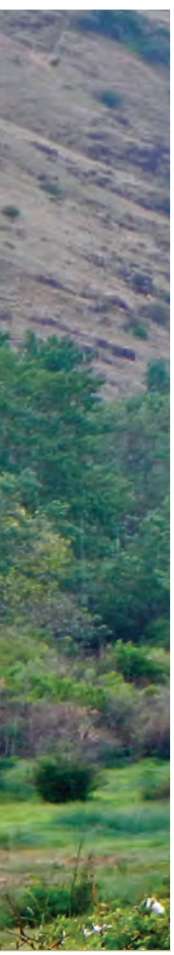


Figure 32. Location map and photograph of East Birch Creek



The valley narrows upstream of Pearson Creek, and East Birch reaches EB6– EB8 become naturally confined or partially confined. The natural channel confinement is exacerbated in these reaches by the presence of East Birch Creek Road along the valley bottom, especially in reaches EB7 and EB8.

The entrenchment and confinement of the East Birch Creek reaches result in high shear stress being applied within the channel over the range of low to high flood discharges. The channel:total shear stress ratios for the 100-year discharge ranged from 1.37 to 2.02, indicating that much of the available energy from the flow is being applied to the stream channel rather than being distributed across the floodplain.

The hydraulic characteristics for the 2-year discharge result in the estimated transport stage (Φ, ratio of applied shear stress to critical shear stress for a given grain size) indicating mobility of the median grain size (D50) in all reaches. The transport stage for the larger D84 grain sizes indicates mobility in reaches EB3 – EB5 ($\Phi > 1.2$) and EB7 – EB8 ($\Phi > 2.1$); in all other reaches $\Phi < 1.2$. This finding suggests that bedload being transported from higher gradient reaches (EB6 – EB8) is being stored in lower gradient reaches EB1 and EB2. This finding is consistent with field observations that indicate the channel morphology in these lower gradient reaches is responding to upstream sediment supply through aggradation and channel migration.

The amount of large wood present in all East Birch Creek reaches was much less than would be expected, and much less than benchmark values used by resource management agencies. The average number of large wood pieces per 100 meters ranged from 0.3 to 4.0. Log jam density was better, with the average number of log jams per kilometer ranging from 1.0 to 12.1. These low densities of large wood material are likely a result of a low wood supply from the riparian zone and from upstream sources.

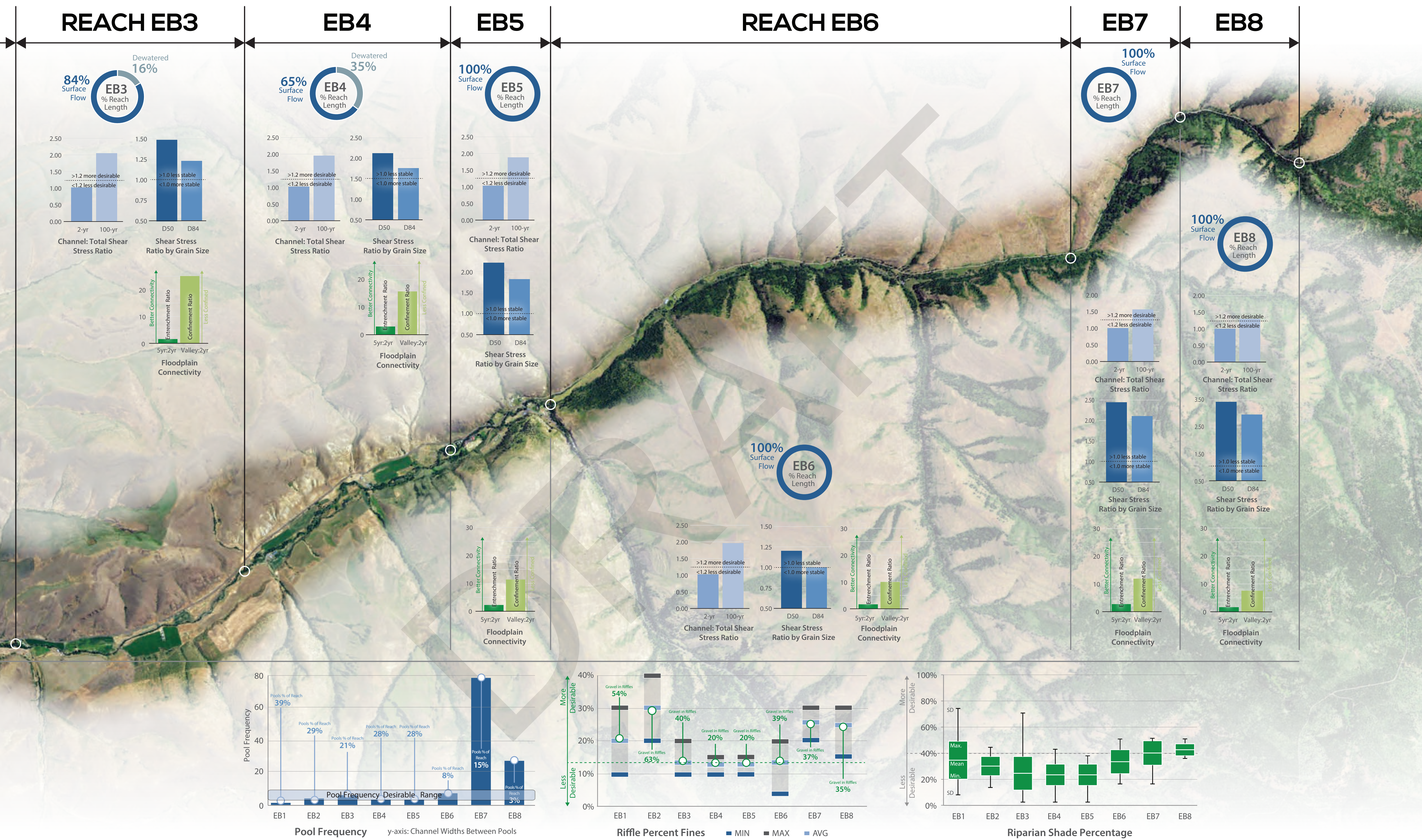
Field surveys from 2015 indicate that streambank instability is a concern in nearly all reaches of East Birch Creek. Reaches EB4 and EB5 had only 6% of their reach lengths comprised of unstable banks. The percentage of bank instability in the remaining reaches ranged from 13% (EB7) to 67% (EB1).

Nearly all of the East Birch Creek reaches contain a large portion of geomorphic units characterized as pools. The average number of pools per kilometer ranged from 2.7 (EB7) to 18.9 (EB1), which is in the high functionality range based on regional performance standards. The average percentage of a reach comprised of pool was also high functioning in many reaches, ranging from 21% (EB3) to 37% (EB1). However, the pool frequency (channel widths between pools) was lower than expected in the reaches with pool-riffle channel types (EB1 and EB2), ranging from 1.4 (EB1) to 4.2 (EB2). This short spacing between pools reflects the straightened, entrenched characteristics of these two reaches, wherein the local hydraulic conditions result in frequent bed scour. The pool frequency was higher than expected in the reaches with step-pool/cascade channel types (EB7 and EB8), ranging from 28 (EB8) to 79 (EB7). This long spacing between pools reflects the channel confinement and lack of instream structure that typically creates the frequently repeating sequences of step-pool features.

The sediment mobility characteristics in East Birch Creek result in variable substrate habitat quality conditions. The average gravel percentage in riffles were high in 6 of 8 reaches (35% - 63%), while only 20% in reaches EB4 and EB5. However, the amount of fine sediment in riffles indicated lower habitat quality, with the average percent fines in riffles ranging from 13% (EB4) to 28% (EB2).

Field surveys from 2015 indicate that the lack of mature riparian vegetation plant communities is a concern in all reaches of East Birch Creek. The average percent of a stream reach that was shaded by riparian vegetation ranged from 24% (EB4) to 43% (EB8). In reaches EB1 – EB5 the dominant riparian vegetation was a mix of shrubs and trees, while in reaches EB6–EB8 trees comprised 60% - 100% of the riparian shade. The lack of mature riparian vegetation plant communities, particularly in the unconfined reaches of EB1 – EB4, contributes to late-summer elevated water temperatures observed in East Birch Creek.

East Birch Creek - Reach Summary



EAST BIRCH CREEK

Figure 33. Geomorphic assessment reach summary of East Birch Creek

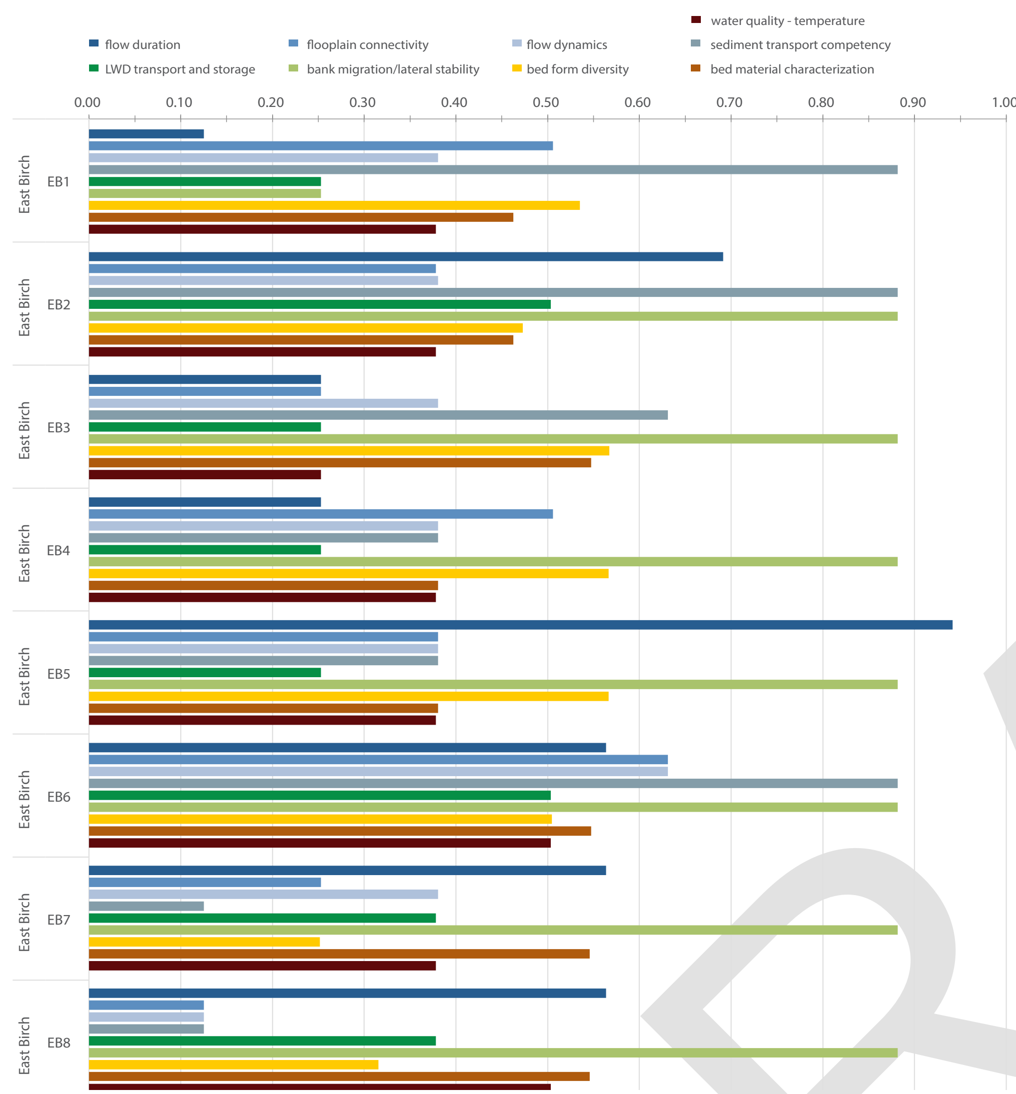
East Birch Creek - Reach Function

Results of the watershed and reach assessments indicate a large range of hydrogeomorphic functionality exists among the East Birch Creek reaches (Figure 34).

The hydrologic parameter of flow duration is one of the lowest indicators in reaches EB1 – EB4, which is largely driven by the significant surface water withdrawals and dewatering of East Birch Creek reaches.

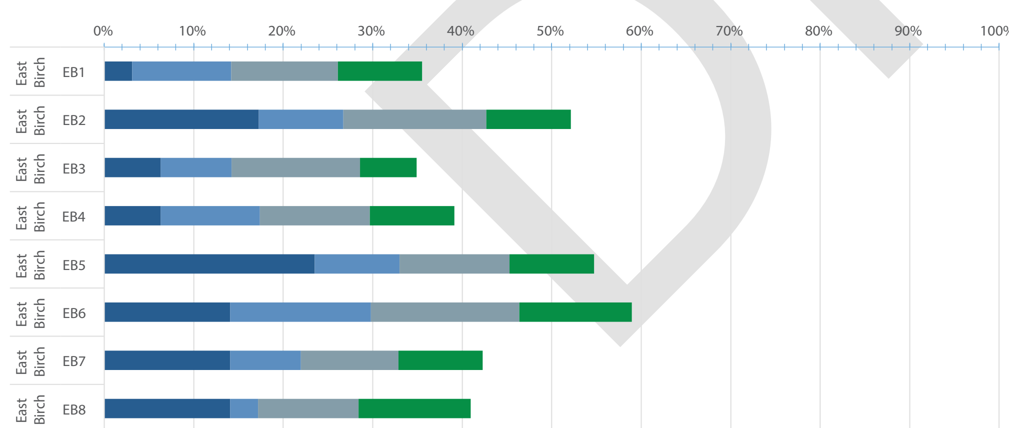
Large wood material transport and storage is another low functioning parameter due to the very low quantities of large wood present in these reaches.

In the upper reaches of EB7 and EB8, the apparent lack of instream structure and roughness contributes to the low functioning parameters of floodplain connectivity, flow dynamics, and sediment transport.



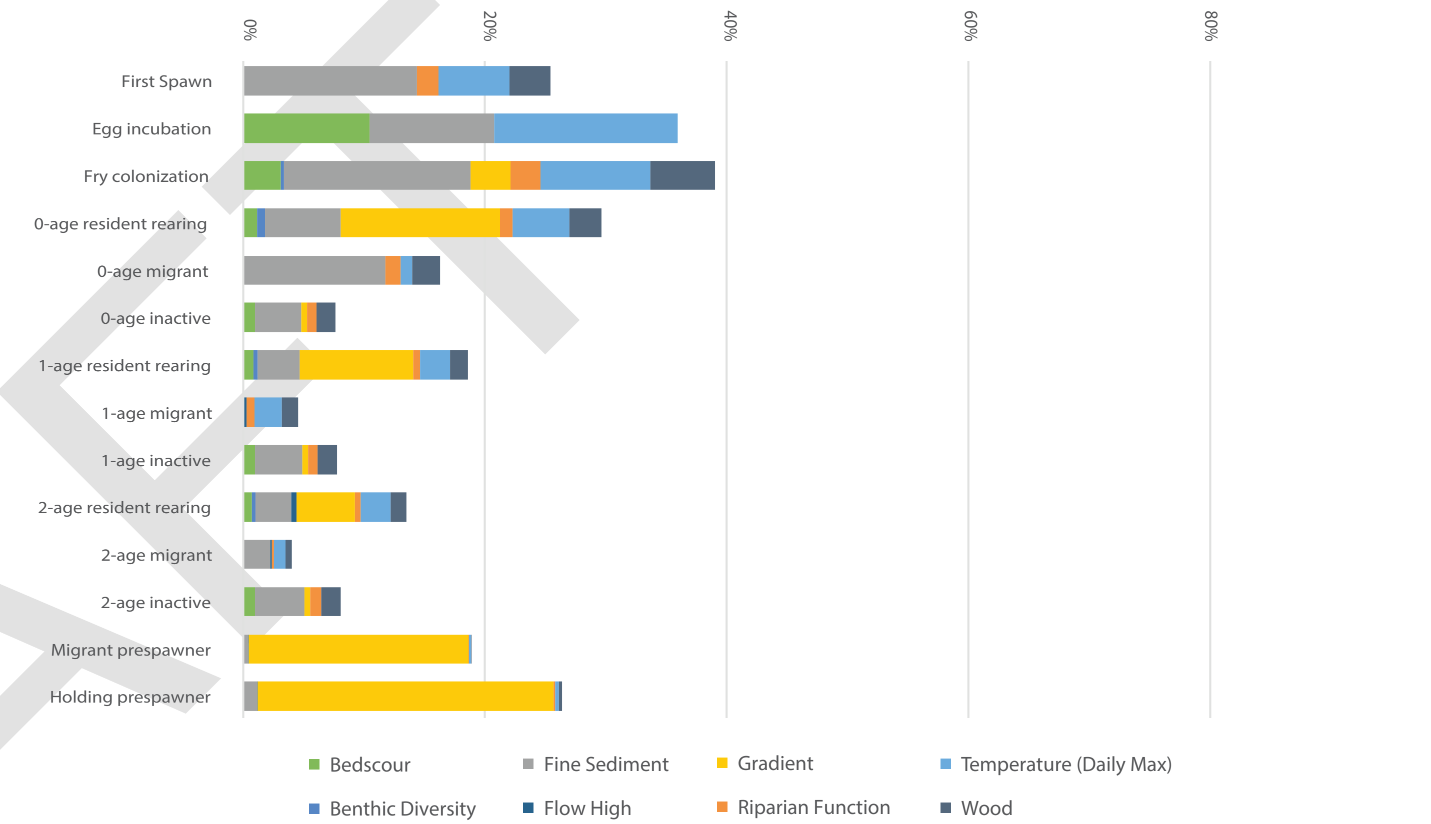
■ *Figure 34. Functional parameter scores by reach in East Birch Creek*

The overall hydrogeomorphic functionality in East Birch Creek ranges from 34% of fully functional (EB3) to 57% of fully functional (EB6) (Figure 35). In the lower reaches of East Birch Creek (EB1 – EB4), the lowest performing functional category is hydrology, due to low stream flows. In the upper reaches (EB5 – EB8), the lowest functional category is hydraulic, due largely to lack of connectivity between the channel and floodplain.

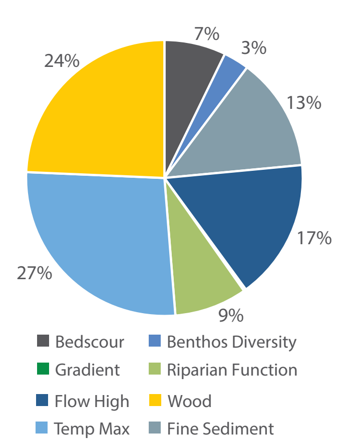


■ *Figure 35. Functional category relative percent of total reach function in East Birch Creek*

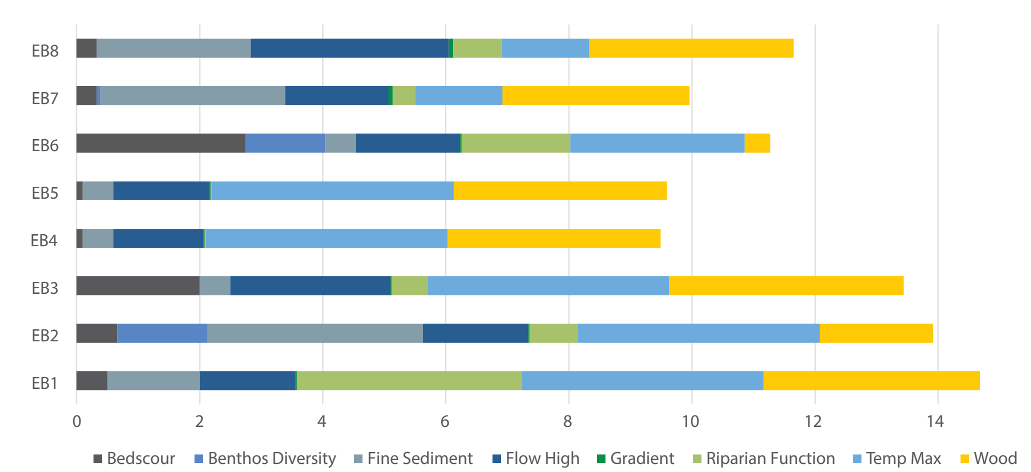
East Birch Creek - Reach Fishery



■ *Figure 37. Steelhead sensitivity (%) to limiting factors by life stage in East Birch Creek*



■ *Figure 36. Steelhead limiting factors distribution in East Birch Creek*



■ *Figure 38. Steelhead limiting factors distribution by reach in East Birch Creek*

East Birch Creek - Reach Fishery

Steelhead Population and Habitat Limiting Factors

East Birch Creek supports the largest population of steelhead in the Birch Creek watershed. It spans from lower elevations to headwater areas and has commensurate habitat diversity. However, similar to the other streams throughout the Birch Creek watershed, degraded conditions in East Birch Creek have resulted in a depressed steelhead population.

Overall, maximum daily water temperature, the lack of woody material in the channel and fine sediment are most limiting to steelhead populations in East Birch Creek (Figure 36). Early life history stages are most sensitive to elevated water temperatures and fine sediment due to their impacts on egg incubation and fry colonization (Figure 37). However, adult steelhead in East Birch Creek are more sensitive to increased channel slopes, which is likely associated with channel modifications and lack of woody material in the channel. In general, temperature is most limiting in the lower reaches of the watershed (EB1 through EB6), while fine sediment and lacking woody material are the most limiting in EB7 and EB8 (Figure 38).

Throughout East Birch Creek, productivity and capacity have been reduced from estimated historic conditions by 80% and 50%, respectively (Figure 39). Currently, productivity is relatively evenly distributed among reaches with EB6 as the most productive reach and EB2 being the least productive reach (Figure 40). Habitat capacity estimates for East Birch Creek are highest in EB6 followed by EB1 and EB2. Capacity in the remaining five reaches is much less by comparison (Figure 41). As a consequence of reduced productivity and capacity, the equilibrium abundance for naturally produced East Birch Creek steelhead has been reduced from historic conditions by two thirds.

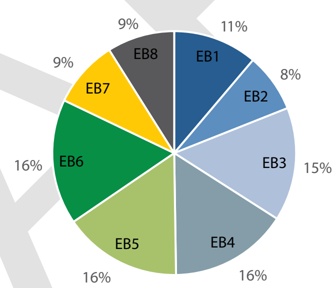


Figure 40. Distribution of steelhead productivity in East Birch Creek by reach

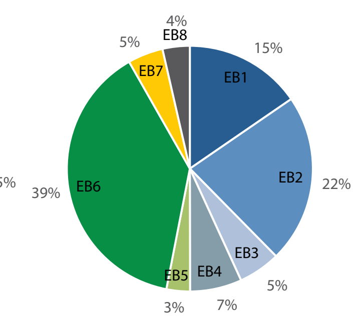


Figure 41. Distribution of steelhead capacity in East Birch Creek by reach

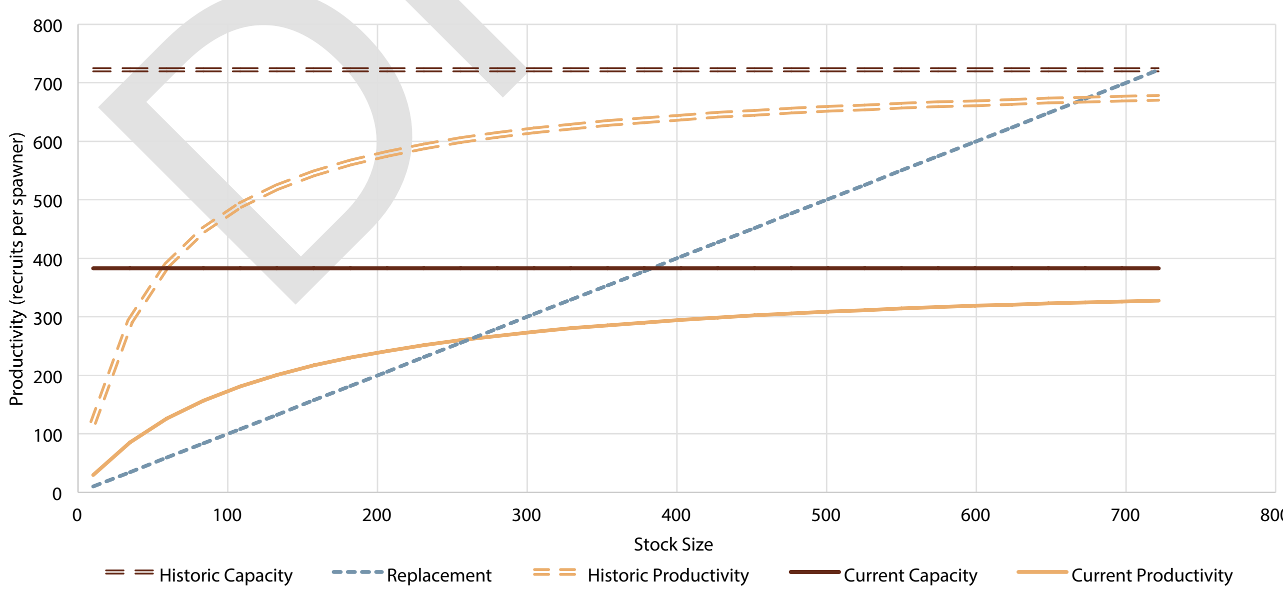


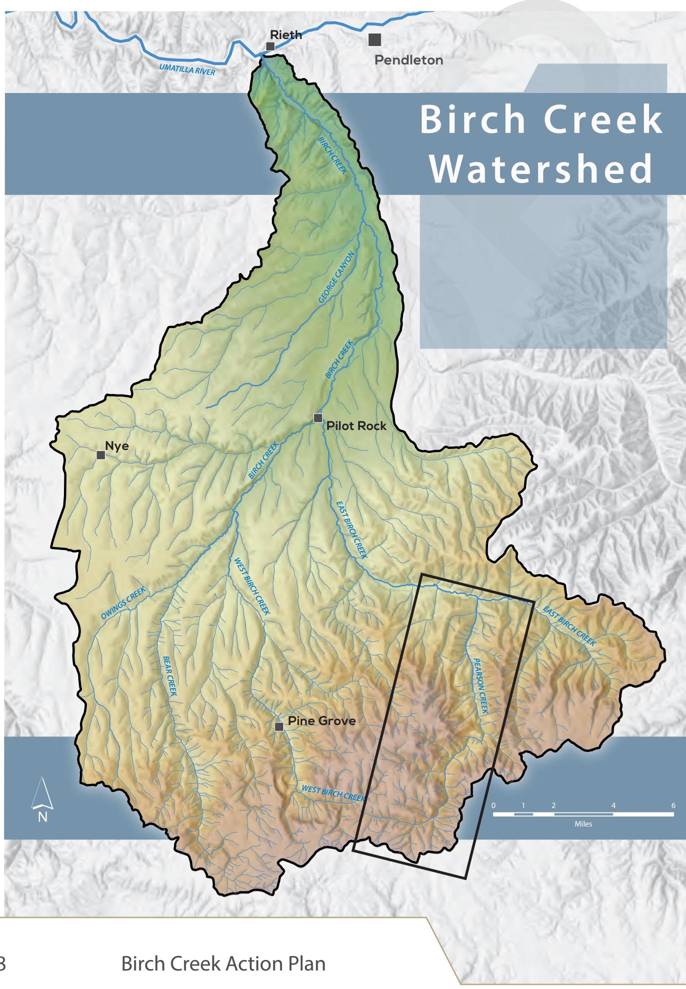
Figure 39. Stock recruitment relationships for the current and historic scenarios based on habitat productivity and capacity in East Birch Creek.

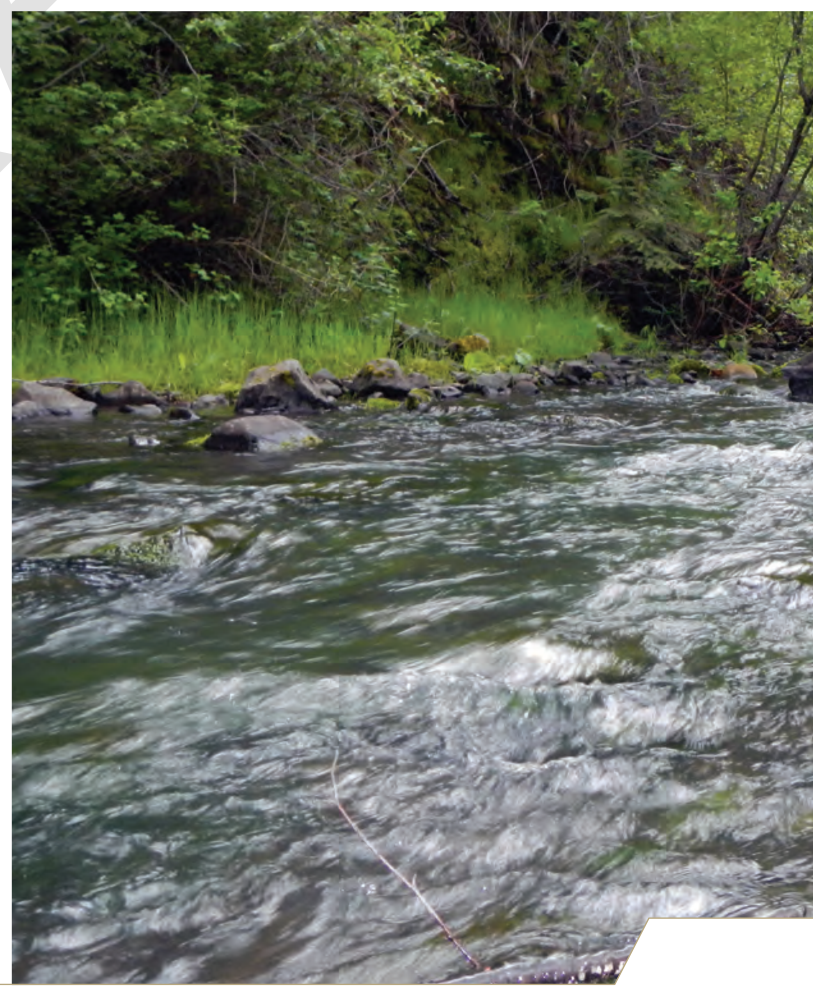
Pearson Creek

Pearson Creek extends approximately 12.2 miles from the confluence with East Birch Creek upstream to the headwaters of the watershed (Figure 42). There are five geomorphic reaches along this distance, ranging in length from 0.9 miles (P1) to 4.0 miles (P2). The physical characteristics of these reaches are summarized in Figure 43.

During the field surveys of Pearson Creek in 2015, there was surface water flow observed in all reaches. Low stream flow conditions in all reaches of Pearson Creek during the late summer months are natural since there are no surface water withdrawals. The functional hydrology metric of specific peak discharge (the 100-year discharge per unit area of valley bottom) indicates that reach P1 is a geomorphically active reach, with a specific peak discharge of 53.8. This reflects the valley confinement of P1 and the proximity to the confluence with Lower Pearson Creek. This ratio ranges from 3.8 (P5) to 16.6 (P4) in the remainder of Pearson Creek, where the channel is less confined in the valley bottom.

All of the Pearson Creek reaches are situated in confined or partially-confined valley bottoms. Due to this confinement all of the reaches are relatively high gradient (2.7% to 4.3%) with low sinuosity (1.08 – 1.09). However, even when considering the physical setting of these reaches, all of them appear to be disconnected from the available valley bottom. The entrenchment ratios range from 1.54 to 1.89. At the larger 100-year flood discharge, the percentage of the valley bottom inundated ranges from 34% (P5) to 69% (P1), indicating significant disconnection from the valley bottom. The natural channel confinement is exacerbated in these reaches by the presence of Pearson Creek Road along the valley bottom, which is likely the cause of the disconnection between the stream and the floodplain. Indeed, in the absence of Pearson Creek Road, the sinuosity of reaches P2 – P5 would likely be larger than what currently





exists, suggesting that the existing step-pool channel types (based on slope) may be a forced characteristic due to the road.

The confinement of Pearson Creek reaches result in high shear stress being applied within the channel over the range of low to high flood discharges. The channel:total shear stress ratios for the 100-year discharge ranged from 1.51 to 1.72, indicating that much of the available energy from the flow is being applied to the stream channel rather than being distributed across the floodplain.

The hydraulic characteristics for the 2-year discharge result in the estimated transport stage (Φ, ratio of applied shear stress to critical shear stress for a given grain size) indicating mobility of the median grain size (D50) in all reaches. The transport stage for the larger D84 grain sizes indicates mobility in reach P2 ($\Phi > 2.2$) and likely mobility in the remaining reaches ($\Phi > 1.4$).

■ *Figure 42. Location map and photograph of Pearson Creek*

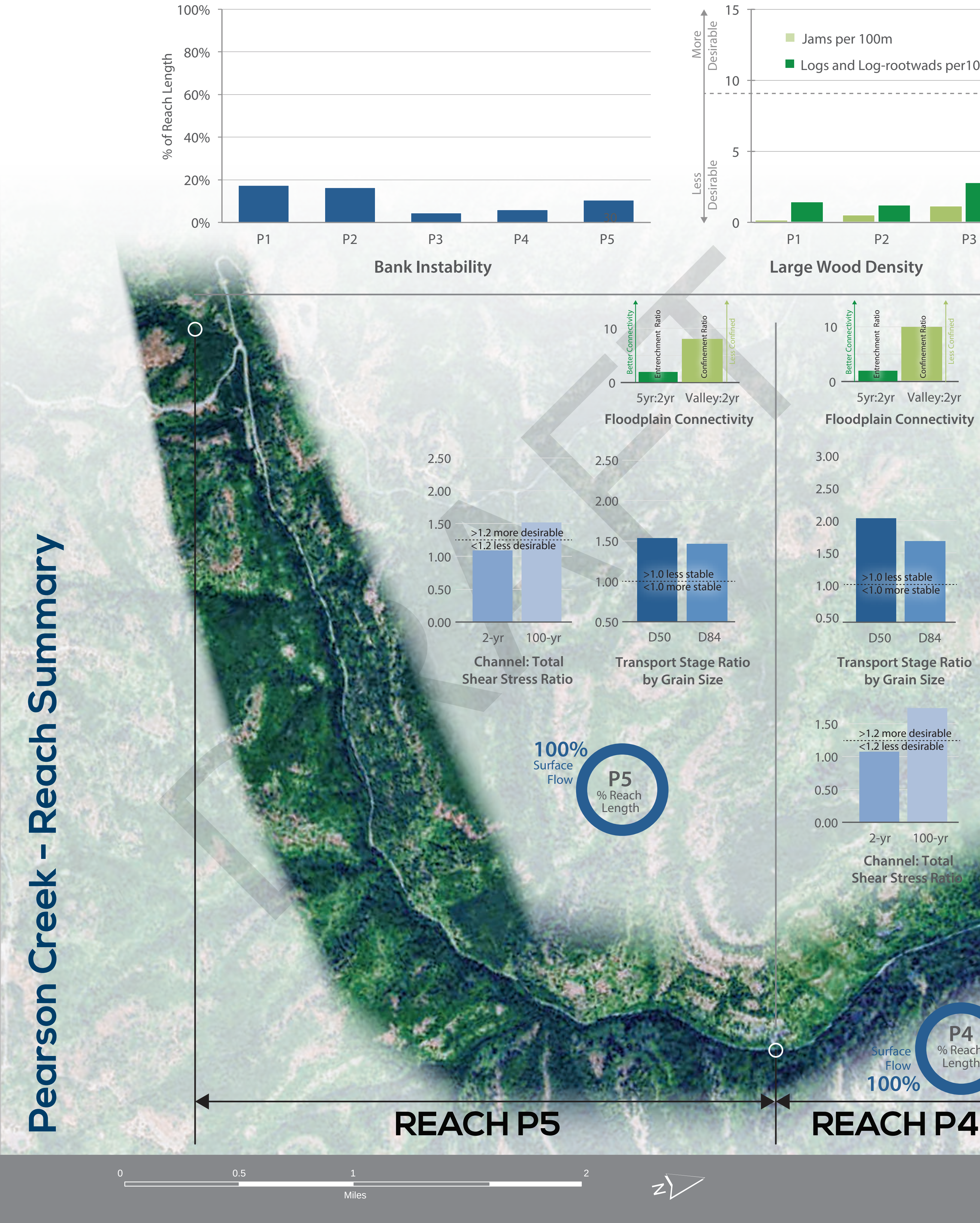
The amount of large wood present in all Pearson Creek reaches was much less than would be expected, and much less than benchmark values used by resource management agencies. The average number of large wood pieces per 100 meters ranged from 0.8 to 2.8. Log jam density was better, with the average number of log jams per kilometer ranging from 0.6 to 11.4. These low densities of large wood material are likely a result of a low wood supply from the riparian zone and hillslopes.

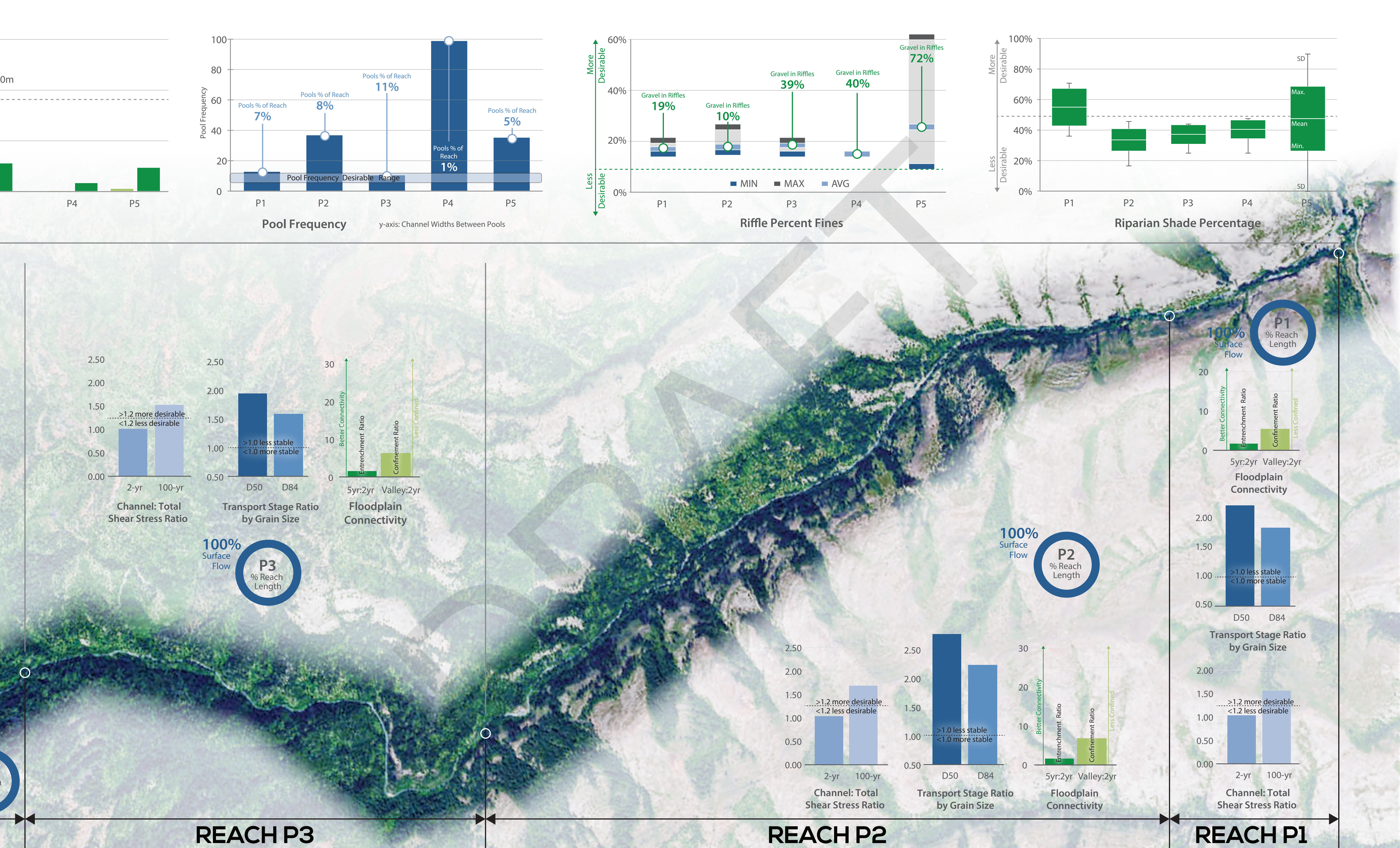
Field surveys from 2015 indicate that streambank instability is a concern in reaches P1 and P2. These reaches had 16% - 17% of their reach lengths comprised of unstable banks. The percentage of bank instability in the remaining reaches ranged from 5% (P3) to 10% (P5).

Nearly all of Pearson Creek reaches contain a very small portion of geomorphic units characterized as pools. The average number of pools per kilometer ranged from 1.9 (P4) to 9.6 (P3), which is in the mid- to low-functionality range based on regional performance standards. The average percentage of a reach comprised of pool was also low functioning in all reaches, ranging from 1% (P4) to 11% (P3). The pool frequency was higher than expected in the reaches with step-pool channel types (P2 – P5), ranging from 10.6 to 100. This long spacing between pools reflects the channel confinement and lack of instream structure that typically creates the frequently repeating sequences of step-pool features.

The sediment mobility characteristics in Pearson Creek result in variable substrate habitat quality conditions. The average gravel percentage in riffles was high in reaches P3 – P5 (39% - 72%), while only 10% and 19% in reaches P2 and P1, respectively. However, the amount of fine sediment was atypical for the existing plane-bed/step-pool channel types, with the average percent fines ranging from 15% (P4) to 26% (P5).

Field surveys from 2015 indicate that the lack of mature riparian vegetation plant communities is a concern in all reaches of Pearson Creek. The average percent of a stream reach that was shaded by riparian vegetation ranged from 37% (P3) to 55% (P1). In all reaches trees comprised 62% - 100% of the riparian shade. These findings suggest that while streamside vegetation does contain mature trees, the amount of riparian forest along the reaches is less than desired.


Pearson Creek - Reach Summary
100%
80%
60%
40%
20%
0%
% of Reach Length
P1
P2
P3
P4
P5
Bank Instability
15
10
5
0
More Desirable
Less Desirable
Jams per 100m
Logs and Log-rootwads per10
P1
P2
P3
Large Wood Density
10
0
Better Connectivity
Entrenchment Ratio
Confinement Ratio
Less Confined
5yr:2yr
Valley:2yr
Floodplain Connectivity
2.50
2.00
1.50
1.00
0.50
0.00
>1.2 more desirable
<1.2 less desirable
2-yr
100-yr
Channel: Total Shear Stress Ratio
2.50
2.00
1.50
1.00
0.50
>1.0 less stable
<1.0 more stable
D50
D84
Transport Stage Ratio by Grain Size
100% Surface Flow
P5 % Reach Length
10
0
Better Connectivity
Entrenchment Ratio
Confinement Ratio
Less Confined
5yr:2yr
Valley:2yr
Floodplain Connectivity
3.00
2.50
2.00
1.50
1.00
0.50
>1.0 less stable
<1.0 more stable
D50
D84
Transport Stage Ratio by Grain Size
1.50
1.00
0.50
0.00
>1.2 more desirable
<1.2 less desirable
2-yr
100-yr
Channel: Total Shear Stress Ratio
P4 % Reach Length
Surface Flow
100%
REACH P5
REACH P4
0
0.5
1
2
Miles
N
DRAFT



■ *Figure 43. Geomorphic assessment reach summary of Pearson Creek*

Pearson Creek - Reach Function

Results of the watershed and reach assessments indicate a large range of hydrogeomorphic functionality exists among the Pearson Creek reaches (Figure 44).

The parameters of floodplain connectivity, flow dynamics and sediment transport are some of the lowest indicators, which is largely driven by the confinement of Pearson Creek and the lack of in-channel structure and roughness.

Large wood material transport and storage is another low functioning parameter due to the very low quantities of large wood present in these reaches.

The lateral channel stability appears to be good in most Pearson Creek reaches.

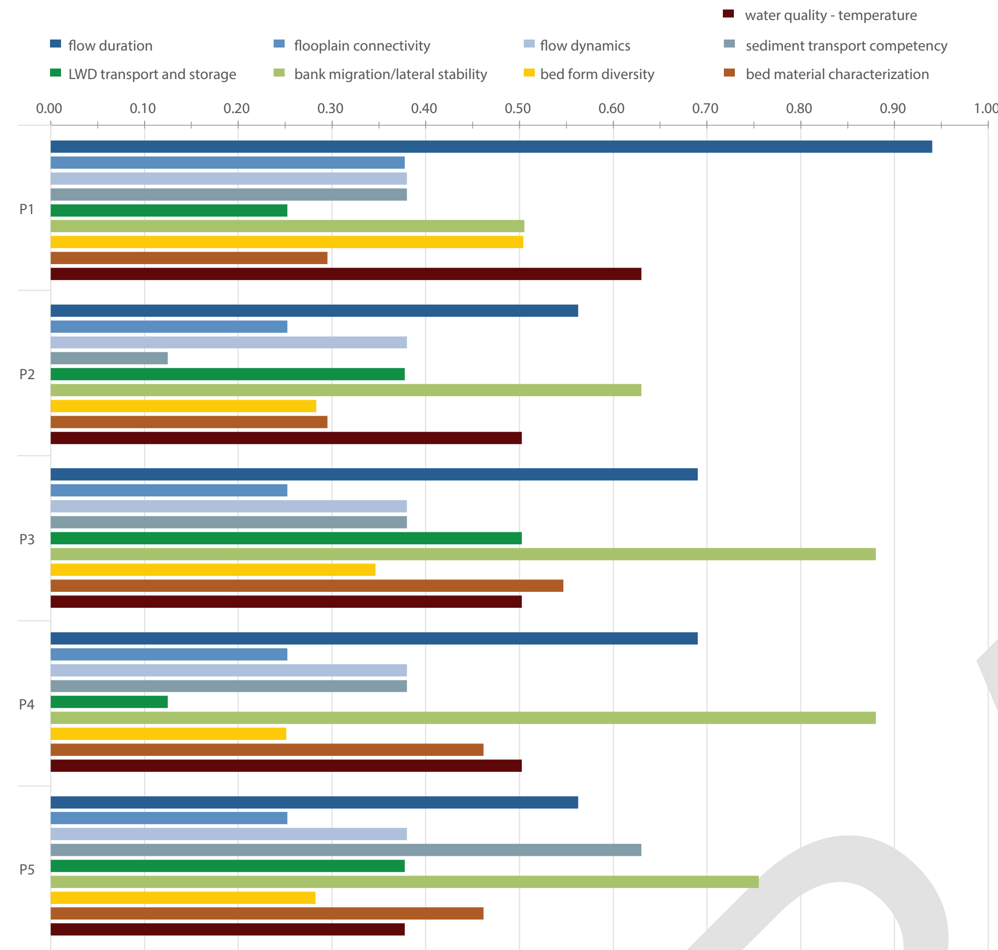


Figure 44. Functional parameter scores by reach in Pearson Creek

The overall hydrogeomorphic functionality in Pearson Creek ranges from 43% of fully functional (P2) to 58% of fully functional (P1) (Figure 45).

The lowest performing functional category is hydraulic, due lack of connectivity between the channel and floodplain, and the lack of instream structure.

The highest performing category is hydrology, due largely to perennial stream flow even during late-summer months of July through September.

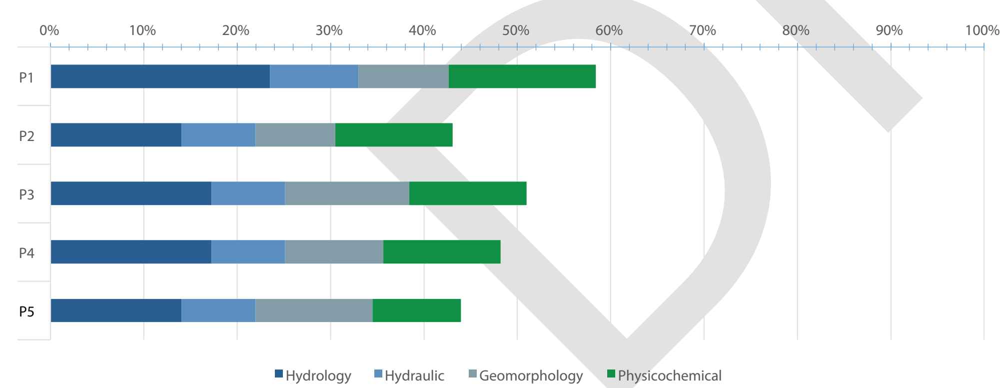


Figure 45. Functional category relative percent of total reach function in Pearson Creek

Pearson Creek - Reach Fishery

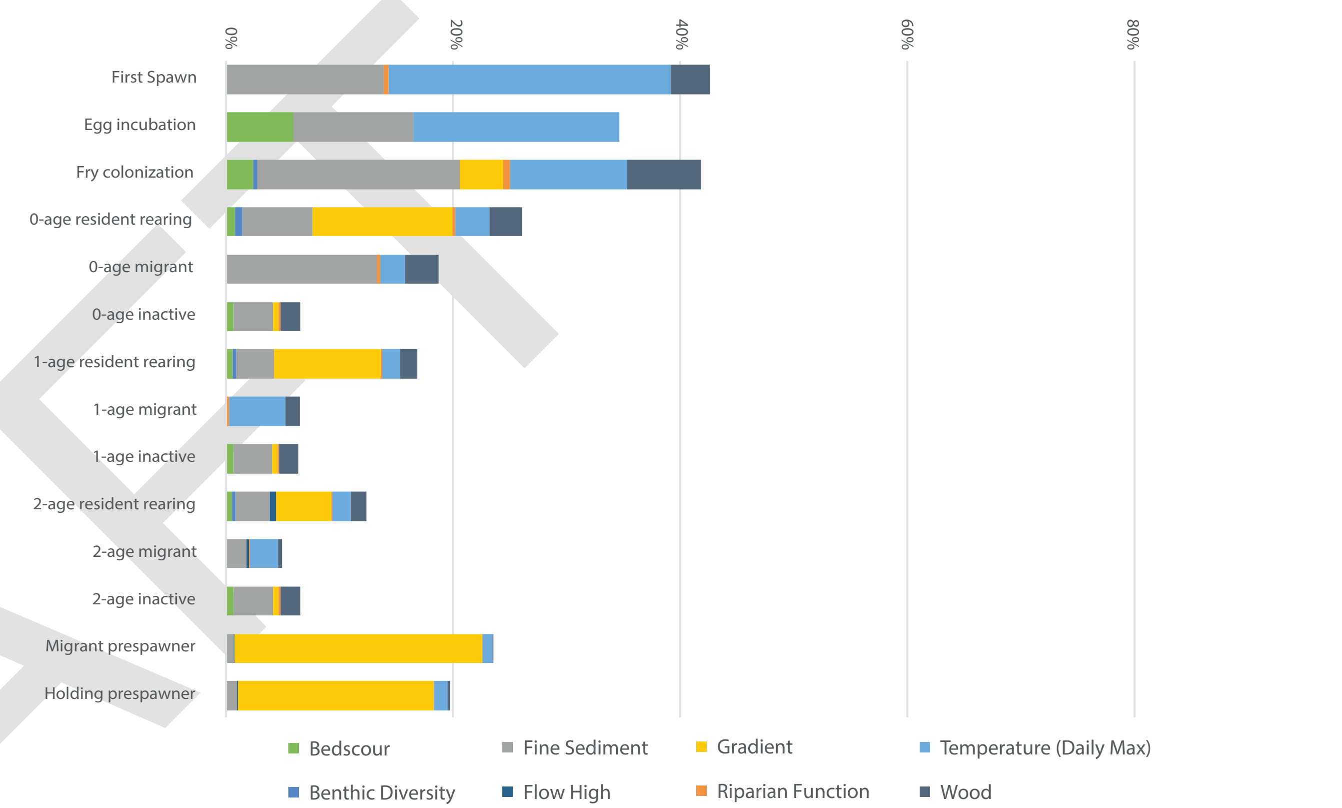


Figure 46. Steelhead sensitivity (%) to limiting factors by life stage in Pearson Creek

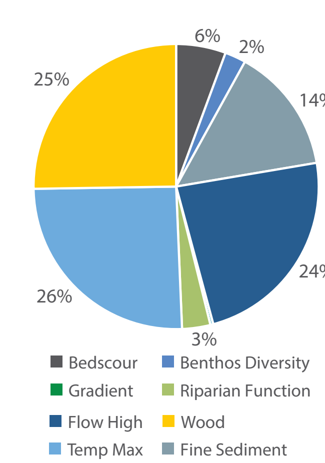


Figure 47. Steelhead limiting factors distribution in Pearson Creek

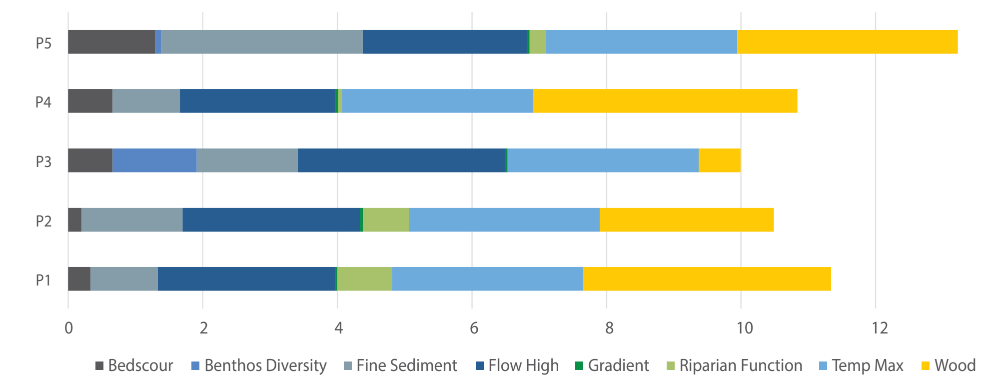


Figure 48. Steelhead limiting factors distribution by reach in Pearson Creek

Pearson Creek - Reach Fishery

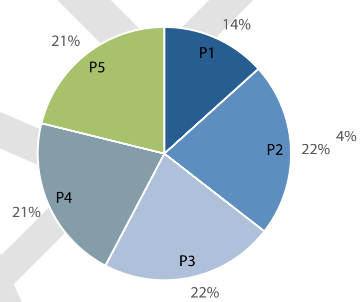
Steelhead Population and Habitat Limiting Factors

As a tributary relatively high in the watershed, Pearson Creek's greatest potential for contributing to overall watershed steelhead productivity is successful spawning and early life history survival. In Pearson Creek, those life-history stages (spawning, egg incubation, fry colonization and first year rearing) are most sensitive to fine sediment and temperature (Figure 46).

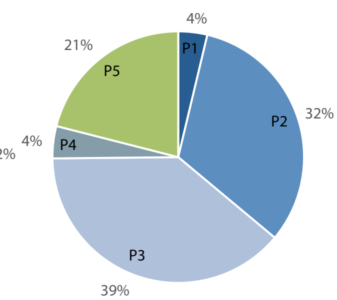
Overall, maximum daily water temperature and the lack of woody material in the channel are most limiting to steelhead populations in Pearson Creek (Figure 47). Because early life stages are most effected by temperature in Pearson Creek, it is the factor most likely causing reductions in productivity. However, given its relatively high elevation combined with a relatively mature riparian canopy throughout most of its length, temperature is not as limiting for steelhead compared to most of the other streams in the Birch Creek Watershed.

Fine sediment is most limiting to steelhead in reach P5, while temperature is most limiting in the other four reaches (Figure 48). The lack of woody structures in the channel are limiting steelhead production in all reaches except P3.

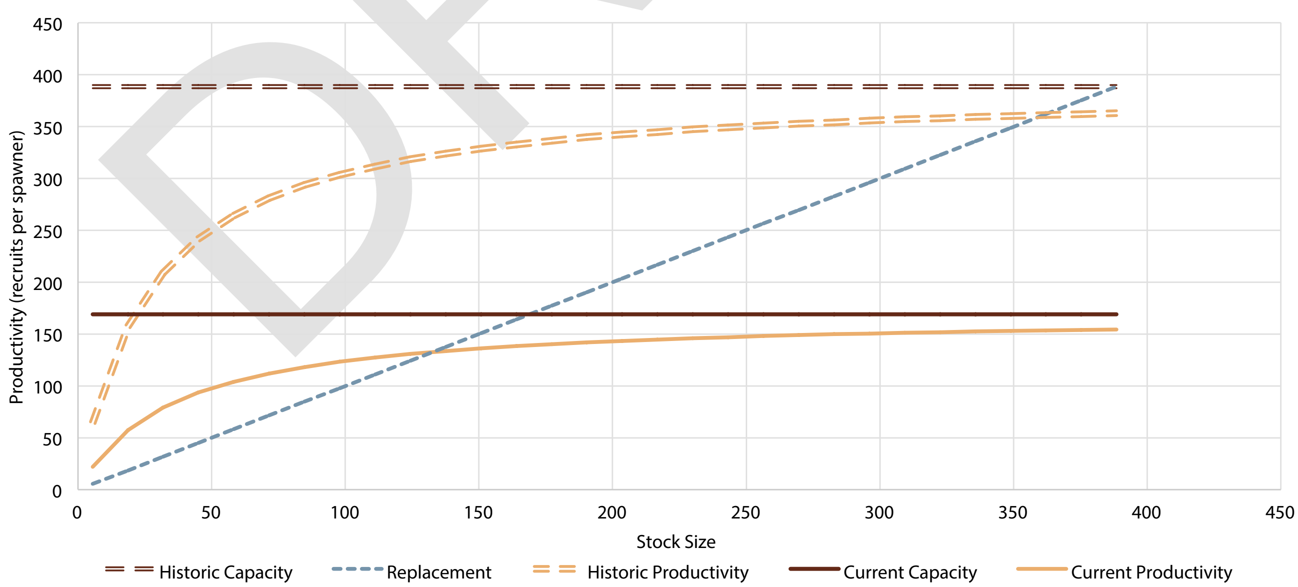
Throughout Pearson Creek, productivity and capacity have been reduced from estimated historic conditions by more than 70% and 50%, respectively (Figure 49). Currently, productivity is relatively evenly distributed among reaches with P2 as the most productive reach and P1 being the least productive reach (Figure 50). Reaches P2 and P3 comprise over 70% of the total habitat capacity for Pearson Creek (Figure 51) owing to the relative lengths of those reaches, relatively functional pool habitat diversity and relative abundance of woody debris jams.



■ *Figure 50. Distribution of steelhead productivity in Pearson Creek by reach*



■ *Figure 51. Distribution of steelhead capacity in Pearson Creek by reach*



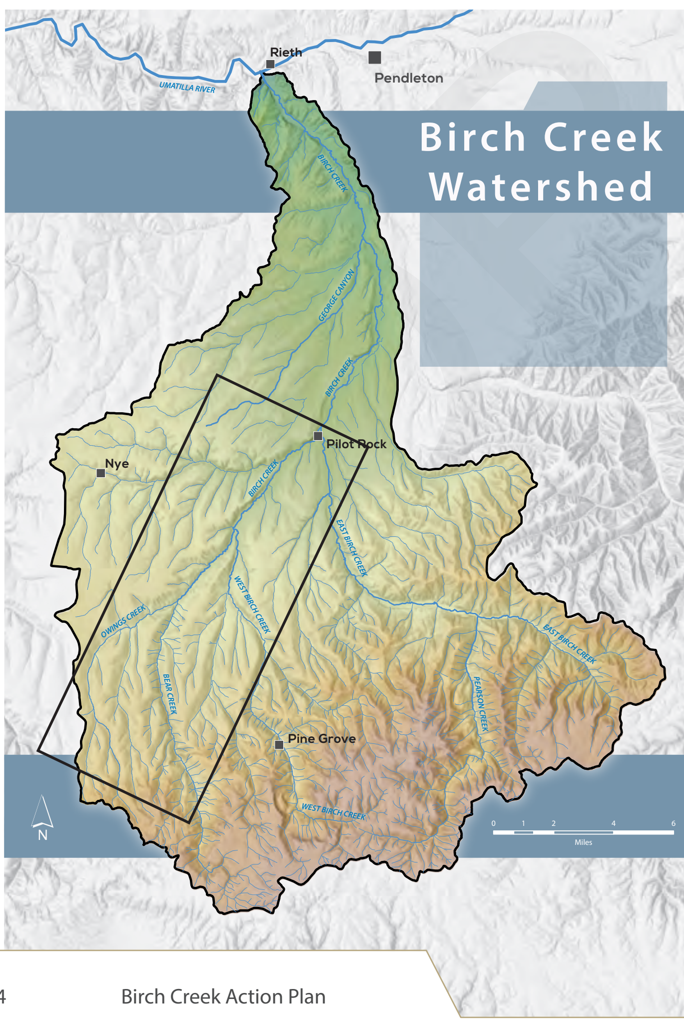
■ *Figure 49. Stock recruitment relationships for the current and historic scenarios based on habitat productivity and capacity in Pearson Creek.*

West Birch Creek

West Birch Creek extends approximately 17.5 miles from the confluence with East Birch Creek in Pilot Rock, upstream to the headwaters of the watershed (Figure 52). There are eight geomorphic reaches along this distance, ranging in length from 1.1 miles (WB8) to 3.1 miles (WB2). The physical characteristics of these reaches are summarized in Figure 53.

Four of the eight West Birch Creek reaches experience extremely low stream flow during the late summer months of July through September. During the field surveys in 2015, there was no surface water flow in portions of reaches WB3 – WB6. The percentage of reach lengths dewatered ranged from 23% in reach WB6 to 46% in reach WB4. Based on data from The Freshwater Trust (2010), the amount of surface water rights in West Birch Creek are approximately 60% of the natural stream flow from July through September. These low stream flows contribute to late-summer elevated water temperatures observed in West Birch Creek.

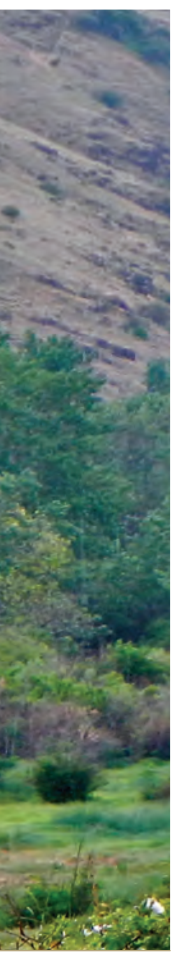
Despite being situated within unconfined or partially-confined valley bottom, West Birch Creek reaches WB1, WB2, and WB4 have been disconnected from the floodplain. As an indicator of channel straightening, all three reaches are much less sinuous than expected, with sinuosity ranging from 1.08 (WB2) to 1.16 (WB4). In response to channel straightening, reaches WB1, WB2, and WB4 have become incised vertically into the valley bottom, with entrenchment ratios ranging from 2.11 to 3.15. Reach WB3 is less incised and better connected to the floodplain, with a larger entrenchment ratio of 3.73. At the larger 100-year flood discharge, the percentage of the valley bottom inundated ranges from 41% (WB3) to 61% (WB2), indicating significant floodplain disconnection. The valley narrows and steepens upstream of WB4, and West Birch reaches WB5 – WB8 alternate between



■ *Figure 52. Location map and photograph of West Birch Creek* confined and unconfined. The natural channel confinement is exacerbated in these reaches by the presence of West Birch Creek Road along the valley bottom, especially in reaches WB7–WB8. Indeed, in the absence of West Birch Creek Road, the sinuosity of reaches WB5 – WB8 would likely be larger than what currently exists, suggesting that the existing plane-bed and step-pool channel types (based on slope) may be a forced characteristic due to the road.

The entrenchment and confinement of the West Birch Creek reaches result in high shear stress being applied within the channel over the range of low to high flood discharges. The channel:total shear stress ratios for the 100-year discharge ranged from 1.48 to 2.06, indicating that much of the available energy from the flow is being applied to the stream channel rather than being distributed across the floodplain.

The hydraulic characteristics for the 2-year discharge result in the estimated transport stage (Φ, ratio of applied shear stress to critical shear stress for a given grain size) indicating mobility of the median grain size ($D50$) in all reaches. The transport stage for the larger $D84$ grain sizes indicates mobility in reaches WB4, WB5, and WB8 ($\Phi > 1.23$); in all other reaches $\Phi < 1.2$. This finding suggests that bedload being transported from higher gradient reaches is being stored in lower gradient reaches WB1 – WB3.



The amount of large wood present in all West Birch Creek reaches was much less than would be expected, and much less than benchmark values used by resource management agencies. The average number of large wood pieces per 100 meters ranged from 0.7 (WB1) to 5.3 (WB8). Log jam density was better, with the average number of log jams per kilometer ranging from 2.9 (WB5) to 14.9 (WB7). These low densities of large wood material are likely a result of a low wood supply from the riparian zone and hillslopes.

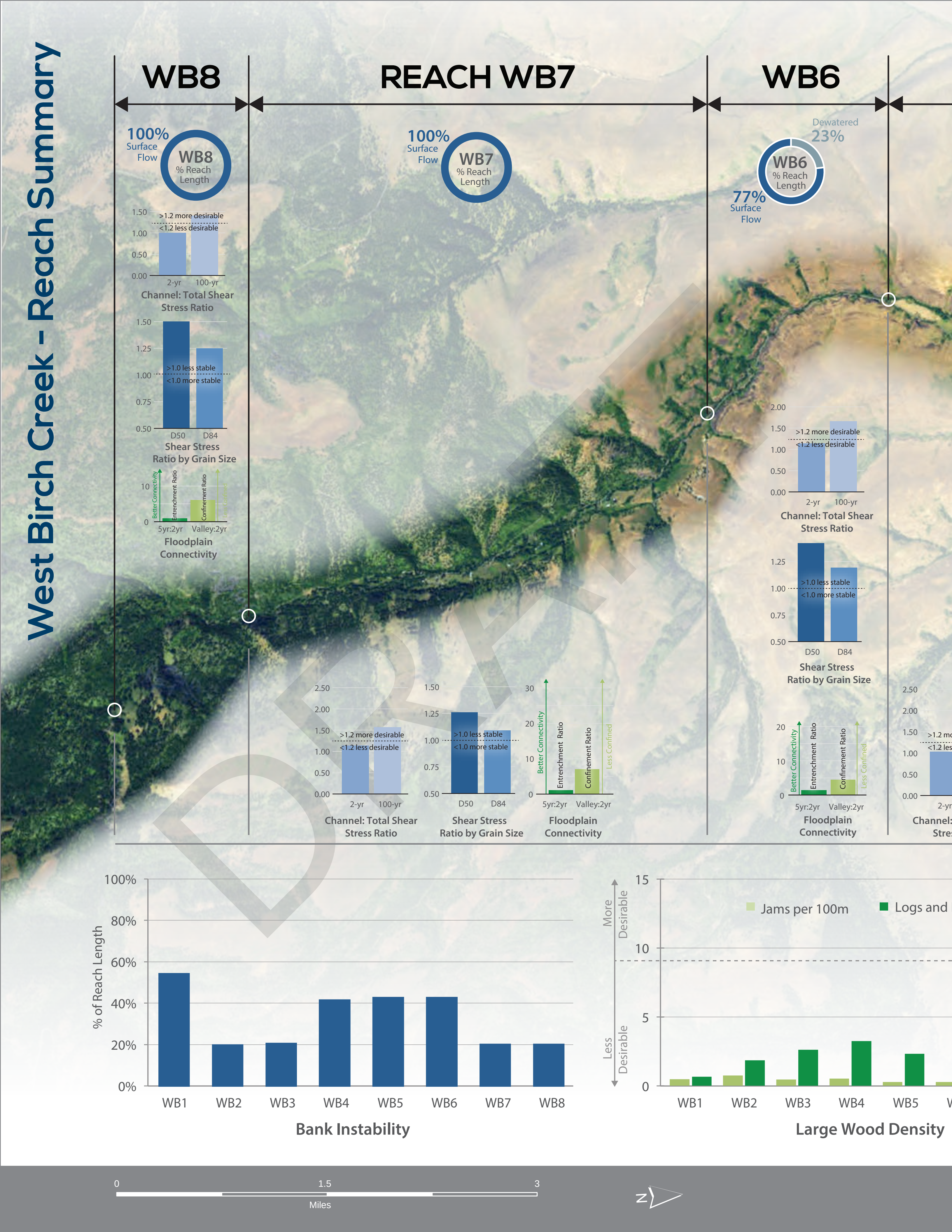
Field surveys from 2015 indicate that streambank instability is a concern in nearly all reaches of West Birch Creek. The percentage of bank instability in all reaches ranged from 21% (WB7) to 55% (WB1).

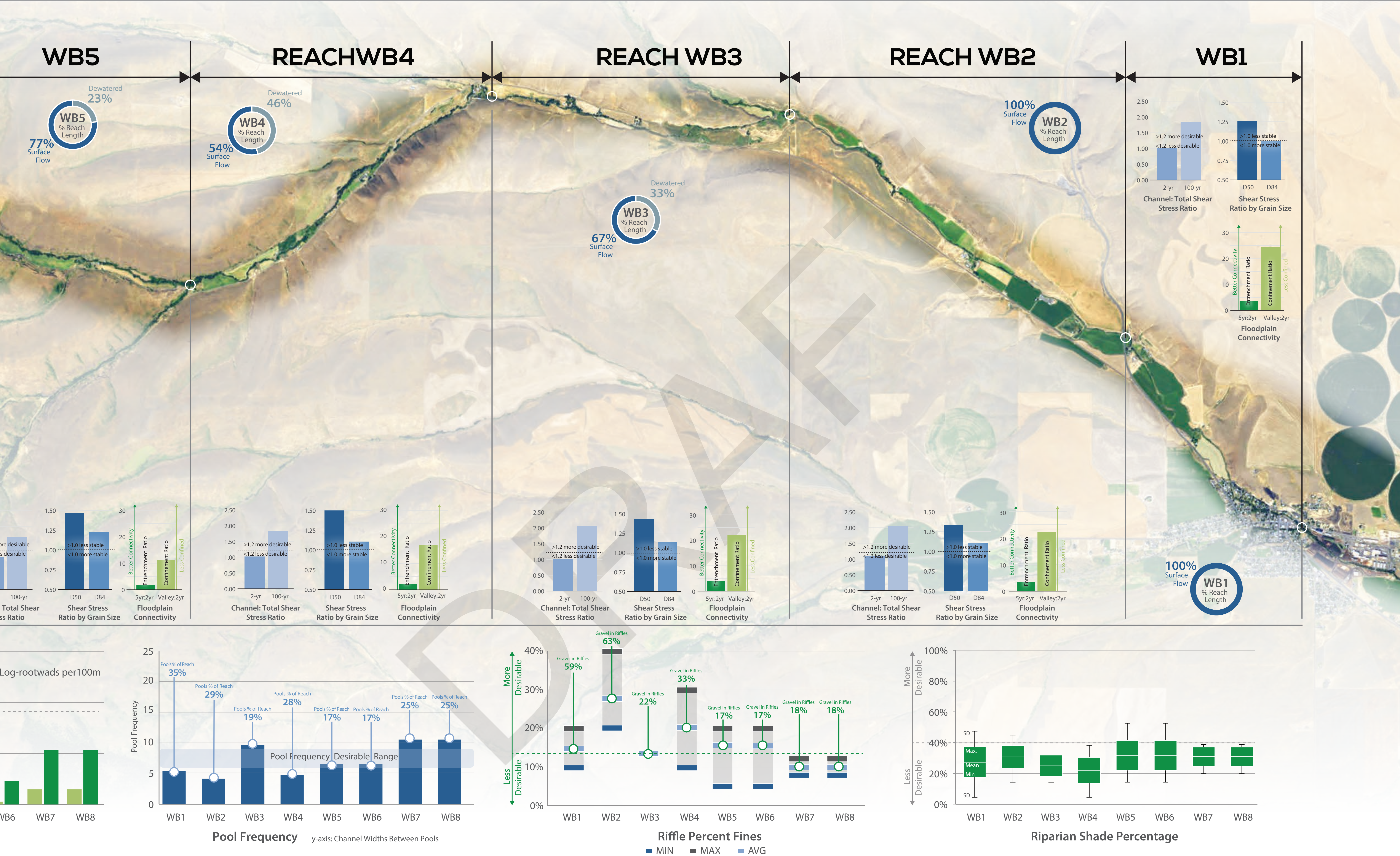
Nearly all of the West Birch Creek reaches contain a large portion of geomorphic units characterized as pools. The average number of pools per kilometer ranged from 5.9 (WB7) to 16.6 (WB4), which is in the moderate to high functionality range based on regional performance standards. The average percentage of a reach comprised of pool also indicated moderate to high functioning in many reaches, ranging from 17% (WB5) to 35% (WB1). However, the pool frequency (channel widths between pools) was lower than expected in the reaches with pool-riffle channel types (WB1 and WB2), ranging from 4.2 (WB1) to 5.4 (WB2). The pool frequency of 10.6 was higher than expected in the reaches with step-pool/cascade channel types (WB7 and WB8). This long spacing between pools reflects the channel confinement and lack of instream structure that typically creates the frequently repeating sequences of step-pool features.

The sediment mobility characteristics in West Birch Creek result in variable substrate habitat quality conditions. The average gravel percentage in riffles were high in reaches WB1 – WB4 (33% - 63%), while only 17% – 18% in reaches WB5 – WB8. However, the amount of fine sediment in riffles indicated lower habitat quality in reaches WB1 – WB4, with the average percent fines in riffles ranging from 15% (WB1) to 28% (WB2). The percent fines in the upstream reaches of WB5 – WB8 indicated better habitat quality, with the percentage of fines ranging from 10% - 14%.

Field surveys from 2015 indicate that the lack of mature riparian vegetation plant communities is a concern in all reaches of West Birch Creek. The average percent of a stream reach that was shaded by riparian vegetation ranged from 22% (WB4) to 31% (WB5). In reaches WB1 and WB3 the dominant riparian vegetation was a mix of shrubs and trees, while in the remaining reaches trees comprised 53%- 100% of the riparian shade. The lack of mature riparian vegetation plant communities, particularly in the unconfined reaches, contributes to late-summer elevated water temperatures observed in West Birch Creek. These findings suggest that while streamside vegetation does contain mature trees, the amount of riparian forest along the reaches is less than desired.

West Birch Creek - Reach Summary





WEST BIRCH CREEK

Figure 53. Geomorphic assessment reach summary of West Birch Creek

West Birch Creek - Reach Function

Results of the watershed and reach assessments indicate a large range of hydrogeomorphic functionality exists among the West Birch Creek reaches (Figure 54).

The hydrologic parameter of flow duration is one of the lowest indicators in reaches WB3 – WB6, which is largely driven by the significant surface water withdrawals and dewatering of West Birch Creek reaches. Elevated water temperature problems are compounded by the lack of mature riparian vegetation in most reaches. Large wood material transport and storage is another low functioning parameter due to the very low quantities of large wood present in these reaches. In the upper reaches of WB5 – WB8, the apparent lack of instream structure and roughness contributes to the low functioning parameters of floodplain connectivity, flow dynamics, and sediment transport.

The overall hydrogeomorphic functionality in West Birch Creek ranges from 32% of fully functional (WB4) to 53% of fully functional (WB2) (Figure 55). In the lower reaches of West Birch Creek (WB3 – WB6), the lowest performing functional category is hydrology, due to low stream flows. In the upper reaches (WB5 – WB8), the lowest functional category is hydraulic, due largely to lack of connectivity between the channel and floodplain.

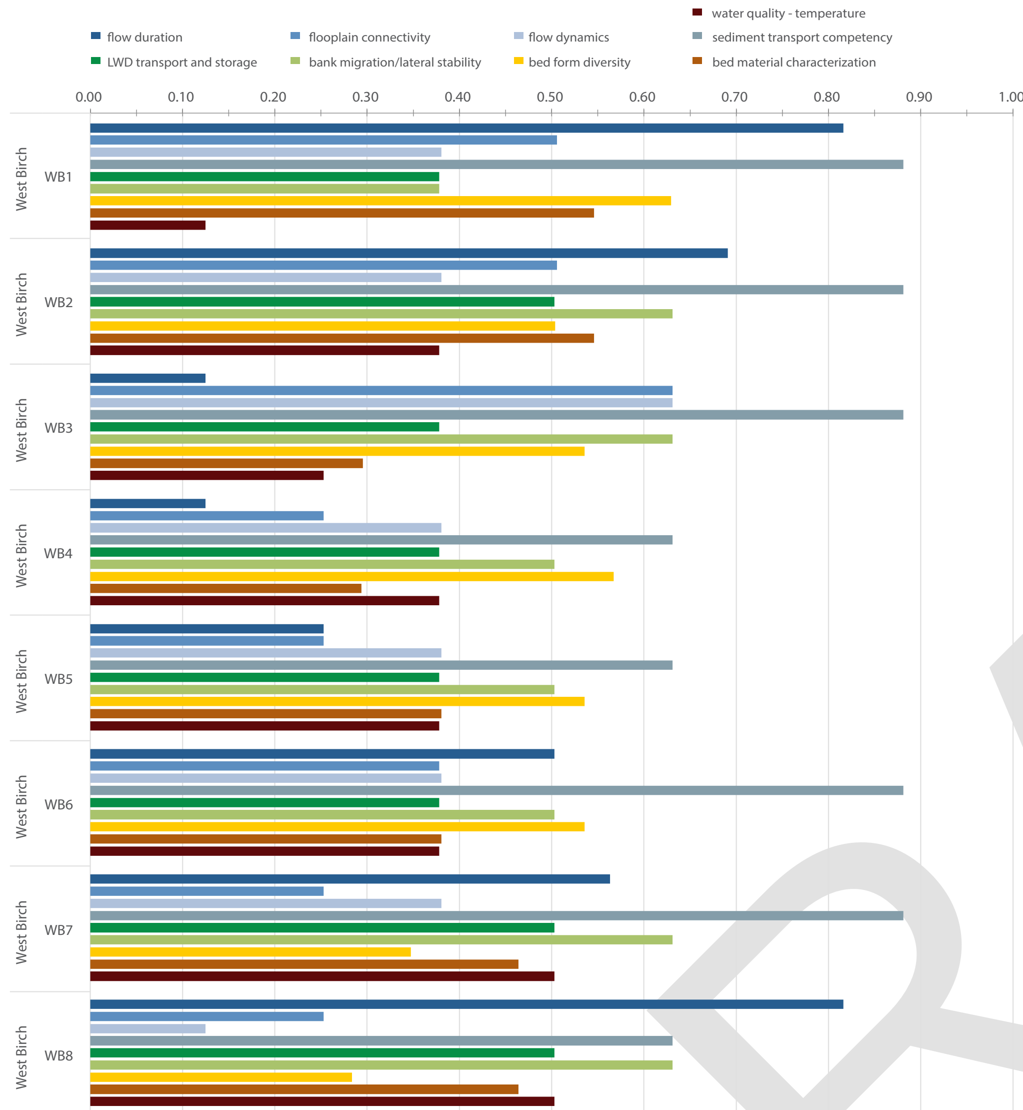


Figure 54. Functional parameter scores by reach in West Birch Creek

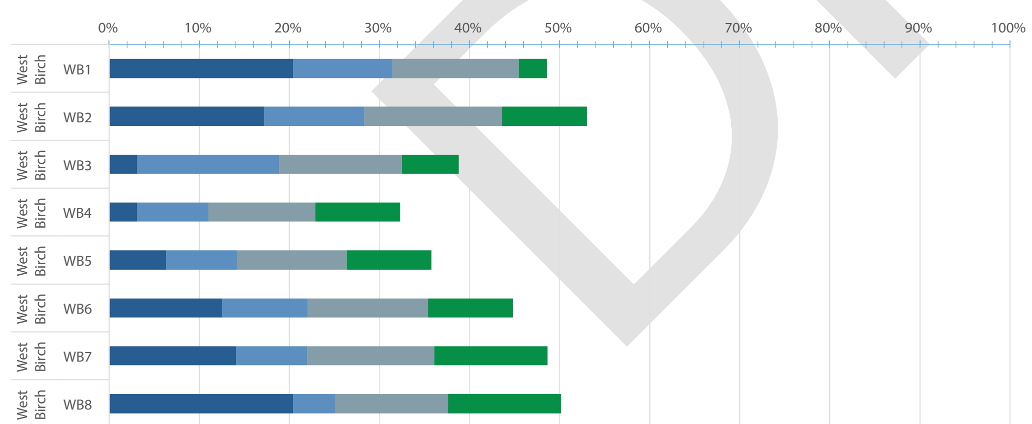


Figure 55. Functional category relative percent of total reach function in West Birch Creek

West Birch Creek - Reach Fishery

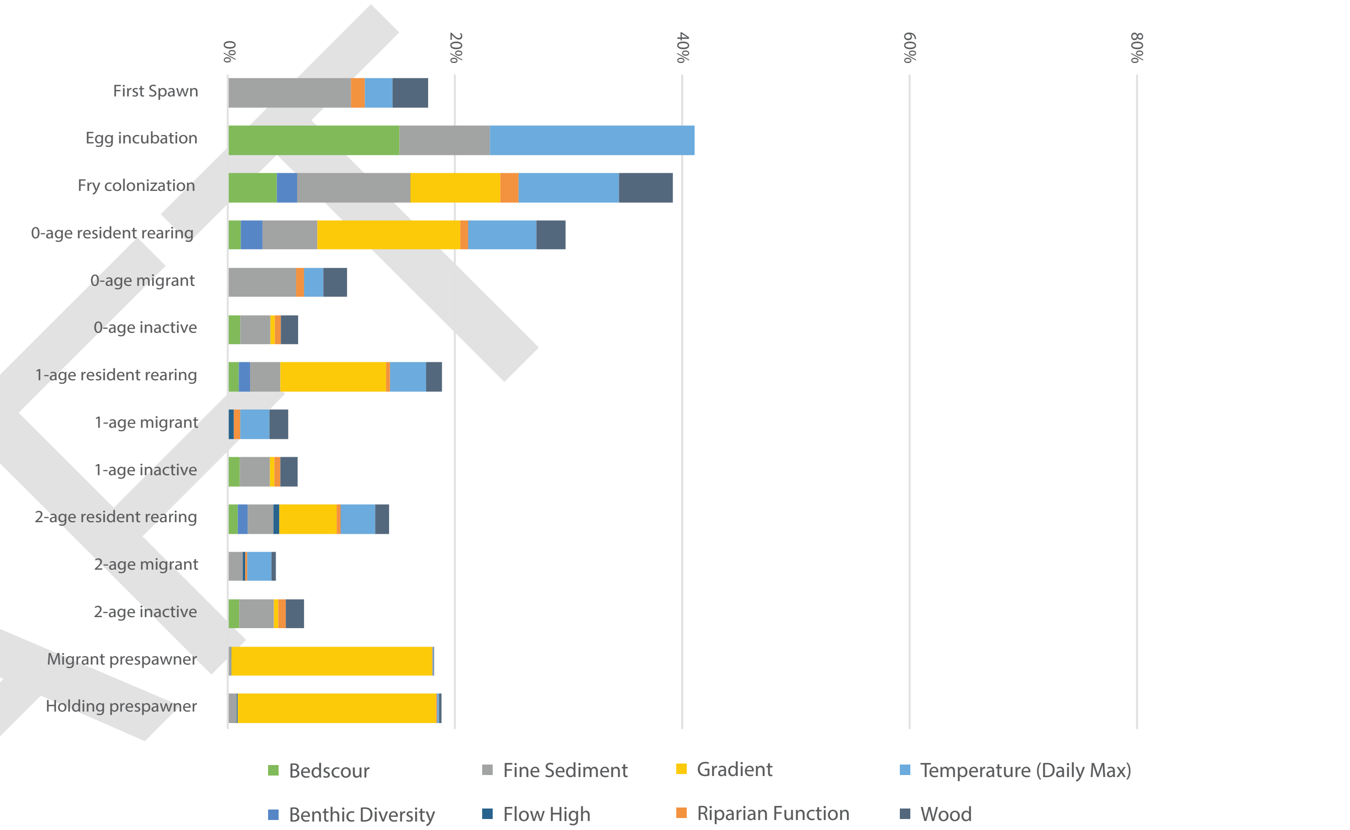


Figure 56. Steelhead sensitivity (%) to limiting factors by life stage in West Birch Creek

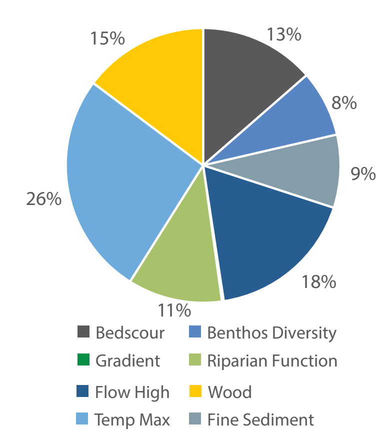


Figure 57. Steelhead limiting factors distribution in West Birch Creek

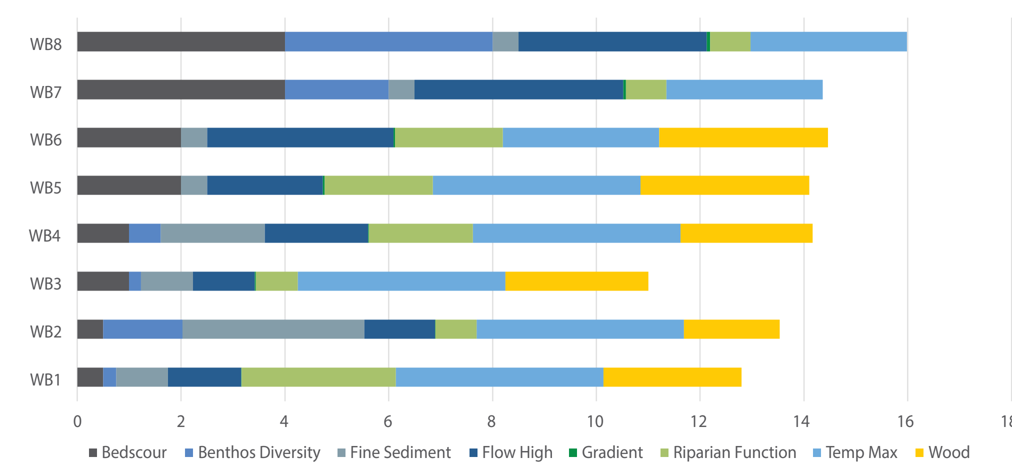


Figure 58. Steelhead limiting factors distribution by reach in West Birch Creek

West Birch Creek - Reach Fishery

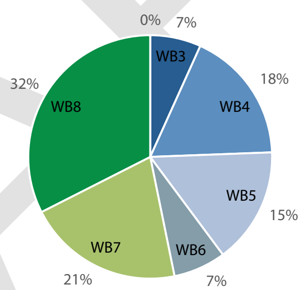
Steelhead Population and Habitat Limiting Factors

Aside from the mainstem Birch Creek, the West Birch Creek steelhead population has likely been the most impacted throughout the watershed. As a relatively long stream in the watershed that spans from the headwaters through diverse landscape types, a fully functional West Birch Creek should be among the most highly productive steelhead streams in the watershed. However, considerable habitat degradation throughout most of its length has resulted in a population that is only slightly more productive than the mainstem Birch Creek.

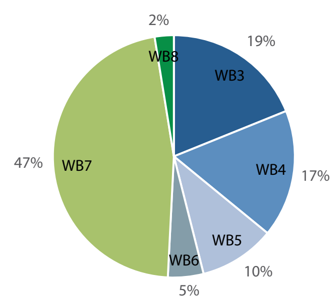
Overall, maximum daily water temperature, bedscour, fine sediment and gradient are limiting factors that early life history stages of steelhead are most sensitive to in West Birch Creek (Figure 56). While temperature is the most significant limiting factor, West Birch Creek steelhead are less limited by temperature than are steelhead in other tributaries.

This is largely because West Birch Creek geomorphic reaches are limited by multiple factors, each of which must be addressed to achieve improvements in performance (Figure 57). In general, temperature is nearly equally limiting to steelhead throughout all reaches, while bedscour and benthos diversity become more limiting in the higher reaches (Figure 58).

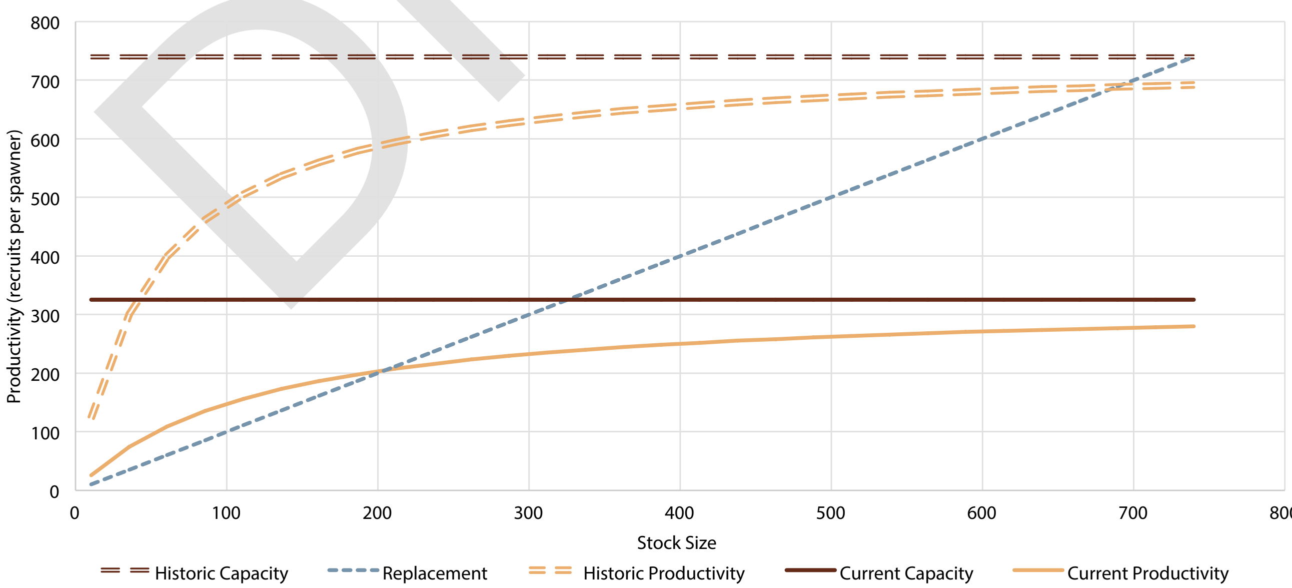
Throughout West Birch Creek, productivity and capacity have been reduced from estimated historic conditions by 80% and 60%, respectively (Figure 59). Currently, productivity is highest in Reach WB7 and WB8, and no production is occurring in WB1 and WB2 (Figure 60). Nearly half of the total habitat capacity in West Birch Creek is in Reach WB7 (Figure 61). As a consequence of reduced productivity and capacity, the equilibrium abundance for naturally produced West Birch Creek steelhead has decreased by 73% in comparison to the population's historic potential.



■ *Figure 60. Distribution of steelhead productivity in West Birch Creek by reach*



■ *Figure 61. Distribution of steelhead capacity in West Birch Creek by reach*



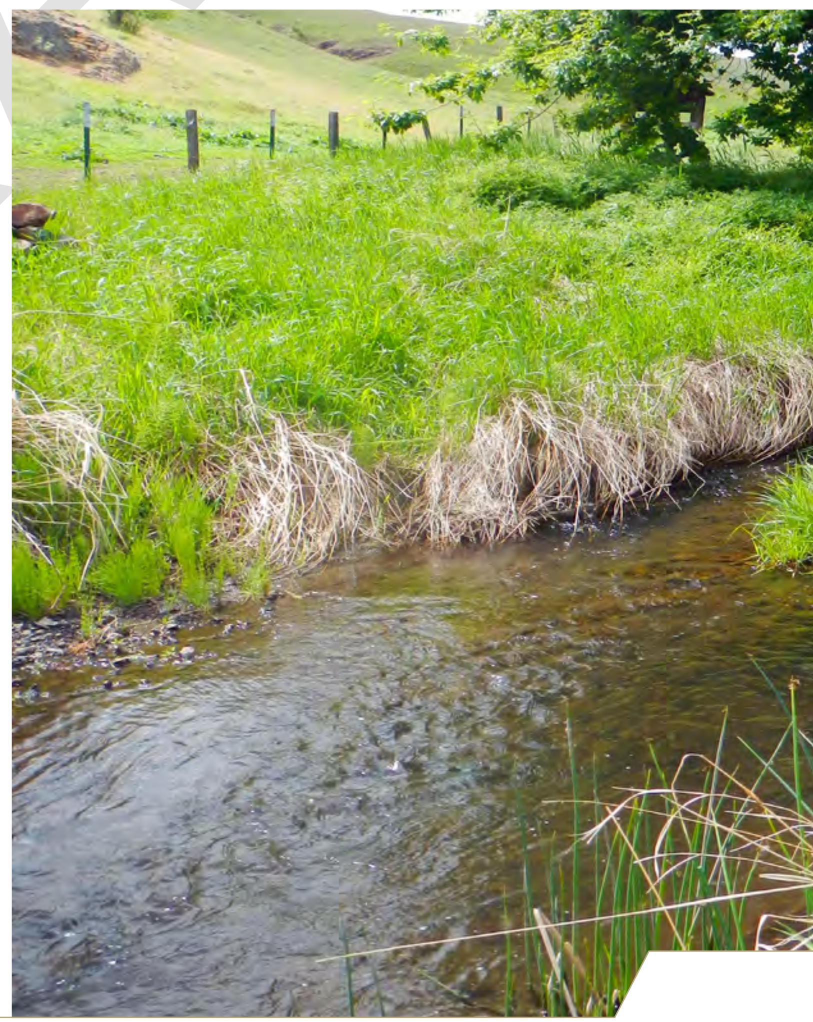
■ *Figure 59. Stock recruitment relationships for the current and historic scenarios based on habitat productivity and capacity in West Birch Creek.*

Bear Creek

Bear Creek extends approximately 15.6 miles from the confluence with West Birch Creek upstream to the headwaters (Figure 62). There are six geomorphic reaches along this distance, ranging in length from 1.8 miles (BR2) to 3.8 miles (BR1). The physical characteristics of these reaches are summarized in Figure 63.

A large portion of the Bear Creek tributary was not physically sampled during the 2015 surveys due to restricted access. An approach was developed in collaboration with the BCTT for utilizing available remote sensing data, modeling outputs, road survey observations and application of results from sampled reaches with similar characteristics to create analyses results for those non-sampled reaches. For the functional parameters of flow duration, floodplain connectivity, flow dynamics and sediment transport competency, the hydrology and hydraulic modeling efforts, based on the 2013 LiDAR data, provide summary outputs. Aerial photograph interpretation of the 2013 orthophotos, which consisted of an assessment of open riparian canopy, was combined with the reach-averaged bankfull width derived from hydraulic modeling to provide data for the water quality-temperature parameter. The remaining parameters of LWD transport and storage, bank migration/lateral stability, bed form diversity, and bed material characterization were evaluated by applying information from the most geomorphically similar reach. Although physical sampling of each reach is preferred, the best available information was used to determine physical conditions and functionality for this assessment.

The most downstream reach of Bear Creek (BR1) experiences extremely low stream flow during the late summer months of July through September. During the field surveys in 2015 (road survey observations),



there was no surface water flow in 33% of reach BR1. These low stream flows contribute to late-summer elevated water temperatures observed in lower Bear Creek and West Birch Creek.

All of the Bear Creek reaches are situated in confined or partially-confined valley bottoms. Due to this confinement, reaches BR2 – BR6 are relatively high gradient (1.9% to 6.3%) with low sinuosity (1.09 – 1.19). However, even when considering the physical setting of these reaches, 3 of the 6 (BR1, BR4, BR5) appear to be disconnected from the available valley bottom. The entrenchment ratios range from 1.77 to 2.02.

■ *Figure 62. Location map and photograph of Bear Creek*

At the larger 100-year flood discharge, the percentage of the valley bottom inundated ranges from 44% (BR5) to 54% (BR3), indicating significant disconnection from the valley bottom.

The confinement of Bear Creek reaches result in high shear stress being applied within the channel over the range of low to high flood discharges. The channel:total shear stress ratios for the 100-year discharge ranged from 1.9 to 2.5, indicating that much of the available energy from the flow is being applied to the stream channel rather than being distributed across the floodplain.

The hydraulic characteristics for the 2-year discharge result in the estimated transport stage (Φ, ratio of applied shear stress to critical shear stress for a given grain size) indicating mobility of the median grain size (D50) in all reaches. The transport stage for the larger D84 grain sizes indicates mobility in reaches BR3, BR5, and BR6 ($\Phi > 1.27$). This finding suggests that bedload being transported from higher gradient reaches is being stored in lower gradient reaches BR1 and BR2.

Bear Creek - Reach Summary

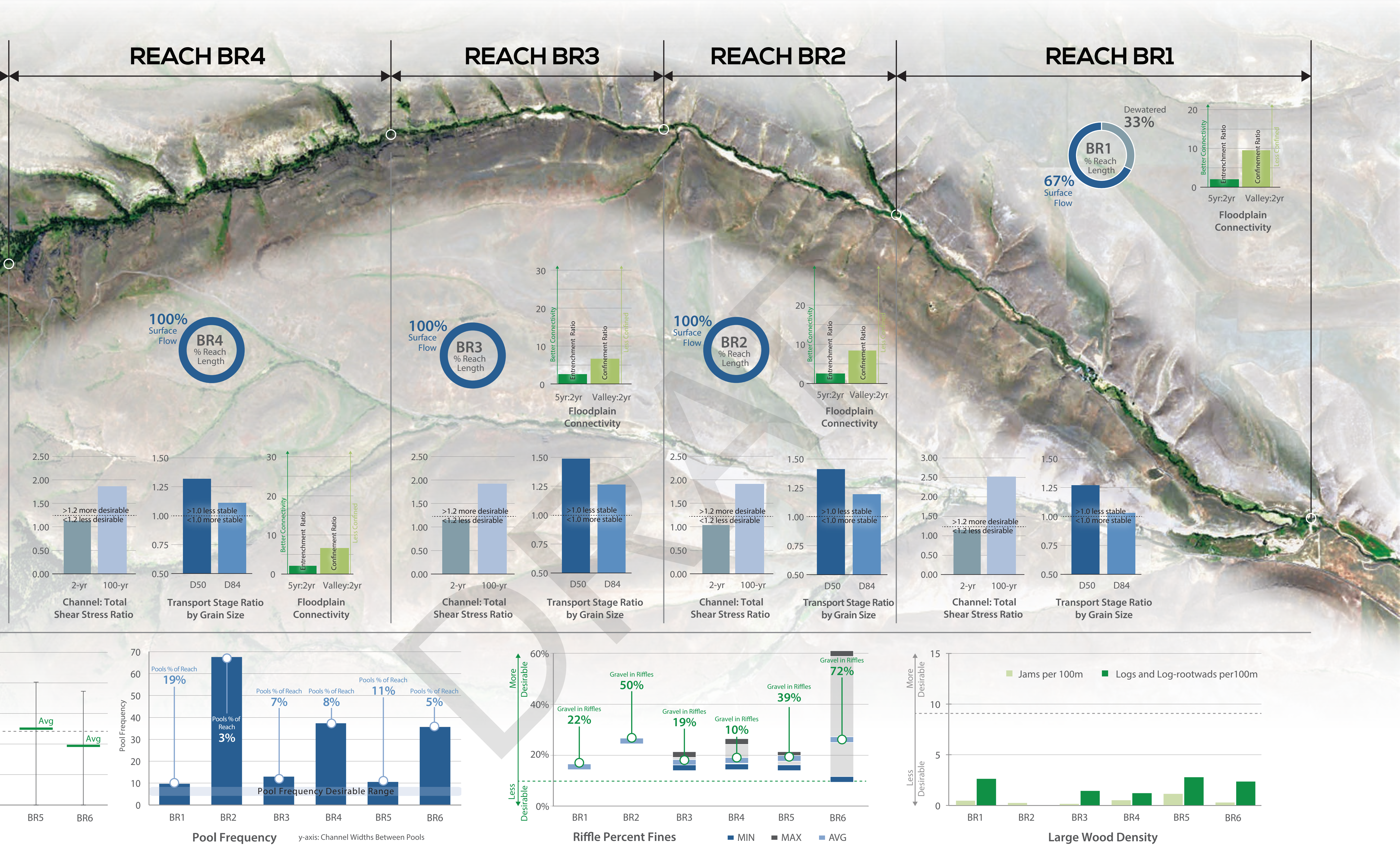


Figure 63. Geomorphic assessment reach summary of Bear Creek

Bear Creek - Reach Function

Results of the watershed and reach assessments indicate a large range of hydrogeomorphic functionality exists among the Bear Creek reaches (Figure 64).

The parameters of sediment transport and Bedform diversity are some of the lowest indicators, which is largely driven by the confinement of Bear Creek and the lack of in-channel structure and roughness.

The low abundance of mature riparian vegetation likely contributes to elevated water temperatures and reduced large wood supply to the stream.

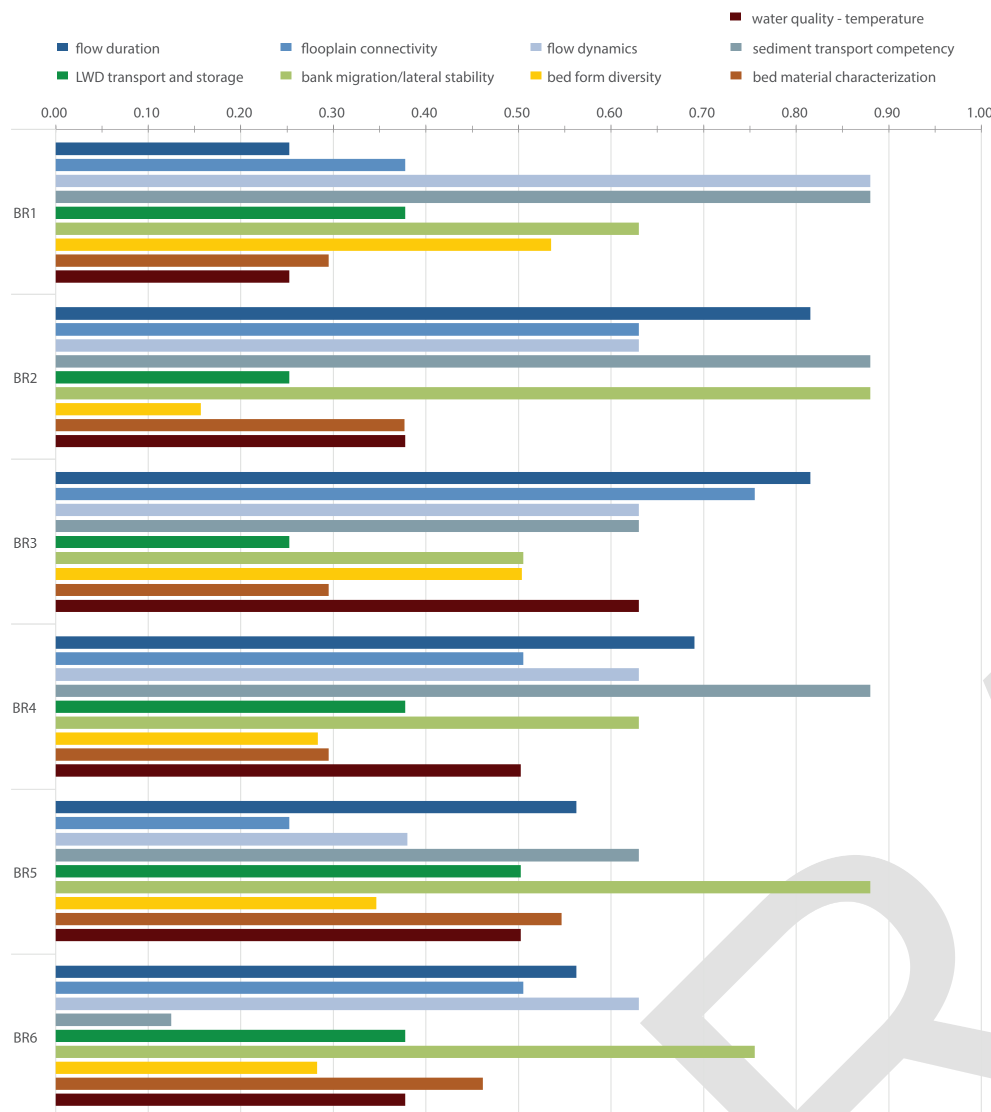


Figure 64. Functional parameter scores by reach in Bear Creek

The overall hydrogeomorphic functionality in Bear Creek ranges from 42% of fully functional (BR1) to 64% of fully functional (BR3) (Figure 65).

The lowest performing functional category is hydrology in BR1, which is largely driven by the significant surface water withdrawals and dewatering of this reach.

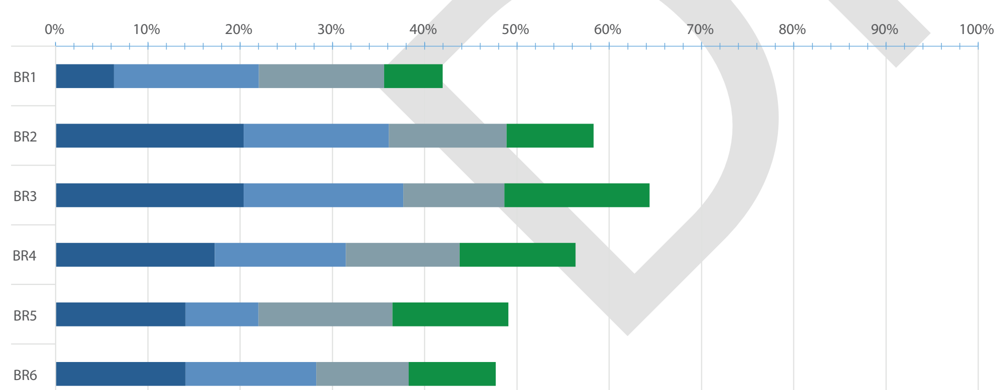


Figure 65. Functional category relative percent of total reach function in Bear Creek

Bear Creek - Reach Fishery

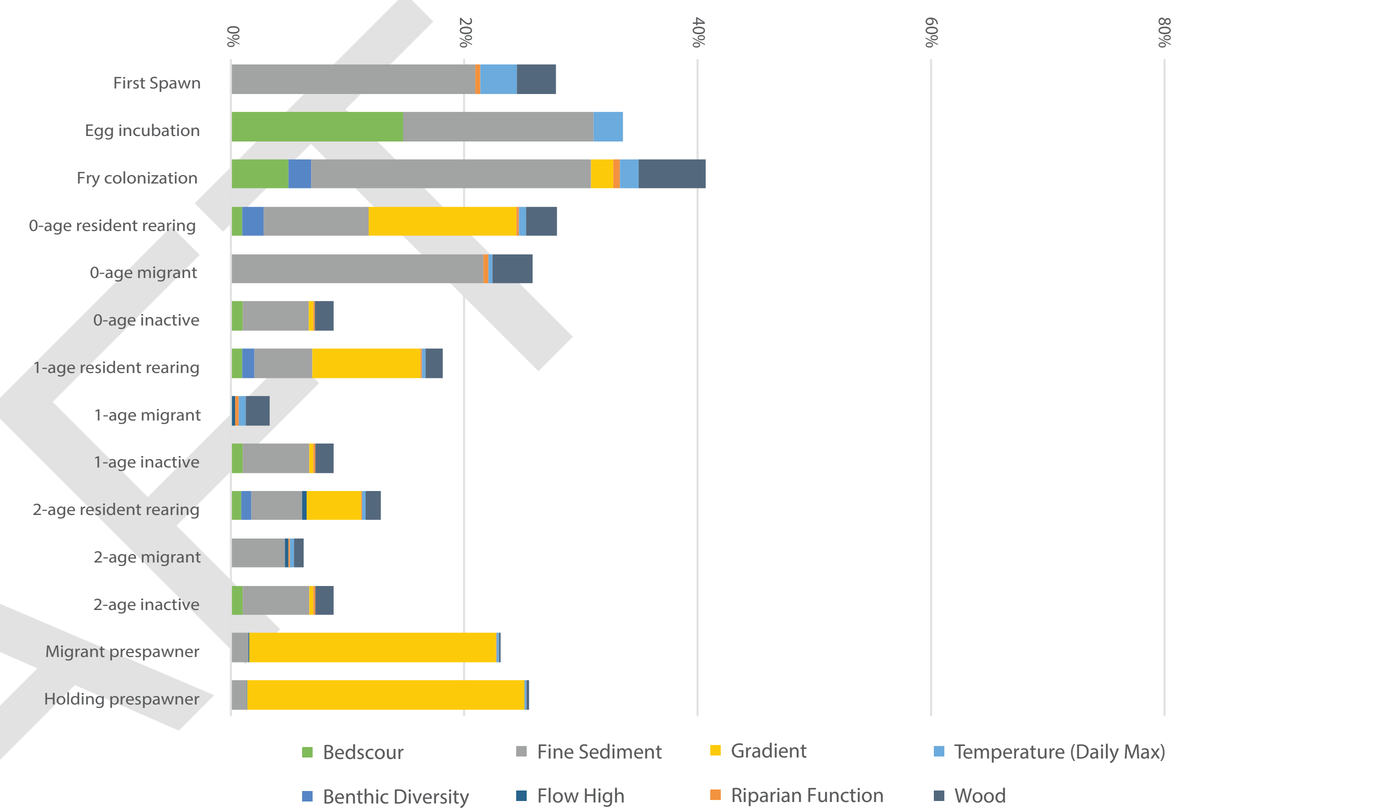


Figure 66. Steelhead sensitivity (%) to limiting factors by life stage in Bear Creek

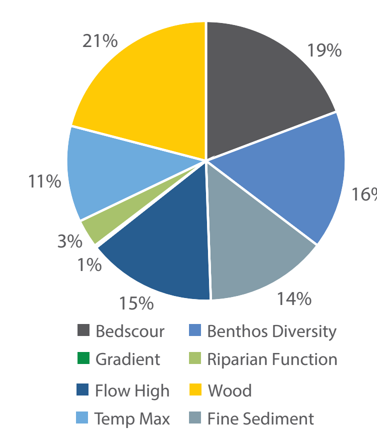


Figure 67. Steelhead limiting factors distribution in Bear Creek

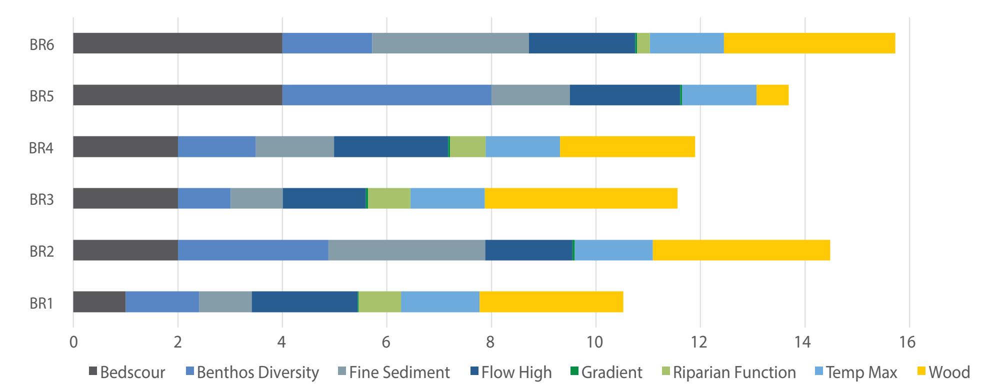


Figure 68. Steelhead limiting factors distribution by reach in Bear Creek

Bear Creek - Reach Fishery

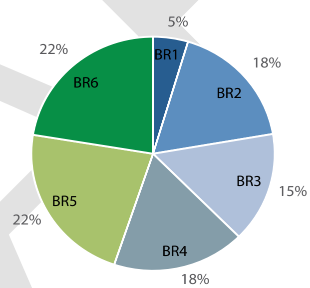
Steelhead Population and Habitat Limiting Factors

As a tributary relatively high in the watershed, Bear Creek's greatest potential for contributing to overall watershed steelhead productivity is successful spawning and early life history survival. In Bear Creek, those life-history stages (spawning, egg incubation, fry colonization and first year rearing) are most sensitive to fine sediment (Figure 66).

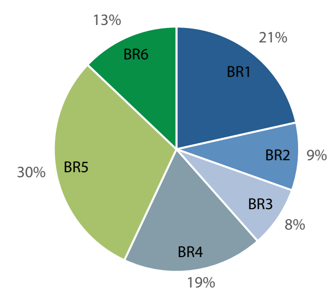
Overall, limiting factors to steelhead in Bear Creek appear to be relatively evenly distributed among the eight attributes analyzed (Figure 67). However, because early life stages are most effected by fine sediment in Bear Creek, it is the factor that is most likely causing most of the reduction in productivity. Fine sediment is most limiting in reaches BR2 and BR6 and woody debris in the channel is limiting to capacity throughout all reaches except BR5 (Figure 68). Notable in Bear Creek is relatively suitable water temperature. Although temperature is somewhat degraded, it appears to be well within the limits for a healthy steelhead population.

The apparent availability of cool water conditions in Bear Creek is a likely explanation for its comparatively high productivity throughout the watershed.

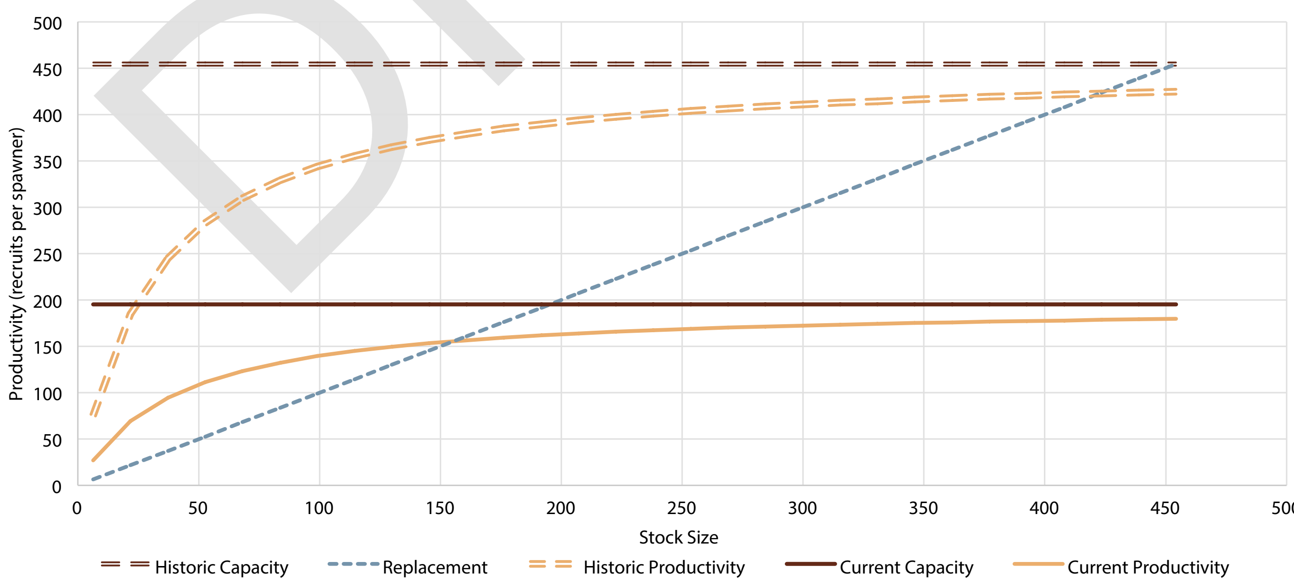
Throughout Bear Creek, productivity and capacity have been reduced from estimated historic conditions by 65% and 50%, respectively (Figure 69). Currently, productivity is relatively evenly distributed among reaches with BR5 as the most productive reach and BR1 being the least productive reach (Figure 70). Habitat capacity estimates for Bear Creek are highest in BR5 and lowest in BR3 (Figure 71). Common among the reaches currently exhibiting the highest productivity is relatively stable flow conditions, stable banks and mature riparian communities while reaches with the highest capacity have relatively functional pool habitat diversity and relative abundance of woody debris jams.



■ *Figure 70. Distribution of steelhead productivity in Bear Creek by reach*



■ *Figure 71. Distribution of steelhead capacity in Bear Creek by reach*



■ *Figure 69. Stock recruitment relationships for the current and historic scenarios based on habitat productivity and capacity in Bear Creek.*

Action Plan Strategy

While the Birch Creek Watershed currently supports a population of steelhead, aquatic habitat conditions are in need of improvement. Changes in land use and resource management practices have occurred for over a century, resulting in ecological, geomorphic and hydrologic conditions that have contributed to fish population declines. Recognizing that improvements to these conditions and fish populations cannot be realized immediately, this strategy provides a prioritized framework of project types that address the restoration needs in both the near-term and long-term. The strategy was developed in five basic steps, which include:

Five Strategy Steps

1. Guiding Vision: A diverse group of management agencies and watershed stakeholders collaborated to develop the project vision, goals and objectives to guide assessment methodologies, provide strategic direction and objectives that need to be achieved.
2. Restoration Needs: Determined what specific geomorphic and habitat parameters, in each of the Tier 1 stream reaches, are impaired and estimated the degree to which the current function deviates from normative conditions. In parallel with estimating geomorphic and habitat impairments, attributes limiting fish populations at key life stages in Tier 1 stream reaches were estimated.
3. Where to Restore: Based on a collaborative process with the BCTT, criteria to prioritize reaches based on where restoration efforts would provide the most benefit to natural processes and fish population response were established.
4. How to Restore: Based on estimated geomorphic, habitat and fish population impairments, and with consideration of potential climate change, restoration action types to address impairments in each stream reach were selected.
5. Monitoring and Adaptive Management: To evaluate restoration success and adjust future projects to past successes, a plan to monitor the watershed at the site-, reach- and watershed-scale was developed.

Previous Restoration Effort

Since 1995 over $2 million has been invested in Birch Creek Restoration Projects (OWEB 2016). Included in that investment are the removal of more than 12 fish passage barriers. These projects included removal and/or modifications to irrigation dams, retrofitting culverts with passage structures, and installing bridges. In addition to the passage barrier removal, over 7,000 linear feet of stream channel/riparian area have been restored through channel realignments, installation of woody debris structures, rock/boulder placement, riparian planting, and riparian fencing. Restoration project sponsors have included the CTUIR, ODFW, UBWC, USFS and private landowners, and many of the projects are cooperative among agencies and landowners.

Collectively, past restoration efforts have contributed to restoring conditions in the watershed and accessibility to habitat. Those efforts also provided a foundation for informing this strategy. Through this strategy development, future restoration projects can be pursued and implemented to specifically prescribe project actions that target needs in a systematic fashion. The project action types, completed previously, can be effective and are included in the strategy. These and other projects will be implemented in a manner that seeks to restore watershed- and reach-scale processes that create ecological conditions necessary for steelhead to thrive.

Climate Change and Restoration Planning

Like many watersheds within the Columbia River Basin, predictions of climate change over the next 20 to 60 years suggest that the Birch Creek watershed will be drier and warmer than recent history (Mote et al., 2014). Among many of the projected impacts of climate change, Birch Creek streams are likely to experience an earlier snowmelt runoff that will result in reduced stream flows during the summer and early fall time periods. When coupled with predicted increases in air temperature and reduced shading of streams, summer stream temperature conditions are projected to be worse than the already deleterious conditions that exist for much of the spring, summer and fall periods. For example, using the A1B future climate scenario, mean August stream temperatures throughout the Birch Creek Watershed are projected to increase by up to 1.5 °C over the next several decades (USFS, 2014) (Figure 72).

The Birch Creek Watershed restoration strategy is designed to accommodate the predicted climate change impacts on stream flow and temperature. The strategy is based on assessing the watershed- and reach-scale functions of hydrologic, hydraulic, geomorphic and physicochemical processes. This landscape and streamscape approach to process-based restoration is intended to result in implementing restoration actions that address fundamental causes of habitat degradation while also providing resiliency to future climate variability (Rieman et al., 2015; Wohl et al., 2015).

Strategy

The types of restoration actions described in this strategy represent general treatments that address the primary functional limitations of each reach. As specific reach- and site-scale restoration plans are developed, it is expected that these plans and designs will incorporate climate change and resiliency considerations specific to the reach and site conditions at the time of implementation. This can be accomplished by (Beechie et al., 2013a; Perry et al., 2015):

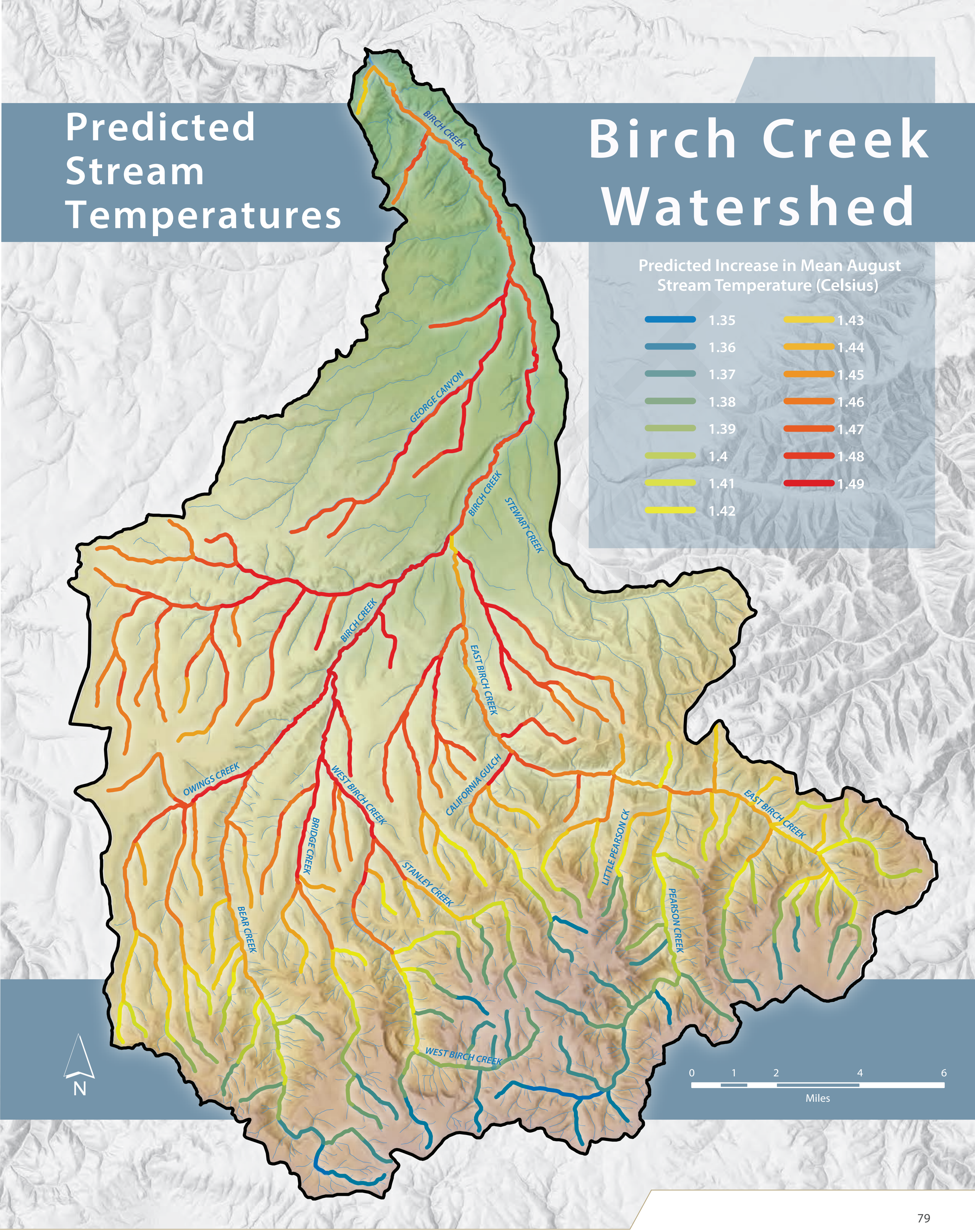
- Applying location- and time-specific predictions of climate change effects on stream flow and temperature
- Predicting effects on biota, geomorphology, and ecology
- Assessing the ability of restoration actions to moderate climate change effects
- Determining the ability of restoration actions to increase ecological function, habitat diversity, and steelhead population resilience

The categories and types of restoration actions differ in the extent to which climate change effects are moderated. Those actions that are most effective at addressing stream temperature increases, reduced stream flows, and increasing steelhead resilience include (Beechie et al., 2013a):

- Longitudinal connectivity through removal of fish passage barriers
- Floodplain reconnection laterally and vertically
- Improved surface water and groundwater management
- Improved native riparian plant community

All of these restoration actions are central to the Birch Creek Watershed restoration strategy.

■ *Figure 72. Predicted Stream Temperatures Map (facing page) - this map represents the temperature difference (in Celsius) of predicted mean August temperature (2040 A1B climate scenario) minus the mean August temperature from 1993 – 2011*



Predicted Stream Temperatures
Birch Creek Watershed
Predicted Increase in Mean August Stream Temperature (Celsius)
1.35
1.36
1.37
1.38
1.39
1.4
1.41
1.42
1.43
1.44
1.45
1.46
1.47
1.48
1.49
BIRCH CREEK
GEORGE CANYON
STEWART CREEK
EAST BIRCH CREEK
OWINGS CREEK
WEST BIRCH CREEK
CALIFORNIA GULCH
BRIDGE CREEK
STANLEY CREEK
LITTLE PEARSON CK
PEARSON CREEK
BEAR CREEK
N
0 1 2 4 6
Miles

Action Plan Strategy

Watershed Actions

Fundamental to the strategic approach in this Action Plan are the principles of process based restoration. Inherent to those principles are a hierarchy of priorities relative to the effectiveness of restoring functional conditions at the watershed-scale. Details of the prioritization hierarchy are described in the Approach and Process chapter and listed below in order of priority:

- Protection
- Conservation
- Reconnection
- Restoration

Protection

Although many of the Tier 1 reaches in the Birch Creek Watershed are substantially degraded, the watershed still supports a significant component of the natural production of steelhead in the Umatilla Subbasin (Contor, 2015). This production must first and foremost be protected against further degradation, and must be sufficiently protected to allow for a natural level of adaptation to climate change and resiliency to local disturbance (Mantyka-Pringle et al. 2016). Priority protection areas are reaches, or portions of reaches, that exhibit one or more of the following attributes:

- Areas where ecological processes are highly functioning across the range of spatial and temporal scales
- Areas of particular importance to the biological productivity of steelhead: those that currently support productive and/or abundant levels of spawning and rearing indicated by a high Neq
- Areas with the greatest potential for fully restoring ecological processes, regardless of their current condition

Throughout all of the Tier 1 reaches, hydrogeomorphic function is generally poor and in need of restoration. Because hydrogeomorphic functionality in all the reaches is poor, protection efforts are primarily focused on reaches where the number of steelhead at equilibrium (Neq) value, for each reach, is the highest. The Neq value includes both capacity and productivity results and, therefore, represents the total current biological significance of a reach.

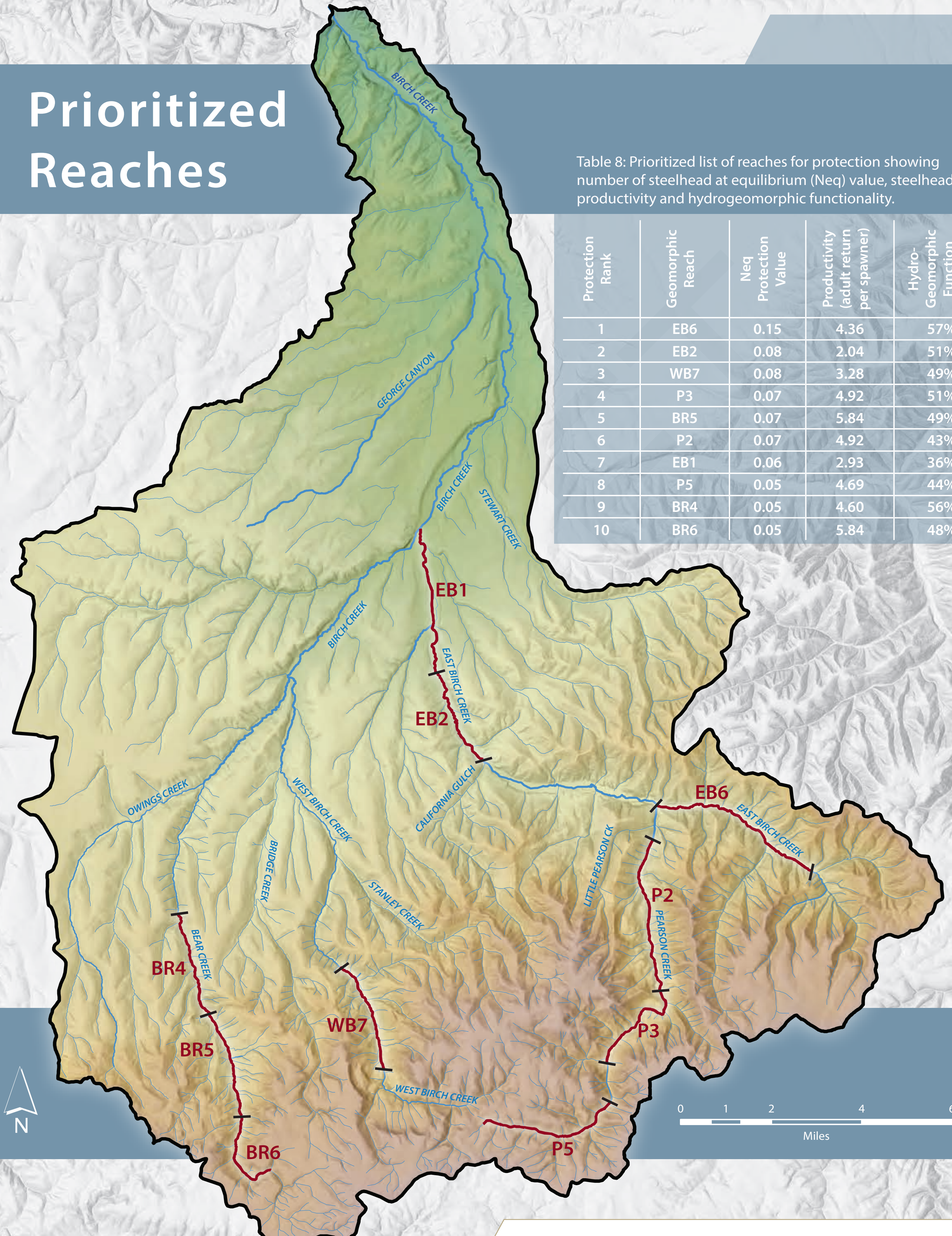
Based on modeled results, the top 10 Tier 1 reaches where steelhead would benefit most from protection are shown in Table 8 and Figure 73. Common among these prioritized protection reaches are relatively stable flows, the presence of large woody material, naturally stable streambanks, relatively high pool frequency, intact riparian vegetation communities and relatively high spawning productivity (Table 8). This indicates that protection measures should mostly focus on keeping water in the channel, maintaining functional buffers and providing security for spawning steelhead.

While this prioritized list of reaches provides guidance on the reaches that would benefit most from protection, it is unlikely that funding and/or access will be available to protect an entire reach all at once. With this understanding, the strategy for maximizing the benefits of protection, with resources available, is to select specific areas where the most functional parameter(s) can be protected. Ideally, those specific areas will be where protection could be combined with other restoration efforts that also restore other functional parameters and address the most significant limiting factors.

Prioritized Reaches

Table 8: Prioritized list of reaches for protection showing number of steelhead at equilibrium (Neq) value, steelhead productivity and hydrogeomorphic functionality.

Protection Rank	Geomorphic Reach	Neq Protection Value	Productivity (adult return per spawner)	Hydro-Geomorphic Function (% functionality)
1	EB6	0.15	4.36	57%
2	EB2	0.08	2.04	51%
3	WB7	0.08	3.28	49%
4	P3	0.07	4.92	51%
5	BR5	0.07	5.84	49%
6	P2	0.07	4.92	43%
7	EB1	0.06	2.93	36%
8	P5	0.05	4.69	44%
9	BR4	0.05	4.60	56%
10	BR6	0.05	5.84	48%



■ *Figure 73. Map of reaches prioritized for protection*

Action Plan Strategy

Conservation

This restoration strategy is focused on identifying opportunities to protect, restore and enhance natural processes that result in productive steelhead habitat. This includes identifying opportunities to address disturbances of ecological processes at the watershed and sub-basin scales – opportunities that are generally categorized as conservation management and planning.

Conservation is based on maintaining and improving sustainable resource management practices that affect the ecological processes across the range of spatial and temporal scales. This includes efforts to protect, enhance and restore stream flows and high water quality. While these types of strategies are considered passive restoration actions, their implementation and long-term success is critical to realizing the effectiveness of active reach- and site-scale restoration treatments in stream channels, banks and floodplains described elsewhere in this strategy.

Ongoing conservation practices have been applied throughout the Birch Creek Watershed over the past several decades, and recent planning efforts help ensure that these practices will continue into the future. ODFW and CTUIR (2006) identified conservation management strategies for Lower Birch Creek, East Birch Creek and West Birch Creek. These strategies included water conservation and management, riparian zone fencing and planting, conservation reserve programs, and road management. Similar conservation management strategies have been identified for the larger Umatilla River watershed (ODEQ, 2012), with improvement plans focused on agricultural practices, conservation reserve programs, forest management and transportation management. Similarly, the plans for improving nonpoint sources of pollution from agricultural lands are focused on addressing eroding agricultural, range and forest lands, eroding streambanks, runoff and erosion from roads, and runoff from livestock and other agricultural operations (ODA, 2015).

The Birch Creek Watershed Action Plan is complementary to the other existing planning efforts in the larger Umatilla River Watershed, whereby the conservation efforts identified in this strategy are intended to be implemented in collaboration with similar efforts of landowners and resource managers in the watershed. The primary conservation actions identified for the Birch Creek Watershed are based on the needs identified in the watershed assessment and reach assessment, including:

Water management and Irrigation Efficiency

Water availability is a critical need for fish habitat and agricultural operations. Irrigation efficiency and water conservation projects can simultaneously improve aquatic habitat and agricultural economics. Increasing the quantity of stream flows can be accomplished by projects that fall into two general categories: 1) irrigation efficiencies that improve conveyance infrastructure, and 2) water transactions that increase stream flow by purchasing, leasing and/or modifying water rights.

Focus sub-basins: Coombs Peak – Birch Creek, Stewart Creek – Birch Creek, Lower East Birch Creek, West Birch Creek

Soil conservation and Sediment Management

Excessive sediment in stream channels represents adverse impacts for fish habitat and agricultural productivity. Implementation of best management practices on agricultural, range and forest lands will help control the erosion of sediment from hillslopes.

Water and sediment control basins in the uplands will improve the ability to farm on sloping land, reduce sediment erosion, control runoff and improve downstream water quality. Streamside vegetation protection and enhancement will limit the delivery of eroded sediment to stream channels.

Poorly functioning roads can result in concentrated runoff that causes significant soil erosion and sediment delivery to stream channels. Road access throughout the watershed is important for agricultural production, forest management and recreation activities. Ensuring a properly functioning road network will minimize impacts to fish and stream ecosystems, while maintaining the important transportation network. These road impacts can be addressed through improved road drainage and stream crossings, as well as road realignment, decommissioning, and restoration.

Focus sub-basins: Upper East Birch Creek, Pearson Creek, Bear Creek, West Birch Creek

Conservation Reserve Programs

There are several different types of programs available through state and federal agencies that help landowners with sustainable land use practices in an economically feasible approach by enrolling crop, pasture, range, and forest lands in long-term vegetation management programs. The implementation details vary widely among these programs, but all of them generally involve retiring the land from cropping, grazing or timber harvesting for the length of the contract. Enrolled land is typically selected from highly erodible land or environmentally sensitive areas and converted to permanent, perennial vegetation cover. To offset the loss of production from enrolled lands, landowners are compensated through annual rental payments for the term of the contract, which typically extends for 10 to 15 years. Cost share funding is usually provided to help in planting and maintaining the vegetation cover.

Focus sub-basins: Bear Creek, Lower East Birch Creek, West Birch Creek, Stewart Creek – Birch Creek, Coombs Peak – Birch Creek

Water management and irrigation efficiency can improve stream flows in many reaches of the Birch Creek Watershed.

Conservation reserve programs can foster long-term stream health and benefit landowners.

Hillslope and gully sediment erosion in the lower Bear Creek sub-basin.

Some roads have a high risk of sediment delivery to streams (top), while other roads are of less concern (bottom).

Connectivity-Fish Passage

Connectivity among and between habitats is critical to steelhead population sustainability throughout the Birch Creek Watershed. The 73 identified barriers restrict passage connectivity either at a specific life history stage or seasonal flow condition. Although the potential barriers don't appear to be restricting a significant extent of the historic range, they do have an effect on the population by restricting the migration patterns of juvenile life history stages. These restrictions prevent juvenile fish from moving from poorly suited habitat conditions to more suitable areas. Additionally, restricting juvenile fish reduces dispersal and thereby subjects them to the effects of density dependence. Exacerbating migratory restrictions are degraded habitat conditions. In all, these barriers contribute to juvenile mortality, which reduces watershed productivity and eventual stock size of each respective cohort.

Given the number and types of barriers present throughout the watershed, barrier removal was prioritized by reach. Individual barriers were given a weight based on their risk rating (low, medium, high) to populate a weighting function used to discern between more and less important barriers. Then the average productivity and total capacity of habitat above each barrier was estimated based on reach-level results.

The amount of equilibrium abundance above each barrier was calculated to discriminate between barriers that are at potential risk of failure with significant production above them, from barriers that are not at risk of failure or would have a lower impact on the population should they fail. Individual barriers were combined with others in their respective reaches, then used to calculate the approximate equilibrium abundance of steelhead upstream of each reach.

The weighted steelhead equilibrium abundance, upstream of each reach, was used to prioritize the order in which reach barriers should be removed, modified or repaired. This is intended to direct future barrier removal projects to areas where they will provide the most benefit to the steelhead population throughout the watershed. While it is not likely that funding and/or access will be available to address all barriers in a given reach at one time, the prioritization is intended to provide guidance on where to focus efforts in a sequential and most beneficial manner.

Table 9 shows the prioritized ranked list of the top seven reaches where barrier removal would be most beneficial to steelhead. The table includes the weighted obstructed steelhead equilibrium abundance above each reach as well as the number of minor, moderate, and major barriers within that reach.

Table 9. Seven highest priority barrier removal reaches, the upstream steelhead equilibrium abundance (Neq) and the number of barriers in each reach by risk rating.

Prioritized Rank	Geomorphic Reach	Weighted Obstructed Neq	Number of Barriers and Risk Rating		
			Minor	Moderate	Major
1	B2	931	0	0	2
2	B5	375	0	1	4
3	B1	175	4	2	1
4	EB2	189	2	4	0
5	EB1	116	4	3	0
6	WB1	116	2	3	1
7	WB4	54	0	0	1

Stream Bariers to Fish Passage*. The 73 identified barriers restrict passage connectivity either at a specific life history stage or seasonal flow condition. Although the potential barriers don't appear to be restricting a significant extent of the historic range, they do have an effect on the population by restricting the migration patterns of juvenile life history stages.*

Reach Actions

Reach Prioritization

Reaches with restoration potential are distributed throughout the watershed. Prioritized restoration actions were developed using a quantitative approach based on reach-scale hydrogeomorphic function assessment results and the biological needs of steelhead.

The first step of the reach-scale restoration strategy was to answer the question about where to work. Reach prioritization was completed through the application of a multi-criteria evaluation process. The BCTT worked collaboratively to develop nine selection criteria that use assessment results as a guide to prioritize reaches within each of the five Tier 1 streams. Of the nine selection criteria used, five are biologically based and four are based on hydrogeomorphic function (Table 10). Each criterion was assigned a value ranging from 1 (low priority) to 3 (high priority) for each reach. The threshold between low, medium and high priority for each criterion was based on the distribution of the assessment results for each criterion (Table 10). The nine criteria scores were summed for each reach, resulting in a prioritization of the reaches ranging from low priority (low total score) to high priority (high total score). Results of this prioritization scoring are shown in figures 74-78.

The next step in answering the question about where to work was prioritizing a sequence, among Tier 1 streams, in the order that provides the most benefit to the steelhead population. The sequenced order is shown as six phases (Table 11). While implementing projects based on prioritized reaches and sequential phases is an ideal scenario, the BCTT understands that funding and/or access restrictions will play a significant role in implementation sequence. However, the guidance of these results will help sponsors seek out projects that will provide the greatest benefit over the life of this strategy.

Within this functional framework, fish abundance, distribution, habitat use, and productivity (biota/biology) were considered in terms of their response to changes in the primary watershed- and reach-scale functional parameters.

Table 10. Reach prioritization selection criteria showing relative value ranking thresholds.

Selection Criteria	Description	Relative Value of Selection Criteria		
		1	2	3
1	Steelhead Abundance (capacity/productivity)	highest third rank	middle third rank	lowest third rank
2	Steelhead population growth rate (productivity)	highest third rank	middle third rank	lowest third rank
3	Steelhead population spatial structure	highest third rank	middle third rank	lowest third rank
4	Steelhead population diversity	highest third rank	middle third rank	lowest third rank
5	Obstruction to Fish Passage	low	medium	high
6	Hydrologic function	>60%	30% to 60%	<30%
7	Hydraulic function	>60%	30% to 60%	<30%
8	Geomorphology function	>60%	30% to 60%	<30%
9	Physicochemical function - water temperature	>60%	30% to 60%	<30%

Table 11. Birch Creek Watershed restoration implementation phases.

Phase Number	Description
1	Begin passage evaluations and restoration in lower Birch Creek and lower East Birch Creek, and develop a restoration work plan for East Birch Creek
2	Implement passage restoration in lower Birch Creek and lower East Birch Creek, implement restoration work plan for East Birch Creek, and develop a restoration work plan for Pearson Creek habitat and lower West Birch Creek obstructions
3	Implement Pearson Creek restoration work plan and lower West Birch Creek passage restoration actions, and develop a restoration work plan for West Birch Creek
4	Implement West Birch Creek habitat restoration actions, and develop a restoration work plan for Bear Creek
5	Implement Bear Creek restoration work plan, and develop a detailed work plan for lower Birch Creek
6	Implement lower Birch Creek restoration work plan

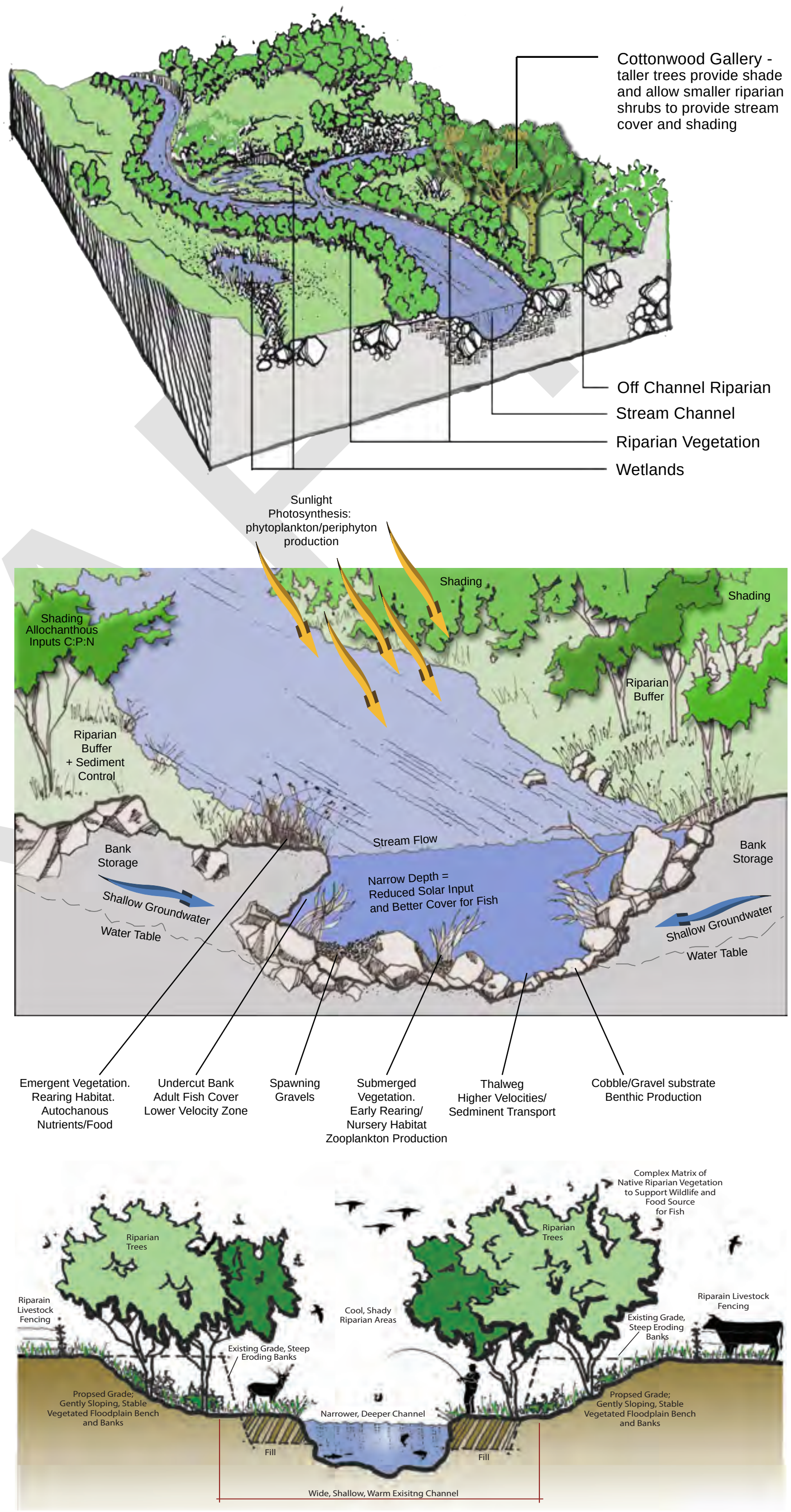
Action Plan Strategy

Restoration Actions

After answering the question on where to work, the next step of the reach-scale restoration strategy was to answer the question of what type of restoration actions would be most beneficial in the respective Tier 1 reaches. Hydrogeomorphic functional deficiencies and steelhead limiting factors were the basis of determining needed restoration actions for each reach. The BCTT evaluated several methods to define restoration action types and determined that using restoration action types developed by Bonneville Power Administration, for similar planning processes in the region, was appropriate in the Birch Creek Watershed.

A total of 36 specific restoration actions are grouped into 10 restoration groups (Table 12). The most beneficial restoration group types were identified for each reach and shown on the following pages by each Tier 1 stream.

Land management practices and restoration actions implemented in the watershed can influence physical and ecological processes in many ways. Considering the purpose of this plan to maintain and improve conditions that support and restore functional watershed processes and healthy steelhead populations in balance with local community needs, coordination of objectives for land use and natural resources management is necessary. The BCTT and other stakeholder agencies can promote positive changes in the Birch Creek Watershed by collaboratively working with land owners and managers to plan and implement appropriate and effective actions.



Protection and enhancment of streambanks allows for the establishment of riparian vegetation, improved instream habitat, and creates deeper pools and refugia. As riparian vegetation matures it will provide shade to the stream channel and reduce water temperature.

■ *Table 12. Restoration groups and restoration actions identified to address the restoration needs in Tier 1 streams of the Birch Creek Watershed*

Restoration Group Number	Restoration Group	Restoration Action
1	Dedicating Land and Water to the Preservation and Restoration of Stream Habitat	1.1. Protect land and water (easement, acquisition)
2	Channel Modification	2.1. Channel Reconstruction
		2.2. Pool Development
		2.3. Riffle Construction
		2.4. Meander (Oxbow) Re-connect - Reconstruction
		2.5. Spawning Gravel Cleaning and Placement
3	Floodplain Reconnection	3.1. Levee Modification: Removal, Setback, Breach
		3.2. Remove - Relocate Floodplain Infrastructure
		3.3. Restoration of Floodplain Topography and Vegetation
		3.4. Floodplain Construction
4	Side Channel / Off-Channel Habitat Restoration	4.1. Perennial Side Channel
		4.2. Secondary (non-perrenial) Channel
		4.3. Floodplain Pond - Wetland
		4.4. Alcove
		4.5. Hyporheic Off-Channel Habitat (Groundwater)
		4.6. Beaver Re-introduction
5	Riparian Restoration and Management	5.1. Riparian Fencing
		5.2. Riparian Buffer Strip, Planting
		5.3. Thinning or removal of understory
		5.4. Remove non-native plants
6	Fish Passage Restoration	6.1. Dam removal or breaching
		6.2. Barrier or culvert replacement/removal
		6.3. Structural Passage (Diversions)
7	Nutrient Supplementation	7.1. Addition of organic and inorganic nutrients
8	Instream Structures, Large Wood and Logjams	8.1. Rock Weirs
		8.2. Boulder Placement
		8.3. LWD Placement
9	Bank Restoration, Modification, and Removal	9.1. Modification or Removal of Bank Armoring
		9.2. Restore banklines with LWD - Bioengineering
10	Water Quality and Quantity Impacts	10.1. Aquire Instream Flow (Lease- Purchase)
		10.2. Improve Thermal Refugia (spring reconnect, other)
		10.3. Irrigation System Upgrades -Water Management
		10.4. Reduce - Mitigate Point Source Impacts
		10.5. Upland Vegetation Treatment - Management
		10.6. Road Decomissionsing or abandonment
		10.7. Road Grading - Drainage Improvments

Action Plan Strategy

Lower Birch Creek

The hydrogeomorphic function in the five reaches of Lower Birch Creek (Figure 74) is most limited by extreme low flows, lack of floodplain connectivity, lack of large woody material, and poor riparian conditions. The greatest limiting factors for steelhead are high water temperatures and poor habitat conditions with very low levels of large woody material. Restoration efforts in these reaches, shown in Table 13, should focus on increasing and maintaining instream flow, improving connectivity between the stream channel and floodplain (both surface and subsurface connections), and improving geomorphic conditions of the channel and floodplain. Improvements in connectivity and geomorphic conditions of the channel and floodplain can be completed through reconstruction of streambanks and floodplain surfaces. Additional space will be needed in the valley floor in order to achieve an appropriate channel plan form and functional riparian environment. These restoration types can simultaneously benefit agriculture practices by naturally stabilizing streambanks and providing increased shallow groundwater storage. Increases in water storage and water availability through the valley, in combination with improved channel and floodplain form, is expected to result in a healthier and more robust riparian plant community, increased availability of future large woody debris, and improved bank stability.

Table 13. Restoration groups and recommended actions for Lower Birch Creek

Reach	Restoration Groups	Recommended Actions
B1	2, 4, 5, 8, 9, 10	Acquire instream flow, channel and meander reconstruction, riparian restoration and LWD placement
B2	2, 3, 4, 5, 8, 9, 10	Acquire instream flow, channel and meander reconstruction, restore floodplain topography and riparian restoration
B3	2, 3, 4, 5, 8, 9, 10	Acquire instream flow, channel and meander reconstruction, Restore floodplain topography and riparian restoration
B4	2, 3, 4, 5, 8, 9	Acquire instream flow, restore floodplain topography, channel reconstruction and riparian restoration
B5	2, 4, 5, 8, 9, 10	Acquire instream flow, restore floodplain topography, channel reconstruction and riparian restoration

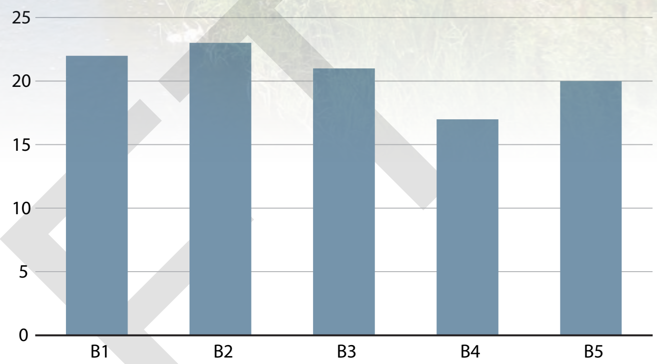


Figure 74. Summary of reach restoration priority for Lower Birch Creek

Action Plan Strategy

East Birch Creek

The eight reaches of East Birch Creek (Figure 75) are most limited in physical functionality by extreme low flows, lack of large wood material, and a lack of connectivity between the channel and floodplain. Steelhead are especially limited in the lower reaches by high water temperatures and lack of surface flow, which impacts both spawning productivity and habitat capacity. Restoration efforts in East Birch Creek, shown in Table 14, should focus on increasing and maintaining instream flow through the summer season, improving geomorphic and habitat conditions of the channel, increasing connectivity between the stream channel and floodplain (both surface and subsurface connections), adding large wood material where appropriate, and improving riparian vegetation conditions. The lowest most reach (EB1) is highly functional in sediment transport competency, and poorly functioning for bank migration and stability, indicating a vertically stable channel with a tendency to move and expand laterally in the valley floor. Increasing the lateral development of the channel in EB1 through meander and floodplain construction will improve bank stability conditions and increase floodplain connectivity. Throughout the lower reaches of East Birch Creek, increases in shallow groundwater storage and availability in the riparian environment in combination with improved channel and floodplain complexity is expected to result in a healthier and more robust riparian plant community, increased availability of future large woody debris, and improved bank stability. Upper reaches of East Birch Creek (EB7 and EB8) would benefit from improvements in channel form and increased channel roughness and complexity.

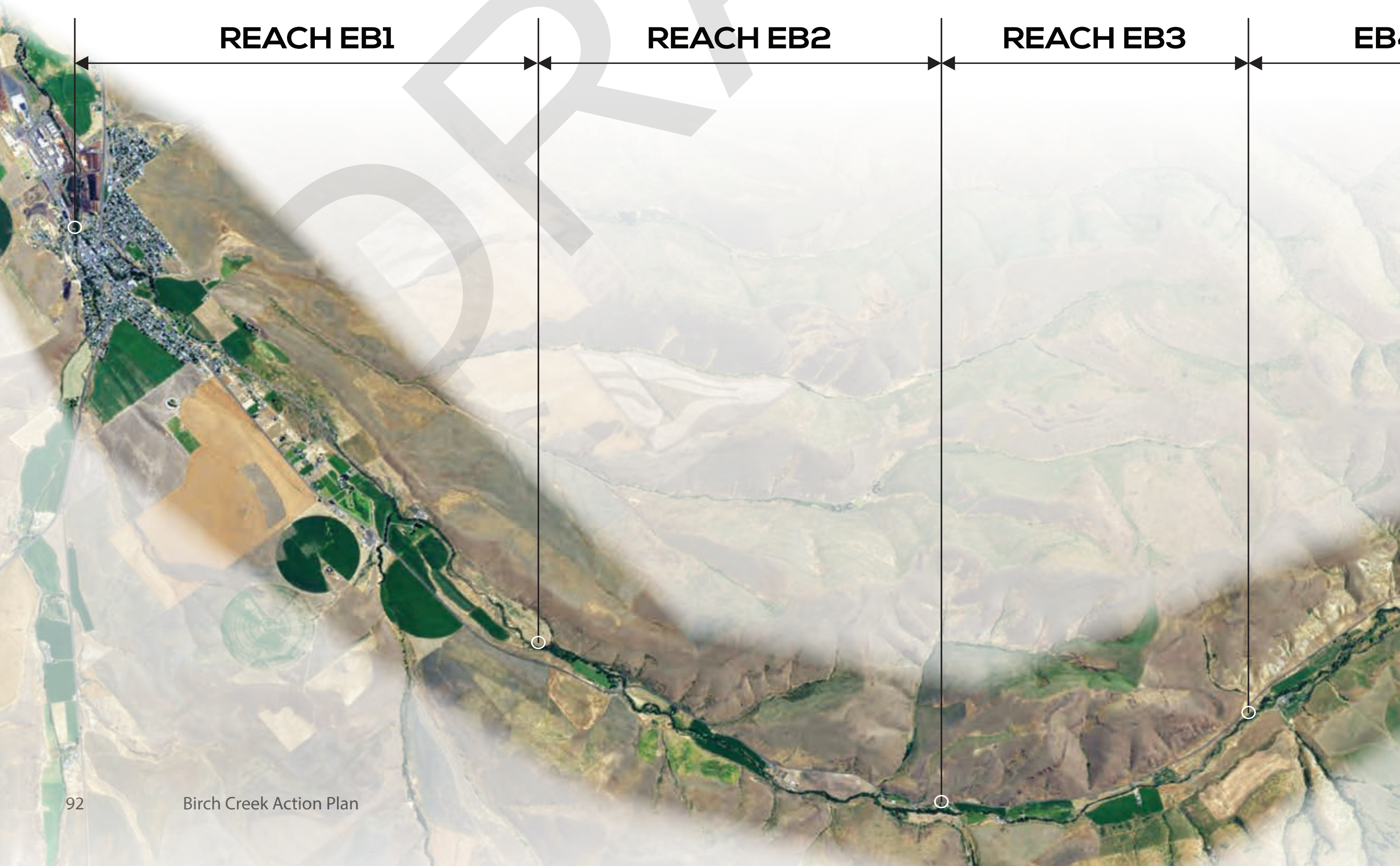


Table 14. Restoration groups and recommended actions for East Birch Creek

Reach	Restoration Groups	Recommended Actions
EB1	2, 3, 5, 8, 9, 10	Acquire instream flow, channel and meander reconstruction, Restore floodplain topography and riparian vegetation
EB2	2, 3, 4, 5, 8, 9, 10	Restore floodplain topography and vegetation, floodplain construction and riparian buffer strip/planting
EB3	2, 3, 4, 5, 8, 9, 10	Restore floodplain topography and vegetation, channel and meander reconstruction, LWD placement
EB4	2, 3, 4, 5, 8, 9, 10	LWD placement, bioengineering and floodplain construction
EB5	2, 3, 4, 5, 8, 9, 10	LWD placement, floodplain construction and riparian buffer/planting
EB6	2, 4, 5, 8, 9, 10	Channel and meander reconstruction, LWD placement and riparian buffer/ planting
EB7	2, 3, 4, 8, 9	LWD and boulder placement, channel reconstruction and pool development,
EB8	2, 3, 4, 8, 9	LWD and boulder placement, channel reconstruction and pool development

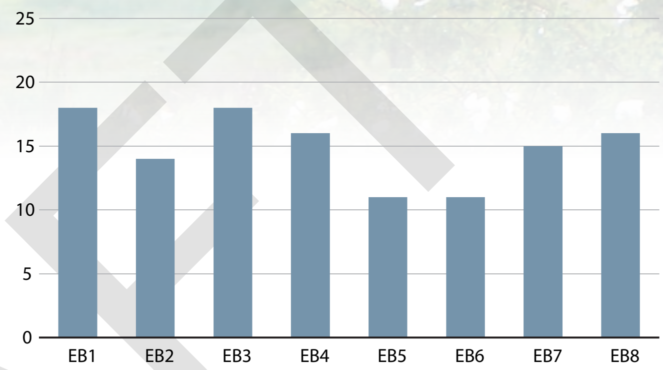
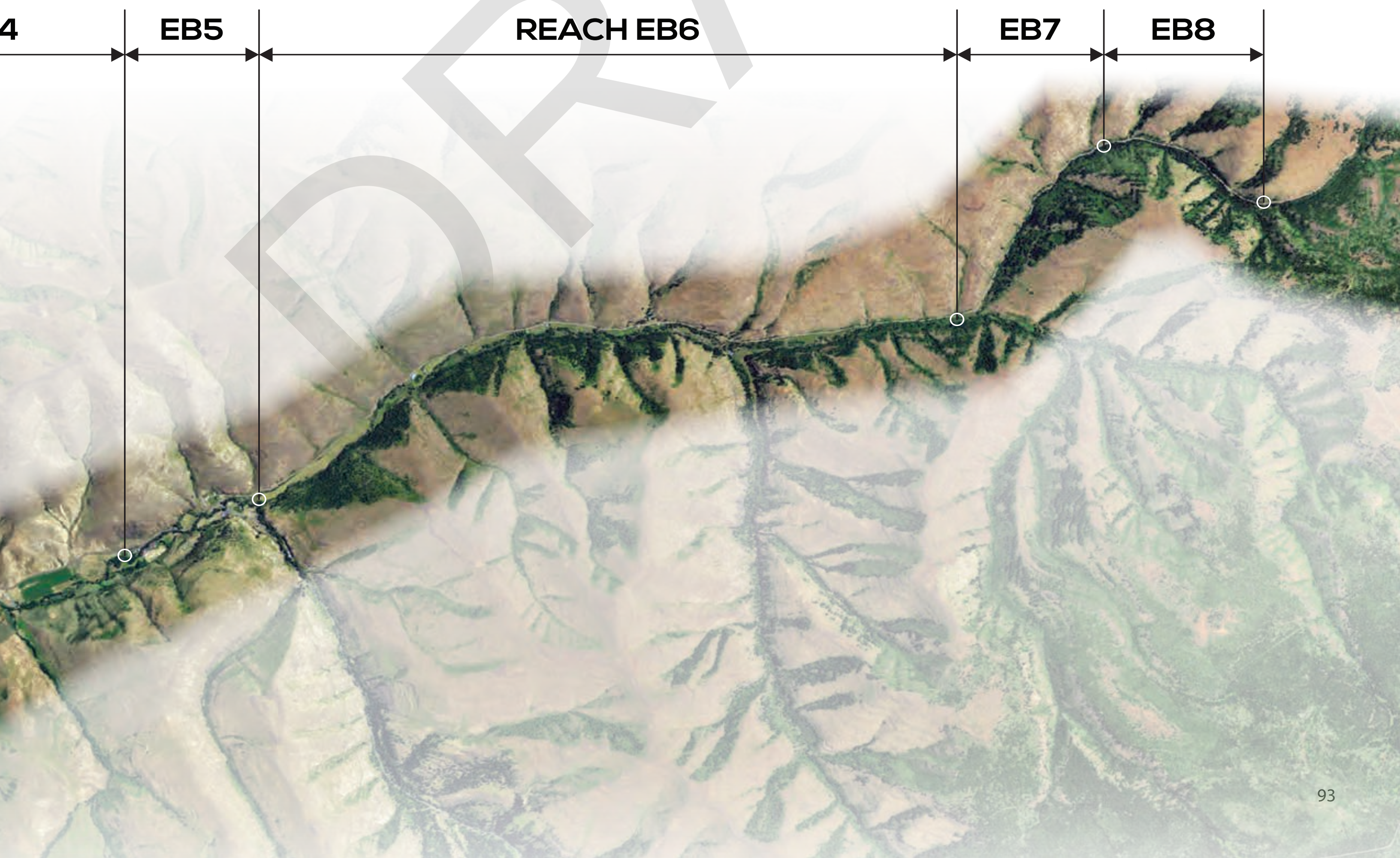


Figure 75. Summary of reach restoration priority for East Birch Creek



Action Plan Strategy

Pearson Creek

The five reaches of Pearson Creek (Figure 76) are most limited in physical functionality by low bed form diversity, a lack of connectivity between the channel and floodplain, lack of large woody material, and channel confinement indicated by flow dynamics and sediment transport. Steelhead are limited by high water temperatures and poor habitat conditions due to a lack of large woody material. Restoration efforts in Pearson Creek, shown in Table 15, should focus on improving geomorphic conditions of the channel and floodplain, improving habitat complexity, increasing floodplain connectivity, adding large woody material, and improving riparian vegetation conditions.

Modifying the channel and floodplain in ways that reduce channel entrenchment and allows water to access the riparian area during high-flow events will address many of the limitations. Particularly, improvements should be made in all reaches to those areas where Pearson Creek Road is encroaching on the channel and limiting floodplain development and processes. Large woody material should be added, especially to reaches P1, P4, and P5 where counts are very low, to improve habitat diversity and floodplain complexity.

Table 15. Restoration groups and recommended actions for Pearson Creek

Reach	Restoration Groups	Recommended Actions
P1	2, 3, 4, 5, 8, 9, 10	LWD placement, channel and meander reconstruction, floodplain connectivity
P2	2, 3, 4, 8, 9	Restoration of floodplain topography and vegetation, floodplain connectivity, LWD placement
P3	2, 3, 4, 8, 9	Restoration of floodplain topography and vegetation, floodplain construction, LWD placement
P4	2, 3, 8, 9	LWD placement, restoration of floodplain topography and vegetation, floodplain connectivity
P5	2, 3, 8, 9	Restoration of floodplain topography and vegetation, LWD placement, Floodplain connectivity

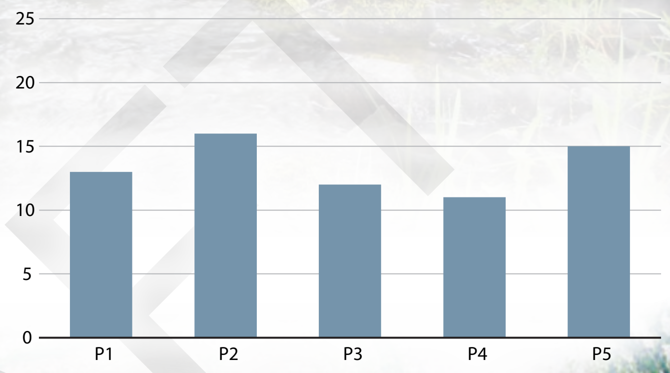


Figure 76. Summary of reach restoration priority for Pearson Creek

Action Plan Strategy

West Birch Creek

The eight reaches of West Birch Creek (Figure 77) are most limited in physical functionality by extreme low flows, lack of connectivity between the channel and floodplain, lack of large woody material, poor bed material makeup, and bed form diversity. Steelhead are especially limited in the lower reaches by high water temperatures and habitat degradation in all reaches. Restoration efforts in West Birch Creek, shown in Table 16, should focus on increasing and maintaining instream flow through the summer season, improving geomorphic and habitat conditions of the channel, improving floodplain function and increasing connectivity between the stream channel and floodplain (both surface and subsurface connections), adding large wood material, and improving riparian vegetation conditions. The uppermost reach, WB8, is in a forested area where floodplain and channel morphology can be improved with woody material additions and complex habitat features. Reaches EB7 and EB6 are impacted by West Birch Creek Road and increased floodplain space and connectivity should be improved by changes to road alignment and floodplain form. Beginning in reach WB5 and extending through the lower reaches, actions should be applied to increase summer low flows and reduce water temperatures.

Although assessment results indicate a vertically stable channel in reaches WB1, WB2, and WB3, actions should be applied to improve geomorphic conditions and floodplain connectivity by increasing lateral development of the channel within the valley floor. Meander and floodplain construction of the channel in the lower reaches, in combination with improved channel and floodplain complexity is expected to increase shallow groundwater storage and availability in the riparian environment, and could improve bank stability resulting in a healthier and more robust riparian plant community. Large woody material added to the channel and floodplain would provide additional benefit to geomorphic stability and fish habitat capacity.

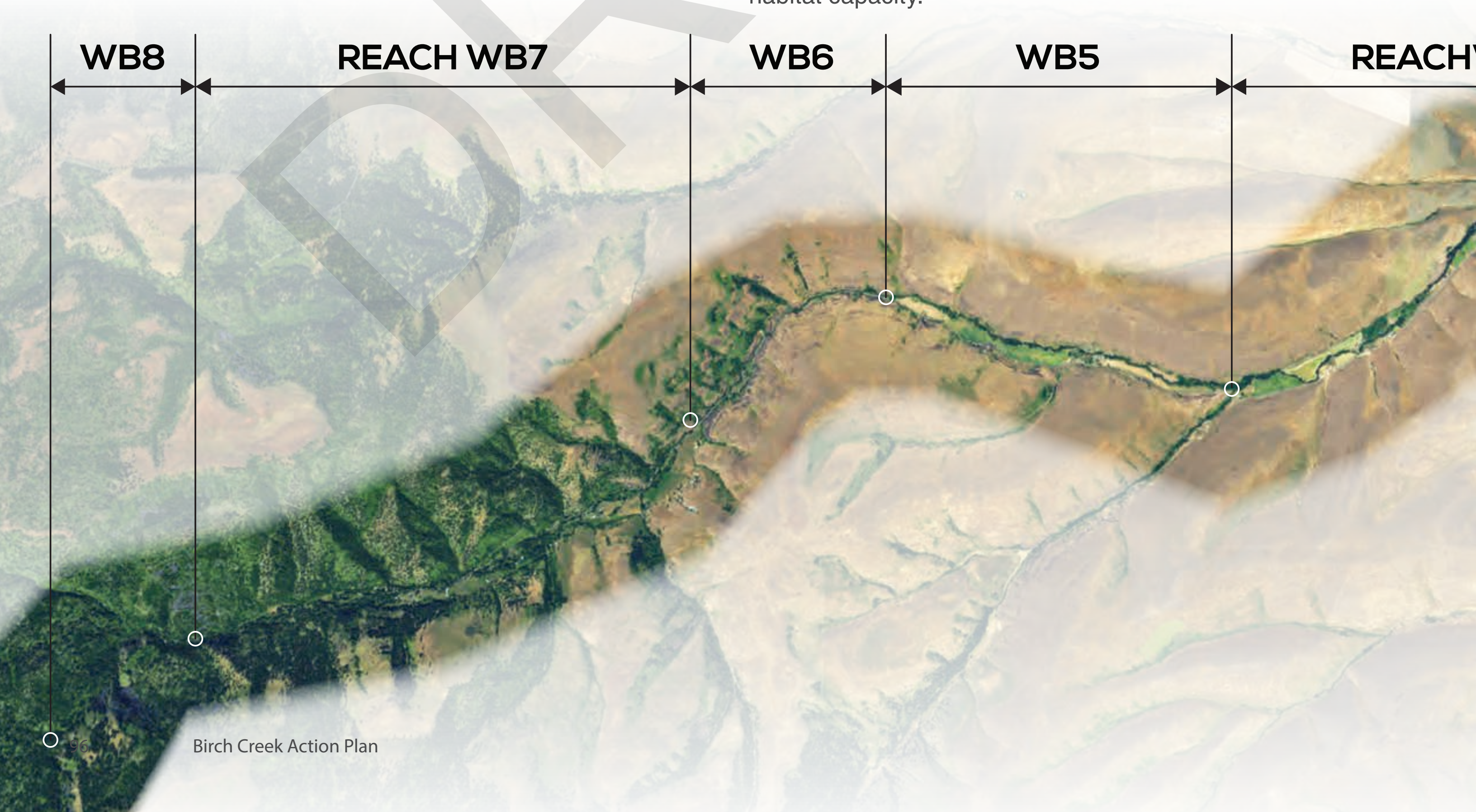


Table 16. Restoration groups and recommended actions for West Birch Creek

Reach	Restoration Groups	Recommended Actions
WB1	2, 3, 5, 8, 9, 10	LWD and boulder placement, floodplain and meander reconstruction, riparian buffer strip/planting
WB2	2, 3, 4, 5, 8, 10	Restore floodplain topography and vegetation, LWD and boulder placement, riparian buffer strip/planting
WB3	2, 3, 4, 5, 8, 9, 10	Acquire instream flow, restore floodplain topography and vegetation, floodplain reconstruction
WB4	2, 3, 4, 5, 8, 9, 10	Acquire instream flow, restore floodplain topography and vegetation, floodplain reconstruction
WB5	2, 3, 4, 5, 8, 9, 10	Restore floodplain topography and vegetation, acquire instream flow, floodplain reconstruction
WB6	2, 3, 5, 8, 9, 10	LWD additions, floodplain reconstruction, channel reconstruction
WB7	2, 3, 4, 8, 9	Channel reconstruction, floodplain reconstruction, LWD additions,
WB8	2, 3, 4, 8, 9	LWD additions, floodplain reconstruction, restoration of floodplain topography and vegetation

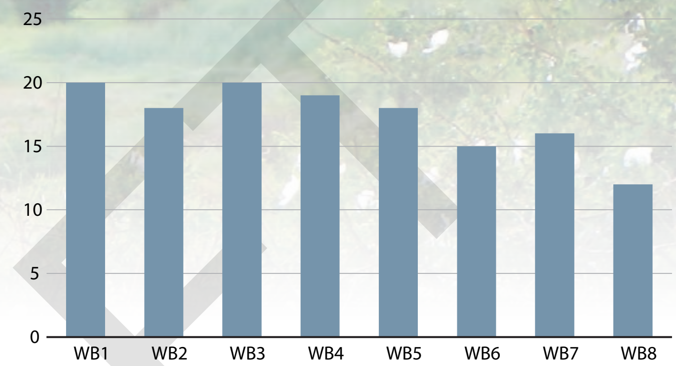
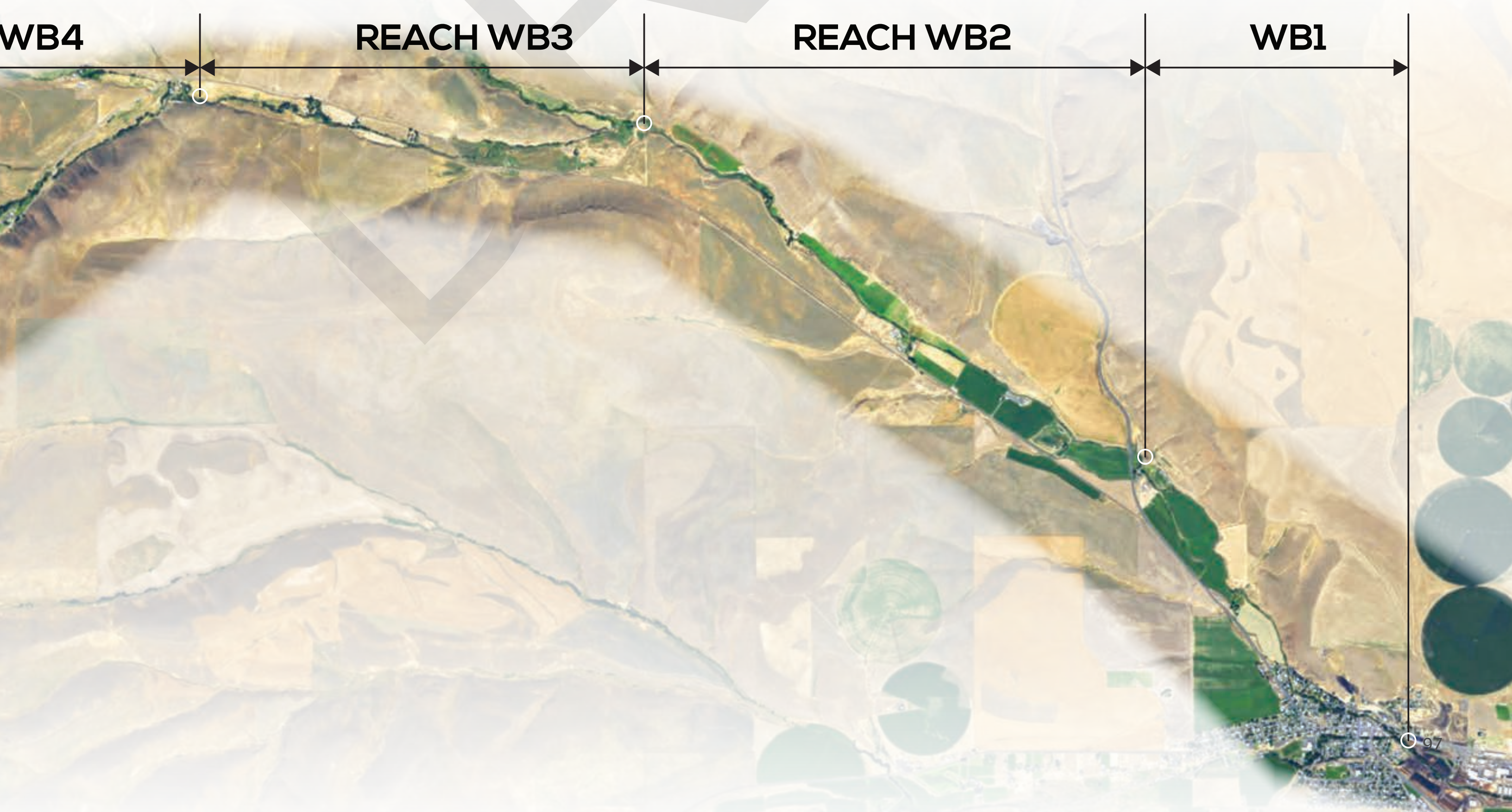


Figure 77. Summary of reach restoration priority for West Birch Creek



Action Plan Strategy

Bear Creek

The six reaches of Bear Creek (Figure 78) are most limited in physical functionality by extreme low flows, lack of connectivity between the channel and floodplain, lack of large woody material, poor bed material makeup, and bed form diversity. Steelhead are most limited in Bear Creek by poor habitat conditions due to a lack of large woody debris. Bear Creek offers a unique opportunity within the entire Birch Creek watershed because temperature, while somewhat degraded, appears to be suitable for all life history stages of steelhead.

Although restoration action recommendations are challenging in Bear Creek because of restricted access, the assessment results suggest that restoration efforts should focus on increasing and maintaining instream flow through the summer season in reaches BR1 and BR2, adding large woody material in all reaches, and improving riparian vegetation conditions in the downstream reaches (Table 17). The uppermost reaches, BR5 and BR6, are located in coniferous forest where floodplain and channel morphology can be improved with woody material additions. Beginning in reach BR5 and extending through the lower reaches, increases to summer low flow would provide passage for juvenile fish and increase the overall habitat capacity.

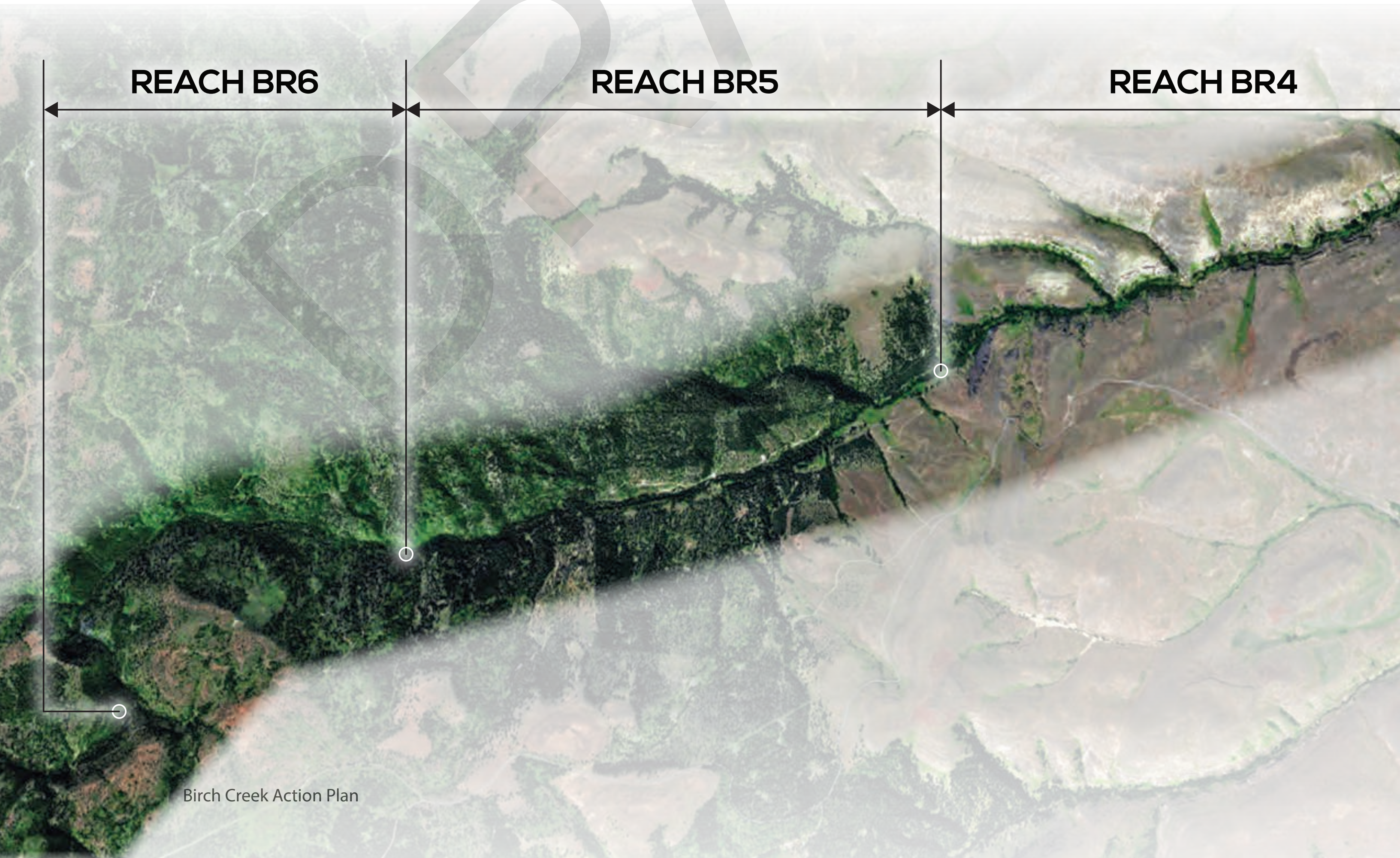


Table 17. Restoration groups and recommended actions for Bear Creek

Reach	Restoration Groups	Recommended Actions
BR1	2, 4, 5, 10	Acquire instream flow, LWD placement, riparian buffer
BR2	2, 4, 5, 8, 9, 10	Acquire instream flow, LWD placement, riparian buffer
BR3	2, 5, 8, 9	LWD placement, channel reconstruction, riparian buffer
BR4	2, 5, 8, 9	LWD placement, channel reconstruction, riparian buffer
BR5	2, 5, 8, 9	LWD placement, channel reconstruction, riparian buffer
BR6	2, 4, 5, 8, 9	LWD placement, channel reconstruction, pool development

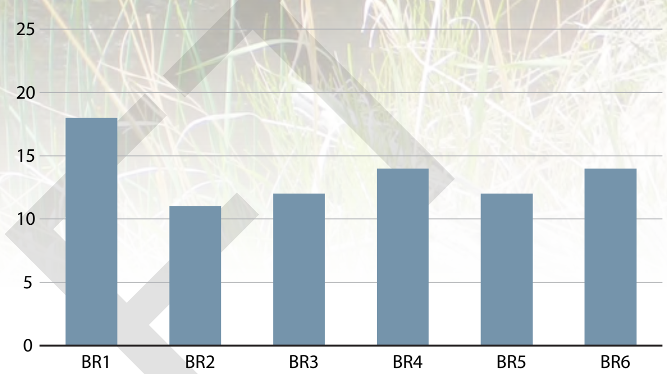


Figure 78. Summary of reach restoration priority for Bear Creek

Monitoring and Adaptive Management

The fundamental underpinnings of monitoring and adaptive management is determining ways to continually improve the effectiveness of restoration projects. The Action Plan approach is intended to address disturbances of ecological processes at spatial scales ranging from the watershed to the reach and to the habitat unit on temporal scales from years to decades. Project types, at the range of scales considered in the Action Plan, will vary considerably. Project-specific monitoring should be conducted to determine if and how projects and/or project types are addressing limiting factors and achieving their intended objectives. However, because implementation of this plan

River Vision Touchstones

Riparian Vegetation - Size, density, cover and seral class of native species and rate of recruitment can be measured. Noxious and invasive species size, density and rate of recruitment can be monitored to show decreases. Planting success is measured as a percentage of survival.

Aquatic Biota - Steelhead spawning surveys indicate the number of returning adults and can be compared to past surveys. Juvenile outmigrants can be sampled to determine recruitment and spawning success.

Connectivity - Restoring floodplain and channel conditions that improve the exchange of water between the channel, floodplain surface and hyporheic zone is measured as increased area of inundation. The passage of adult and juvenile steelhead between habitats can be measured by surveys of presence/absence or species composition.

Hydrology - Restoration actions that strategically increase instream flow and reduce water temperatures can be evaluated by analyzing stream discharge and thermistor data.

Geomorphology - Channel form improvements are detected with physical metrics of channel and floodplain geometry that can be compared to appropriate and expected ranges of condition. Habitat features and woody material can be documented.

will take decades to complete, and owing to the range of scales and diversity of anticipated project types, it is not practical to expect certain responses like watershed-scale fish production to be measurable after each project is finished. Results of monitoring analyses can be used to make adjustments and inform future projects such that effectiveness increases as more knowledge is gained. Acknowledging that funding for monitoring projects is limited, this monitoring and adaptive management approach is intended to be more strategic and tied to individual project specific objectives.

In response to the growing scientific information supporting the effectiveness of addressing natural processes in stream restoration (Beechie et al. 2010, Beechie et al. 2013b, Cluer and Thorne 2014, Junk et al. 1989, Kondolf et al. 2006, and Roni et al. 2013), the CTUIR's habitat restoration program has shifted from site-scale restoration to the reach- scale (Jones et al. 2015). In general, this shift focuses on addressing processes that create and maintain functional habitat conditions rather than symptoms of degradation. The watershed and reach assessments completed for the Birch Creek Watershed Action Plan focused on characterizing river ecosystem functionality.

Concurrent with the CTUIR habitat program's shift to process based restoration principles (Beechie et al. 2010) was the development of Umatilla River Vision (Jones et al. 2008). Central to the Umatilla River Vision are fundamental touchstones (hydrology, geomorphology, connectivity, and native riparian vegetation) that are used in the development of the Action Plan strategy. The functional assessment approach used in this plan was specifically designed to align with the touchstones by quantifying river ecosystem functionality in the categories of Hydrology, Hydraulic, Geomorphology and Physicochemical attributes. As such, monitoring and adaptive management of this plan is directly tied to the touchstone associated objectives that should be established for each project.

The Physical Habitat Monitoring Strategy (PHAMS) was developed by the CTUIR with the goal of providing monitoring approaches for reach-scale restoration projects (Jones et al. 2015). To maintain consistency within the CTUIR habitat restoration program, River Vision, and priorities used to develop the Action Plan, the PHAMS methods and the methods used to develop the Action Plan are appropriate for projects in the Birch Creek watershed. Details of these methods that are applicable to the Birch Creek watershed are summarized below, however, specific metrics, methods and protocols are described in Jones et al. (2015) and the appendices, and should be used as the guidance documents for future monitoring.

Metrics and methods in the PHAMS are described relative to common objectives and restoration actions within each of the River Vision touchstones. Because restoration projects will vary in their objectives and scope, the monitoring parameters selected for each project may vary. However, for similar project types, the same metrics can be used in order to build a database of projects and eventually a statistically robust analysis of the effectiveness of project types. There are seven key steps in the PHAMS approach to monitoring individual restoration actions:

1. Identify project goals and objectives
2. Develop hypotheses of expected project outcomes
3. Choose monitoring parameters
4. Choose the monitoring design
5. Choose the sampling scheme
6. Implement monitoring
7. Analysis and reporting

Monitoring River Vision Touchstones

Hydrology

Restoring water quality and water quantity are objectives of the Action Plan that directly affect each of the other touchstones and ultimately the biotic community. Water quality parameters include water temperature, turbidity, dissolved nutrients and contaminants. Water quantity parameters include volume and timing of surface waters and groundwater throughout the water year. Example project types might include; water right purchase/lease, irrigation system upgrades, connecting springs/side channels, riparian planting, and floodplain reconnection. Restoration of hydrologic processes is broken down into six objectives and six monitoring metrics shown in Table 18.

Geomorphology

Restoration efforts within this plan focus, in part, on restoring key geomorphological processes in order to reconnect rivers with their floodplains, reduce erosion and sediment supply to reaches and restore stable and functional channel form. Example restoration actions might include levee removal or setback, channel meander enhancement, livestock exclusion, installation of wood structures and road removal or improvement. Geomorphologic restoration actions are broken down within six objectives and monitored by 21 different metrics as shown in Table 19.

Connectivity

Longitudinal connectivity (i.e. fish passage) include modification, removal, or replacement of barriers. Passage barriers can be physical structures (dams, weirs, culverts), flow (dry channels or high-velocity), and thermal. Unlike other touchstones, longitudinal connectivity does not have a direct measure; rather, the qualities of specific features that inhibit or promote longitudinal connectivity are generally identified and quantified. There are three Connectivity restoration objectives and seven corresponding monitoring metrics as shown in Table 20.

Riparian Vegetation

Restoring riparian vegetation is intended to increase riparian function with site-appropriate native vegetation and/or remove invasive species. Riparian restoration project types might include; conservation easements, fencing, planting, invasive species removal and removal of barriers preventing lateral floodplain connectivity. At the site and reach-scales, measuring the outcomes of riparian restoration typically involves collecting field data on cover, density, size and rate of recruitment. There are three Riparian Vegetation restoration objectives and four corresponding monitoring metrics as shown in Table 21.

Monitoring and adaptive management are included in this Action Plan because it is expected that restoration science will continue to evolve. Likewise, monitoring the effectiveness of projects completed within this Action Plan is expected to contribute to the evolution of restoration science. While recommendations and strategies included in this Action Plan are based on available data, community input and currently accepted scientific methods, the CTUIR acknowledges that monitoring results will be valuable for increasing the efficiency and effectiveness of restoring the Birch Creek watershed.

■ *Table 18. Hydrology restoration objectives and corresponding monitoring metrics. Methods described in Jones et al. (2015)*

Hydrology Restoration Objective	Monitoring Metrics
Reconnect surface and groundwaters to increase the diversity of water temperature	Diversity of flowpath length and number
Decrease maximum stream temperature	Maximum mean weekly temperature and temperature diversity
Reduce suspended sediment	Suspended sediment load (turbidity as a surrogate)
Increase water temperature variability	Buffering temperature in mainstem channel
Increase floodplain storage capacity and increase summer base flow	Water residence time or transient storage
Restore streamflow	Stream gaging and associate metrics-the flow exceeded 90 percent of the time, the base flow index, and the average of the annual minimum flow divided by catchment area

■ *Table 19. Geomorphology restoration objectives and corresponding monitoring metrics. Methods described in Jones et al. (2015)*

	Geomorphology Restoration Objective	Monitoring Metric
Floodplain or planform metrics	Restore floodplain channels and channel migration	Percentage of floodplain disconnected
		Percentage of floodplain connected at different magnitude flows (bankfull, 5-year, and 10-year flows)
		Braid-channel ratio (Lsc/Lmain)
		Node density or channel complexity index
		Channel migration rate
		Bank erosion rate
		Turnover rate of floodplain surfaces, half-life of floodplain surfaces
	Restore channel meanders	Sinuosity (Lc/Lv)
In channel metrics	Aggrade an incised channel	Entrenchment ratio or confinement ratio (Wfp/Wbf)
		Aggradation rate
	Restore channel cross section	Channel geometry (bankfull width, bankfull depth, width/depth ratio)
	Increase in-channel habitat diversity (structures)	Wood counts
		Pool frequency or spacing
		Percent pool area
		Residual pool depth (dmax/dtail)
	Reduce coarse sediment supply	Ratio of surface particle size to subsurface particle size (D*)
		Armoring ratio
		Ratio of sediment supply to transport capacity (Q*)
		Facies mapping
	Reduce fine sediment supply	V* (fine sediment volume divided by residual pool volume)
		Fine sediment percentage in bed material

Table 20. Connectivity restoration objectives and corresponding monitoring metrics. Methods described in Jones et al. (2015)

Connectivity Restoration Objectives	Monitoring Metrics
Increase adult salmon passage between and within habitats	Presence/absence, number present
	Statutes related to passage
	Quality of structural barrier or habitat limiting passage
Improve juvenile salmon passage between and within habitats	Presence/absence, number present, species composition
	Statutes related to passage
	Quality of structural barrier or habitat limiting passage
Restore streamflow	Presence/absence, number present, species composition

Table 21. Riparian vegetation restoration objectives and corresponding monitoring metrics. Methods described in Jones et al. (2015)

Riparian Vegetation Restoration Objectives	Monitoring Metrics
Increase Riparian function of site-appropriate native vegetation	Size, density, cover, and age or seral classes of native ore site-appropriate species and rate of recruitment by native and site-appropriate species
	Reduce an/or remove invasive species
Increase Riparian function of site-appropriate native vegetation (for restoration projects with plantings)	Size, density, cover, and rate of recruitment by invasive, noxious, or other site-inappropriate species
Restore streamflow	Percent survival (number of trees/shrubs alive by number of trees/shrubs planted *100) - can report more specifically by species, landform, or distance from stream; percent damage by animal

Future of the Action Plan

The Birch Creek Watershed Action Plan was developed by the CTUIR and partners with a vision to establish Birch Creek as a healthy and functional ecosystem. This vision includes ensuring a reliable water resource so that Birch Creek sustainably supports native fish populations, in balance with the needs of agricultural producers and the local community.

Through effective collaboration among the CTUIR, project partners, technical contributors and members of the community, an assessment of Birch Creek was completed to identify baseline watershed conditions, stream processes and functionality, and factors limiting steelhead success. This assessment informed the strategy for identifying and prioritizing Protection, Conservation, Reconnection and Restoration actions throughout the Birch Creek Watershed. The Action Plan provides a template for maintaining and creating natural habitats for fish while also supporting a thriving community and strong economy.

The Action Plan will be implemented in the Birch Creek Watershed over the next several decades. The timeframe for implementing individual restoration actions will vary due to available financial and technical resources; available data and information; restoration prioritization needs; and restoration action opportunities. Within this Action Plan, each restoration action is viewed as a key local building block for achieving steelhead recovery and sustainability.

Partnerships are a key component for implementing the Action Plan. The CTUIR, partner agencies and community stakeholders work collaboratively on a regular basis to ensure coordination and effective project development throughout the Birch Creek Watershed. Landowners are encouraged to discuss potential projects with the CTUIR and project partners, such as ODFW, UBWC, Umatilla County SWCD and USFS. Tribal and agency staff will work with landowners to develop project concepts and guide them through the implementation process.

The Birch Creek Watershed Action Plan continues the CTUIR conservation and restoration efforts on private and public lands in the Umatilla River Basin through strong and lasting collaboration with multiple private, state and federal entities. Implementing the Action Plan will encourage the continuation of existing beneficial conservation and restoration actions, while also fostering future efforts in larger scale, holistic, ecosystem-based approaches toward fulfilling the River Vision Touchstones. Collectively, these activities will result in more vibrant ecosystems, more healthy fish populations and stronger communities throughout the Umatilla River Basin.

More Information

For more information about the CTUIR Fisheries Program in the Birch Creek Watershed, please contact:

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Glossary

Term	Definition
Action	Proposed activities to improve selected physical and ecological processes that may be limiting the productivity, abundance, spatial structure or diversity of the focal species. Examples include removing or modifying passage barriers to reconnect isolated habitat, planting appropriate vegetation to reestablish or improve the riparian corridor along a stream that reconnects channel-floodplain processes, placement of large wood to improve habitat complexity, cover and increase biomass.
Active channel	of an alluvial stream is a short-term geomorphic feature subject to change by prevailing discharges; its upper limit is defined by a break in the relatively steep bank slope of the active channel to a more gently sloping surface beyond the channel edge. The break in slope normally coincides with lower limit of perennial vegetation so that the two features, individually or in combination, define the active-channel reference level.
Aggradation	is the raising or elevating of a bottomland surface through the process of alluvial deposition; conceptually it is the vertical component of accretion and is most frequently applied to sediment deposition on a channel bed, bar or other near-channel surfaces, flood plain, or, less often, low-lying alluvial terrace.
Alluvial deposit	alluvium
Alluvium	A general term for detrital deposits made by streams on river beds, floodplains, and alluvial fans; esp. a deposit of silt or silty clay laid down during time of flood. The term applies to stream deposits of recent time.
Anthropogenic	Caused by human activities.
Armoring	as a fluvial-geomorphic process, is the winnowing of fine particles from the uppermost bed sediment of a stream channel, resulting in a bed-surface layer of generally gravel to boulder sizes that are resistant to scour; because armoring occurs at specific flow rates, the armor layer may be susceptible to removal by higher flow and sedimentation during lower flow.
Avulsion	as applied to fluvial processes, is a rapid change in the course or position of a stream channel, especially by incision (erosion) of lowland alluvium, to bypass a meander and thereby shorten channel length and increase channel gradient; avulsion commonly occurs during floods but also can occur by normal processes of lateral migration of a stream channel during non-flood discharges.
Bank	as a geomorphic concept, typically refers to a sloping margin of a natural, stream-formed, alluvial channel that confines discharge during non-flood flow; within the earth sciences, designation of a right or left bank is done when looking in the downstream direction.
Bankfull discharge	a hydrologic term, is the flow rate (m3 s-1) when the stage (height) of a stream is coincident with the uppermost level of the banks -- the water level at channel capacity, or bankfull stage. Thus, the concept of bankfull discharge, which often approximates the mean annual flood for perennial streams, includes the flood plain as a unique, identifiable geomorphic surface, all higher surfaces of alluvial bottomlands being terraces, and acknowledgement that bankfull discharge occurs only when stream stage is at flood-plain level.
Bank material	is the sediment of which the mostly sloping sides, or banks, of a stream channel are formed; like bed material, it is generally reflective of the size range of the total sediment load of the stream, may be partly residual, but for regime channels is mostly indicative of the suspended-load transported by streams during non-flood periods.
Bar	is in-channel sediment of relatively coarse bed material, typically coarse sand through cobbles in size, that is generally deposited during the recession of a high flow and is mostly exposed during periods of low flow.

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Bed load	or sediment discharged as bed load, is the sediment that is moved by saltation, rolling, or sliding on or near the stream bed, essentially in continuous contact with it.
Bed material	is the sediment of which the mostly horizontal bed of a stream channel is formed; it is generally reflective of the size range of the total sediment load of the stream, in many cases may be partly residual, but is mostly indicative of the bed-load sizes transported by the stream.
Bedrock	The solid rock that underlies gravel, soil or other superficial material and is generally resistant to fluvial erosion over a span of several decades, but may erode over longer time periods.
Benthos diversity	A measure of the diversity and production of the benthic macroinvertebrate community; also used to describe the diversity of the physical structure along a streambed (i.e., benthos habitat diversity).
Cfs	Cubic feet per second; a measure of water flows
Channel forming flow	Sometimes referred to as the effective flow or ordinary high water flow and often as the bankfull flow or discharge. For most streams, the channel forming flow is the flow that has a recurrence interval of approximately 1.5 years in the annual flood series. Most channel forming discharges range between 1.0 and 1.8 years. In some areas it could be lower or higher than this range. It is the flow that transports the most sediment for the least amount of energy, mobilizes and redistributes the annually transient bedload, and maintains long-term channel form.
Channel morphology	The physical dimension, shape, form, pattern, profile and structure of a stream channel.
Channel planform	The two-dimensional longitudinal pattern of a river channel as viewed on the ground surface, aerial photograph or map.
Channel units	Morphologically distinct areas within a channel segment that are on the order of at least one to many channel widths in length and are defined by distinct hydraulic and geomorphic conditions within the channel (i.e. pools, riffles, and runs). Channel unit locations and overall geometry are somewhat stage dependent as well as transient over time, and observers may yield inconsistent classifications. To minimize the inconsistencies, channel units are interpreted in the field based on the fluvial processes that created them during channel forming flows, then mapped in a geographic information system (GIS) to provide geospatial reference.
Control	A natural or human feature that restrains a streams ability to move laterally and/or vertically.
Critical shear stress	relative to fluvial geomorphology and hydraulics, is the lowest required value of shear stress applied by flowing water to initiate motion of individual particles of specified size (diameter) along the bed of a stream.
Degradation	is the lowering of a bottomland surface through the process of erosion; conceptually it is the opposite of the vertical component of aggradation and is most frequently applied to sediment removed from a channel bed or other low-lying parts of a stream channel.
Discharge	as a hydrologic term of streamflow, is expressed as the movement downstream per unit length of channel of a volume of water; water discharge is given in volume per unit time, typically cubic meters per second (m3 s-1). As a sedimentology term, discharge is the movement of a mass of sediment per unit length of channel in a specified time interval; technically it is expressed in watts per meter (W m-1), but informally it is viewed as mass per unit time. Owing to theoretical considerations, the term sediment-transport rate is preferred to that of sediment discharge.
Diversity	Genetic and phenotypic (life history traits, behavior, and morphology) variation within a population. Also refers to the relative abundance and connectivity of different types of physical conditions or habitat.
Ecosystem	An ecologic system, composed of organisms and their environment. It is the result of interaction between biological, geochemical and geophysical systems.
Extirpation	The loss of a local or regional population, with the species continuing to survive elsewhere.
Fine sediment	Sand, silt and organic material that have a grain size of 2.0 mm or less.
Flood	is any climatically controlled, relatively high streamflow that overtops the natural or artificial banks in any reach of a stream, thereby being of geomorphic significance; where a flood plain exists, a flood is any flow that spreads over or inundates the floodplain.

Term	Definition
Floodplain	The portion of relatively smooth land bordering a stream, built of sediment carried by the stream and deposited in slackwater beyond the influence of the swift current of the channel; the level of the floodplain is generally about the stage of the mean annual flood, and therefore one and only one floodplain level can occur in a limited reach of valley bottom land.
Fluvial	Pertains to the action of a river or stream; included are stream processes (fluvial processes), fluvial landforms, such as fluvial islands and bars, and biota living in and near stream channels. Common usage is often extended by geomorphologists to hydrologic processes on hillslopes.
Fluvial process	A process related to the movement of flowing water that shape the surface of the earth through the erosion, transport, and deposition of sediment, soil particles, and organic debris.
Geomorphic reach	An area containing the active channel and its floodplain bounded by vertical and/or lateral geologic controls, such as alluvial fans or bedrock outcrops, and frequently separated from other reaches by abrupt changes in channel slope and valley confinement. Within a geomorphic reach, similar fluvial processes govern channel planform and geometry resulting from streamflow and sediment transport.
Geomorphology	A composite science in the study of landforms, including investigations into the processes that cause and alter the landforms.
GIS	Geographical information system. An organized collection of computer hardware, software, and geographic data designed to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.
Gradient	as applied to stream channels, is the rate of elevation change between two specified sites of horizontal distance measured along the thalweg of the channel; it is generally expressed as a non-dimensional number (m m-1)
Hydrology	The cycle of water movement from the atmosphere to land, surface-water, and ground-water bodies, including movement among land and water bodies, before returning to the atmosphere.
Indicator	A variable used to forecast the value or change in the value of another variable; for example, using temperature, turbidity, and chemical contaminants or nutrients to measure water quality.
Instability	As a descriptor of geomorphic processes and landforms, refers to a condition of imbalance between inflows and outflows of matter through or over a landscape feature. As a geomorphic concept, instability is often expressed as some state of dynamic- or quasi-equilibrium, signifying that geomorphic processes and landforms are almost always in a condition of dis-equilibrium and are almost always adjusting to regain relative stability; an objective if applying the term is to determine the degree to which a process or landform deviates from stability or equilibrium.
Large woody material (LWM)	Large downed trees or parts of trees that are transported and deposited by the river during high flows and are often deposited on gravel bars or at the heads of side channels as flow velocity decreases. The trees can be downed through river erosion, wind, fire, landslides, debris flows, or human-induced activities. Synonymous with large woody debris (LWD).
Limiting factor	Any factor in the environment that limits a population from achieving complete viability with respect to any Viable Salmonid Population (VSP) parameter.
Meander	of a stream is one of a series of regular, sharp, freely developing, and sinuous curves, bends, loops, turns, or windings in the course of a stream; the process of stream meandering is a means of channel-gradient adjustment through sorting of stored sediment by erosion at the outside of a bend and deposition, as a point bar, at the inside of the bend.
Pool	as applied to alluvial stream channels, is a relatively deep, low velocity reach of quiescent flow between upstream and downstream riffles, or rapids, at which the flows are ordinarily more rapid and turbulent.
Pool-riffle sequence	in alluvial stream channel refers to a succession of one or more combinations of pools and riffles along the channel in the downstream direction; during flood the normally low water velocities in pools and higher water velocities at riffles are reversed, causing scour and removal of accumulated sediment from pooled reaches and deposition of bed sediment on riffles.
Reach	of a stream refers to an uninterrupted part of a stream channel between two points; generally the two points are where readily recognizable tributary inflows occur, but can also include features such as meander bends, gorges, or a significant change in geology.
Restoration	as applied to stream corridors (bottomlands) that have been altered through human activity, is the attempt to recreate the adjusted physical and biological conditions that were present prior to the alteration; a goal of restoration, therefore, is to minimize and eliminate the effects of human-induced alterations, thus promoting stable landforms, bioproductivity, and species diversity.
Riffle	as applied to alluvial stream channels, is a short, relatively shallow and coarse-bedded length over which the stream flows at ordinarily higher velocity and greater turbulence than it does through upstream and downstream pooled reaches where cross-sectional areas of the channel are greater, bed material is smaller, and velocities and turbulence are less.

Term	Definition
Riparian area	as applied to the study of fluvial systems, is an ecological term referring to that part of the fluvial landscape inundated or saturated by flood flows; it consists of all surfaces of active fluvial landforms up through the flood plain including channel, bars, shelves, and related riverine features such as oxbow lakes, oxbow depressions, and natural levees. Particularly in arid and semiarid (water-deficient) environments, the riparian zone may support plants and other biota not present on adjacent, drier uplands.
Riverine	is that characteristic by which a feature or process pertains to or is formed by a river.
River mile (RM)	Miles measured in the upstream direction beginning from the mouth of a river or its confluence with the next downstream river.
Salmonid	Fish belonging to the family Salmonidae, including steelhead trout and salmon.
Saltation	is the process by which sediment, generally of sand size and coarser, bounces along the stream bed by the impact of the flow of water or of other moving particles.
Sediment	is detached fragmental material that originates from either chemical or physical weathering of rocks and minerals and is transported by, suspended in, or deposited by water or air or is accumulated in beds by other natural agencies.
Sediment yield	is sediment-transport rate per unit area, generally from watersheds or drainage basins larger than the field scale; erosion studies, however, may consider sediment yield from smaller areas of the hillslope or plot scale.
Shear	is a strain, or change in shape or volume of a body resulting from stress; as applied to fluvial processes and sediment transport, it typically refers to the stress that is exerted on sediment particles by a moving fluid – air, water, and ice.
Shear stress	is that portion of stress acting tangentially as a tearing action (as opposed to that portion that acts as a normal stress) to a plane or surface; thus, a sediment particle resting on a channel bed is affected by the shear stress created by water moving on the bed.
Side channel	A distinct channel with its own defined banks that is not part of the main channel, but appears to convey water perennially or seasonally/ephemerally. May also be referred to as a secondary channel.
Sinuosity	as applied to stream-channel pattern, is a non-dimensional ratio, generally expressed in meters per meter or kilometers per kilometer, of the length of the channel thalweg to the length of the stream valley, measured between the same points.
Slope	is any inclined surface of the earth. As a geomorphic measurement, slope is the inclination, generally measured in degrees departure from horizontal or expressed as a non-dimensional number (meters per meter), of any surface of the earth's landscape (including sub-aqueous surfaces); for application to models of hillslope soil loss, steepness is often used synonymously with slope.
Stability	as a descriptor of geomorphic processes and landforms, refers to a condition of approximate balance between inflows and outflows of matter through or over a landscape feature. As a geomorphic concept, stability generally is regarded as being an integration of processes affecting a system and thus has time-independence; the term often is used synonymously with (dynamic or quasi) equilibrium.
Subbasin	A subbasin (or sub-basin) represents the drainage area within a larger defined watershed; synonymous with sub-watershed.
Terrace	A relatively stable, planar surface formed when the river abandons its floodplain. It often parallels the river channel, but is high enough above the channel that it rarely, if ever, is covered by over-bank river water and sediment. The deposits underlying the terrace surface are primarily alluvial, either channel or overbank deposits, or both. Because a terrace represents a former floodplain, it may be used to interpret the history of the river.
Thalweg	The line within a stream channel connecting the lowest points at all locations along the channel.
Tributary	A stream feeding, joining, or flowing into a larger stream or lake.
Valley segment	An area of river within a watershed sometimes referred to as a subwatershed that is comprised of smaller geomorphic reaches. Within a valley segment, multiple floodplain types exist and may range between wide, highly complex floodplains with frequently accessed side channels to narrow and minimally complex floodplains with no side channels. Typical scales of a valley segment are on the order of a few to tens of miles in longitudinal length.
Viable salmonid population	An independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity.
Watershed	is a drainage divide or a "water parting", but common usage of the term has been altered to signify a drainage-basin area contributing water to a network of stream channels, a lake, or other topographic lows where water can collect.

Birch Creek
Watershed Action Plan

Confederated Tribes of the Umatilla Indian Reservation