CTUIR GRANDE RONDE SUBBASIN RESTORATION PROJECT ANNUAL REPORT

A Columbia River Basin Fish Habitat Project

Northwest Power Planning Council Project # 199608300

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CONFEDERATED TRIBES UMATILLA INDIAN RESERVATION

BONNEVILLE POWER ADMINISTRATION

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Introduction/Background Information

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Grande Ronde Subbasin Restoration Project was initiated by the Confederated Tribes of the Umatilla Indian Reservation in 1996 to protect, enhance, and restore riparian and instream habitat for natural production of anadromous salmonids in the Grande Ronde River Subbasin. The project works with other agencies and private landowners to promote land stewardship and enhance habitat for focal fish species, primarily spring Chinook salmon, summer steelhead, bull trout, and resident trout. Emphasis is placed on improving juvenile rearing habitat and adult spawning habitat by restoring natural channel morphology and floodplain function, cold water refugia, and complex aquatic habitat that supports required life histories for focal species.

During Fiscal Year 2018 (May 1, 2018-April 30, 2019), the CTUIR was involved in multiple planning processes and projects. Planning efforts included: Expert Panel, Grande Ronde Model Watershed Board and Technical Committees, and ongoing coordination with multiple agencies, organizations, and private landowners associated with fish habitat project development. Additionally, project staff continued BPA-CTUIR Accord land acquisition planning, identification, and development of future site specific fish habitat projects. Project development and initial planning included; baseline field surveys, assessments, development of conceptual project plans, coordination with private landowners, and initiation of environmental planning.

During the reporting period, project staff were focused on: 1) CC44 Southern Cross Conservation Property monitoring, adaptive management, and ongoing maintenance, 2) Rock Creek Phase 3 project planning, design, environmental permitting, and construction; 3) Bird Track Springs planning and design, permitting, and initiation of a 2 year construction period beginning in August, 2018; 4) Middle Upper Grande Ronde (MUGRR) Phase I project planning, design, and environmental permitting, 4) Winter Canyon planning and design, and 5) Dark Canyon Cunha, Catherine Creek (Southern Cross, Kinsley, Kirby, and Fite), and Rock Creek conservation easement maintenance. Additionally, CTUIR staff continued to coordinate with the Wallowa-Whitman National Forest on fish passage and habitat project planning and development in the headwaters of the Grande Ronde Basin.

Construction on the CC44 Southern Cross project was completed in fall 2016, and CTUIR staff continued monitoring and evaluation, including water temperatures, groundwater elevations, vegetation, geomorphic and instream habitat, biological, and photo points within the Project area. Work during the reporting period also included coordinating, planning, field surveys, project development/design, and construction for projects along the Grande Ronde River, Rock Creek, and Lookingglass Creek. Activities included coordinating with project partners and private landowners to develop future project opportunities, baseline field investigations and surveys, development of conceptual plans, initiation of funding proposals, and initiation of environmental compliance planning in preparation for further project development and implementation in 2018 and beyond.

Background

The CTUIR retains aboriginal and treaty rights related to fishing, hunting, pasturing of livestock, and gathering of traditional plants within the Tribes Ceded Territory, including the Grande Ronde Subbasin. The CTUIR Department of Natural Resources (DNR) has developed and accepted a First Foods organization and approach to ecosystem management based on the cultural traditions and practices of the Longhouse. The organization follows the serving order of food and conceptually "Extends the Table" to manage for sustainability within the Ceded Territory. The First Foods are considered to be the minimum ecological products necessary to sustain CTUIR culture. The order is watershed-based beginning with water as the foundation and progressing to salmon (Pacific lamprey, steelhead, trout, and whitefish), deer, cous, and huckleberry. The First Foods provide clear linkages to treaty rights and natural resources and defines direction and goals that relate to the community culture. In conjunction with the First Food principle, the CTUIR DNR developed the River Vision (Jones K. L., 2008) that describes and organizes ecological processes and functions that provide the First Foods.

The River Vision outlines physical and biological processes encompassing 5 touchstones: **Hydrology, Geomorphology, Connectivity, Riparian Vegetation, and Aquatic biota** which together with the First Foods, provide an overall framework for guiding tribal programs in regards to protecting and restoring ecological processes and functions. Healthy watershed processes and functions are the fundamental elements that create diversity, resiliency, and the ability of our river systems to provide sustenance and natural resources to support our culture and heritage.

The Subbasin historically supported viable and harvestable populations of spring/summer and fall Chinook salmon (*Oncorhynchus tshawytscha)*, coho salmon (*O. kisutch*), sockeye salmon (*O. nerka),* summer steelhead *(O. mykiss),* Pacific lamprey (*Entosphenus tridentatus*), bull trout (*Salvelinus confluentus*), rainbow/redband *(O. mykiss sp.)*, and mountain whitefish (*Prosopium williamsoni).* These native fishes are paramount to tribal cultures, economies and the region (CBFWA, 1990) and (CRITFC, 1995). Beginning in the late 1800's, fish populations started to decline with sockeye and coho extirpated in the early 1900's. The abundance of Chinook, steelhead, bull trout, and other fish species has also been dramatically reduced (NPCCa, 2004) and (NPCCb, 2004). With declining fish populations, Tribal governments and State agencies were obligated to eliminate or significantly reduce subsistence and sport fisheries by the mid 1970's. By the early 1990's, Snake River spring-summer Chinook and summer steelhead populations were suppressed to the point of triggering Federal ESA listings (spring-summer Chinook in 1992 and summer steelhead in 1997, and bull trout in 1998). Other native fish, including Pacific lamprey populations are also highly suppressed and with possible future ESA listing. The following tables illustrate estimated historic and current spring Chinook salmon and summer steelhead returns to the Grande Ronde Subbasin (NPCCa, 2004). Of particular note is an 87 percent decrease in spring Chinook and 70 percent decrease in summer steelhead populations from estimated historic levels.

The **CTUIR Grande Ronde Subbasin Restoration Project** (199608300), funded by Bonneville Power Administration (BPA) through the Northwest Power Planning Council Fish and Wildlife Program (NPPC), is an ongoing effort initiated in 1996 to protect, enhance, and restore fish habitat in the Grande Ronde River Subbasin. The project focuses on the mainstem Grande Ronde and major tributaries that provide spawning and rearing habitat for Threatened Snake River spring-summer Chinook salmon, summer steelhead, and bull trout. The project also provides benefits to other resident fish and wildlife.

The project is an integral component of Subbasin Plan implementation and is well integrated into the framework of the Grande Ronde Model Watershed (GRMW) established by the NPCC in 1992 to coordinate restoration work in the Subbasin. As a co-resource manager in the Subbasin, the CTUIR contributes to the identification, development, and implementation of habitat protection and restoration in cooperation with Federal, State, and local agencies. The CTUIR, ODFW, GRMW, and other participating agencies and organizations have made significant progress towards addressing habitat loss and degradation in the Subbasin (see http://www.grmw.org/).

The project was initiated in 1996 under the NPCC-BPA Early Action Project process. The project was proposed through the GRMW and NPCC program to provide the basis from which to pursue partnerships and habitat grant funds to develop and implement watershed and fish habitat enhancement activities in the Subbasin. Annual project budgets have averaged about $136,000 and ranged from a high of $200,000 in 1999. Annual operating budgets and associated tributary habitat efforts by the CTUIR were increased as a result of the CTUIR-BPA Accord Agreement with an annual average budget of $589,500. The project has historically administered multiple grants from various agencies, including Natural Resource Conservation Service (NRCS) Wetland Reserve Program (WRP), CREP, WHIP, and EQIP, OWEB, EPA-ODEQ 319, GRMW-BPA, CRITFC, NMFS, USFWS, ODOT, and NAWCA and developed an effective working relationship with multiple agencies and organizations.

The project has been successful in the development and implementation of several large-scale, partnership habitat enhancement projects and has developed effective interagency partnerships, working at the policy and technical levels with the Grande Ronde Model Watershed Program (GRMWP), federal and state agencies, and private landowners. A complete project overview and technical approach is described in the 2013 NPPC Project Proposal for the CTUIR Watershed Restoration Project (199608300) incorporated here by reference.

During the 22-year project history, the CTUIR has helped administer and implement a number of projects, enhancing nearly 50 miles of instream habitat. Conservation easements totaling about 1,900 acres on six large ranches/farms have been secured through a combination of NRCS WRP, CREP, and BPA programs (Figure 2). The project has constructed 18 miles of fence, 18 off-channel water developments, and installed over 160,000 trees, shrubs, sedge/rush plugs, and seeded over 800 acres with native/native-like grass seed. Improving habitat trends and biological response can be readily observed at a number of projects. A combination of both passive and active strategies have been developed and implemented, however project areas are in an early stage of recovery. Restoration efforts including: conservation easements, riparian/wetland enclosures, development of off-channel water sources, removal of livestock, re-vegetation, channel restoration, large wood additions and removal of dikes, old roadbeds and railroad prisms have resulted in improving trends.

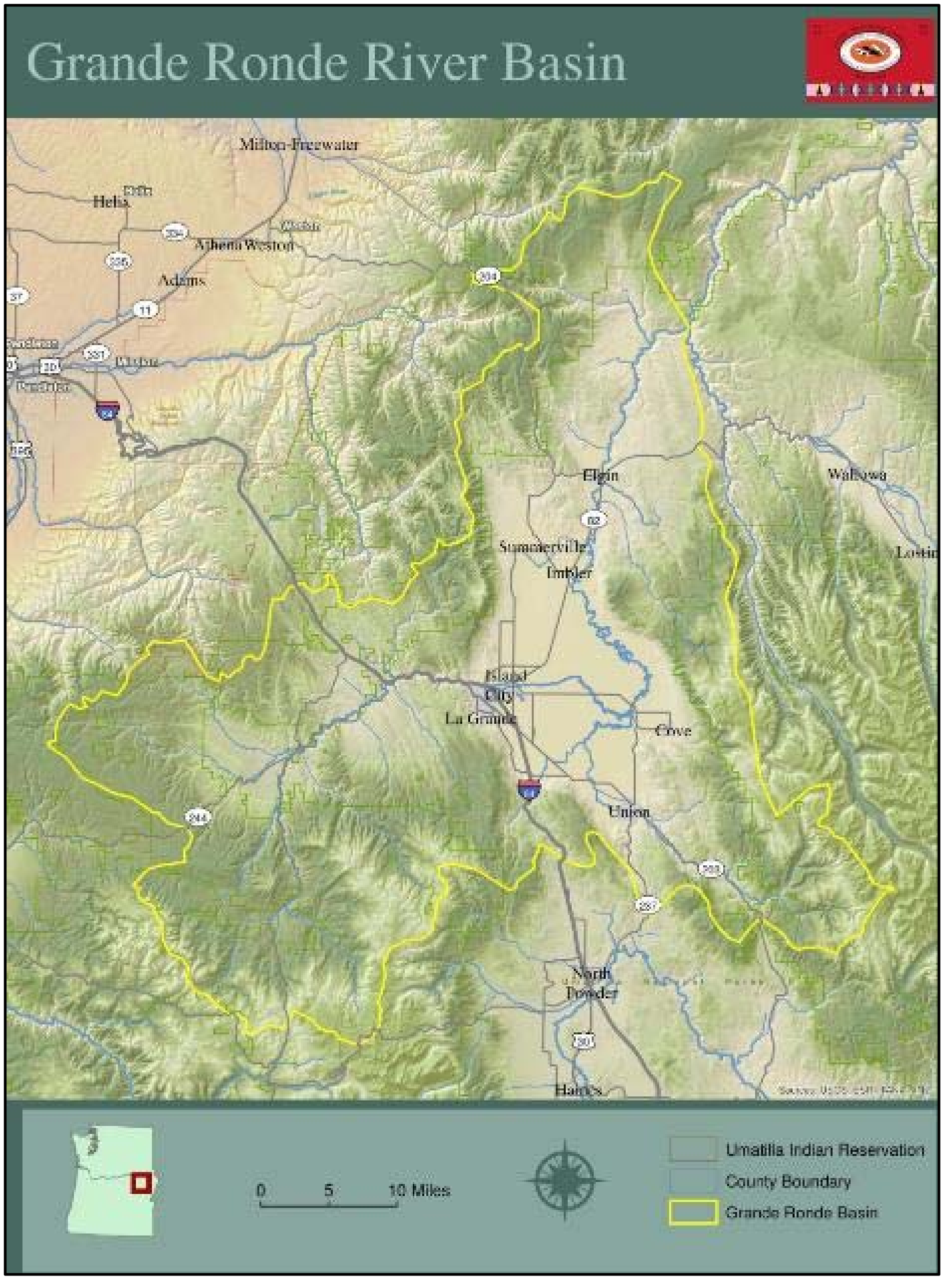
Project results are reported in various forms including Pisces status reports, project completion reports, and annual reports. The GRMW maintains a complete database on project implementation and results through development of project completion reports.

Description of Project Area

The project is located in the Grande Ronde Subbasin, in the southwest portion of the Blue Mountain Ecological province (Figure 1). The Subbasin encompasses about 4,000 square miles in northeastern Oregon and southeastern Washington. The headwaters of the Grande Ronde River originate near Anthony Lakes in the Elkhorn Mountains and flow northeast for about 212 miles before joining the Snake River in Washington at river-mile (RM) 169.

The Subbasin is divided into three watershed areas—the Lower Grande Ronde, Upper Grande Ronde, and Wallowa watersheds. Approximately 46 percent of the Subbasin is under federal ownership. Historic land uses include timber harvest, livestock grazing, mining, agriculture and recreation.

FIGURE 1 UPPER GRANDE RONDE SUBBASIN VICINITY



A comprehensive overview of the Subbasin is contained in the Grande Ronde Subbasin Plan (NPPC, 2004). The CTUIR Grande Ronde Subbasin Restoration Project focuses primarily on the Upper Grande Ronde portion of the Subbasin, which includes approximately 1,650 square miles with 917 miles of stream network (about 221 miles of salmon habitat). However, past project development and success of the program in terms of the types of projects that have been developed and the partnerships that have formed, are leading to watershed restoration project opportunities throughout the Subbasin. Figure 1 illustrates the vicinity of the Grande Ronde Subbasin within the Blue Mountain Province and key projects that have been completed, are underway, or planned under the CTUIR’s Grande Ronde Subbasin Restoration Project.

Grande Ronde Subbasin fish populations have declined and habitat degradation is widespread in tributary streams. Mainstem Columbia River harvest, development of Columbia and Snake River hydroelectric projects, and habitat degradation has played an important role in the demise of Grande Ronde Subbasin fisheries (NPCC 2004a and b).

Although hatchery programs currently support subsistence and sport fishing opportunities for steelhead and limited Chinook salmon, there remains significant need to re-build viable and harvestable fish stocks throughout the Subbasin.

TABLE 1 SUMMARY OF ESTIMATED HISTORIC AND CURRENT GRANDE RONDE SPRING CHINOOK SALMON RETURNS BY POPULATION (DATA PROVIDED BY B. JONNASSON, ODFW PERS. COMM. 2004)

	Estimated Historic Returns		**Estimated Current Returns**					
Population	count	% of total	count	% of total	**Miles of spawning habitat**	**Adults /Mile Template**	**Adults /Mile Current**	**% Decrease Historic to Current**
Wenaha Spring Chinook	1,800	15%	453	30%	*45.60*	39.48	9.94	75%
Minam Spring Chinook	1,800	15%	347	23%	*42.54*	42.31	8.16	94%
Wallowa-Lostine Spring Chinook	3,600	30%	211	14%	*56.10*	64.17	3.76	95%
Lookingglass Spring Chinook	1,200	10%	190	12%	*29.82*	40.24	6.37	81%
Catherine Creek Spring Chinook	1,200	10%	188	12%	*29.82*	40.24	6.30	84%
Upper Grande Ronde Spring Chinook	2,400	20%	132	9%	*79.11*	30.34	1.67	84%
Total	**12,000**		**1,521**		***283.00***	**42.4**	**5.37**	**87%**

TABLE 2 SUMMARY OF ESTIMATED HISTORIC AND CURRENT GRANDE RONDE SUMMER STEELHEAD RETURNS BY POPULATION (DATA PROVIDED BY B. JONNASSON, ODFW PERS. COMM. 2004)

	Estimated Historic Returns		**Estimated Current Returns**					
Population	count	% of total	count	% of total	**Miles of spawning habitat**	**Adults /Mile Template**	**Adults /Mile Current**	**% Decrease Historic to Current**
Lower Grande Ronde	2,400	16%	608	14%	253.84	9.45	2.39	75%
Joseph Creek	3,600	24%	945	21%	223.10	16.14	4.24	74%
Wallowa River	3,750	25%	1,193	27%	173.45	21.62	6.88	68%
Upper Grande Ronde	5,250	35%	1,755	39%	613.96	8.55	2.86	67%
Total	**15,000**		**4,500**		1,264.35			**70%**

Figures 2 and 3 display estimates of historic and current abundance, productivity, and life history diversity predicted through the Ecosystem Diagnosis and Treatment (EDT) Method for Grande Ronde Subbasin Chinook salmon and summer steelhead, respectively (NPCC, 2004a and Mobrand, 2003). Graphs illustrate that current abundance, productivity, and life history diversity for spring Chinook and summer steelhead has been reduced from estimated historic levels.

Chinook and steelhead populations furthest from historic potential are in geographic areas that have experienced the highest levels of anthropogenic influence with significant declines illustrated for Wallowa-Lostine, Catherine Creek, Lookingglass, and Upper Grande Ronde spring Chinook and Upper Grande Ronde, Wallowa, and Joseph Creek summer steelhead. Current productivity and life history diversity for spring Chinook in the Wenaha and Minam watersheds (primarily designated wilderness areas) is similar to estimated historic conditions (NPPC, 2004a).

FIGURE 2 EDT ESTIMATES OF ABUNDANCE, PRODUCTIVITY, AND LIFE HISTORY DIVERSITY COMPARED TO THE ESTIMATED HISTORIC POTENTIAL FOR GRANDE RONDE SUBBASIN CHINOOK SALMON (NPCC 2004A, FIGURE 8, PG. 54)

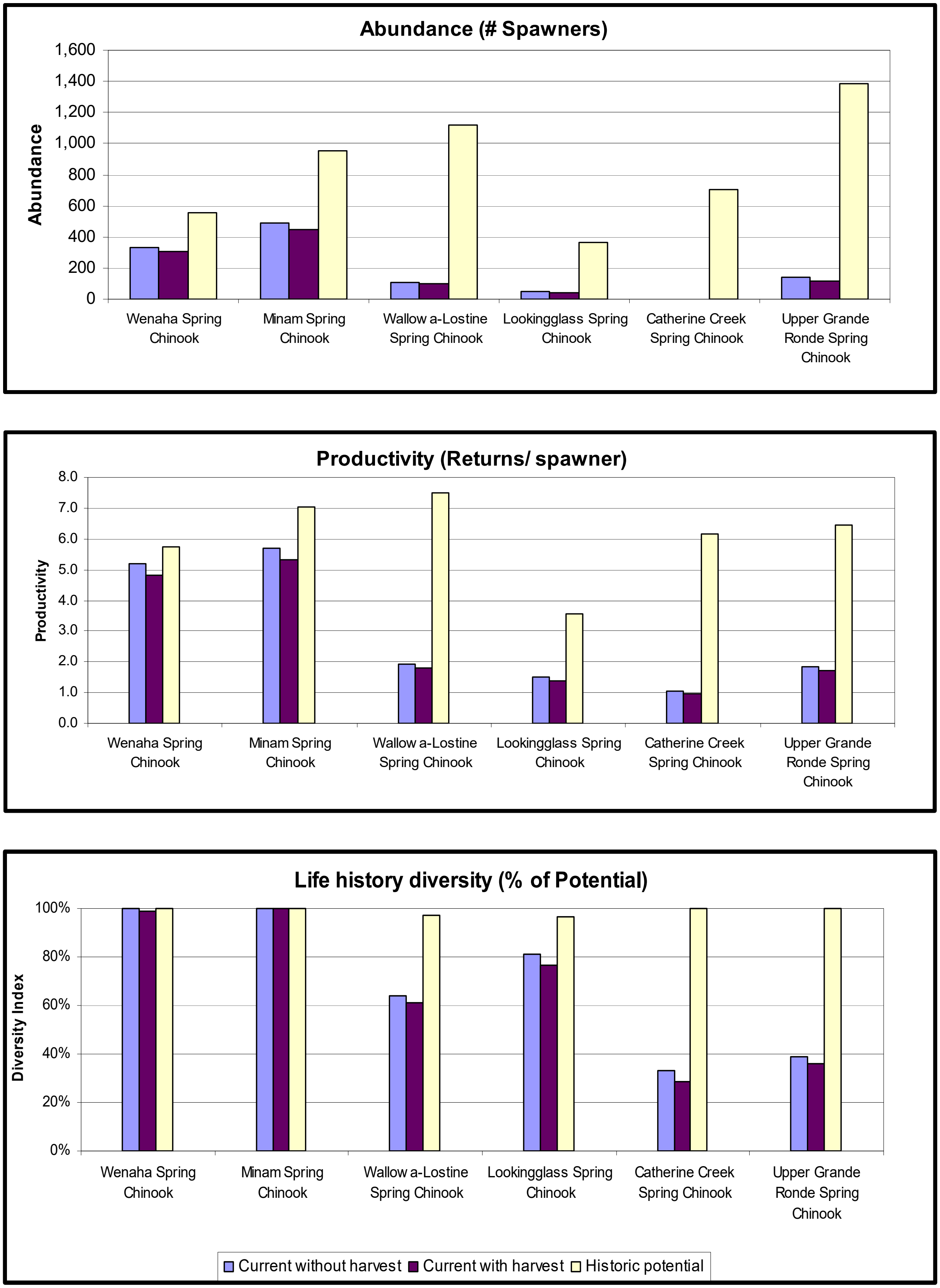
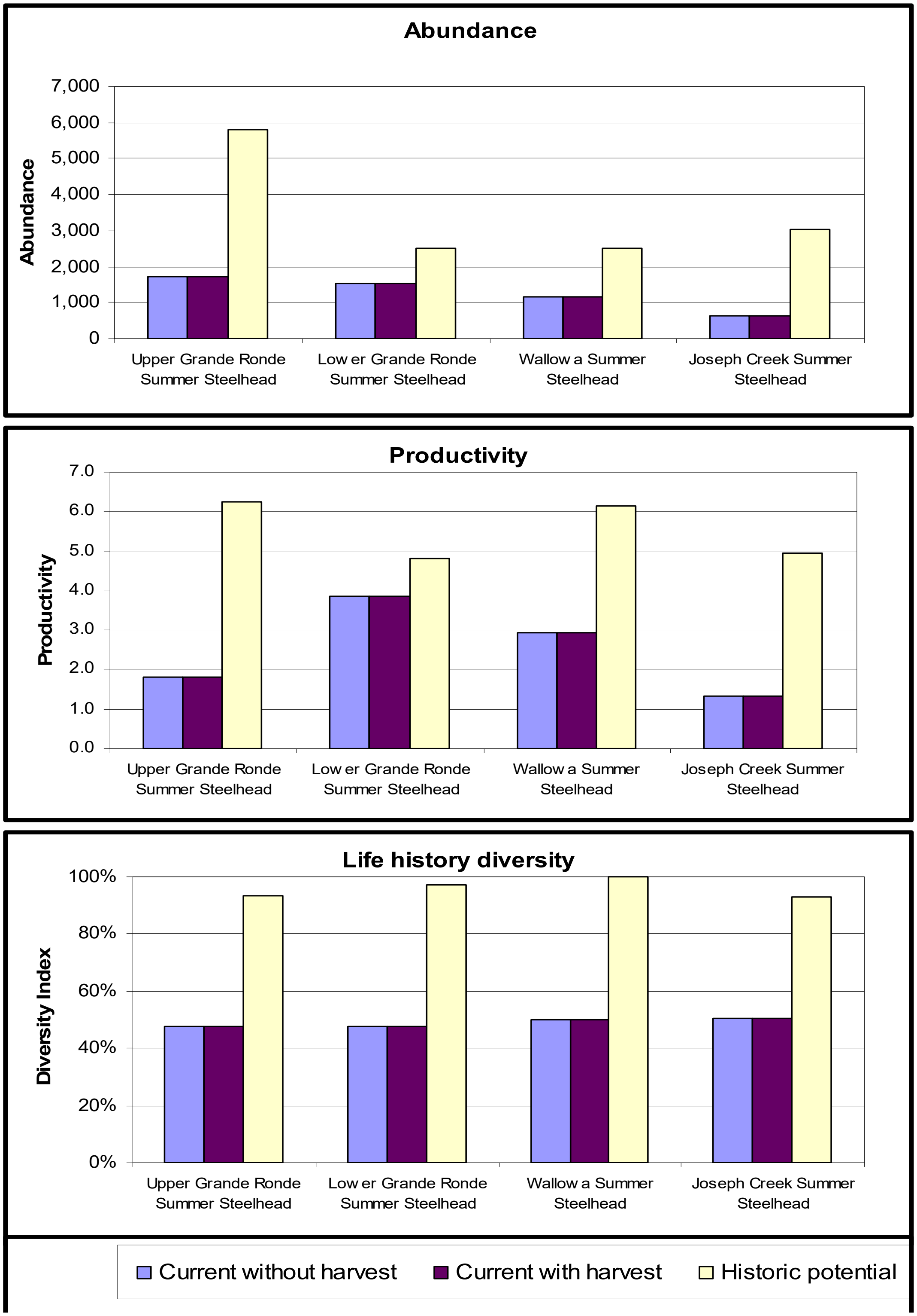


FIGURE 3 **EDT ESTIMATES OF ABUNDANCE, PRODUCTIVITY, AND LIFE HISTORY DIVERSITY COMPARED TO ESTIMATED HISTORIC POTENTIAL FOR GRANDE RONDE SUBBASIN SUMMER STEELHEAD (NPCC 2004A, FIGURE 22, PG. 72)**



Degradation of instream and riparian habitat in the Subbasin has been the dominant cause of salmon and steelhead decline (NPCC, 2004). The adverse effects of poorly managed logging, grazing, mining, dams, irrigation withdrawals, urbanization, exotic species introductions, and other human activities have been documented in all of Columbia River tributaries (ISG 1996). Riparian and instream habitat degradation has most severely impacted spring Chinook production potential in the Grande Ronde Subbasin (ODFW and CTUIR 1990, NPCC 2004a) and habitat loss and degradation has been widespread with the exception of road-less and wilderness areas (Anderson et al. 1992; CTUIR 1983; Henjum et al.1994; McIntosh et al. 1994).

Approximately 379 miles of degraded stream miles have been identified in the Subbasin (ODFW et al. 1990), with an estimated 80 percent of anadromous fish habitat in a degraded condition (Anderson et al. 1992). McIntosh (1994) documented a 70 percent loss of large pool habitat in the Upper Grande Ronde River since 1941. Riparian shade on low gradient streams was found to be less than 30 percent (Huntington, 1993). Stream channelization, diking, wetland drainage, and use of splash dams were common and widespread practices until the 1970's resulting in severe channel incision and degradation in some locations. The Oregon Department of Environmental Quality (ODEQ) listed over 60 stream reaches in the Subbasin on the State's list of water quality limited water bodies 303 (d). Of these stream segments, 24 are listed for habitat modification, 27 for sediment, and 49 for temperature. Table 3 illustrates priority areas for water quality treatment in the Subbasin (ODEQ, 2000).

TABLE 3 GEOGRAPHIC PRIORITY AREAS FOR WATER QUALITY TREATMENT IN THE UPPER GRANDE RONDE WATERSHED DEVELOPED THOURSOUGH TMDL PROCESS (H=HIGH, M=MEDIUM, L=LOW) (NPCC 2004A, TABLE 18, ODEQ, 2000)

Watershed	Temperature	Sediment	Flow
Lookingglass	L[1]	L	L
Lower Grande Ronde	L	L	L
Willow/Philips	H	H	H
Indian/Clark	M	M[2]	M
Catherine Creek	H	H	H
Beaver	M	M	L[3]
GRR Valley	H	H	H
Ladd Creek	H	H	H
Upper Grande Ronde	H	H	H[4]
Meadow Creek	H	H	H[4]
Spring/Five Pts.	H	M	M

Watershed analysis through the EDT (NPCC, 2004a and Mobrand, 2003) and synthesis through the Subbasin Plan Management Plan development process, identified instream habitat condition, high water temperature, sediment loads, and flow modification as primary limiting factors for Chinook and steelhead (pg. 11 NPCC 2004c, pg. 3 NPCC 2004d). Primary habitat degradation includes:

- **Channel Habitat Conditions** – Channel instability associated with removal of streamside cover and channelization has resulted in channel incision/down cutting, increased gradient, reduced channel length, elevated erosion, increased width-to-depth ratios, and loss of channel complexity. The quality of instream habitat has correspondingly been altered throughout much of the Subbasin.

- **Sediment** – Loss of upland and streamside vegetative cover has increased the rates of erosion. Soils lost from upland areas has overwhelmed hydraulic processes resulting in decreased availability of large pool habitat, spawning areas, riffle food production, and hiding cover.
- **Riparian Function** – Riparian habitat degradation is the most serious habitat problem in the subbasin for fish (McIntosh 1994, ICBEMP 2000). The loss of floodplain connectivity resulting from road/dike construction and channel incision, in addition to reduced habitat suitability for beaver, have altered dynamically stable floodplain environments and contributed to degradation and limited habitat recovery." This loss leads to secondary effects that are equally harmful and limiting, including increased water temperature, low summer flows, excessive winter runoff, and sedimentation.
- **Low Flow** – Water resources in many streams have been over-appropriated resulting in limited summer and fall base flow, development of fish passage barriers, and increased summer water temperatures.

Table 4 illustrates key habitat limiting factors by geographic priority area. The table has been edited from the Subbasin plan to depict only those geographic areas addressed under this proposal. These watersheds have been identified as the three highest priority areas to conduct habitat restoration with the greatest response in Chinook salmon and steelhead production potential (NPCC, 2004a, Supplement, Pgs. 49-50, Table 5-6).

TABLE 4 GRANDE RONDE SUBBASIN PRIORITY GEOGRAPHIC AREAS AND HABITAT LIMITING FACTORS (NPCC, 2004A)

Watershed	Fish Population(s)	EDT Priority Geographic Area(s) highlighted areas are priorities for multiple pops.	Habitat Limiting Factors
Wallowa River (including Lostine River)	Wallowa Steelhead Wallowa-Lostine Chinook Lostine/ Bear Cr Bull Trout	**Steelhead Priorities** Prairie Creek Upper Wallowa River –Wallowa Chinook Hurricane Cr , Whiskey Cr Lower Wallowa (1-3) -Minam Steelhead **Chinook Priorities** Lower Lostine – Wallowa Steelhead Mid-Wallowa – Wallowa Steelhead	➢ Key Habitat Quantity (reduced wetted widths) ➢ Habitat Diversity (reduced wood, riparian function) ➢ Sediment ➢ Temperature ➢ Flows
Upper Grande Ronde	Upper GR Steelhead Upper GR Chinook Upper GR Complex Bull Trout	Mid GR 4 (GR 37 - 44) - Chinook Mid GR Tribs 4 (Whiskey, Spring, Jordan, Bear, Beaver, Hoodoo…) Phillips Creek Upper GR Ronde 1 (45-48) - Chinook Mid GR 3 (GR – 34-36) Valley Sheep Cr, Fly Cr, Lower Meadow Cr – Chinook	➢ Sediment ➢ Flow ➢ Temperature ➢ Key Habitat Quantity (reduced wetted widths)
Catherine Creek/ Middle Grande Ronde	Upper GR Steelhead Catherine Cr Chinook Catherine Cr Bull Trout Indian Cr Bull Trout	Mid Catherine Creek (2-9) – UGR Steelhead SF, NF Catherine Creek Lower Grande Ronde R. 2	➢ Key Habitat Quantity (reduced wetted widths) ➢ Habitat Diversity (reduced wood, riparian function) ➢ Sediment ➢ Flow ➢ Temperature

Habitat protection and restoration needs in the Subbasin have been recognized in numerous reviews, planning processes, and reports (CTUIR, 1983), Noll and Boyce 1988, (ODFW, 1990), Wallowa-Whitman et.al. 1992, (Huntington, 1993) GRMWP (1994), (Mobrand, 2003), (NPCC, 2009), and (NPCCa, 2004). NPCC (2004a) Appendix 5 (pg 254) provides a relatively complete list of habitat protection and restoration strategies that can be applied to achieve goals and objectives. The NMFS proposed recovery plan for Snake River Chinook salmon recognized the importance of tributary habitat restoration and protection of habitat on both federal and private lands to Chinook and steelhead recovery (NMFS, 1997). NMFS has recently restarted the recovery planning effort for Chinook salmon and steelhead and tributary habitat restoration is expected to play a prominent role in the final NMFS recovery plan. NRC, (1996) has also noted the importance of protecting and rehabilitating freshwater habitat as part of salmon recovery. They specifically note the importance of riparian areas and recommend that habitat reclamation or enhancement should emphasize rehabilitation of ecological processes and function. The USFWS draft bull trout recovery plan recognized the importance of habitat protection and restoration as well (USFWS, 2002), specifically noting the need to improve water quality, reduce or eliminate fish passage barriers, and restoring impaired instream and riparian habitat.

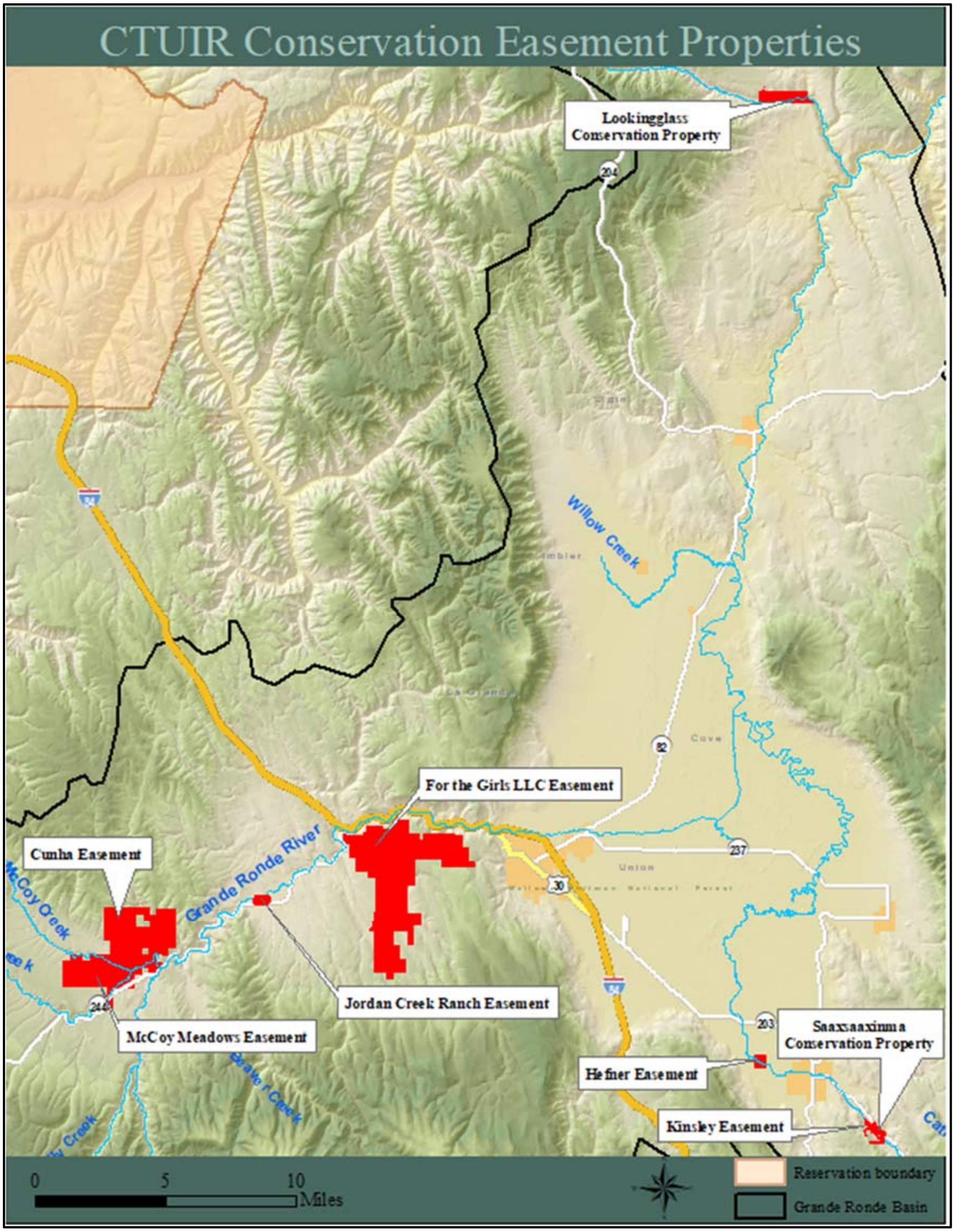
Noteworthy Accomplishments, FY2018

- Continued fish habitat enhancement activities, including maintenance, monitoring, and adaptive management, on the Catherine Creek (CC 44) Southern Cross Phase III project, which permanently protects 1 mile mainstem and 64 acres of historic floodplain.
- Maintained and monitored conservation easements on the Grande Ronde River, Catherine Creek, Rock Creek, Meadow Creek, and Dark Canyon Creek (Figure 4).
- Initiated planning, field surveys, and design on projects planned for construction through 2019 including:
    - Wood acquisition for the Middle Upper Grande Ronde River (MUGRR) Project.
    - Completed field surveys and site stake-out on the Rock Creek Phase 3 Project.
    - Continued planning and design on the 8 mile Middle Upper Grande Ronde River reach.
    - Completed planning and design on the Bird Track Springs Project in cooperation with the Bureau of Reclamation (BOR) and the U.S. Forest Service, covering over 4 miles of the mainstem Grande Ronde River and several side channel habitats.
    - Continued planning and design on the Longley Meadows Project on the Grande Ronde River.
- Completed construction of the Rock Creek Phase III Project. Construction activities included:
    - 28 constructed riffles and imbedded boulders
    - 54 large wood structures along the main channel
    - 300+ wood pieces along floodplain, side channel, and alcoves
    - 1,900 feet willow/brush bank treatments
    - .82 miles main channel excavation
    - 462 feet side channel excavation
    - 10 alcoves constructed
    - 5,248 feet draw bottom road obliteration
    - 3,000 feet (1599 cubic yards) historic push up levees removed

- Completed Phase I construction of the Bird Track Springs Project. 2018 accomplishments included:
    - 108 large wood structures completed
    - 563 boulders salvaged (557 installed)
    - Environmental controls followed (installation of silt fence, 1200C permit and dust abatement)
    - 1 temporary bridge installed and removed
    - 25% of sod salvage, storage and placement
    - 43% of woody riparian woody clumps
    - 40,963 CY (54%) of channel excavation (approximately 2,780 feet of main channel and about 3,696 feet of side channel) and 8885 CY of material screening
    - 56% of riffles and 11% of point bars completed
    - Applied native grass seed (15 lbs/ acre) and straw mulch to 8 acres of disturbed area

- Project Leader participated on the Grande Ronde Model Watershed Board of Directors and Technical Implementation Team to review and develop projects.
- Project Leader and Assistant Biologist participated in the Technical Advisor Committee for the Atlas Process.
- Project Leader and Assistant Biologist participated in NRCS Local Working Group and Regional Conservation Partnership Program planning (RCCP).
- Staff conducted monitoring and evaluation activities on project areas, including expanded water temperature and groundwater monitoring efforts at restoration sites and application and monitoring of ungulate browse deterrent.
- CTUIR habitat staff supported other research and monitoring efforts at project sites including AEM and CTUIR physical habitat monitoring program.
- CTUIR staff hosted multiple tours on the Bird Track Springs Project for groups and individuals during 2018, including local newspaper article interviews, Trout Unlimited groups, the Oregon Water Resources Sponsored Place-Based Planning Group, Bureau of Reclamation and partners from the Idaho's Salmon River Basin and Idaho's Governors Salmon Program, as well as tours with other agencies and individuals.
- Project Leader and Biologists presented at symposiums, meetings, and information sessions including GRMW Implementation Team meetings, CTUIR Habitat Program meeting, 2019 State of the Science Meeting, 2019 CTUIR Legal Counsel Retreat, CTUIR Department of Natural Resources Open House, Grande Ronde Habitat temperature presentation, and Grande Ronde Basin Partnership OWEB FIP presentation.
- Pursued future restoration efforts by continuing discussions with federal land managers and private landowners about restoration opportunities along Catherine Creek, Grande Ronde River, Dry Creek, Whiskey Creek, Indian Creek, Rock Creek, and Winter Canyon Creek.
- Project staff coordinated with landowners, NRCS, and UCSWCD to provide technical assistance for restoration project enrollment in EQIP, CREP, and OWEB small grants on Rock Creek (For the Girls LLC) and Bird Track Springs (Jordan Creek Ranch).

FIGURE 4 CTUIR CONSERVATION EASEMENT PROPERTIES MAP



Discussion of Completed Work

Rock Creek Fish Habitat Enhancement Project Phase III

The Rock Creek Project encompasses nearly 16 miles of fish habitat on Rock, Little Rock, Sheep, Graves and Little Graves Creek. The project is located within the Snake River Spring-Summer Chinook Salmon and Summer Steelhead Recovery Plan assessment units UGC-2 and UGS-16, respectively. UGS-16 has been identified by the BiOp Expert Panel as one of the highest priority geographic units to protect and restore summer steelhead habitat. UGC-2 is identified as having high intrinsic potential for Chinook in the lower reaches of Rock Creek. The project area is located 6.8 miles west of La Grande, Oregon in Township 3 South, Range 37 East, all or portions of Sections 5 and 6 on private land. The Rock Creek watershed encompasses 52.9 square miles (33,856 acres) and flows southeast to northwest. Elevations range from 6,070 feet to 2,930 feet with an average annual precipitation of 25 inches. The project area is characterized as a typical mid-elevation Blue Mountain forested watershed interspersed with open dry meadows in the uplands and typically narrow floodplains.

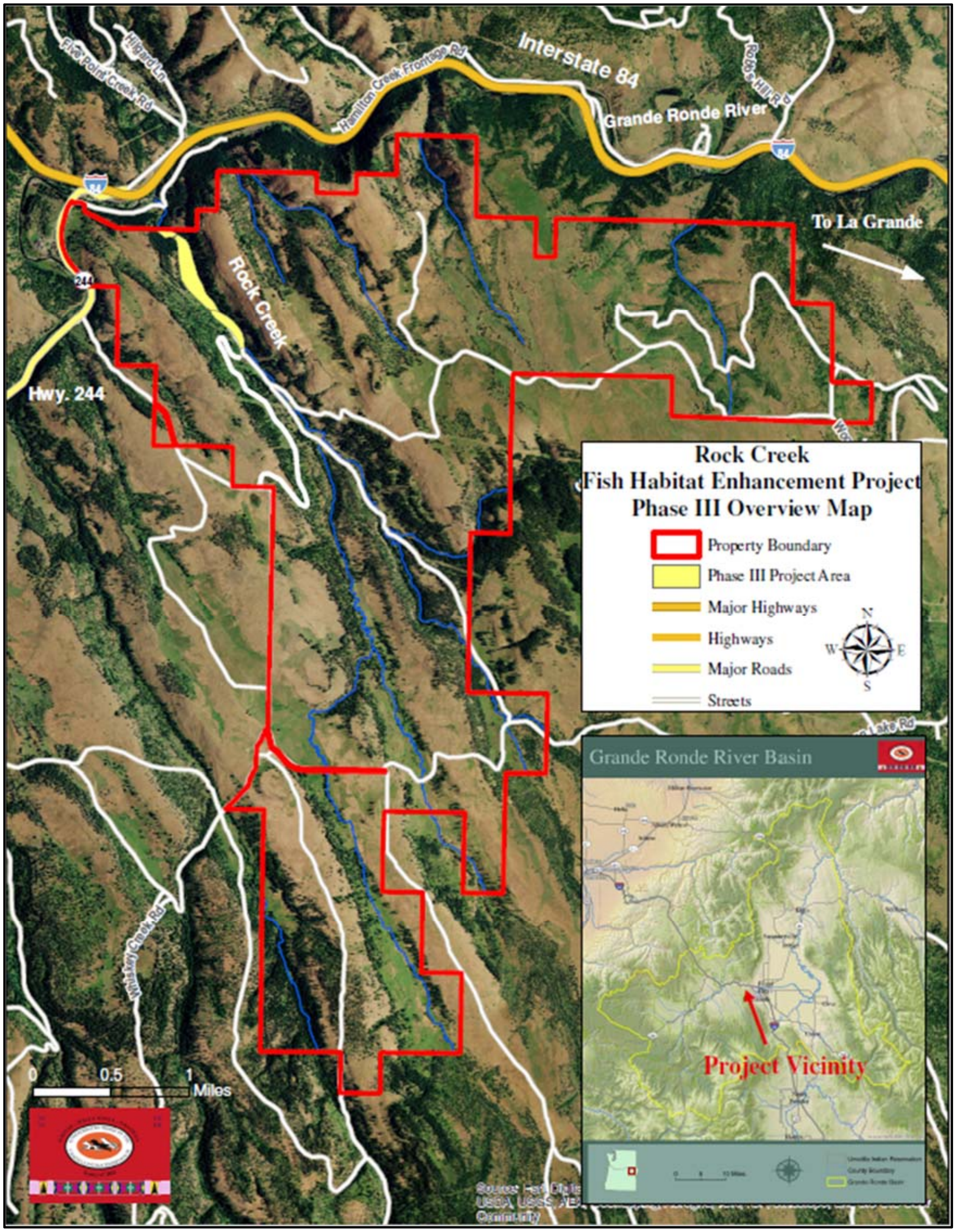
Approximately 3 miles of lower Rock Creek has been channelized by historic draw bottom road construction, installation of levees and utilities (power lines, gas pipelines, fiber optics), and agriculture. Channel and floodplain alterations contributed to channel incision, increased channel slope, coarsening sediment and streambed armoring, and streambank erosion. The project area has experienced a significant loss of riparian and wetland vegetation due to floodplain alterations and overgrazing by livestock.

Phase 1 and 2 of the project were constructed in 2013 to 2015 along Graves Creek, Upper Rock Creek, Little Rock Creek, and Sheep Creek. These phases consisted primarily of large wood additions to increase habitat complexity and riparian fencing to protect habitat. Work along Graves Creek included large wood, riffle construction and –re-activation of a 1945 pre-channelization stream channel.

Phase 3 of the project was constructed July 30 to November 9, 2018 (Figure 5). This project phase included the lower 1 mile reach of Rock Creek, beginning approximately 0.25 miles upstream from the confluence with the Grande Ronde River. The project included new channel construction (re-alignment), draw bottom road and levee decommissioning, floodplain grading, alcove construction and re-activation of historic channel swales, installation of large wood material, removal of an undersized bridge, riparian planting and seeding, and habitat protection.

Overall project objectives include diversifying existing homogenous, plane bed aquatic and riverine habitat observed in the existing channelized condition to a diverse plan form with appropriate dimension, pattern, profile, and floodplain connectivity naturally exhibited in unconfined alluvial floodplains, including increased groundwater and hyporheic functions. Targeted life requisites for salmonid spawning and rearing habitat include: summer water temperature/cold water refuge, depth, velocity, cover, sediment, and riparian/wetland. Habitat and geomorphic features and processes enhanced to improve spawning and rearing suitability include: decreased channel slope, velocity, and width to depth ratio, increased diversity of pool, riffle, run habitat types, large pools, off channel habitat, including side channels and alcoves, and improved diversity of sediment size and storage/sorting of suitable spawning gravel.

FIGURE 5 ROCK CREEK FISH HABITAT ENHANCEMENT PROJECT PHASE III OVERVIEW MAP



Project Objectives

- **Protect Habitat:** Maintain/expand current CTUIR/BPA riparian easement fence to encompass widened channel meander alignment and adjacent floodplain.

- **Enhance Riparian Habitat:** Broadcast seed and mulch riparian with native plant mix to rehab disturbed areas in floodplain and decommissioned levee and road grade. Install in-stream willow bank treatments. Protect plantings until vegetation has established and is providing bank stability and shade.

- **Enhance Floodplain Connectivity:** Remove channel confinement structures (obliterate draw bottom road and remove levees and one bridge along Rock Creek) and activate side channels and alcoves.

- **Enhance in-stream structural diversity, complexity, and geomorphic stability:** Install large wood and riffle boulder complexes to provide roughness, overhead cover, and velocity diversity. Main channel construction including the development and creation of new meander bends that will increase channel sinuosity, decrease channel slope and assist in floodplain reconnection and the development of more diverse channel structure and hydraulic variability.

- **Reduce streambank erosion rates:** Use bioengineering techniques, planting/seeding, activation of floodplain, and protection (fencing) of riparian area to facilitate bank stability. Visual assessments indicated that the bulk of the sediment supply is from localized stream bank erosion. Stream bank stabilization may be achieved using several techniques including rest from grazing, or adding native material such as large woody debris (LWD), sedge/rush mats, trenching willow cuttings and brushy debris into stream banks.

- **Improve Water Quality:** Improve/increase channel and floodplain interactions to diversify hyporheic exchange, including facilitating preferential flow from hillside cold water spring seeps into alcoves, side channels, and main channel. Promote vegetative cover/shade, and decrease channel width to depth ratio to lower summer stream temperatures and increase winter temperatures.

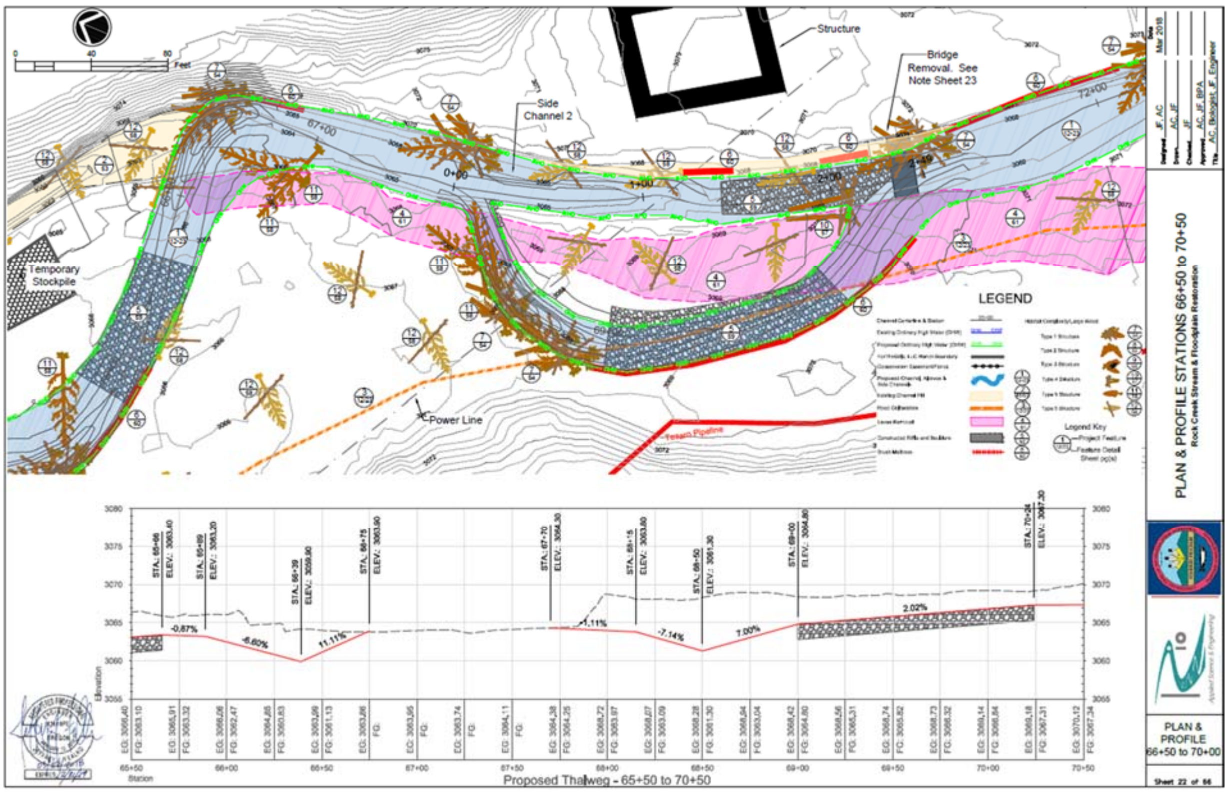
Project Metrics

Phase III construction included new main channel and side channel excavation, large wood, riffle and boulder cluster installation, removal of floodplain levees and draw bottom road, side channel and alcove activation, and instream/floodplain re-vegetation (Figure 6).

- **Construct New Rock Creek Main Channel, Side Channels, Alcoves, and Riffles with Boulders:** Approximately 4,308 feet of new Rock Creek main channel and 462 feet of side channel were constructed that will allow the confined and straightened channel to once again meander the valley bottom width, increasing channel sinuosity, decrease channel slope, and assist in floodplain reconnection and the development of more diverse channel structure and hydraulic variability. Construction of secondary channels, alcoves, and other periphery habitats was focused in areas where low swales or historic channels currently existed. These channel forms will principally be dependent on stream hydraulics for development.

A total of 28 riffles were constructed and will aid in maintaining floodplain connection and preventing potential headcuts or channel degradation. Boulder clusters were embedded in each of the riffle locations to increase channel bottom roughness, provide habitat diversity and velocity refuge, and assist in maintaining vertical grades. Pools will be located in natural areas of scour to increase persistence of depth, while providing velocity refuge for adult and juvenile salmonids. Glides occur in transitions between pools and riffles and will be zones of depositional features where gravels are deposited to increase spawning potential through the reach.

FIGURE 6 UPPER ROCK CREEK PROJECT DESIGN FLOWING LEFT TO RIGHT



- **Install Large Wood Complexes along Rock Creek:** Approximately 54 large wood complexes were installed along project area main channel and side channels to recreate complex and diverse habitat components within the project reach (Figure 7). Typical instream wood placement configurations mimicked natural debris accumulations, and were designed to stabilize stream banks, provide overhead cover, and facilitate back-watering activation of alcoves, side channels, and floodplain swales. These structures will provide shade for fish species, hiding cover from predators, velocity refuge, bank stability, and a food source (insects).

FIGURE 7 ROCK CREEK TYPE 2 LARGE WOOD COMPLEX

More than 300 wood pieces were installed on floodplain and alcoves, designed to provide roughness decrease overland flow velocities when the river is high and overtopping its banks. Fine sediment in suspension during these high flow events will settle out around floodplain wood, providing excellent growth medium for cottonwood and willow seeds as floodwaters recede. Wood within the floodplain will provide protection zones for this emerging vegetation, and restrict flows through certain areas.

- **Streambank Treatments and Revegetation:** Approximately 1,900 feet of brush mattress was installed along the banks of newly constructed Rock Creek main and side channels (Figure 8). These features are composed of trenched dead branches, salvaged shrub material, and live willow cuttings. Brushy material will increase roughness along banks, and willow growth will shade the channel and provide bank protection as robust root mass establish.

FIGURE 8 BIOENGINEERED BANK TREATMENT – WILLOW/BRUSH MATTRESS

- **Removal of Floodplain Levees and Road Decommission on Rock Creek:** Approximately 1599 cubic yards (3,000 feet) of levee material were removed from the lower one mile of Rock Creek floodplain allowing the re-connection of the stream with its floodplain. Some of the material was salvaged to be used as a base lift during riffle construction, some disposed of in channel fill areas and off-site disposal areas.

  Approximately 5,248 feet of draw bottom road that ran parallel to Rock Creek on the southwest side (river left) of the channel was decommissioned (Figure 9). Once vehicles and equipment no longer needed access, the road was de-compacted and fractured to a depth of 24 inches. This will result in the rehabilitation of floodplain vegetation, and hydraulic reconnection of cold water hillside springs with Rock Creek.

FIGURE 9 DRAW-BOTTOM ROAD DECOMMISSIONING

Meeting the Terms and Conditions of HIP III

Fish Screen Criteria

By the time in-water construction commenced on Rock Creek in 2018 there was no flow connecting the remaining small intermittent and isolated pools. This resulted in no need to pump water from fish-bearing segments of the creek. Water management and pumping was limited to dewatering isolated, de-fished pools within the new channel, fed only by groundwater. Discharge of pumped water was managed by utilizing adjacent floodplain to filter turbid discharge water, eliminating the need to discharge turbid water to active streamflow. As follows, there were no days during project construction in which work needed to be put on hold due to high flows.

Erosion, Pollution and Contaminant Control

As mentioned above, turbidity exceedance was not encountered due to summer base flows dropping below riverbed substrate, leaving only small disconnected pools. No spills or contaminate release, and no erosion control failures occurred.

Post-Project Condition

Before start of excavating new Rock Creek channel segments, ground surface material in the proposed channel alignment was salvaged, which included grubbing riparian vegetation (primarily willows, sedges and rush mats) and storing in cool/wet conditions. Salvaged plant material was re-planted along completed new channel segments. Additionally, topsoil in new channel excavation limits was also salvaged and set aside for installation along banks of the new channel alignment to promote riparian recovery.

Site Restoration

As described above, attention was made to salvage and replant much of the native plant material that would be within the limits of new channel excavation. Slight adjustments were made to field fit project design elements to minimally disturb established robust plant communities. One project objective was to decommission 5,248 feet long draw-bottom road that runs along valley left of Rock Creek. Due to years of vehicle compaction a D6 dozer was utilized to scarify and fracture the roadbed to a depth of at least 24 inches. Doing so allows post-construction riparian plantings to better establish roots within the old road prism. In addition, 6 acres of Rock Creek floodplain (including decommissioned road and access routes) were planted with native grass seed and straw mulched overtop to help retain moisture and reduce amount of seed relocated by wind and rain.

Fish Salvage

By the commencement of salvage operations, the majority of Rock Creek within the area of project disturbance did not have standing or flowing water, which made it unnecessary to isolate individual construction sites or to bypass flows around work areas. A total of four days of salvage operations were conducted between 8/14/2018 and 8/20/2018 on 19 sites. Fish capture progressed each day until water temperatures reached 18°C.

Salvage operations were conducted using the following protocol:

1. Project biologists snorkeled deeper pools within the project area 24 hrs prior to salvage operations to determine presence/absence of salmonid species and to estimate their numbers.
2. A block net was installed in larger pools to reduce the movement of fish within the salvage area.
3. Debris and vegetation/algae were removed prior to fish salvage efforts.
4. Release sites were chosen at locations around the confluence of Rock Creek with the Grande Ronde River where there were deeper pools and available cold-water refuge.
5. Capture using seine nets was utilized first (where suitable) followed by electro-fishing.
6. Project biologists recorded:
    a. salvage area average width, depth, and length in meters –
    b. water temperature in degrees centigrade (at start and end of salvage passes) –
    c. number of passes per site –
    d. fish captured were counted by species –
    e. type of capture method (seine or electrofishing) was recorded –
    f. When electrofishing the pulse width (nms), frequency (htz), voltage, and the number of seconds on electro-fisher were recorded for each pass.
    g. Salvage operations using electro-fisher were suspended when water temperatures reached >= 18°C.
    h. A site was considered depleted when two consecutive passes were made with zero salmonid species being captured or seen.
    i. Captured fish were placed in aerated coolers and transported to release sites within 10 minutes of capture.
    j. No in-water construction activity commenced until salvage operations were complete.
    k. Any fish mortality was recorded and dead fish retained for inspection by NOAA staff.

Salvage Results

There were 19 sites salvaged along lower Rock Creek during the 2018 in-water construction window with no Chinook captured or observed and 57 *O. mykiss* captured (Table 5).

TABLE 5 ROCK CREEK FISH SALVAGE

Site Location	O. mykiss (age 0)	O. mykiss (age 1)	O. mykiss (age 2)	O. mykiss/site
37+00	0	5	3	8
42+00	0	3	1	4
43+25	0	3	0	3
46+00	0	5	0	5
47+00	1	1	0	2
48+00	0	2	0	2
49+00	1	1	0	2
49+50	2	3	1	6
65+00	0	1	0	1
67+00	0	2	0	2
67+25	3	5	2	10
67+50	0	9	3	12
Total	7	41	10	57

Salvage Discussion

Overall, the Rock Creek Phase III salvage operation was successful in depleting construction sites and relocating 57 ESA listed juvenile *O. mykiss* without observing any salmonid mortalities. However, salmonids were only 2% of total fish caught, with 1,384 non-salmonids making up the majority of fish salvaged from the project area. Of these 23 mortalities were recorded, giving a mortality rate of less than 2% for non-ESA listed species. Non-salmonids species were recorded as "Other" on salvage data sheets, and consisted of northern pikeminnow, dace, redside shiner, sculpin, sucker, and chisel mouth. In addition, crayfish, frogs, and freshwater mussels were recorded and relocated outside of the Phase III project area (Figure 10).

Site 67+00 was previously identified as being occupied by a colony of freshwater mussels (*M. falcate*). CTUIR Freshwater Mussel Project staff assisted in the collection and relocation of 60 mussels from this site during fish salvage operations.

FIGURE 10 CTUIR STAFF CONDUCTING FISH SALVAGE ON ROCK CREEK

Bird Track Springs Fish Habitat Enhancement Project Phase I

Project Purpose and Location

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Department of Natural Resources Fisheries Program, Wallowa-Whitman National Forest, La Grande Ranger District, Bureau of Reclamation, and Bonneville Power Administration partnered to plan, design, and implement the Bird Track Springs Fish Habitat Enhancement project. Funding for the project included grants through the Grande Ronde Model Watershed (BPA funding) and Oregon Watershed Enhancement (OWEB) Focused Investment Program Funding (FIP).

Year 1 project was initiated in mid-August 2018 and completed on January 11, 2019. Year 2 project work is scheduled for late June through November 2019.

The project is located along the mainstem Upper Grande Ronde River near Bird Track Springs Campground, approximately 10 miles southwest of the City of La Grande, Oregon along Highway 244 (Township 3 South, Range 36 East, Section 15) between river miles 144-146.

The scope of the fish habitat and floodplain restoration project includes channel, side channel, and floodplain swale construction, installation of large wood structures, streambank bioengineering, work area isolation and water management, channel reclamation, temporary bridge installations, site clean-up, and extensive seeding and planting.

The project includes construction of approximately 5,000 linear feet of new main channel (including four confluences with the existing channel); construction/excavation of approximately 9,500 linear feet of side channels; construction of approximately 1,200 linear feet of alcoves; construction of approximately 2,000 linear feet of floodplain swale connections; construction of 14 riffles in the main channel; construction of 48 riffles in side channels; construction of 300 in-channel wood structures; construction of approximately 3,600 linear feet of edge roughness; construction of approximately 3,700 feet of brush trench; construction/placement of approximately 225 floodplain roughness features (primarily large and small wood structures and whole trees); and the excavation of approximately 85,000 cubic yards of material over a one to two year construction period.

The perimeter of the project area was posted with closure signs and mobilization of construction contractor equipment began in early August. The logging contractor started staging material in early August at the former Jordan Creek Ranch corral area. Wildland fire restrictions and permit timing limited access to all of the planned staging areas, resulting in all the wood being staged on the former corral site on Jordan Creek Ranch in staging areas 6 & 7. Wood piles for different size classes and types were established and sorted.

Fish Screen Criteria

There was no pumping of water by the contractor from fish-bearing waters that required compliance with fish screen criteria. Water that was pumped by the contractor was either free of fish to begin with or de-fished before pumping.

Erosion, Pollution and Contaminant Control

Silt fence was installed, maintained and inspected by the contractor in compliance with the 1200C permit. Access roads were treated with water during dry periods to control dust and spill kits were strategically placed for easy access during construction. Turbidity was monitored and reported during the in-water work window by the contractor (see attached data).

Post-Project Condition

Riparian areas cleared within 150' of the ordinary high water were treated with wood installations, constructed riffles and excavated channels. Grading was returned to planned or existing following post project disturbed areas.

Site Restoration

Cleared native vegetation was salvaged and replanted or used in the construction of wood structures Native grass seed and potted plants were planted in disturbed areas and straw mulch was used on seeded and planted areas. Grubbed material consisting of woody debris and sod were dispersed on disturbed areas to assist rehabilitation. Following the 2nd year of construction, disturbed areas will be treated with native grass seed, straw mulch and native plant species to assist in recovery.

Implementation

This was the first year of a 2 year project with the remaining work to conclude by December 31, 2019. Bypass construction will begin as early as March depending on variance permitting, while the remainder of main channel, side channel 3 complex and connections will occur over the 2019 construction season. This will include riffle mining, channel excavation and grading, large wood installments, riffle construction, site clean-up and demobilization. Originally the project schedule was going to bisect the project in to an upstream and downstream portion for years 1 and 2. However, the delay in receiving permits and the lack of access from wildland fire restrictions changed the operations to completing work south of the existing channel in 2018 and the remaining work in the existing channel and North of it will be completed in 2019.

2018 Accomplishments

- Environmental controls followed (installation of silt fence, 1200C permit and dust abatement)
- 1 temporary bridge installed and removed
- 25% of sod salvage, storage and placement
- 43% of woody riparian woody clumps
- 40,963 CY (54%) of channel excavation (approximately 2,780 feet of main channel and about 3,696 feet of side channel) and 8885 CY of material screening
- 56% of riffles and 11% of point bars completed
- 563 boulders salvaged and 557 boulders installed
- Wood structures completed
    - Type A1 Apex Jam – 6
    - Type B1 Meander Jam – Upstream Component – 2
    - Type B2 Meander Jam – Middle Component – 3
    - Type B3 Meander Jam – Downstream Component – 7
    - Type B4- Meander Jam- Mallet Jam – 2

- Type C1- Longitudinal Channel Margin Jam – 6
    - Type C2- Angled Channel Margin Jam -- 12
    - Type D1- Deflector Jam (Small) – 5
    - Type D2- Deflector Jam (Large) – 1
    - Type E- Single Log Sweeper – 6
    - Type E- Double Log Sweeper – 3
    - Type F- Floodplain Roughness – 24
    - Type G1- SC Habitat- Single Log – 2
    - Type G3- SC Habitat- Triple Log – 1
    - Type H- Cover Log – 26
    - Type J- Reinforced Habitat Structure – 2
    - Brush Bank Treatment – 521 LF
    - Roughened Edge Bank Treatment – 1,696 LF
    - Live Brush Trench – 24
- Applied native grass seed (15 lbs/ acre) and straw mulch to 8 acres of disturbed area
- USFS planted 8,000 one gallon potted plants in Jordan Creek Ranch area and 3,120 willows planted in wood structures

Fish Salvage

Fish salvage efforts for Bird Track Springs fish habitat enhancement project began on August 20, 2018 and concluded on September 26, 2018. The terminus to side channel 10, wood structures near station 86+50 and the bend in the river between stations 76+00 and 81+00 were de-fished during the salvage period. Stream temperatures ranged from 12-17 degrees Celsius during the morning hours between 7:00-9:30 am during the August salvage and 6.9-11.2 C during September. A summary of the catch is below:

- 22 age-0, 9 age-1 and 1 age-2 for a total of 32 *O.mykiss* were captured during the fish salvage efforts
- 407 Pacific lamprey ammocoetes
- 81 western Pearlshell mussels
- The majority of the biomass salvaged was a healthy assemblage of freshwater cyprinids (dace, sculpin, shiner and suckers)

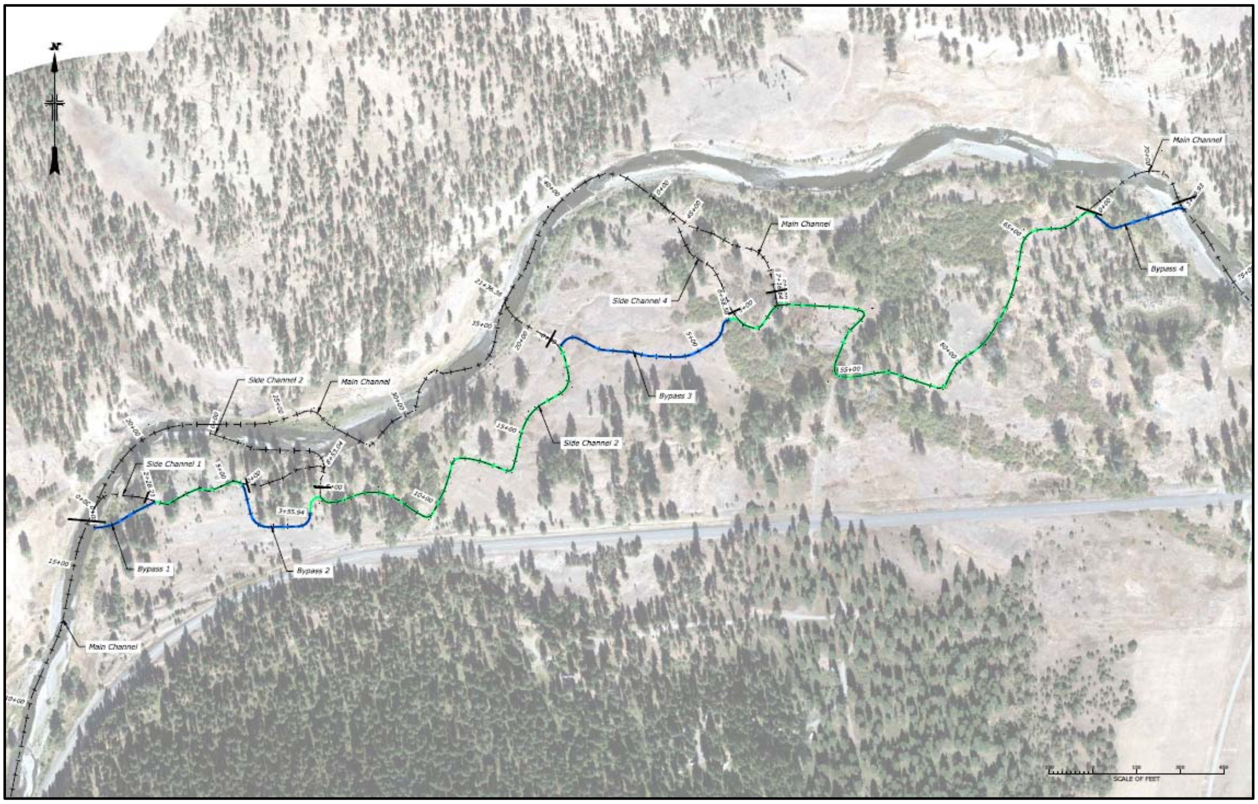
Lessons Learned

- Bank heights of excavated channels were steep and exposed, leading to changes in wood treatments to protect these banks. Cross sections in the design phase may help understand treatments or alternatives.
- Riffle material was not as abundant on site as expected, partially owing to the large amount of fine sediment/topsoil (3-4') in many areas. Test pits prior to construction that pass section 106 permitting may help better understand the underlying material available for construction.
- The specifications of wood for the project may also be changed to more closely approximate the desired classes.

Bird Track Springs Phase 2 Temporary Bypass Plan

To facilitate project completion, a 5,340-foot long temporary bypass channel has been designed as a modification to the Access and Staging/Sequencing Plan for 2019 construction (phase 2) that would utilize newly constructed channels (3,767-feet) along with four temporary bypass channels (1573-feet) as described in Figure 11.

FIGURE 11 BTS 2019 TEMPORARY BYPASS OVERVIEW.



Temporary Bypass Timing and Intent

The intent of the temporary bypass is to 1) Minimize adverse effects to ESA listed salmonids and other fishery resources by flushing fine sediments from newly constructed channel segments while background turbidity levels are high (e.g., spring 2019); 2) Decrease fish handling times and incidental take during fish salvage operations and facilitate effective work area isolation and fish removal; 3) Safely and effectively divert flow during construction; 4) Promote fluvial transport of upstream food material (aquatic insect drift) into newly constructed channels early to facilitate food web recovery ; and 5) Promote volitional fish migration.

The inlet of the bypass channel will be controlled using concrete eco-blocks, concrete jersey barriers, and/or sediment bulk bags to provide a hydraulic control that ensures that the bypass channel maintains flows of 10 to 50 cfs at all times. At the onset of the in-water work period (July 1st), and dependent on river discharge (at or below 50 cfs), the entire river will be diverted into the bypass channel which will facilitate de-watering the main channel in preparation of construction during July 1 through October 15th (established in-water work window). The entire flow will remain in the temporary bypass channel through the in-water work period or when all construction activities have been completed, whichever comes first.

Summary of requested temporary bypass periods:

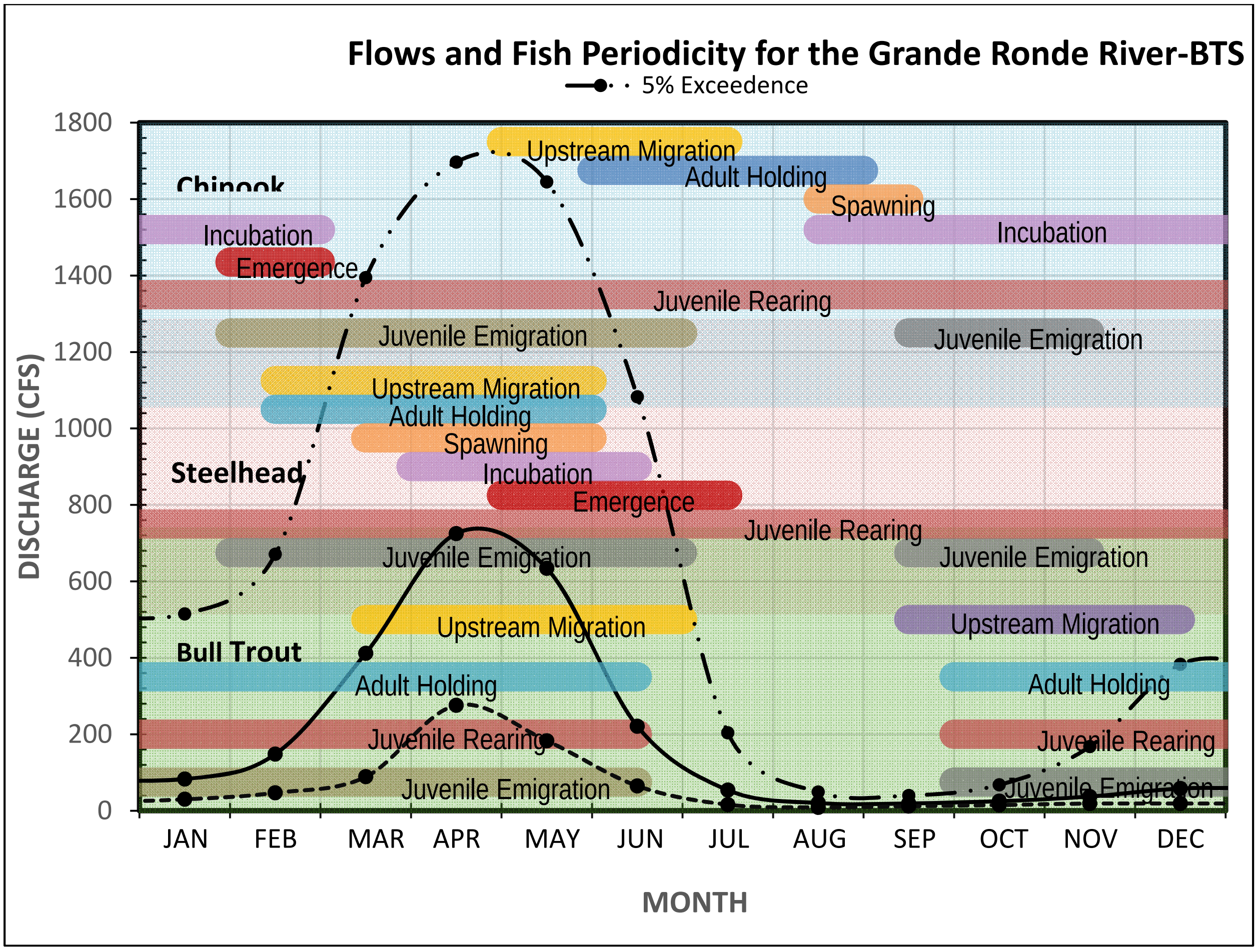
- ≈ March 15, 2019 through June 30, 2019 – Partial flow into bypass channel, with a minimum level of 10 cfs and maximum of 50 cfs.
- ≈ July 1, 2019 through October 15, 2019 – All flow into bypass channel (*Note- date of activation of all flow on July 1st will occur if Grande Ronde flow is at or below 50 cfs*).

Fishery Use and Benefits of Early Activation

Fish life histories and seasonal Grande Ronde River discharge for Spring Chinook salmon and summer steelhead is plotted in Figure 12. Steelhead holding, spawning and incubation life stages were omitted in the Grande Ronde Atlas periodicity chart for the project area reach (UGR 11), but are presented here to recognize potential life stages that could be affected by project actions. Les Naylor, CTUIR RME biologist (Personal Communication, January 2019), has documented limited mainstem Grande Ronde steelhead spawning in the downstream Longley Meadows Reach in recent years, indicating there is in fact previously unknown spawning in the mainstem Upper Grande Ronde River. Steelhead spawning surveys will be conducted in the project reach to monitor and document spawning activity and inform management in the event redds become established in the project reach. Per standard redd survey protocol, redds will be avoided by construction activities, flagged, and a GPS waypoint taken.

The bypass channel will maintain adequate flows for all life stages during operations, including spawning, incubation, emergence, juvenile and adult holding and passage. Early activation will promote sediment flushing from newly constructed channel segments during periods of normal elevated turbidity, promoting food web recovery for rearing and migrating fish soon after activation. According to modeling done by Warren et al. (2014), juvenile Chinook salmon production in a low gradient, mid-order stream is dominated by bottom up food processes such as detritus, periphyton, and macroinvertebrate interactions thus creating an ideal forage base. Fluvial transport of upstream materials (aquatic insect drift) will be facilitated through activation of the bypass channel. The bypass channel will be constructed several weeks prior to being connected to the river and will begin to fill with groundwater, thus providing some primary production to occur before the channel is opened up for fish. There may be a slight reduction in foraging behavior, but will not contribute to an increased likelihood of death or injury to individual fish. Additionally, volitional fish passage is implicit in the designs and juvenile salmonids have a short distance to travel to higher productive waters.

FIGURE 12 ANNUAL HYDROGRAPH AT THE UPSTREAM END OF THE PROJECT REACH (RM 146.1). SALMONID DATA GENERATED IN THE ATLAS PROCESS ARE SHOWN. DARKER PORTIONS OF FISH PERIODICITY BANDS SHOW THE CRITICAL PERIOD AND LIGHTER BANDS SHOW SECONDARY PERIODS OF A GIVEN LIFE STAGE.



Project Hydrology

The project reach sits at approximately 3,100 feet elevation and drains an approximate 475-mi2 watershed extending to a maximum elevation of 7,923 feet. The mean annual precipitation is 26.2 in, most of which falls as snow during winter months. As a result, the annual hydrograph is dominated by snowmelt-derived high flows from April to May. Peak flows also occasionally occur from winter rainstorms. The low flow season typically extends from August through December. Most of the basin is forested (over 73 percent) and has very little development. Average annual hydrology of the Grande Ronde was overlaid with salmonid periodicity as shown in figure 2 (Upper Grande Ronde Atlas, 2016).

Probabilities of discharge exceedance have been calculated for the Grande Ronde River using 85-years of gauging record downstream at the USGS gauge at La Grande, OR (13319000, 1904-1989). Gauge data at La Grande was then transformed to the upstream boundary of the project site through a drainage area ratio method. The drainage area ratio method adjusts known discharges (Q_g) at a stream gage to estimate discharge at an ungauged site (Q_u) using the ratio of drainage areas at the ungauged (A_u) and gauged (A_g) locations (A_u/A_g). That drainage area ratio is adjusted by an exponent (a) and then multiplied by the known streamflow at the stream gauge (Q_g) to estimate discharge at the ungauged location. In equation form, the drainage area ratio approach is expressed as:

$$Q_u = Q_g * \left(\frac{A_u}{A_g}\right)^a$$

For this project, the exponent was solved for algebraically using a historic USGS gage within the project reach that had overlapping data (Grande Ronde near Hilgard, USGS Gauge 13318500, 1937-1956). Transformation of gauge data from the La Grande gauge to the project site was completed using a resulting exponent (‘a’) of 1.14. The following figures depict the annual chance of exceedance for the 95%, 50% and 5% conditions at the project site for the annual period of record followed by the in-water work period.

FIGURE 13 GRANDE RONDE RIVER 5%, 50% AND 95% ANNUAL CHANCE OF EXCEEDANCE AT BTS PROJECT SITE.

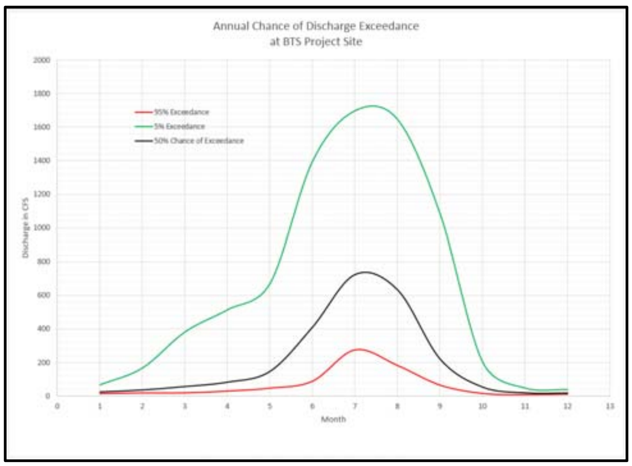
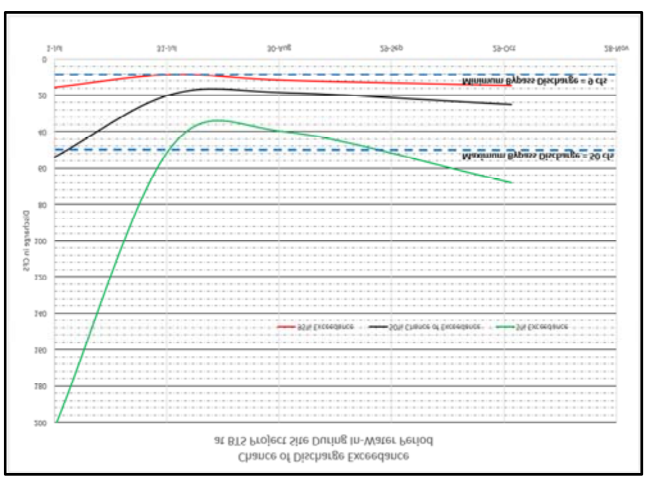


FIGURE 14 GRANDE RONDE RIVER 5%, 50% AND 95% ANNUAL CHANCE OF EXCEEDANCE AT BTS PROJECT SITE DURING THE UPPER GRANDE RONDE IN-WATER WORK PERIOD (JULY 1ST THROUGH OCTOBER 15TH).



Hydraulic modeling demonstrates that upstream and downstream passage for adult and juvenile fish will be provided over the duration of proposed use. The single temporary bypass channel as proposed has many benefits over the original construction plan that included several bypass channels, multiple channel isolations, and multiple fish salvage efforts. The single temporary bypass channel will minimize adverse effects to ESA listed salmonids by decreasing fish handling times and incidental take while providing volitional fish migration in and out of the project area. In addition, secondary benefits will include flushing of fine sediments while background turbidity levels are high and seeding the newly constructed channel segments with aquatic organisms, thereby facilitating more rapid food web recovery in newly constructed channel segments.

The project team has designed and implemented several similar temporary bypass channels for construction purposes in the past that illustrate the effectiveness of the proposed design. As an example, in 2017, all discharge from the Middle Fork of the John Day River (MFJD) was diverted into a temporary bypass channel from July 1st through August 15th for construction of the final phase of the MFJD Oxbow project. The temporary bypass channel was approximately 600-feet long and consisted of a trapezoidal channel with a 16-ft top width and 10 riffles of 2-ft height. This channel had a 2% overall slope, which is over twice that of the steepest bypass channel proposed (Bypass 3 = 0.83% slope). The project was located within a Spring Chinook spawning reach and performed exceptionally well for fish passage during construction that minimized handling as illustrated in the following figures.

FIGURE 15 2017 TEMPORARY BYPASS CHANNEL AT MFJD OXBOW PROJECT AS DESIGNED, PERMITTED AND CONSTRUCTED.

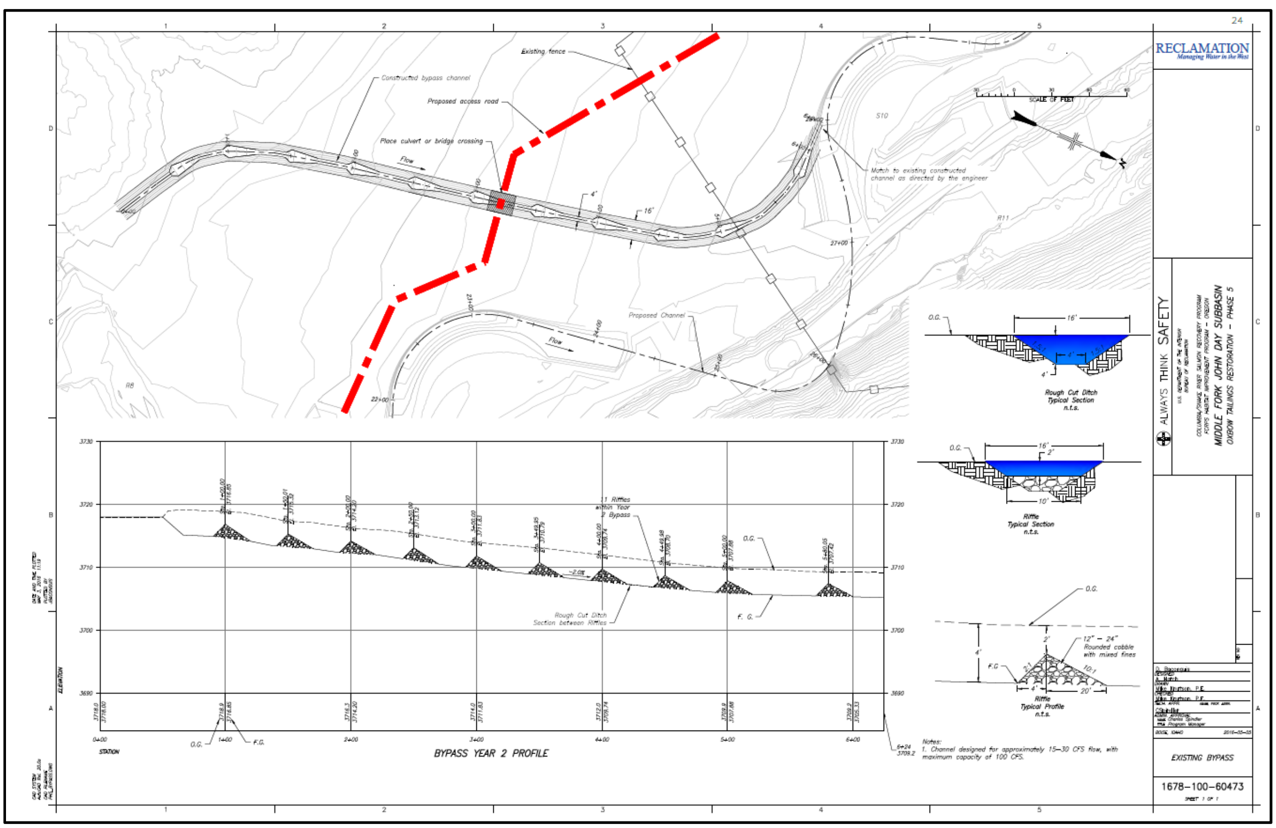


FIGURE 16 2017 TEMPORARY BYPASS CHANNEL AT MFJD OXBOW PROJECT JULY 2017. DISCHARGE OF APPROXIMATELY 35 CFS. CHANNEL SLOPE OF 2%, RIFFLE HEIGHTS OF 2-FEET. NOTE – LOG AND PIPE WERE BRIEFLY PLACED AND REMOVED.

Additionally, a similar bypass strategy involving early activation and utilization of constructed channel segments similar to the BTS bypass channel was employed on Catherine Creek as part of the Southern Cross Fish Habitat Restoration Project. Early activation was highly successful in flushing fine sediments from the newly constructed channel during spring high flow and minimizing effects on fishery resources associated with channel activation during summer base flow.

Proposed Fish Salvage Efforts for Bird Track Springs 2019

Given the potential for late-arriving Chinook to be in the project area, prior to bypass operations and de-fishing, monitoring for adult Chinook presence will be required. A proposed monitoring procedure is as follows:

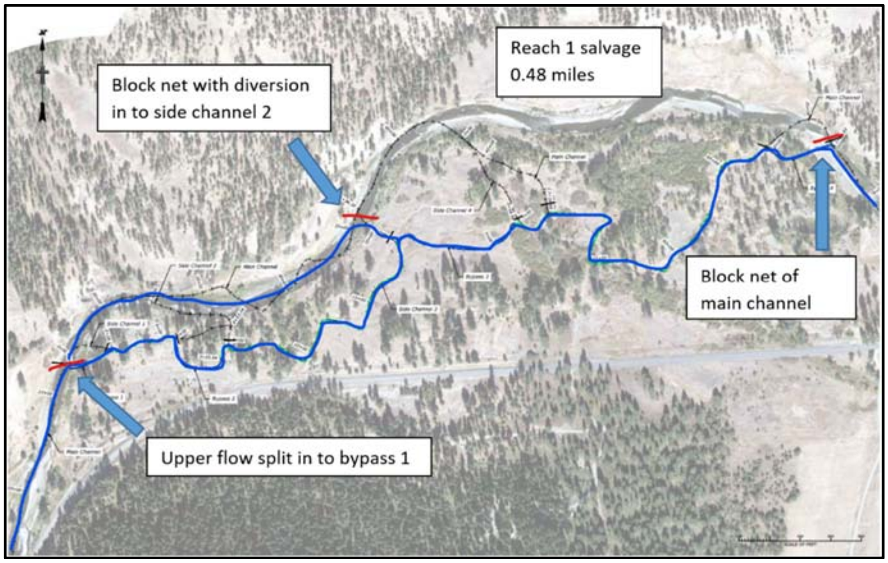
1. Before flows are diverted in to bypass for fish salvage efforts, the existing channel and proposed bypass channel will be walked and snorkeled by experienced surveyors/snorkelers to determine if there are any adult Chinook present.
2. If adult Chinook are encountered, their location will be recorded and follow up surveys will be scheduled.
3. Following a complete survey where no adult Chinook are observed, flows will be diverted for fish salvage efforts in to the bypass channel.

Bypass Channel Length

The current design for bypassing water at Bird Track Springs will require approximately 0.83 miles of existing channel to be dewatered and fish salvaged during the in-water work period of July 1 to October 15. Salvaging fish from a reach this long presents logistic and biological concerns as base flows are approached and stream temperatures often exceed the 18°C limit for electro-fishing. Due to these concerns, the salvage efforts will be divided into an upstream and downstream reach that can be salvaged at separate times. This will reduce the risk of electro-fishing over the recommended stream temperature of 18°C, while also minimizing the number of fish and other aquatic biota handled by fish salvage crews.

The fish salvage effort will be divided into two reaches at the terminus of side channel 2 (SC station 20+00). The upstream reach would be approximately 0.35 miles in length while the downstream reach would be approximately 0.48 miles in length (Figure 17).

FIGURE 17 MAP OF PROPOSED SALVAGE PLAN FOR REACH 1 THAT REQUIRES CONSTRUCTING A TEMPORARY BYPASS CHANNEL BETWEEN THE MAIN CHANNEL AND SIDE CHANNEL 2. RED LINES REPRESENT DIVERSIONS AND/OR BLOCK NETS WHILE THE BLUE LINE REPRESENTS FLOW PATHS.



Water Management

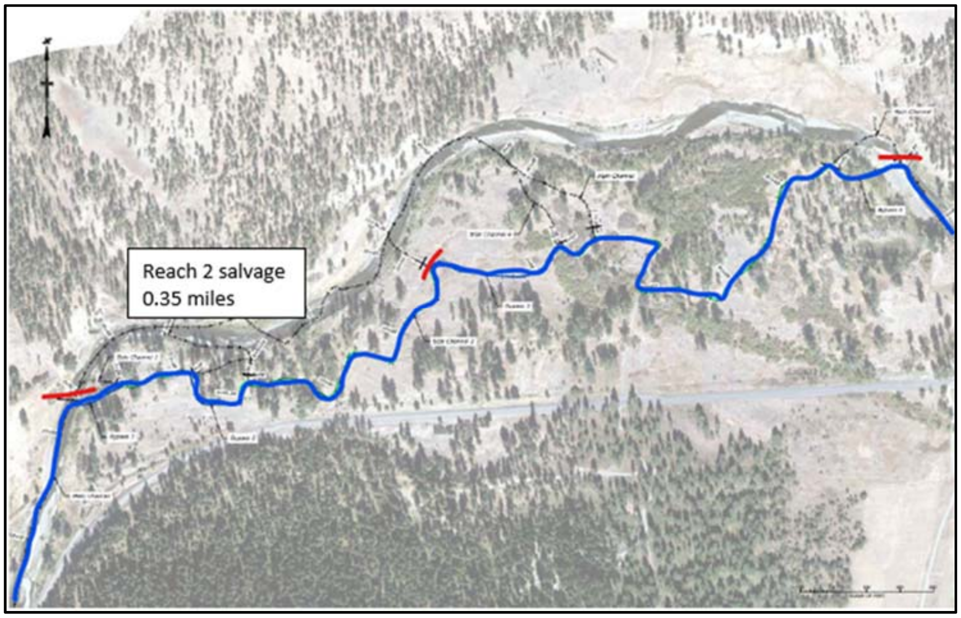
Prior to the onset of the in-water work window, flows will be partitioned between the temporary bypass channel, starting at bypass 1 and the existing channel. (Figure 18).When the in-water work window begins on July 1, flows will be partitioned at bypass 1 according to the temporary bypass plan and fish salvage operations. The following are proposed bypass management guidelines:

1. Bypass flow through entire bypass channel during early and late spring is managed near maximum bypass discharge rates (~50cfs) to maximize sediment flushing as long as Grande Ronde flows into project area exceed 100cfs.
2. As Grande Ronde River flows begin to recede below 100cfs (estimated as approximately mid-June to early July), bypass flow is managed at approximately 50% of total flow entering the project area.
3. Flow split continues to be managed in a 50:50 flow split leading into July. When monitoring demonstrates absence of adult Chinook in existing Grande Ronde River within project area, fish salvage operations will be initiated following isolation of reach 1 to be de-watered.

4. Full diversion into bypass channels will be completed only after flows in the Grande Ronde recede below 50cfs. (Should flows exceed 50cfs, the existing de-fished, Grande Ronde channel will continue to bypass excess flow).

Instantaneous discharge rates will be measured by CTUIR/BOR staff using a Marsh/McBirney or SonTek flow measuring device.

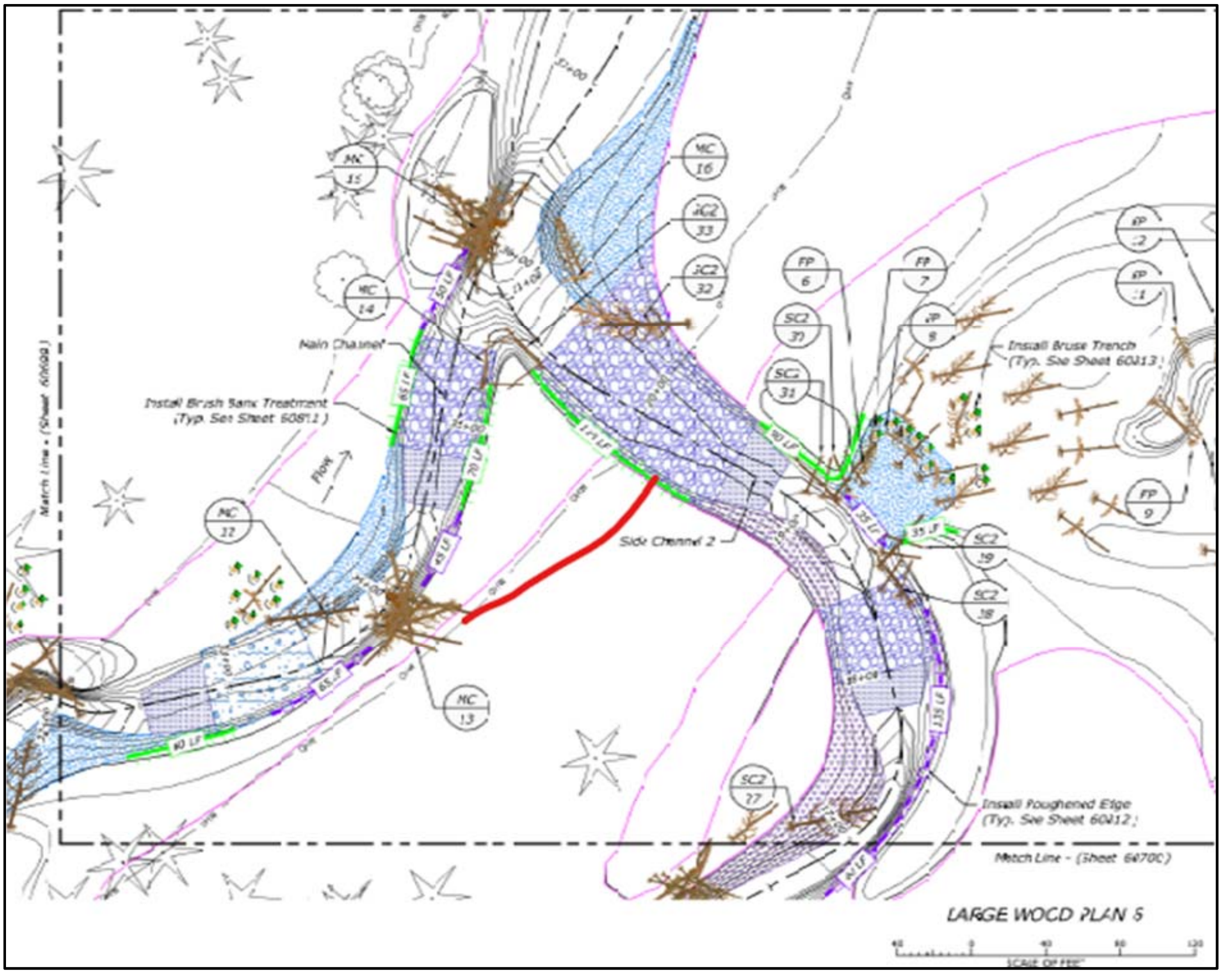
FIGURE 18 SUGGESTED FISH SALVAGE BYPASS PLAN SHOWING REACH 2 FISH SALVAGE WITH FLOWS BEING DIVERTED IN TO SIDE CHANNEL 1 AND ORIGINAL PROPOSED BYPASS CHANNELS. RED LINES REPRESENT DIVERSIONS AND BLOCK NETS WHILE BLUE LINE REPRESENTS FLOW PATH.



Side Channel 2 Bypass Detail

Construction of a temporary bypass channel will occur between main channel station (circa 33+00-35+00) and side channel 2 station (circa 19+00-20+00; Figure 19). This will be accomplished by building the core riffle crest outside of the ordinary high water in side channel 2 near station 20+00 subject to design and approval by Bureau of Reclamation engineers.

FIGURE 19 EXAMPLE DETAIL OF RECOMMENDED BYPASS CONNECTING THE MAIN CHANNEL AND SIDE CHANNEL 2. CORE OF RIFFLE CREST WOULD NEED TO BE CONSTRUCTED IN SIDE CHANNEL 2 AROUND STATION 20+00. RED LINE IS APPROXIMATE LOCATION OF PROPOSED BYPASS CHANNEL.



Discussion

Fish salvage efforts will follow HIP III/NOAA requirements in the original design plan and fish and mussel salvage plans previously established by CTUIR. Other than changes proposed here or amended by ODFW, bypass design will follow guidelines previously established in the temporary bypass plan submitted to ODFW.

Ongoing Work Elements

The following sections present work elements followed by discussion of accomplishments for the project during the contract period.

Manage and Administer Projects

This work element includes a suite of management actions required to administer the project, including preparation of annual operations and maintenance budgets, managing and preparing statements of work and budgets, and milestone and metrics reporting in Pisces, supervising and directing staff activities, conducting vehicle and equipment maintenance and management, payroll, purchasing, subcontracting for services, and administering/inspecting habitat enhancement activities. CTUIR staff administered the Rock Creek Phase III and the Bird Track Springs Phase II Projects, including construction subcontract solicitation, field stakeout, and observation and inspection.

The Project Leader supervised 4 permanent employees and a seasonal crew of 2 180-day fish habitat technicians to accomplish fish salvage and riparian planting project activities. Staff training included 2018 River Restoration Northwest Symposium (Project Leader, Biologists and lead Technician) and Eastern Washington Riparian Planting Symposium (Biologist and lead Technician).

Environmental Compliance and Permits

Environmental compliance methods include development of appropriate documentation under various federal and state laws and regulations governing federally funded project work. Methods involve coordination with various federal and state agencies and development, oversight, and submittal of permit applications, biological assessments, cultural resource surveys, etc.

Primary accomplishments during the reporting period included coordination with BPA environmental compliance personnel to prepare supplemental documentation and reporting for ongoing and planned management actions.

Additionally, CTUIR staff continued EC compliance on projects including the Rock Creek Project Phase III, the Bird Track Springs Project, and the Longley Meadows Project. Activities included preparation of maps illustrating the Area of Potential Effect (APE) to initiate cultural resource investigations and compilation of ESA species information for incorporation into ESA compliance documentation. EC compliance activities will be ongoing for the Bird Track Springs Project in FY2019 with completion scheduled for late summer in preparation to construction initiation.

Coordination and Public Outreach/Education

Coordination and public education were undertaken to facilitate development of habitat restoration and enhancement on private lands, participate in Subbasin planning, ESA recovery planning, BiOp/Remand project development and selection processes, and assist with providing watershed restoration education. CTUIR technical staff coordinates through the GRMW on the Board of Directors and Technical Committee to help facilitate development of management policies and strategies, project development, project selection, and priorities for available funding resources.

The Project Biologist participates in multiple basin programs and processes associated with project prioritization and selection, funding, and technical review. Focus during FY2018 included participation on the Grande Ronde Model Watershed Board of Directors, Executive Committee, and Grande Ronde Basin Technical Atlas Implementation Team to evaluate and select projects for funding recommendations through the GRMW Step-Wise Process. Additionally, CTUIR staff continued working on look forward projects with close coordination between BPA and BOR to develop core project complexes and initiate concept planning in conjunction with CTUIR-BPA Accord land acquisition strategies.

CTUIR staff also participated in a several educational and public outreach activities which included a newspaper article about the CC44 Project for the Grande Ronde Model Watershed Ripples newsletter, a newspaper article about the Southern Cross Project for the East Oregonian, and several tours of the Southern Cross project with OWEB, BOR, CTUIR, and BPA staff.

Planting and Maintenance of Vegetation

The CTUIR habitat program annually participates and/or assumes the lead role in re-vegetation activities on individual habitat restoration and enhancement projects. Planting and seeding methods are developed to address site specific conditions and vegetation objectives. Natural colonization and manual techniques are utilized.

Staff efforts associated with planting during the reporting period included the collection of approximately 8000 live willow cuttings for brush banks and roughened edge treatments on the Bird Track Springs and Rock Creek Projects. Approximately 6,000 containerized trees (Black Cottonwood, Hawthorne, Ponderosa Pine, Douglas fir, Elderberry, Salmonberry, and Red-Osier Dogwood) were purchased and staged by CTUIR staff on the Bird Track Springs Project for installation on point bars, riffle margins, side channels, and floodplains. Disturbed areas were also seeded and mulched with a native grass seed mix consisting of Basin Wild Rye (33.06%), Rosanna Western Wheat Grass (19.07%), Snake River Wheat Grass (9.34%), Tufted Hairgrass (10.41%), Idaho Fescue (16.51%), and Big Blue Grass (9.94%). Containerized plants were installed by a contracted planting crew using a tracked loader with an auger attachment. Multiple applications and pre/post application monitoring of the animal repellant Plantskydd® occurred within the Southern Cross RMZ and McCoy/Meadow Creek Project areas. The Plantskydd Application Monitoring Plan can be viewed on the below link:

https://www.cbfish.org/Document.mvc/DocumentViewer/P160960/plantskydd-application-and-monitoring-plan.pdf

Identify and Select Projects

Habitat protection, restoration and enhancement project opportunities continued to be identified, evaluated, and developed during reporting period. Activities included coordination with basin partners and private landowner to discuss and develop opportunities for future fish habitat and watershed protection and enhancement.

Operate and Maintain Habitat & Structures

CTUIR staff maintains riparian easement fences on nine fish habitat restoration project area properties throughout the field season. Project maintenance includes conducting custodial responsibilities on individual projects to ensure that developments remain in functioning repair and habitat recovery is progressing towards meeting projects goals and objectives. Operations and maintenance of habitat and structures was supervised by biologists and carried out by two permanent technicians, two seasonal technicians (6 month hires), and multiple contractors. Activities included:

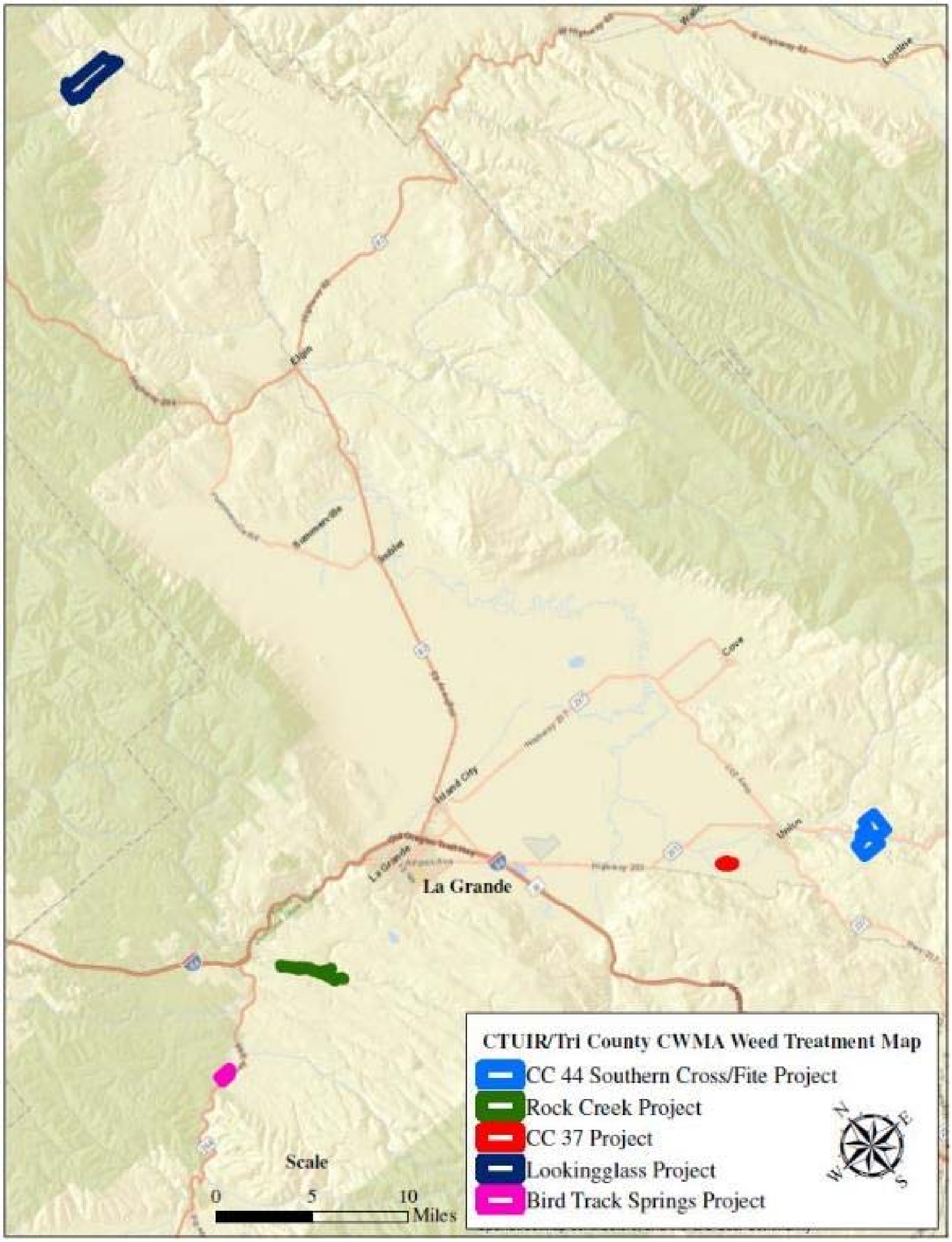
- Layout and maintenance of an irrigation system (hand lines/pumps) within the Southern Cross Riparian Management Zone (RMZ).
- Construction and maintenance of plant enclosures (panels/cages) within the Southern Cross RMZ, and the McCoy Meadows/Meadow Creek Project areas.
- Construction and maintenance of water gaps/water access sites on Meadow Creek (Habberstad), Dark Canyon Creek, Rock Creek, and Catherine Creek Project areas (CC37, CC44).
- Construction and repair of fences along Catherine Creek (CC37, CC44), McCoy Creek, Meadow Creek, Dark Canyon Creek, and Rock Creek Project areas.
- Manual control of noxious weeds within the Southern Cross Conservation Property
- Regular stream/air temperature and groundwater well data collection on Catherine Creek, McCoy/Meadow Creek, Upper Grande Ronde River and tributary streams.
- Collection of willow/cottonwood cuttings for swale channel roughness enhancement and bioengineered bank treatment for the Bird Track Springs and Rock Creek Projects.
- Enhancement of swale channel roughness with willow/cottonwood cuttings (trenching/auguring) within Southern Cross RMZ.
- Spot re-seeding and mulching of swale complexes within the Southern Cross RMZ using riparian and wetland seed mixes.
- Construction of post assisted wood structures within swale channel complexes on Southern Cross Conservation Property utilizing hydraulic and pneumatic post pounders and woven willow cuttings/lodgepole slash.
- General maintenance of project vehicles (trucks/ATVs/trailers), power tools (pumps/chainsaws/augers/pounders), and miscellaneous hand tools.
- Inspected and maintained riparian easement protection fences on CC44 (Southern Cross, Kinsley), and Dark Canyon-Cuhna) properties.
- Treatment of noxious and invasive weeds through a cooperative agreement with the Tri-County Cooperative Weed Management Area (CWMA) on the Southern Cross Conservation Property, Lookingglass Creek Property, CC37 Project, and the Rock Creek Project (Figure 21).
- Fence construction and maintenance on the Jordan Creek Ranch riparian conservation easement (Bird Track Springs Project).
- Large wood inventory survey on US Forest Service property for future projects.
- Ongoing application of Plantskydd® and associated vegetation monitoring within the Southern Cross Riparian Management Zone (RMZ).
- Removal of dilapidated fences on the Bird Track Springs Project.
- Installation of a watering system on wood decks on the Bird Track Springs Project.
- Assisted US Forest Service with plant transport and storage.

FIGURE 20 2018 TRI-COUNTY CWMA NOXIOUS WEED SUMMARY

	Lookingglass Creek Treatments				
Contractor	Weed Species	Time spent	Chemicals	Summary	Acres Treated
Jon Wick	All	16 days (2 applicators)	Transline: 112 oz. Milestone: 40.3 oz.	Targeting Meadow hawkweed and Diffuse Knapweed	13.75 net acres
	Southern Cross Treatments				
Tri-County	All weeds	6 days (2 applicators)	**Riparian:** Transline: 203.3oz. **Upland/Hayfield:** Milestone: 52.5 oz. WeedMaster: 704 oz. 2, 4-D: 272.5 oz.	Transline was used in the riparian area to treat thistles and other weeds growing within the flood plain. Milestone and 2, 4-D were used in the hayfield, and weedmaster was used to spot treat Russian thistle.	**Riparian:** 12.7 net AC **Right-of-way /Hayfield:** 14.3 net AC
	516 Ranch Treatments				
Tri-County	All weeds	3 days (2 applicators)	**Riparian/ Meadow:** Transline: 8 oz. 2, 4-D: 88 oz. Telar: 2 oz. Milestone: 35oz. **Right-of-Way:** Milestone: 35 oz. Plateau: 42 oz.	Telar mixed with 2,4-D to spot spray whitetop, Transline and 2,4-D in riparian areas and Milestone in adjacent meadows and roadsides. Plateau to spot treat Medusahead Rye on roadsides.	**Riparian:** 7.5 net AC **Right-of-way:** 11 net AC

	CC 37				
Tri-County	All weeds	2 days (2 applicators)	**Riparian:** Transline: 228 oz. 2, 4-D: 228 oz.	Treated all weeds within riparian area	**Riparian:** 14.3 net Acres

FIGURE 21 CTUIR/TRI-COUNTY CWMA WEED TREATMENT MAP



Monitoring & Evaluation

Monitoring and evaluation (M&E) of individual projects is conducted either independently by the CTUIR or jointly with project partners, Fish Habitat Enhancement Biological Effectiveness Monitoring 2016 Annual Progress Report (project #2009-014-00; BPA contract #71934) depending on the project. Monitoring and evaluation efforts include annual photo-points, installation of water and air temperature probes, stream channel cross sections and longitudinal profiles, pebble counts, juvenile fish population and habitat surveys, stocking/census surveys on re-vegetation efforts, and groundwater monitoring. Public tours, workshops, and presentations of individual projects will continue to be conducted. These activities provide for the discussion of various approaches, restoration techniques, successes, failures, and ultimately adaptive management.

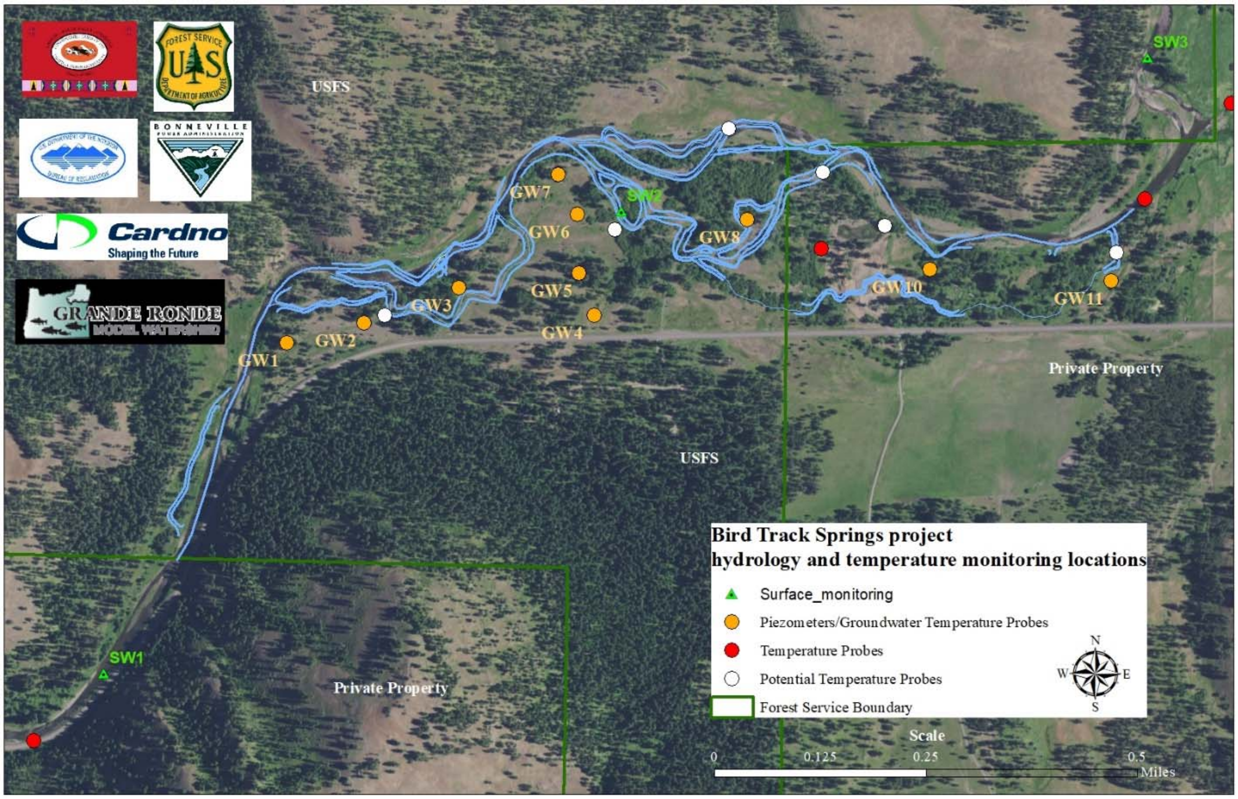
Project staff conducted presence/absence snorkel surveys on side channels as part of the pre-project data collection efforts for the Bird-Track Springs Project.

Following are descriptions of the various M&E components of the project followed by project specific monitoring results.

Groundwater Monitoring

Groundwater wells (piezometers) were installed on Forest Service and private property in November 2017 in the Bird Track Springs and Longley Meadows fish habitat enhancement project areas (Figures 22 & 23), following direction from Bureau of Reclamation (BOR) geologists (Lyons & McAfee, 2017). This action was taken as part of a larger monitoring effort in collaboration with restoration co-managers from the Pacific region and Grande Ronde Basin. In addition to monitoring wells that will capture water levels and groundwater temperatures, surface water temperature probes (existing and proposed) and surface water discharge and stage will be monitored to evaluate changes to the hydrology and temperatures associated with fish habitat enhancement activities.

FIGURE 22 MAP OF GROUNDWATER WELLS, PLANNED SURFACE WATER MONITORING LOCATIONS AND EXISTING AND PROPOSED TEMPERATURE PROBES FOR BIRD TRACK SPRINGS PROJECT AREA. THE BLUE LINES REPRESENT THE NEW CHANNEL ALIGNMENTS.



Year 1 of 2 implementation on the Bird Track Springs Fish Habitat Enhancement Project began in August-2018. Project construction will be completed in November 2019. The Longley Meadows Fish Habitat Enhancement Project is on track to begin implementation in the summer of 2021. The following report and analysis will cover data associated with the groundwater levels and temperatures at Bird Track Springs and Longley Meadows projects. Data collected in the first year of observation is included in a discussion of planned surface water discharge monitoring sites. Collaborating partners will discuss a broader analysis including surface water temperatures in annual reports and ongoing thermal refuge studies.

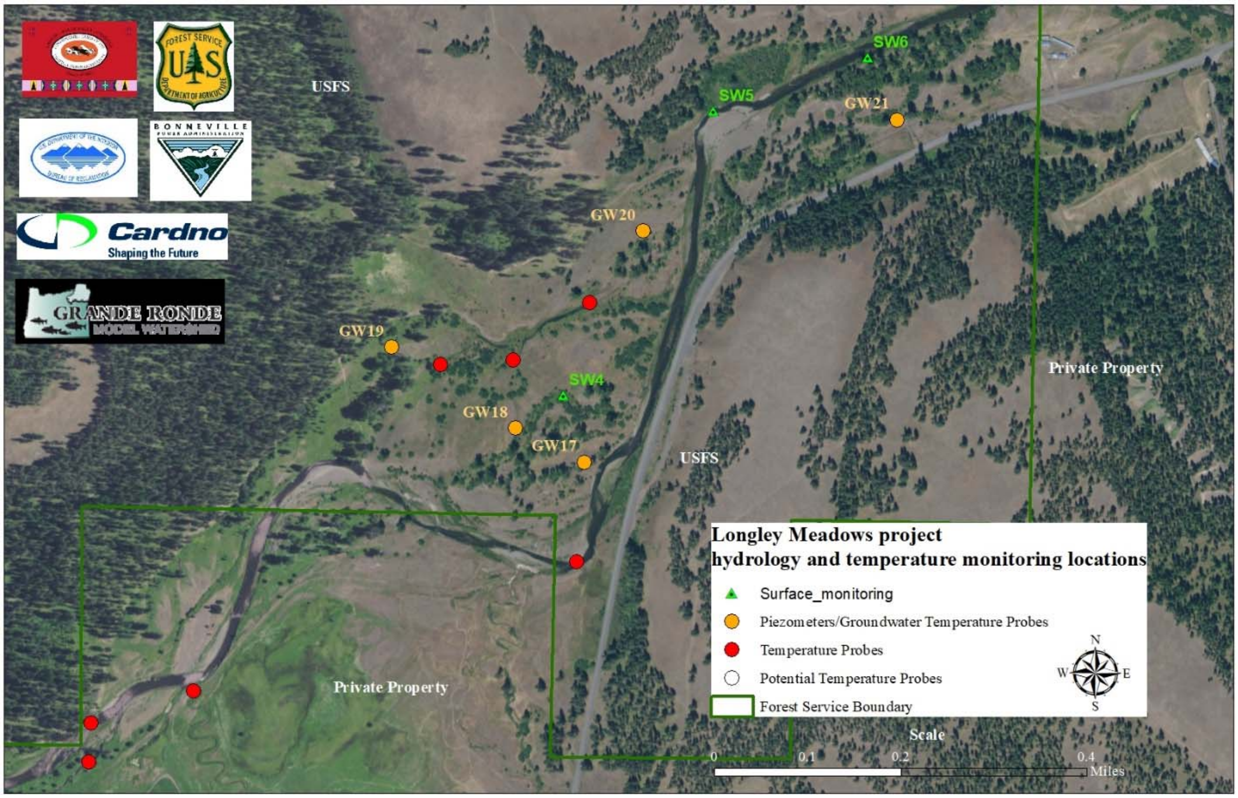
Monitoring Goals & Observations

The goal of monitoring is to evaluate the benefits to salmonid species listed on the Endangered Species act and restoring first foods according to the River Vision (Jones et al., 2008) that occur in the project areas. Objectives include: 1) monitoring changes in groundwater elevation groundwater temperature, 2) monitoring changes in stream temperature and elevation/discharge, and 3) monitoring the presence and quantity of thermal refuge and associated fish use. These efforts will be part of a larger monitoring and evaluation plan and fishery resource monitoring efforts.

Fish salvage efforts during the first year of the Bird Track Springs project have demonstrated the presence of juvenile rainbow trout/steelhead (*Oncorhynchus mykiss*), Pacific Lamprey (*Entosphenus tridentatus*) and Western Pearlshell freshwater mussels (*Margaritifera falcata*).

Despite the limited habitat and cold water refuge these species persist in a degraded environment. Restoration of hydrology and thermal heterogeneity at Bird Track Springs and Longley Meadows will increase the available habitat for threatened species on the Endangered Species act and First Foods for the Confederated Tribes of the Umatilla Indian Reservation.

FIGURE 23 MAP OF GROUNDWATER WELLS, PLANNED SURFACE WATER MONITORING LOCATIONS AND EXISTING AND PROPOSED TEMPERATURE PROBES FOR LONGLEY MEADOWS PROJECT AREA.



Results

Average daily flucutions in water level were ploted against real-time discharge data from the gauge located near Perry, Oregon, operated by the Oregon Water Resource Department (OWRD, 2019) for the period between November-2017 to December-2018. Additionally, monthly water levels were graphed with corresponding groundwater temperatures measured over the same period. In order to stay consistent, well data are reported in metric units of Celsius and meters. For the purposes of this initial evaluation and clarity, well data were grouped by proximity and project, although it should be noted there may be many ways to interpret the following data, which will be available through the CDMS website operated by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR, 2019).

Bird Track Springs

The following graphs are organized with Bird Track Springs project wells 1-11, followed by Longley Meadows project wells 17-21. There are data patterns in common with all well sites that will be mentioned briefly, followed by a more detailed discussion of smaller groups of wells at each project site. Peaks in the average daily discharge measured at the Perry stream gage site correspond to increases in water elevation at all well sites for both project sites. However, there is a difference in the range and amplitude following the peaks in discharge between individual wells and project sites. The duration of increased water level elevation (shallow) occurs between January and June with the lowest elevations (deep) being observed from July to December. Groundwater temperatures are inversely related to water elevations, with lowest temperatures occuring during the highest water elevations and the highest water temperatures occuring in the lowest water elevations.

The first three wells are in the upper portion of the Bird Track Springs project area and in the vicinity of side channel 1 & 2 (Figure 24). Groundwater well 2 (GW 2) has the highest elevation of this group and shows the greatest amplitude following peaks in discharge (Figure 24). The greatest range in temperature was also observed at GW 2 (6.7-14°C-Figure 25). The range of water elevation in groundwater wells 1-3 was 0.8-1 m.

GW wells 4-7 represent a north south transect with the new channel alignment wrapping around the transect (Figure 26). This may be a good area to focus on for a more intensive thermal refugia study proposed by BOR given the potential to alter the groundwater table and how the new channel alignment may influence the transect. GW 4 has the highest water elevation despite it being farther away from the existing channel (Figures 26 & 27). On another interesting note, the January-18 increase in discharge corresponded with increases in water elevations at GW wells 5-7, although dampened at GW 4 when compared to the other wells in this transect (Figure 26). This latter point could be a relationship of distance from the river. Water levels for wells 4-7 ranged from 0.7-2.6 m (Figure 26). GW 6 had the greatest range in temperature (6.6-13.3°C-Figure 27).

Wells 8-11 represent the downstream portion of the project area and have the most sustained high water elevation of the Bird Track Springs wells (Figure 28). Dewatering associated with construction in the summer and fall of 2018 did affect some readings at GW 10 & 11 and were removed from this analysis (Figure 28). However, wells 10 & 11 represent the only wells that are in a completed portion of the project area as of late summer 2018. Water levels for wells 8-11 ranged from 0.3 to 1.8 m (Figure 28). GW 8 had the greatest range in temperature (5.2-16°C-Figure 29).

FIGURE 24 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 1-3 AT BIRD TRACK SPRINGS AND DISCHARGE AT THE PERRY GAUGE, NOVEMBER-17 TO DECEMBER-18

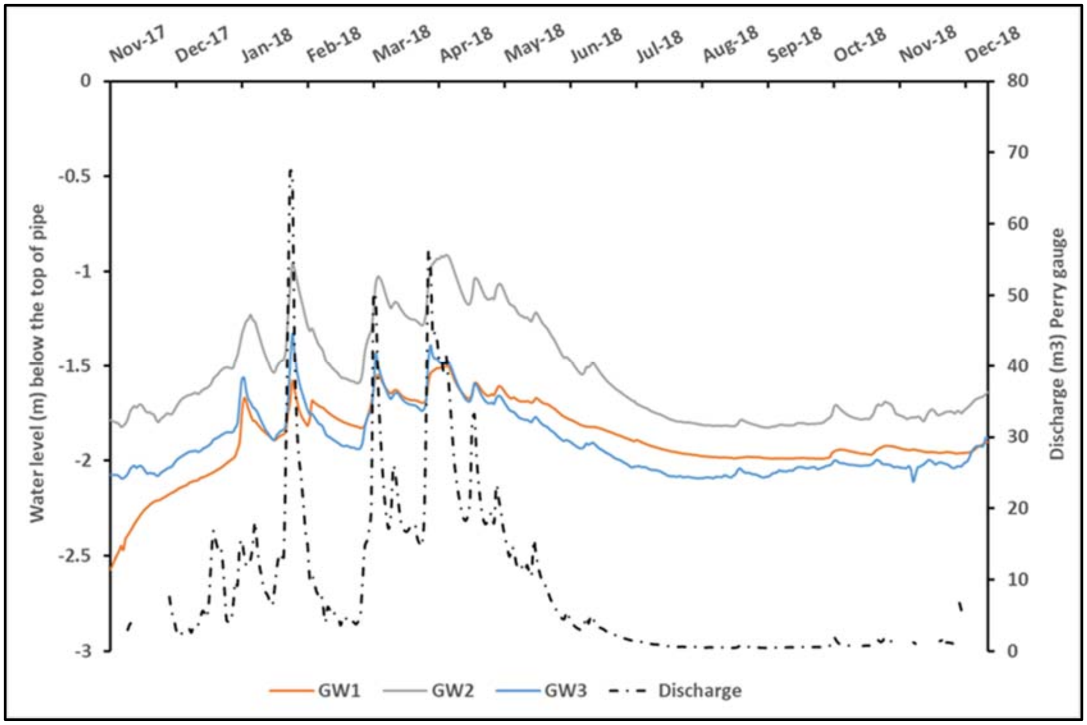


FIGURE 25 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 1-3 AT BIRD TRACK SPRINGS AND CORRESPONDING GROUNDWATER TEMPERATURES, NOVEMBER-17 TO DECEMBER-18. COLORS FOR GROUNDWATER TEMPERATURES AND LEVELS ARE MATCHING.

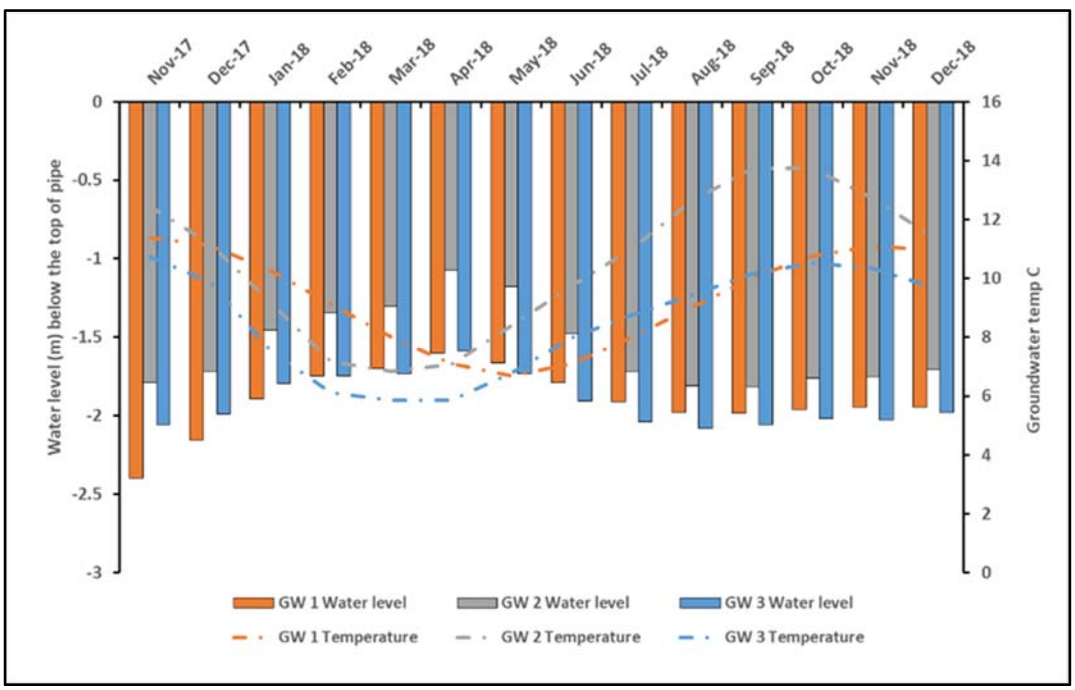


FIGURE 26 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 4-7 AT BIRD TRACK SPRINGS AND DISCHARGE AT THE PERRY GAUGE, NOVEMBER-17 TO DECEMBER-18

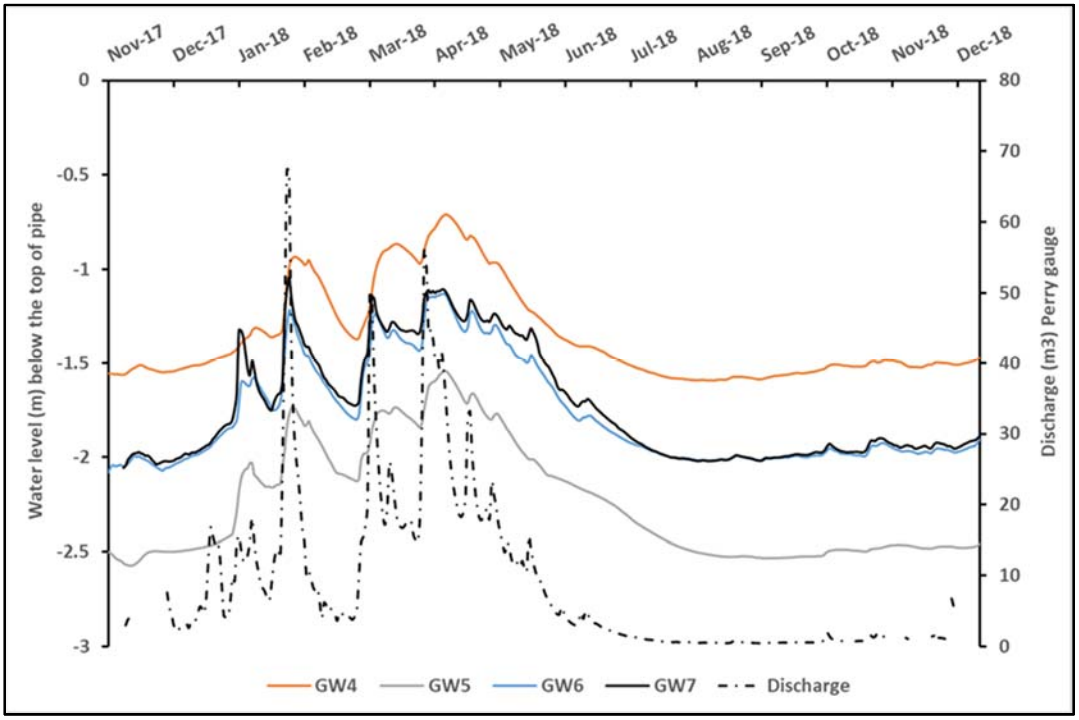


FIGURE 27 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 4-7 AT BIRD TRACK SPRINGS AND CORRESPONDING GROUNDWATER TEMPERATURES, NOVEMBER-17 TO DECEMBER-18. COLORS FOR GROUNDWATER TEMPERATURES AND LEVELS ARE MATCHING.

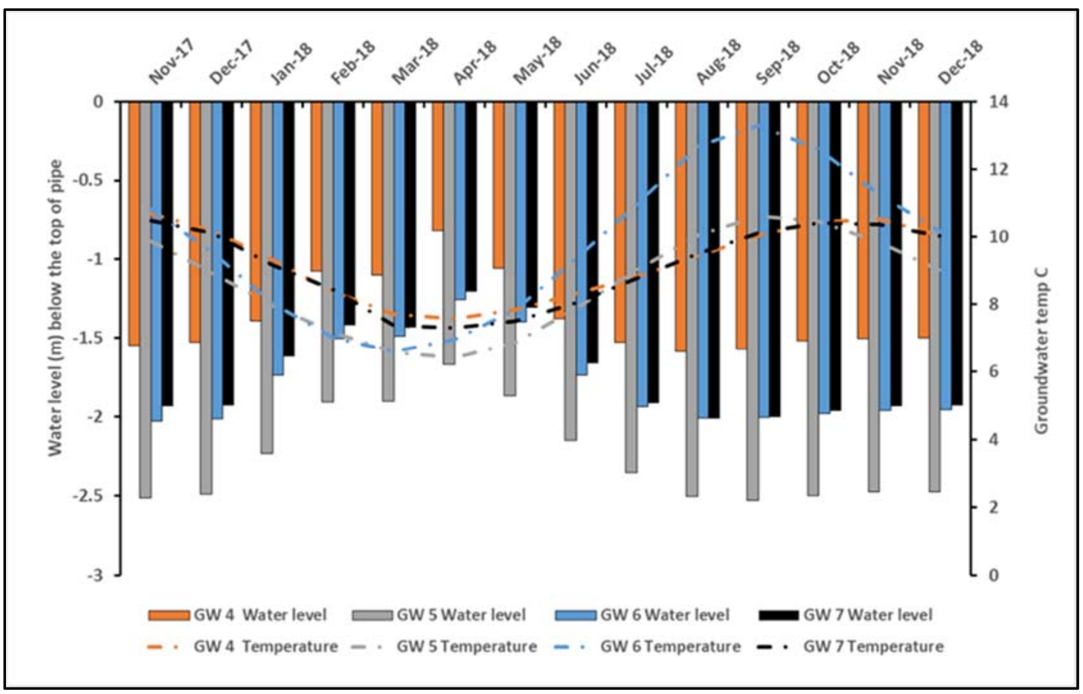


FIGURE 28 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 8-10 AT BIRD TRACK SPRINGS AND DISCHARGE AT THE PERRY GAUGE, NOVEMBER-17 TO DECEMBER-18

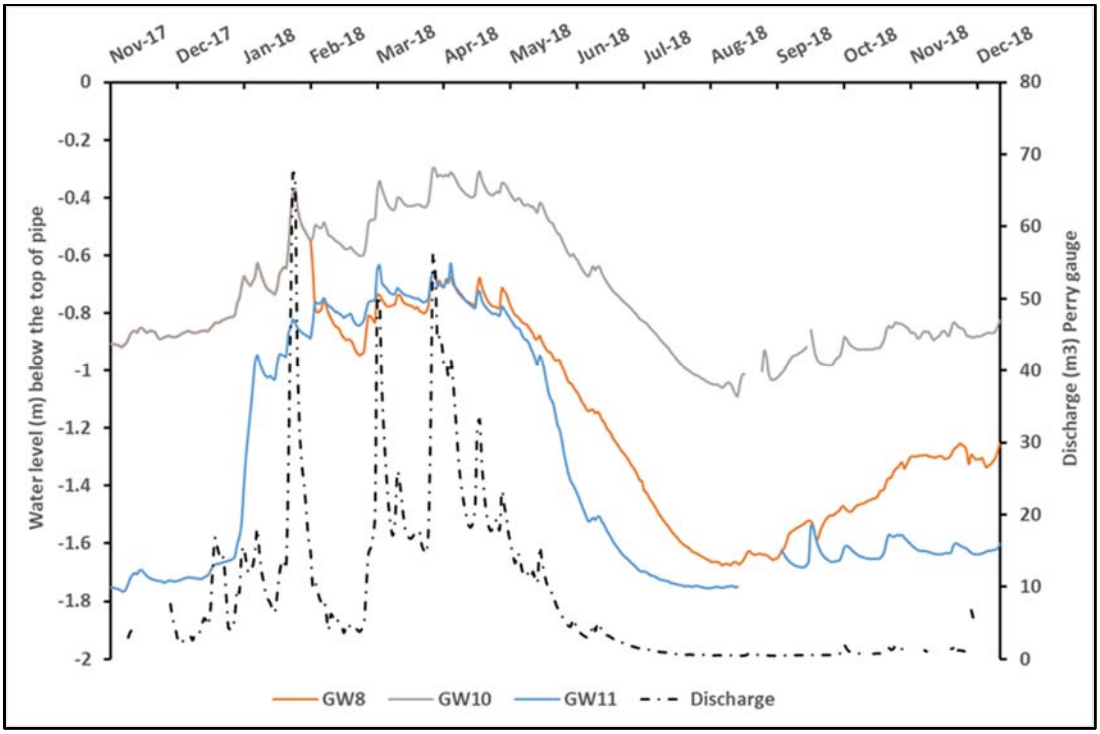


FIGURE 29 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 8-10 AT BIRD TRACK SPRINGS AND CORRESPONDING GROUNDWATER TEMPERATURES, NOVEMBER-17 TO DECEMBER-18. COLORS FOR GROUNDWATER TEMPERATURES AND LEVELS ARE MATCHING.

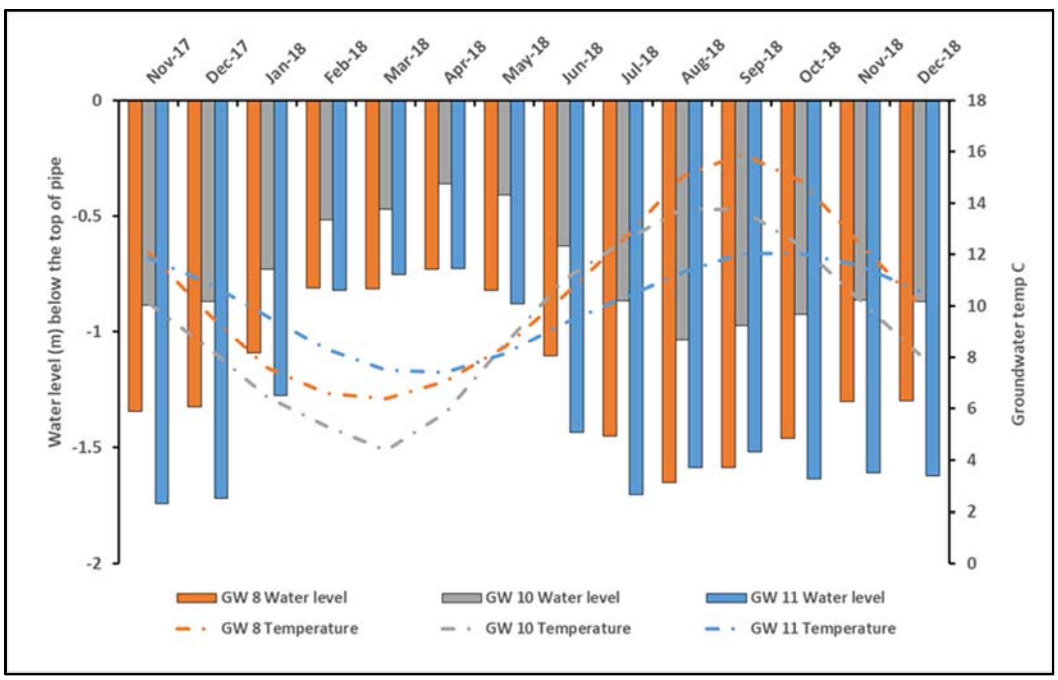


FIGURE 30 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 17-19 AT LONGLEY MEADOWS AND DISCHARGE AT THE PERRY GAUGE, NOVEMBER-17 TO DECEMBER-18

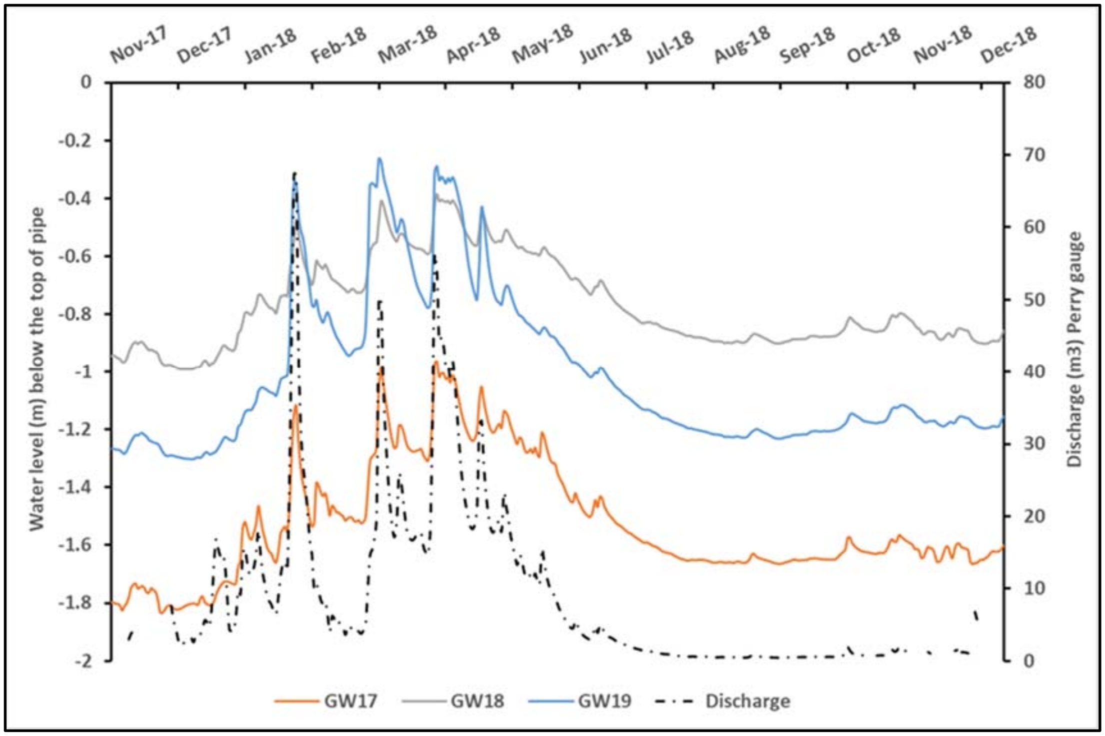


FIGURE 31 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 17-19 AT LONGLEY MEADOWS AND CORRESPONDING GROUNDWATER TEMPERATURES, NOVEMBER-17 TO DECEMBER-18. COLORS FOR GROUNDWATER TEMPERATURES AND LEVELS ARE MATCHING.

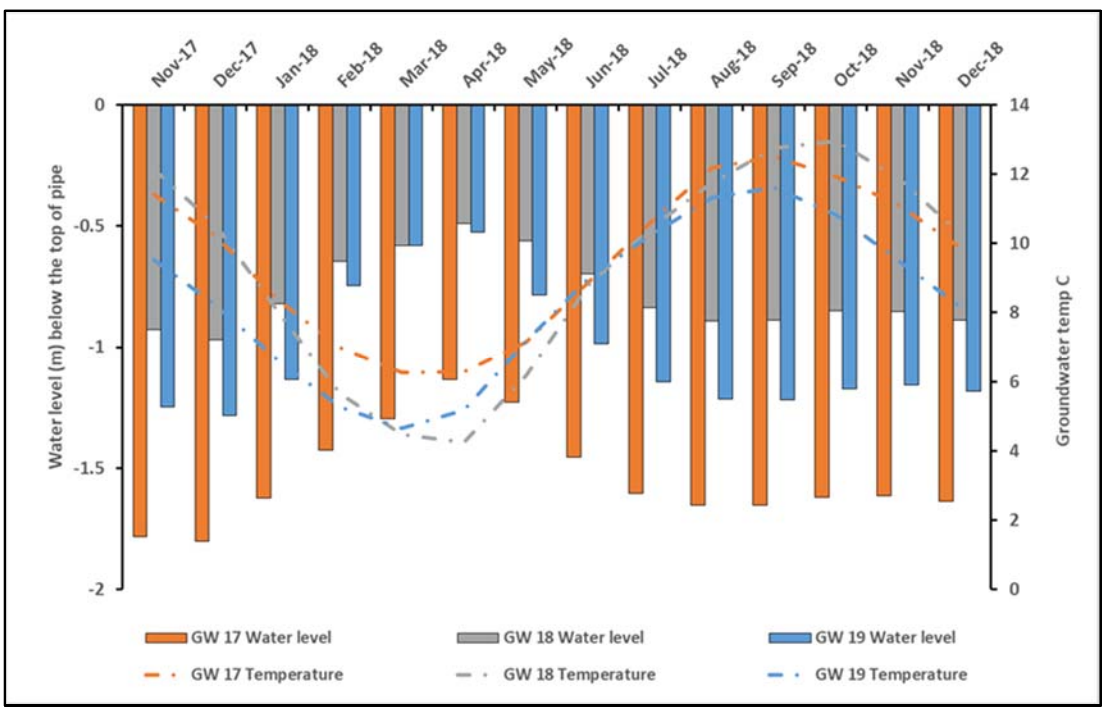


FIGURE 32 AVERAGE DAILY GROUND WATER LEVELS FOR WELLS 20-21 AT LONGLEY MEADOWS AND DISCHARGE AT THE PERRY GAUGE, NOVEMBER-17 TO DECEMBER-18

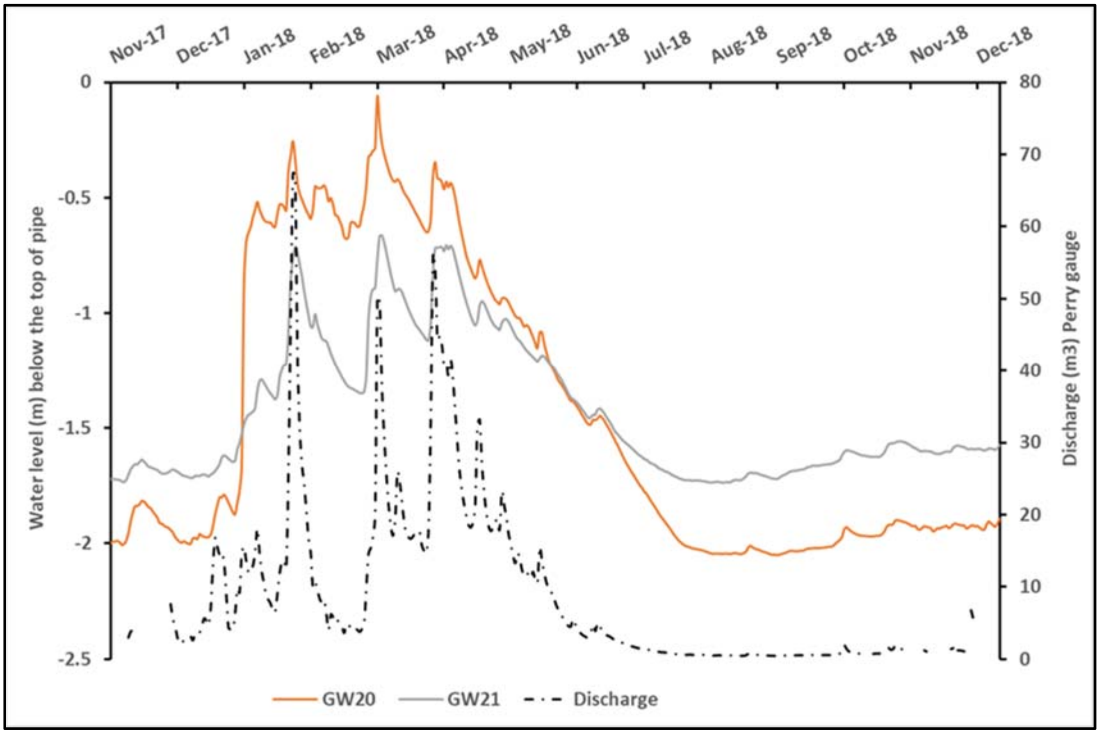
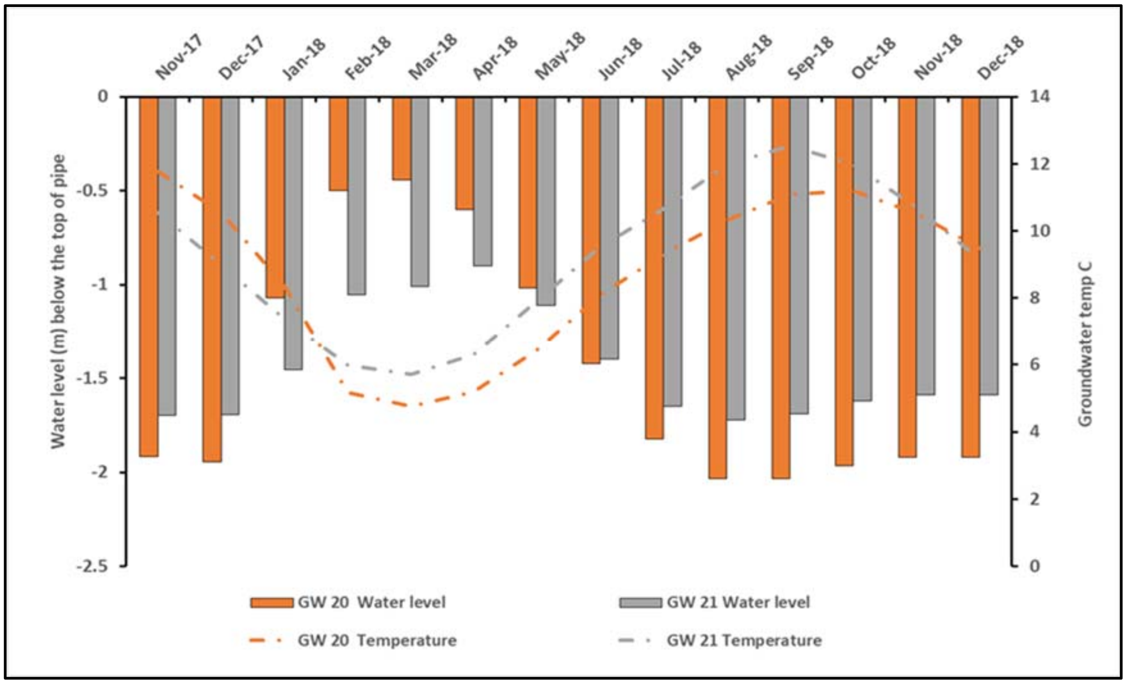


FIGURE 33 MONTHLY AVERAGE GROUNDWATER LEVELS FOR WELLS 20-21 AT LONGLEY MEADOWS AND CORRESPONDING GROUNDWATER TEMPERATURES, NOVEMBER-17 TO DECEMBER-18. COLORS FOR GROUNDWATER TEMPERATURES AND LEVELS ARE MATCHING.



Longley Meadows

Wells 17-18 represent the upstream portion of Longley Meadows Fish Habitat Enhancement Project, orientated in a northwest transect (Figure 30). Interestingly, the closest well to the river (GW 17) has the lowest water elevation (Figure 30). The range of water elevation for wells 17-19 was 0.3-1.8 m (Figure 30). GW 18 had the greatest range of temperature (4.3-13°C) and had the highest water level elevation (Figure 31).

The downstream portion of Longley meadows has two wells (20-21; Figure 32). Groundwater well 21 had a water elevation near the surface in March-18 (Figure 32). Wells 20 had the greatest water elevation range 0.06-2 m and a slightly larger temperature range (4.8-11.8°C).

Discussion

Understanding groundwater data is complicated by several variables such as geology and hydrology, and often monitoring wells may be inadequate in number or location. However, groundwater wells also provide measurable outcomes of how stream restoration projects can influence groundwater elevation and temperature. Increasing the amplitude and duration of cold water elevations and corresponding influence of temperature is a desired outcome of fish habitat restoration activities. Combined with monitoring surface water elevation, discharge and stream temperatures, we may be able to gather a more complete picture of how stream restoration techniques can influence thermal refuge in terms of volume and capacity for aquatic organisms.

Photo Point Monitoring

Photo points are an effective monitoring method used to document morphological changes on restoration projects. Representative photos are taken at intervals throughout each project, the number being determined by the project size and complexity. A master photo point notebook is used to align each subsequent year's photo with the image taken the previous year. Ideally, images are captured in the exact location as the earlier image, with landmarks (trees, hillsides, etc.) used to align the photo. Images are taken during midday for optimal lighting conditions with a Nikon D3100 camera and jpeg images are saved into a master photo point file. Aerial photos are also taken at varying intervals along several project locations.

During 2018 photo points were taken at 4 separate projects. A total of 76 photos were taken, and GPS coordinates were recorded at each photo point site. Each photo point site is marked with a green T-133 post or a 1 foot rebar stake. Photo points are located at sites along project reaches with good visibility of stream-bank vegetation and areas where morphological changes are likely to occur. Photo points are typically taken every year; however, some project photo points are taken every other year. 16 photo points were taken at CC 44 Southern Cross, McCoy Creek, Meadow Creek, and McCoy/Meadow Creek enclosures. Representative samples are provided in figure 27. Of particular note are stark differences in recruitment of riparian vegetation between enclosed and exposed areas in the McCoy Creek/Meadow Creek complex. This project is subject to intense browsing pressure from wild ungulates resulting in extremely limited release of riparian vegetation in untreated areas. This contrast is readily seen when comparing photo points of protected and unprotected areas of the project (Figures 34 and 35).

FIGURE 34 UNPROTECTED REACH ON MCCOY CREEK, JULY 2017.

FIGURE 35 PROTECTED ELK ENCLOSURE ON MCCOY CREEK AND RECENT BEAVER ACTIVITY, DECEMBER, 2018.

FIGURE 36 PRE AND POST PROJECT PHOTO POINTS.

Southern Cross Pre Project 2015

Southern Cross Post Project 2018

Southern Cross Pre Project 2015 | Southern Cross Post Project 2018

McCoy Meadows Enclosures 2011

McCoy Meadows Enclosures 2018

Rock Creek Pre Construction 2016

Rock Creek Construction 2018

2018 Water Temperature Monitoring

Water Temperature 2018 Summary

During 2018, sixty-two temperature probes were deployed within the Grande Ronde Basin, all recording at 1-hour intervals. A review of existing monitoring efforts and planned future project monitoring lead to a temporary reduction of twenty nine temperature loggers in 2018 within the Grande Ronde River and Catherine Creek.. The primary objectives of monitoring stream temperatures are to track changes at existing or proposed habitat restoration projects before and after work are completed.

Summary statistics were calculated for each probe that included the number of records when temperatures were at or exceeded the DEQ lethal limit of 25ºC, the number of records when temperatures were at or exceeded 20ºC, and when temperatures were within a range of 10ºC to 15.6ºC (the optimal growth for juvenile Chinook salmon – as cited by (McCullough, 1999). The number of days when the mean temperature was at or exceeded the DEQ standard of 17.8ºC was also calculated. Diurnal fluctuations in water temperature were also plotted.

Temperature probes deployed are Onset HOBO© Pendant 64k or TidbiTv2 loggers set to record at 1-hour intervals. Pendant 64K probes are housed in a metal tube that is anchored to the streambed and cabled to a post or tree on the bank, while Tidbit v2 probes can be installed in the aforementioned manner or housed in a PVC bushing and cap and installed with underwater epoxy (Isaak, Horan, & Wollrab, 2013). Probe locations have been consistent from 2009 to 2016 and when possible, the same probes are deployed at each site during this period. Each year prior to deployment probes are tested in an ice bath and verified with an NIST certified thermometer.

The following summary of water temperature data will be broken down into an overview of each sub-watershed area which includes: the Upper Grande Ronde River, Meadow Creek, McCoy Creek, Dark Canyon Creek, Rock Creek, and Catherine Creek. A summary of temperature metrics for the Upper Grande Ronde and sub-watersheds can be seen in Table 7.

Grande Ronde Watershed

Twenty five probes were deployed along the Upper Grande Ronde River from Hilgard State Park to the mine tailings upstream of Vey Meadows. During 2018 these probes recorded data for 120-330 days (between 1/1/2018 and 11/26/2018). There were 1,848 records removed from the dataset due to either a probe being out of the water or similar reported problems, leaving 151,154 hours logged for analysis. During 2018 there were 86 records at the lower site below Vey Meadows (GR4) for temperatures >= 25°C. There were 567 records of temperatures >= 20°C at the same site.

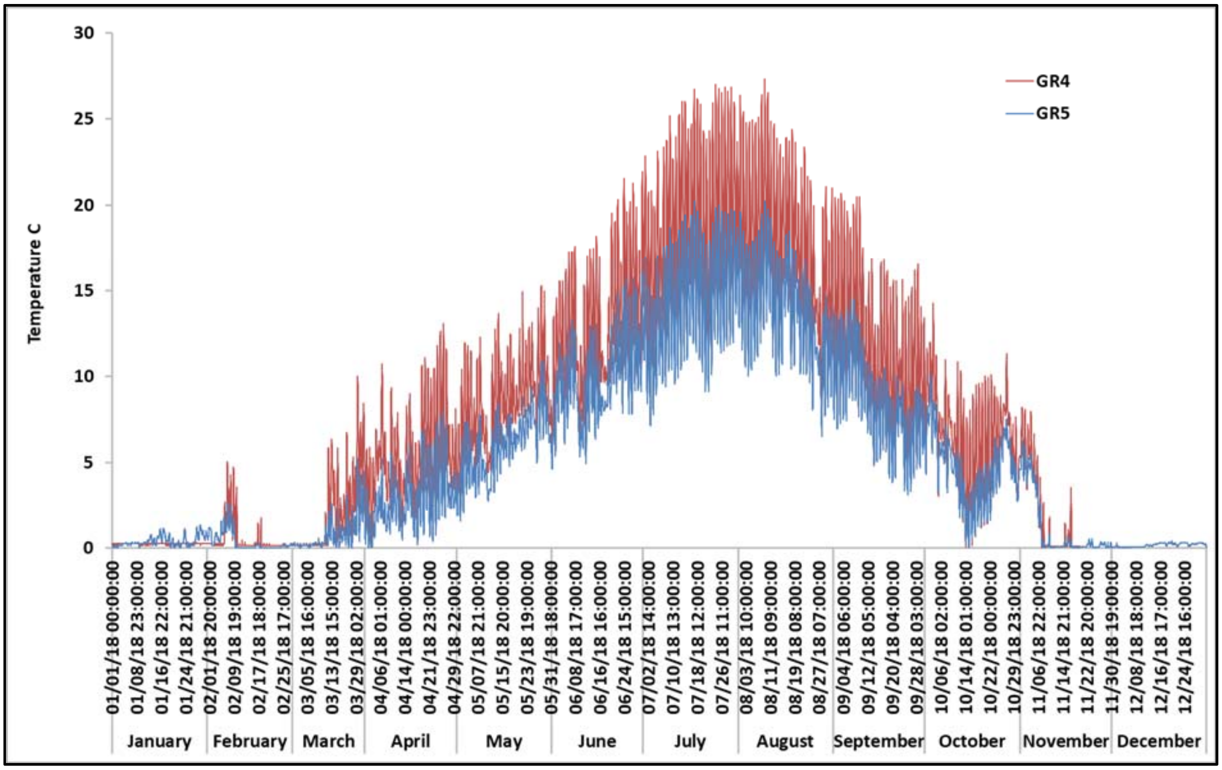
The probe below the Vey Ranch (GR4) had 34 hours of lethal limits recorded compared to 0 at the probe above the acclimation facility (GR5). There were 567 records of temperatures >=20°C at GR4 and 0 records at GR5. Approximately 19.7% of the deployment period at GR4 site was in 10-15.6 °C range compared to 15.8% at GR5, and GR4 had 38 days recorded with a mean >= 17.8 °C compared to 0 at GR5.

- Comparisons with other years show:
  1. GR4 had the highest number of lethal limit and temperature >=25ºC since 2009 (the previous high was in 2013). GR4 had the second lowest percent of time in the 10-

15.6ºC range (highest was in 2011). There were 38 days with a mean daily temperature >=17.8ºC. Since 2009 this is tied for the third highest number of days >=17.8 ºC in the range.

2. GR5 had 6 hours with temperatures >=20ºC in 2018 compared to 60 hours in 2015 and 0-14 in other years. The percentage of time in the 10-15.6ºC range was the lowest in 2018 than all other years since records began in 2009.

FIGURE 37 DIURNAL FLUCTUATIONS IN WATER TEMPERATURE ALONG THE GRANDE RONDE RIVER DURING 2018.



Bird Track Springs, Longley Meadows and Upper Grande Ronde River

CTUIR and Grande Ronde Basin partners are currently involved in restoring fish habitat on private and public land on the Grande Ronde River (RM 142-164.2). One of the primary objectives of fish habitat enhancement projects is to restore thermal heterogeneity to stream temperatures within project reaches. Traditionally, this has been monitored by installing temperature loggers upstream and downstream of a project reach and monitoring pre and post project construction to detect changes in stream temperatures related to restoration activities. Recently, CTUIR habitat personnel have used alternative methods to detect change, support project design and project locations. This has been done through a combination of; 1.) using existing temperature probes in the Grande Ronde River that bracketing project areas, 2.) documenting cold water habitat in the Grande Ronde River and off channel habitats with additional temperature probes, 3.) longitudinal temperature profiles, and 3.) deployment of novel loggers following completion of a restoration project.

Results will be presented in a format that includes: 7 day average daily maximum temperatures with 10-15.6°C optimum feeding range for juvenile Chinook and 18°C non-core rearing for juvenile salmonids (McCullough, 1999) (EPA, 2003) and a longitudinal temperature profile of stream temperature captured over a 4 hour period of time.

The results demonstrate:

- Important cold-water refugia in off-channel habitats in or near Bird Track Springs and Longley Meadows (Figures 39 & 41)
- There is a cooling trend through the upper Grande Ronde River from downstream of Vey Meadows to the confluence with Fly Creek (Figure 42)

FIGURE 38 MAP OF BIRD TRACK SPRINGS PROJECT AREA WITH EXISTING AND FUTURE PLANNED TEMPERATUREPROBES.

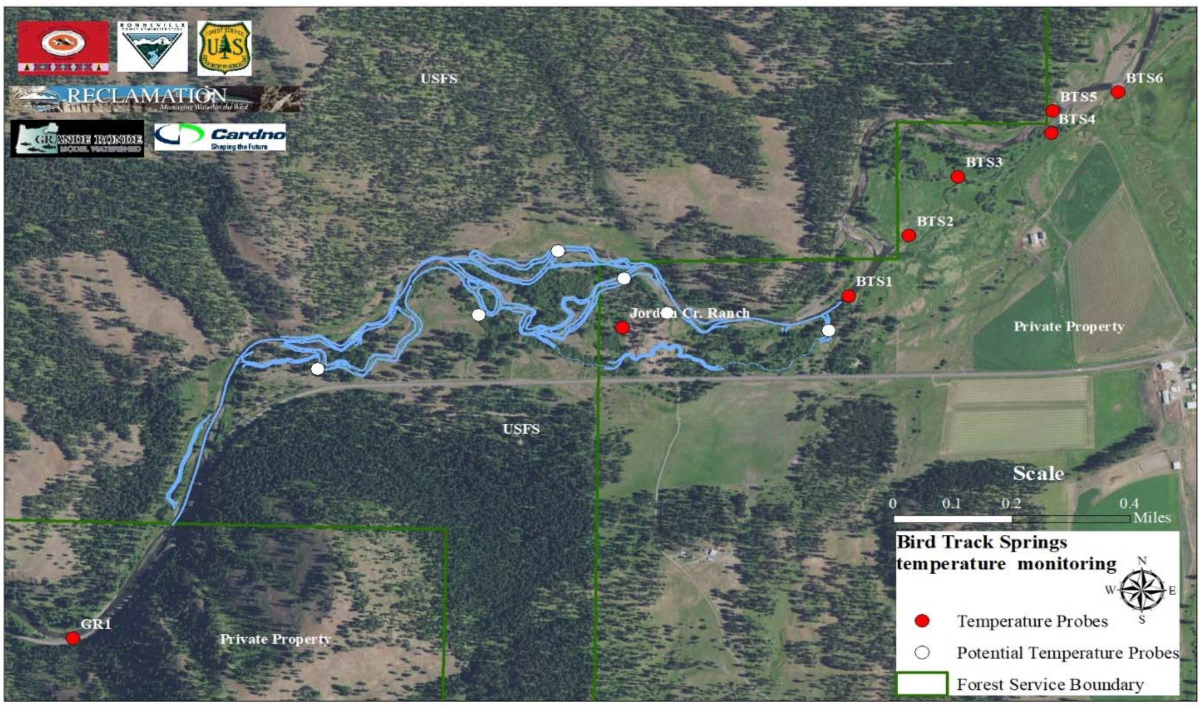


FIGURE 39 7 DAY AVERAGE DAILY MAXIMUM TEMPERATURES (7DADM) FOR BIRD TRACK SPRINGS PROJECT AREA, YEARS 2016 TO 2018. BLUE BOX IS THE OPTIMAL FEEDING TEMPERATURES FOR JUVENILE CHINOOK (10-15.6°C) AND RED DASHED LINE IS NON CORE REARING FOR SALMONIDS (18°C).

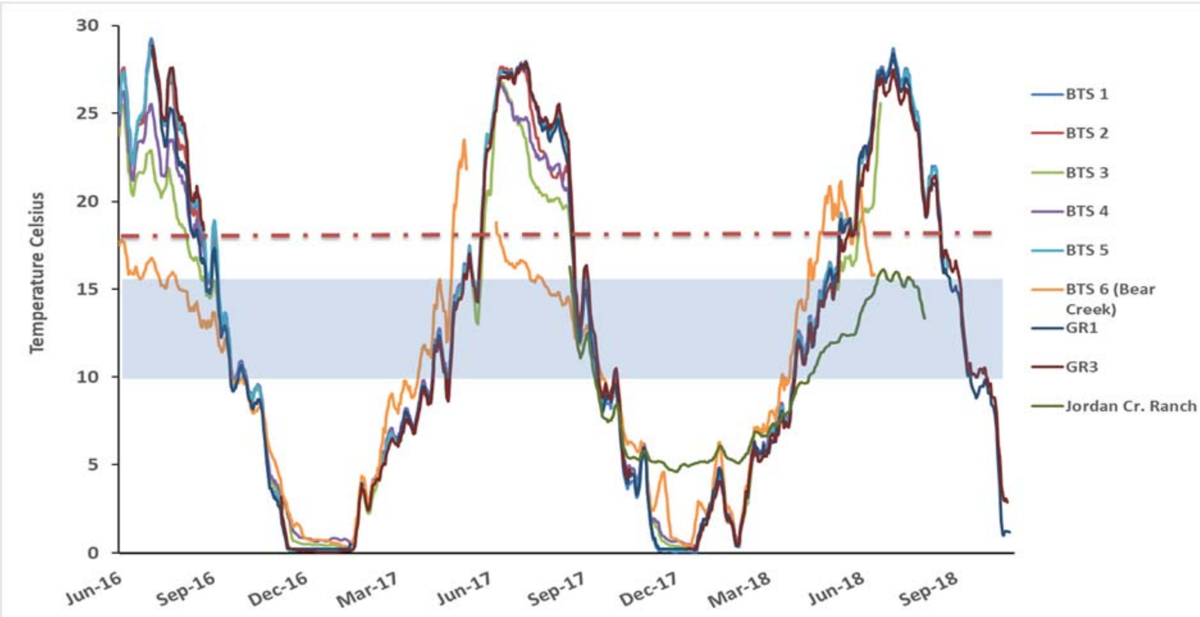


FIGURE 40 MAP OF LONGLEY MEADOWS PROJECT AREA WITH EXISTING AND FUTURE PLANNED TEMPERATURE PROBES.

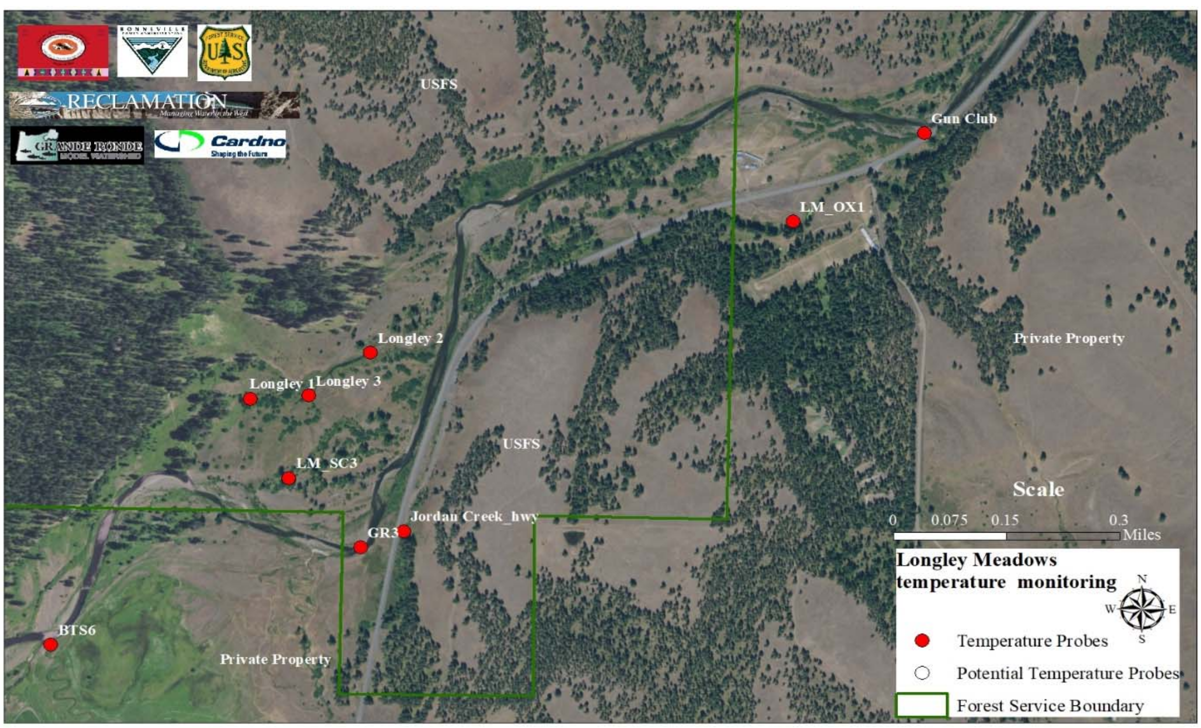


FIGURE 41 7 DAY AVERAGE DAILY MAXIMUM TEMPERATURES (7DADM) FOR LONGLEY MEADOWS PROJECT AREA, YEARS 2016 TO 2018. BLUE BOX IS THE OPTIMAL FEEDING TEMPERATURES FOR JUVENILE CHINOOK (10-15.6°C) AND RED DASHED LINE IS NON CORE REARING FOR SALMONIDS (18°C).

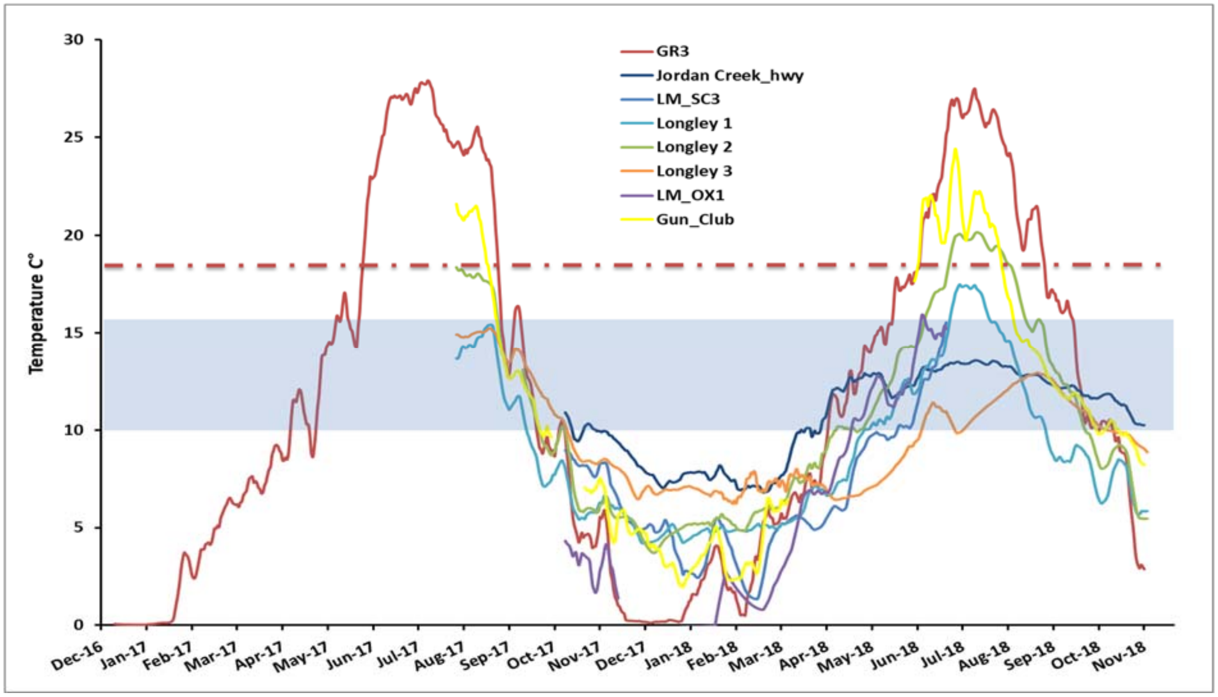
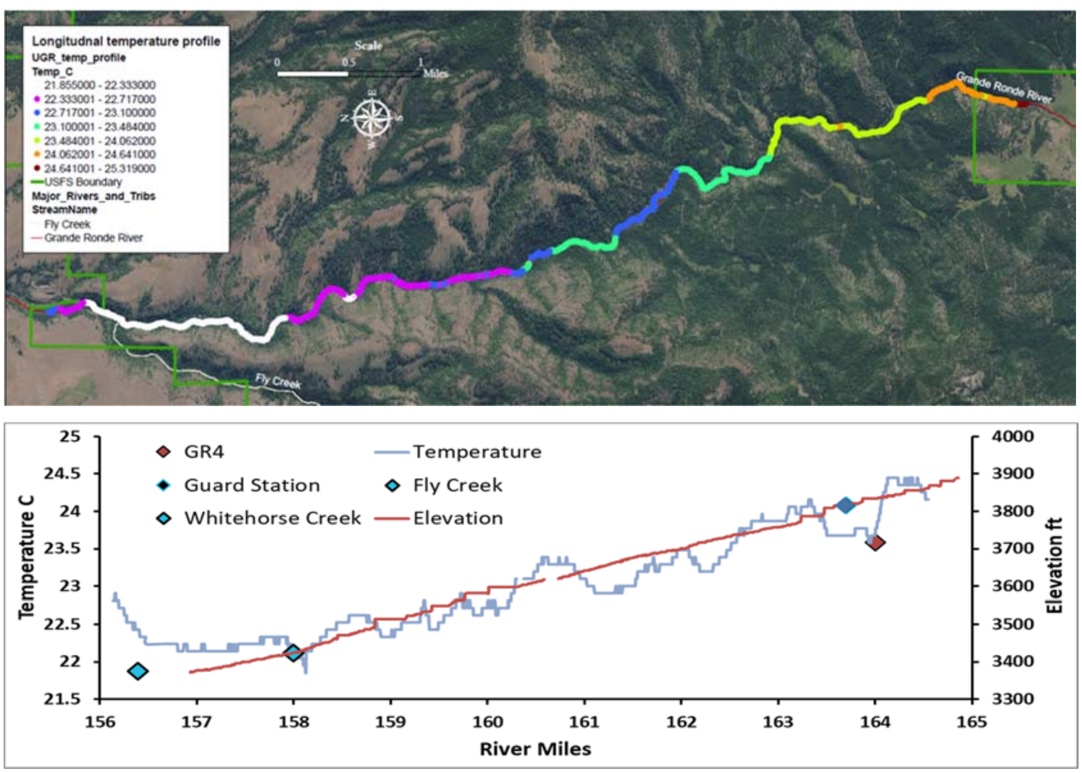


FIGURE 42 STREAM TEMPERATURE PROFILE OF UPPER GRANDE RONDE RIVER ON AUGUST 29, 2017 BETWEENRIVER MILES 156 AND 165 WHERE ADDITIONAL RESTORATION WORK WILL BEGIN IN 2019.



Additional information on cold water analysis in the Upper Grande Ronde River can be found in a technical report on the Pisces web page at:

https://www.cbfish.org/Document.mvc/DocumentViewer/P165232/cold-water-analysis-upper-grande-ronde-river.pdf

Meadow Creek Watershed

The CTUIR Fish Habitat Project had 11 probes deployed in 2018 within the Meadow Creek Watershed covering 4 streams – Battle Creek, Meadow Creek, McCoy Creek, and Dark Canyon Creek. The probe data was then grouped by project for this report. The projects were:

- Dark Canyon (landowner Joe Cunha), with 2 probes – DC1 and 2 at river miles 0.06 and 2.0 respectively.
- McCoy Meadows Ranch (landowner Mark and Lorna Tipperman) Meadow Creek with 2 probes – MEADOW1 and 2 on the main-stem at river mile 2.9 and 1.5 respectively.

Dark Canyon Creek

Summary of CTUIR stream monitoring within the lower 2 miles of 2009 to 2018

In late July 2010, fish habitat enhancements were implemented by CTUIR along 1.9 miles of Dark Canyon Creek and 1 mile of Meadow Creek within the boundaries of the Cunha Ranch. The project area is located near Starkey, Oregon in the Upper Grande Ronde Subbasin. The project legal description is Township 3 South, Range 35 East, portions of Sections 24, 25, and 36, Willamette Meridian, Union County Tax Lot 500. Approximately 150 pieces of large wood were added to Dark Canyon Creek and Meadow Creek in existing pools, or placed in a manner to create pool habitat and provide in-stream habitat complexity. The objective of the large wood additions was to contribute to floodplain formation and stability by increasing roughness, slowing water velocities, and trapping sediment. Furthermore, large wood was used in order to increase pool habitat quality and quantity and to provide thermal and predatory refuge for aquatic species including the aforementioned ESA listed fish species.

In 2012 CTUIR, in cooperation with the landowner and NRCS, developed four off-channel springs for livestock watering, and constructed 3.6 miles of pasture fence. Additional riparian corridor fencing was completed in 2017 along Dark Canyon Creek and Meadow Creek to exclude livestock and protect riparian habitat. The 3,000 acre ranch, along with 2 miles of Dark Canyon Creek and 1 mile of Meadow Creek was protected under a permanent conservation easement in 2015 under the CTUIR-BPA Accord in cooperation with Blue Mountain Land Trust.

Since August 2009, the CTUIR Grande Ronde Fish Habitat program has monitored water temperature at two locations within Dark Canyon Creek – an upper probe site (DC2) at river mile 2.0 and a lower probe site (DC1) at river mile 0.06. Temperatures at these two sites with the exception of 2009 were monitored from April to October each year and starting in 2016 temperatures will be monitored throughout the year.

Diurnal fluctuations in water temperature are less in 2018 than those recorded in 2010, (pre-project, during construction and immediately following construction) at the lower probe site (river mile 0.06), but are similar at the upper probe site (river mile 1.9). This may indicate a possible cooling effect through the project area seen in 2018 that is not present in 2010 (Figures 43 & 44).

A possible cooling trend is also evident when exploring summary values for stream temperatures in Table 6. In 2010 the 308 records of temperatures >=20°C were recorded with similar distribution of values at both upper and lower sites with 52.6% of those records recorded at the upper site compared to 47.4% at the lower. This similarity is not present by 2018 where the upper site records 100 % of the 290 >=20°C records.

From the temperature data collected since 2009, it is evident that water entering the project area has been increasing in the number of >=20°C records (see Figure 45). However, it is beyond the scope of this monitoring effort and these data to explain why this is occurring. The scope of inference for these data is restricted to the project area (the lower 1.9 miles of Dark Canyon Creek), but within that scope it can be demonstrated that following fish habitat restoration actions there is a cooling trend through the project area.

FIGURE 43 PLOT OF DIURNAL FLUCTUATIONS IN WATER TEMPERATURE AT THE UPPER PROBE SITE (RIVER MILE 1.9) FOR 2010 AND 2018. ALTHOUGH THERE IS A SLIGHT SKEW IN TIMING OF PEAK TEMPERATURES THE DIURNAL FLUCTUATION ARE VERY SIMILAR FOR THESE TWO YEARS.

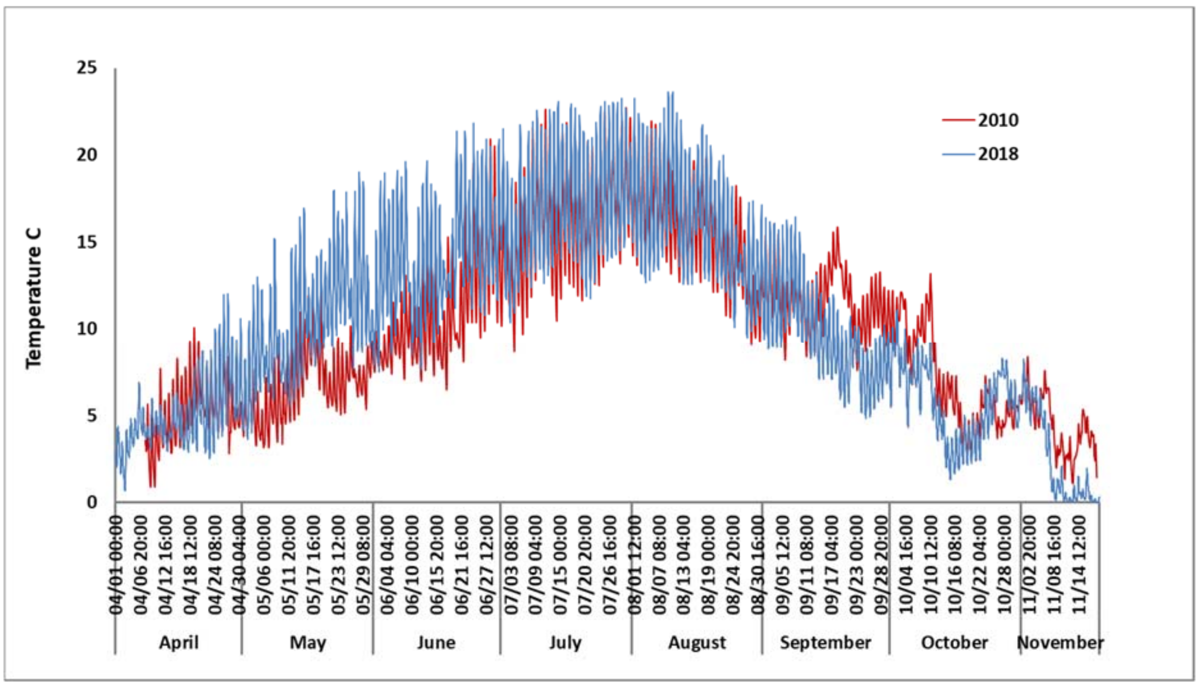


FIGURE 44 PLOT OF THE DIURNAL FLUCTUATION IN WATER TEMPERATURE AT THE LOWER PROJECT SITE (RIVER MILE 0.06) FOR 2010 AND 2018. PLOT SHOWS THE REDUCTION IN DIURNAL FLUCTUATIONS OF WATER TEMPERATURE RECORDED AT THIS SITE IN 2018 COMPARED TO THE PRE-PROJECT/ DATA OF 2010.

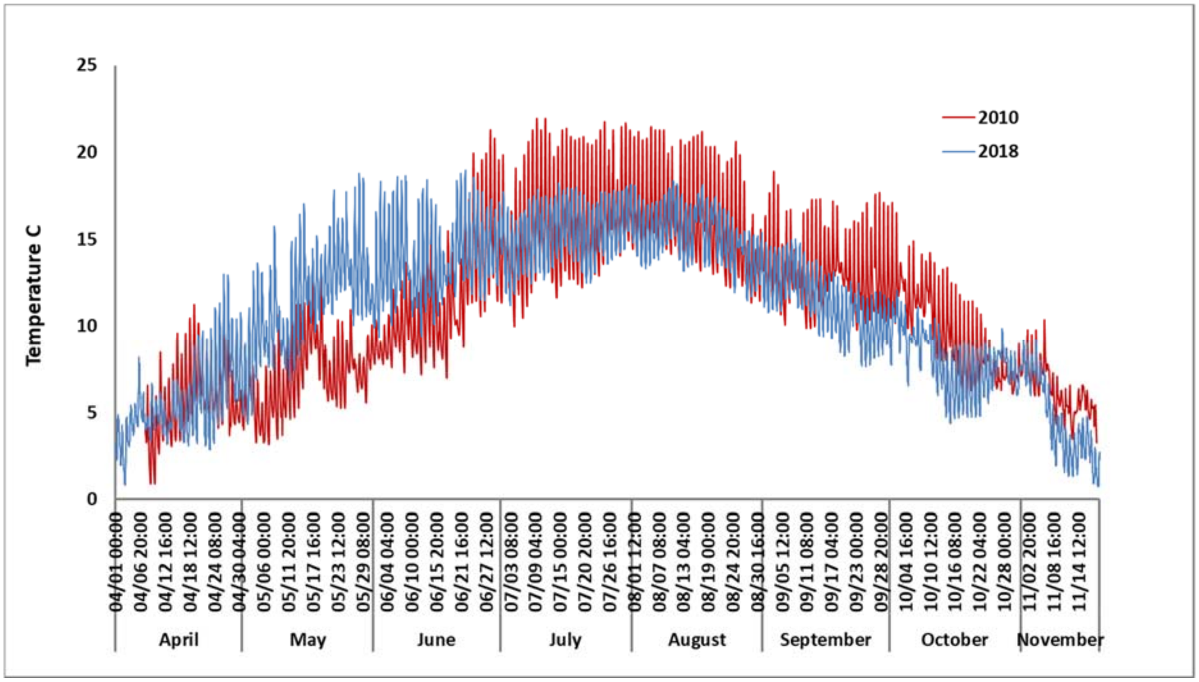


TABLE 6 SUMMARY TABLE FOR WATER TEMPERATURE PROBES AT TWO SITES ALONG DARK CANYON CREEK FROM 2010 TO 2018. SHADED AREA IS THE LOWER PROJECT SITE.

Stream	Location Name	River mile	Year	# of Days Deployed	# of Hours for Analysis	Max Temperature (° C)	Hours >=25 ° C	Hours >=20 ° C	Hrs. at 10 - 15.6 ° C	% at 10 - 15.6 ° C	Mean daily >=17.8 ° C (# days)	% of deployment when Mean daily >=17.8 ° C
Dark Canyon Creek	DC1	0.06	2009	106	2544	23.1	0	93	874	34.4	1	0.9
Dark Canyon Creek	DC1	0.06	2010	226	5398	22	0	146	2156	39.9	0	0.0
Dark Canyon Creek	DC1	0.06	2011	145	3480	20.9	0	36	2120	60.9	0	0.0
Dark Canyon Creek	DC1	0.06	2012	191	4536	24.2	0	75	2204	48.6	2	1.0
Dark Canyon Creek	DC1	0.06	2013	215	5161	24.4	0	154	1988	38.5	5	2.3
Dark Canyon Creek	DC1	0.06	2014	217	5184	20.3	0	11	2345	45.2	3	1.4
Dark Canyon Creek	DC1	0.06	2015	166	3984	20.8	0	22	1969	49.4	3	1.8
Dark Canyon Creek	DC1	0.06	2016	276	6612	18.4	0	0	3033	45.9	0	0.0
Dark Canyon Creek	DC1	0.06	2017	364	8698	21.8	0	0	1916	22.0	1	0.3
Dark Canyon Creek	DC1	0.06	2018	322	7728	19.0	0	0	2542	32.9	0	0.0
Dark Canyon Creek	DC2	1.9	2009	106	2544	22.3	0	43	789	31.0	2	1.9
Dark Canyon Creek	DC2	1.9	2010	226	5399	22.7	0	162	1761	32.6	6	2.7
Dark Canyon Creek	DC2	1.9	2011	145	3480	22.0	0	85	1618	46.5	4	2.8
Dark Canyon Creek	DC2	1.9	2012	191	4535	23.8	0	227	1702	37.5	20	10.5
Dark Canyon Creek	DC2	1.9	2013	215	5161	24.9	0	257	1632	31.6	17	7.9
Dark Canyon Creek	DC2	1.9	2014	217	5184	24.7	0	307	1704	32.9	29	13.4
Dark Canyon Creek	DC2	1.9	2015	166	3984	24.4	0	180	1460	36.6	14	8.4
Dark Canyon Creek	DC2	1.9	2016	276	6611	23.4	0	175	2087	31.6	11	4.0
Dark Canyon Creek	DC2	2.0	2017	364	8699	24.5	0	380	1459	16.8	27	7.4
Dark Canyon Creek	DC2	2.0	2018	322	7728	23.6	0	290	1672	21.6	19	5.9

FIGURE 45 PLOT OF THE NUMBER OF WATER TEMPERATURES >=20°C ON DARK CANYON CREEK. PLOTTED TREND LINE DEMONSTRATES THAT OVERALL WARMER WATERS ARE ENTERING THE PROJECT AREA EACH YEAR (RED BARS), BUT THIS WATER IS COOLING AS IT MOVES THROUGH THE PROJECT AREA TO THE LOWER PROBE SITE (BLUE BARS & TRENDLINE).

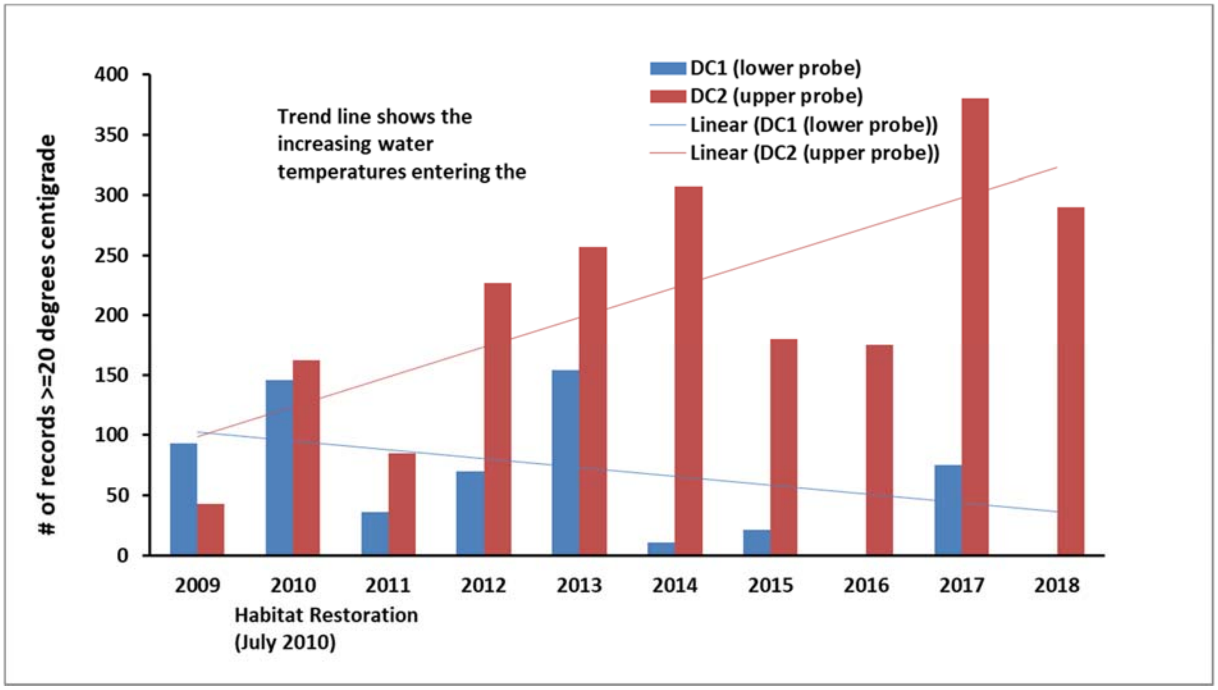
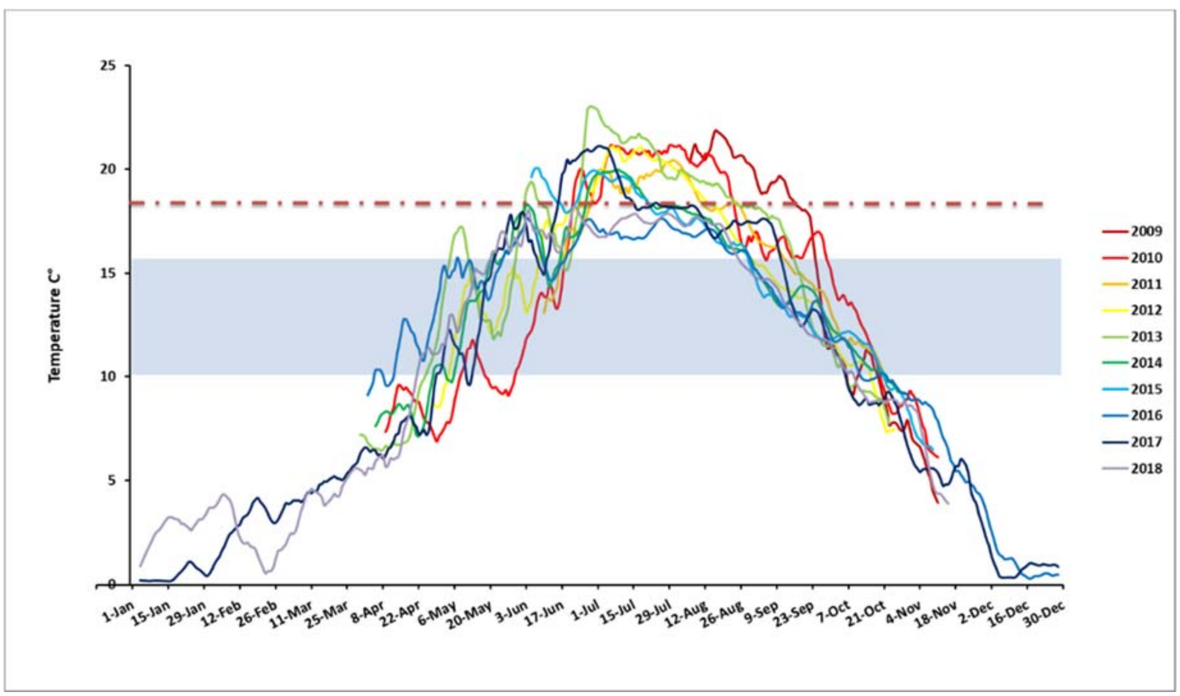


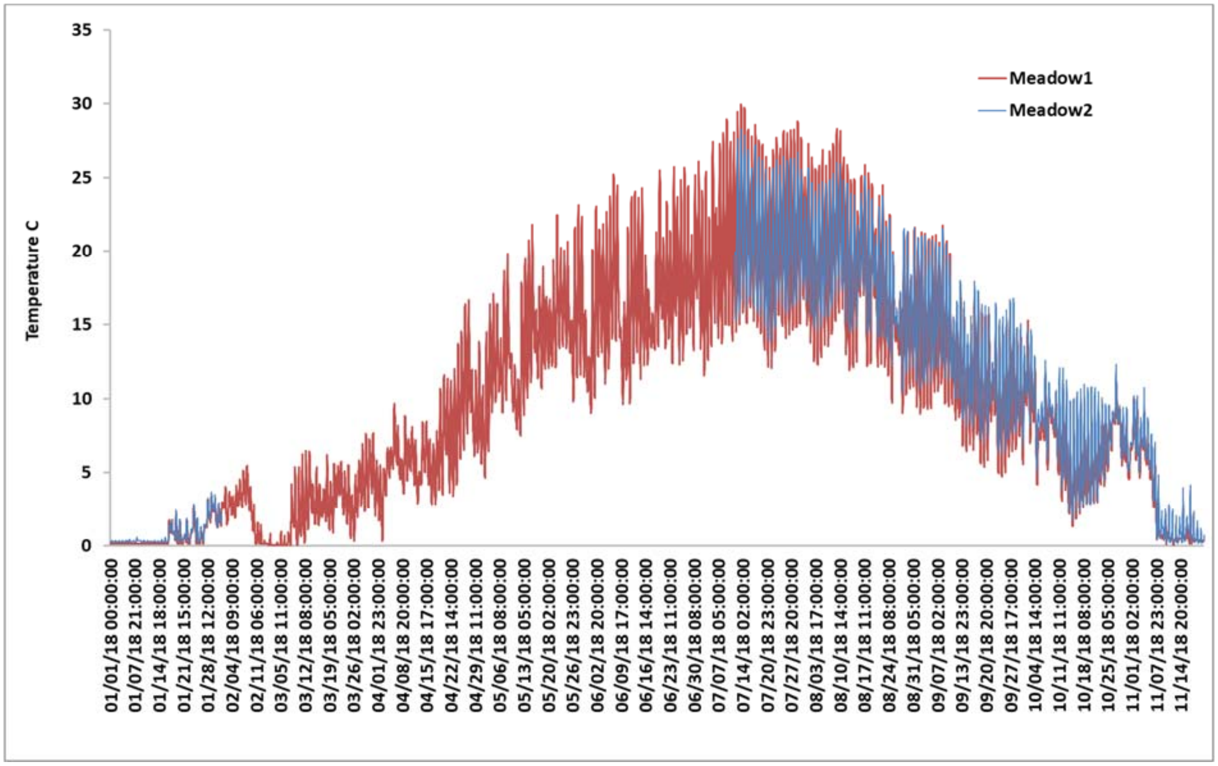
FIGURE 46 7 DAY AVERAGE DAILY MAXIMUM TEMPERATURES (7DADM) FOR DARK CANYON (LOWER), YEARS 2009 TO 2018. COLOR GRADIENT INDICATES PRE-PROJECT (2009-2010; RED) TO POST PROJECT CONDITIONS (2017-2018; BLUE). BLUE BOX IS IDEAL FEEDING TEMPERATURES FOR JUVENILE CHINOOK (10-15.6°C) AND RED DASHED LINE IS UPPER LIMIT FOR JUVENILE REARING (18°C).



Meadow Creek

The probe at river mile 2.9 (MEADOW1) was deployed for 325 days between 1/1/2018 and 11/21/2018 and the probe at river mile 1.5 (MEADOW2) was deployed for 325 days between 1/1/2018 and 11/21/2018. They recorded a total 14,529 hours of data for the analysis.

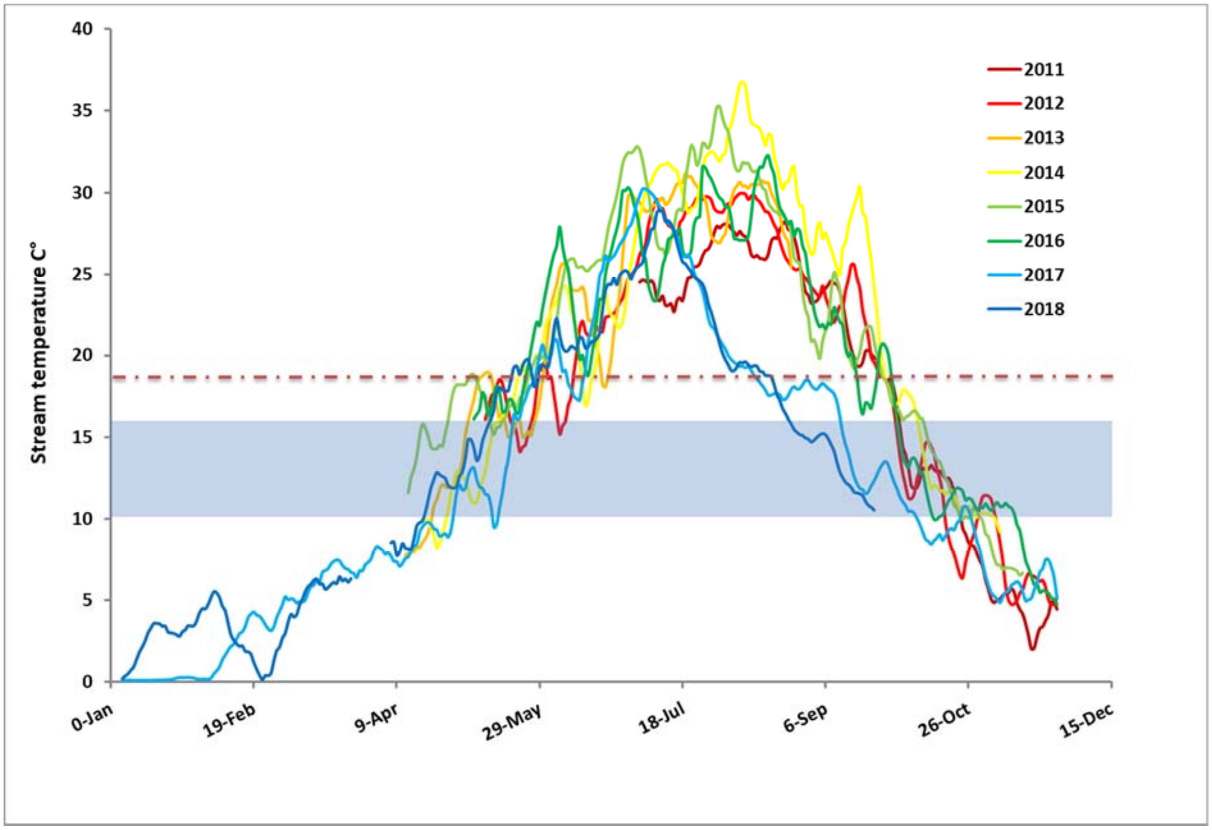
FIGURE 47 DIURNAL FLUCTUATIONS IN WATER TEMPERATURE ALONG MEADOW CREEK DURING 2018.



Rock Creek

Beginning in 2013, a multi-phased restoration effort was started on Rock Creek, and tributaries of Rock Creek by CTUIR with the final phase completed in 2018. One of the primary objectives is to reduce summer peak temperatures for all life stages of ESA-listed salmonids. Five temperature probes were installed on Rock Creek and Graves Creek, starting in 2011. The most downstream probe (Rock 1), at river mile 0.2 is plotted with 7 day average daily maximum (7DADM) temperatures for 2011 to 2018. 2011 and 2012 were pre-project, while 2013-15 and 2018 were implementation year. There was a pronounced decrease in the 7DADM in 2017 and 2018 (Figure 48). Future monitoring will tease out if these years were anomalies or a trend towards cooling water at the downstream end of restoration work.

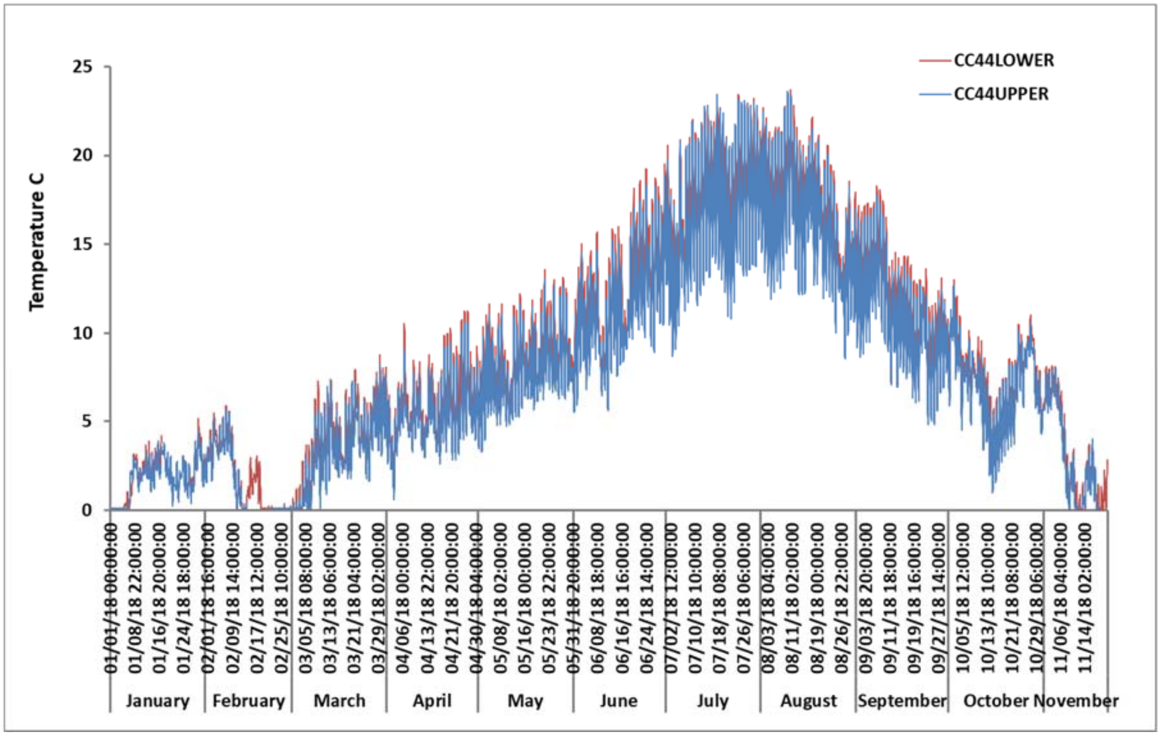
FIGURE 48 7 DAY AVERAGE DAILY MAXIMUM TEMPERATURES (7DADM) FOR ROCK CREEK (LOWER), YEARS 2011 TO 2018. COLOR GRADIENT INDICATES PRE-PROJECT (2011-2012; RED) TO POST PROJECT CONDITIONS (2017-2018; BLUE). BLUE BOX IS IDEAL FEEDING TEMPERATURES FOR JUVENILE CHINOOK (10-15.6°C) AND RED DASHED LINE IS UPPER LIMIT FOR JUVENILE REARING (18°C).



Catherine Creek 44

To monitor water quality (temperature) within the Catherine Creek River Mile 44 (CC44) Project area, CTUIR deployed 20 Hobo Pendant temperature probes within the boundaries of several property owners. The probes were deployed from 1/1/2018 to 11/19/2018 with a range of 102-325 days and a total of 109,123 hours recorded for analysis. There was only 1 lethal hour recorded in 2018.

FIGURE 49 DIURNAL FLUCTUATIONS IN WATER TEMPERATURE ON CATHERINE CREEK (CC44) DURING 2018.



In 2017, CTUIR and basin partners completed a fish habitat enhancement project on Catherine Creek near river mile 44. The design and floodplain connectivity allowed for a great opportunity to restore thermal diversity within the project reach. A network of temperature loggers were deployed following the completion of the project to monitor main-stem and off channel habitats for stream temperature changes. The following results demonstrate the benefit of these off-channel habitats when compared to the main-stem for reducing summer peak temperatures and increasing winter low temperatures, both benefiting ESA-listed salmonids in Catherine Creek basin.

FIGURE 50 MAP OF SELECTED TEMPERATURE LOGGERS MONITORED ON CATHERINE CREEK FISH HABITAT ENHANCEMENT PROJECT 2016-2018.

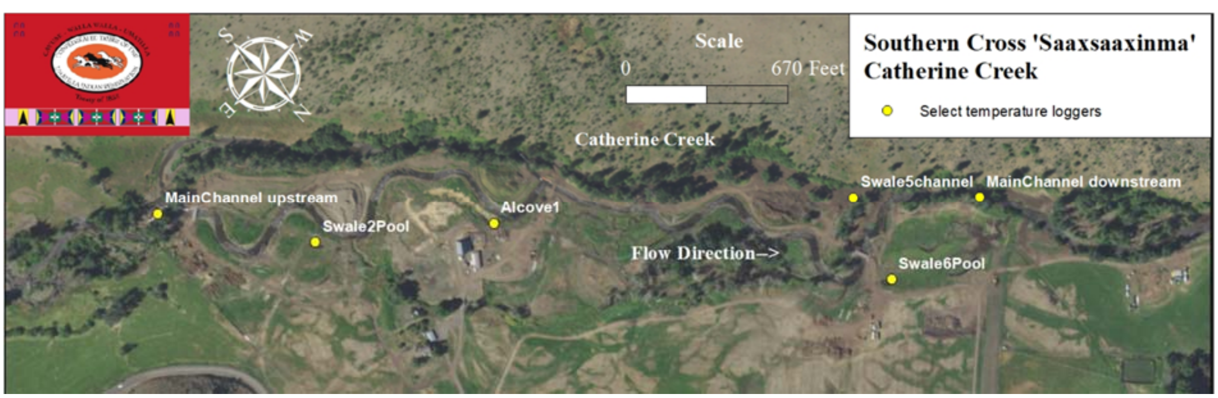
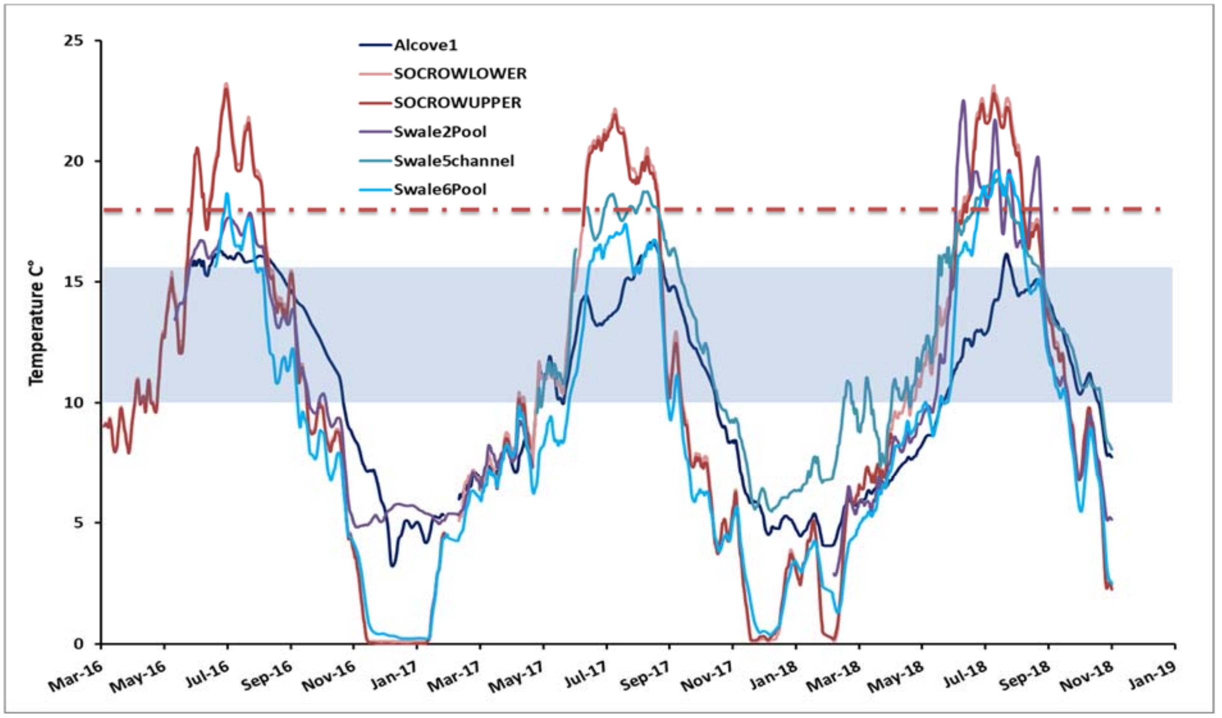


FIGURE 51 7 DAY AVERAGE DAILY MAXIMUM STREAM TEMPERATURE IN CATHERINE CREEK MAINSTEM (RED) AND FLOODPLAIN FEATURES (BLUE) IN TWO YEARS FOLLOWING PROJECT COMPLETION. NOTE STREAM TEMPERATURE ATTENUATION IN FLOODPLAIN FEATURES DURING SUMMER PEAK TEMPERATURES AND WARMER TEMPERATURES DURING WINTER. . BLUE BOX IS OPTIMUM FEEDING TEMPERATURES FOR JUVENILE CHINOOK (10-15.6°C) AND RED DASHED LINE IS UPPER LIMIT FOR CORE JUVENILE REARING.



Additional temperature and dissolved oxygen monitoring of floodplain dynamics, including lagging and buffering can be found at:

https://www.cbfish.org/Document.mvc/DocumentViewer/P165231/southern-cross-temperature-analysis.pdf

https://www.cbfish.org/Document.mvc/DocumentViewer/P165233/dissolved-oxygen-analysis.pdf

TABLE 7 WATER TEMPERATURE STATISTICS FOR 62 SITES IN THE GRANDE RONDE AND CATHERINE CREEK WATERSHEDS IN 2018.

Stream	Location Name	River mile	Year	Start date	End date	# of Days Deployed	# Hours in Deployment Period	# of Hours for Analysis	Max Temperature (° C)	Hours >=25 ° C	Hours >=20 ° C	Hrs. at 10 - 15.6 ° C	% at 10 - 15.6 ° C	Mean daily >=17.8 ° C (# days)
Battle Creek	BATTLE1	0.0	2018	1/1/2018	5/7/2018	126	3024	3026	11.6	0	0	35	1.2	0.0
Catherine Creek	CC37UPPER	37.0	2018	1/1/2018	4/25/2018	114	2746	2735	10.7	0	0	18	0.7	0.0
Catherine Creek	CC44LOWER	40.0	2018	1/1/2018	11/21/2018	325	7792	7608	23.7	0	381	1601	21.0	32.0
Catherine Creek	CC44RICKER1	38.0	2018	1/1/2018	4/24/2018	114	2725	2551	10.8	0	0	12	0.5	0.0
Catherine Creek	CC44UPPER	44.0	2018	1/1/2018	11/19/2018	322	7737	7547	23.6	0	260	1597	21.2	18.0
Catherine Creek	LowerNewChannel	41.0	2018	1/1/2018	4/12/2018	102	2438	2260	10.5	0	0	2	0.1	0.0
Catherine Creek	SCMID	41.2	2018	1/1/2018	11/19/2018	322	7738	7559	24.0	0	358	1606	21.2	27.0
Catherine Creek	SCPool#1	41.3	2018	1/1/2018	4/12/2018	102	2438	2258	9.9	0	0	0	0.0	0.0
Catherine Creek	SCPool#2	40.9	2018	1/1/2018	4/12/2018	102	2438	2260	10.4	0	0	2	0.1	0.0
Catherine Creek	Side_Channel1	41.0	2018	1/1/2018	11/19/2018	322	7739	7561	25.0	1	359	2101	27.8	30.0
Catherine Creek	SOCROWLOWER	40.9	2018	1/1/2018	11/19/2018	322	7739	7550	23.8	0	361	1628	21.6	28.0
Catherine Creek	SOCROWUPPER	41.6	2018	1/1/2018	11/19/2018	322	7737.5889	6332	23.6	0	332	1277	20.2	25.0
Catherine Creek	Swale1Channel	n/a	2018	1/1/2018	11/19/2018	322	7738	5758	23.5	0	28	1090	18.9	0.0
Catherine Creek	Swale2Pool	41.4	2018	1/1/2018	11/19/2018	322	7738	6490	24.2	0	169	1283	19.8	25.0
Catherine Creek	Swale4channel	n/a	2018	1/1/2018	11/19/2018	322	7738	7559	23.3	0	67	1724	22.8	14.0

Stream	Location Name	River mile	Year	Start date	End date	# of Days Deployed	# Hours in Deployment Period	# of Hours for Analysis	Max Temperature (° C)	Hours >=25 ° C	Hours >=20 ° C	Hrs. at 10 - 15.6 ° C	% at 10 - 15.6 ° C	Mean daily >=17.8 ° C (# days)
Catherine Creek	Swale5channel	n/a	2018	1/1/2018	11/19/2018	322	7739	7561	19.9	0	0	2998	39.7	0.0
Catherine Creek	Swale6channel	n/a	2018	1/1/2018	11/19/2018	322	7739	5592	23.6	0	27	1100	19.7	0.0
Catherine Creek	Swale6Pool	41.0	2018	1/1/2018	11/19/2018	322	7739	7560	20.5	0	31	1411	18.7	32.0
Catherine Creek	UpperNewChannel	41.4	2018	1/1/2018	4/12/2018	102	2437	2257	9.9	0	0	0	0.0	0.0
Dark Canyon Creek	DC1	0.1	2018	1/1/2018	11/19/2018	322	7728	7730	19.0	0	0	2542	32.9	0.0
Dark Canyon Creek	DC2	1.9	2018	1/1/2018	11/19/2018	322	7728	7731	23.6	0	290	1672	21.6	19.0
Grande Ronde River	Alcove	152.9	2018	1/1/2018	11/19/2018	323	7744	7744	22.1	0	77	3053	39.4	2.0
Grande Ronde River	BTS1	144.6	2018	1/1/2018	9/17/2018	260	6230	6231	29.5	259	879	1291	20.7	60.0
Grande Ronde River	BTS3	n/a	2018	1/1/2018	7/17/2018	197	4736	4733	27.4	36	185	885	18.7	16.0
Grande Ronde River	BTS4	n/a	2018	1/1/2018	7/17/2018	197	4736	4737	31.8	68	336	934	19.7	22.0
Grande Ronde River	BTS5	143.9	2018	1/1/2018	9/21/2018	263	6322	5836	29.9	120	603	1298	22.2	42.0
Bear Creek	BTS6	0.1	2018	1/1/2018	7/11/2018	192	4596	4597	23.3	0	129	1170	25.5	4.0
Grande Ronde River	FS_coldwater	156.2	2018	1/1/2018	11/21/2018	324	7787	7782	18.4	0	0	3050	39.2	0.0
Grande Ronde River	GR1	146.4	2018	1/1/2018	11/21/2018	325	7788	7751	28.7	228	830	1636	21.1	56.0

Stream	Location Name	River mile	Year	Start date	End date	# of Days Deployed	# Hours in Deployment Period	# of Hours for Analysis	Max Temperature (° C)	Hours >=25 ° C	Hours >=20 ° C	Hrs. at 10 - 15.6 ° C	% at 10 - 15.6 ° C	Mean daily >=17.8 ° C (# days)
Grande Ronde River	GR10	138.7	2018	1/1/2018	11/21/2018	325	7789	7790	28.8	255	995	1598	20.5	67.0
Grande Ronde River	GR11	156.3	2018	1/1/2018	9/21/2018	264	6324	6146	26.4	40	450	1523	24.8	33.0
Grande Ronde River	GR12	155.5	2018	1/1/2018	11/21/2018	324	7787	7788	26.6	48	496	1680	21.6	38.0
Grande Ronde River	GR3	143.3	2018	1/1/2018	11/19/2018	323	7744	7745	27.9	177	836	1629	21.0	58.0
Grande Ronde River	GR4	163.9	2018	1/1/2018	11/21/2018	324	7786	7607	27.3	86	567	1498	19.7	38.0
Grande Ronde River	GR5	170.8	2018	1/1/2018	12/31/2018	364	8736	8579	20.3	0	6	1357	15.8	0.0
Grande Ronde River	GR9	152.1	2018	1/1/2018	11/21/2018	324	7786.5553	7610	27.7	153	676	1696	22.3	50.0
Grande Ronde River	Gun Club	142.2	2018	1/1/2018	11/19/2018	323	7745	7746	26.5	8	232	2730	35.2	17.0
Grande Ronde River	Jordan Cr. Ranch	n/a	2018	1/1/2018	8/29/2018	241	5773	5774	16.4	0	0	2202	38.1	0.0
Grande Ronde River	Jordan Cr_hwy	n/a	2018	1/1/2018	11/19/2018	323	7745	7741	13.8	0	0	4717	60.9	0.0
Grande Ronde River	LM_OX1	n/a	2018	1/1/2018	7/11/2018	192	4600	4594	16.5	0	0	1461	31.8	0.0
Grande Ronde River	LM_SC3	n/a	2018	1/1/2018	10/10/2018	283	6780	4593	16.7	0	0	685	14.9	0.0

Stream	Location Name	River mile	Year	Start date	End date	# of Days Deployed	# Hours in Deployment Period	# of Hours for Analysis	Max Temperature (° C)	Hours >=25 ° C	Hours >=20 ° C	Hrs. at 10 - 15.6 ° C	% at 10 - 15.6 ° C	Mean daily >=17.8 ° C (# days)
Grande Ronde River	Longley 1	n/a	2018	1/1/2018	11/21/2018	325	7790	7791	17.9	0	0	1925	24.7	0.0
Grande Ronde River	Longley 2	n/a	2018	1/1/2018	11/21/2018	325	7790	7790	20.2	0	0	1923	24.7	42.0
Grande Ronde River	Longley 3	n/a	2018	1/1/2018	11/21/2018	325	7790	7790	13.0	0	0	2348	30.1	0.0
Grande Ronde River	Longley Air	n/a	2018	1/1/2018	11/21/2018	325	7790	7790	45.7	n/a	n/a	n/a	n/a	n/a
Graves Creek	GRAVES1	0.5	2018	1/1/2018	10/3/2018	275	6609	6600	21.8	0	52	2387	36.2	0.0
McCoy Creek	MCCOY1	2.7	2018	1/1/2018	5/24/2018	143	3443	3266	22.4	0	21	423	13.0	0.0
McCoy Creek	MCCOY6	1.5	2018	1/1/2018	5/24/2018	143	3443	3121	21.1	0	9	448	14.4	0.0
McCoy Creek	MCCOY7	0.1	2018	1/1/2018	5/24/2018	144	3444	3121	21.9	0	11	435	13.9	0.0
McCoy Creek	MCCOYAIR	n/a	2018	1/1/2018	11/26/2018	330	7913	7737	44.6	n/a	n/a	n/a	n/a	n/a
Meadow Creek	MEADOW1	2.9	2018	1/1/2018	11/21/2018	325	7788	7421	29.9	249	876	1625	21.9	61.0
Meadow Creek	MEADOW2	1.5	2018	1/1/2018	11/21/2018	325	7789	3939	28.3	106	579	730	18.5	42.0
Meadow Creek Wetland	MEADOW5	7.5	2018	1/1/2018	5/7/2018	127	3037	3026	15.8	0	0	170	5.6	0.0
Meadow Creek Wetland	MEADOW6	6.8	2018	1/1/2018	5/7/2018	127	3037	3027	16.3	0	0	173	5.7	0.0
Rock Creek	ROCK1	0.2	2018	1/1/2018	9/27/2018	269	6467	6270	29.9	124	593	1750	27.9	44.0
Rock Creek	ROCK2	1.7	2018	1/1/2018	8/9/2018	221	5293	5042	25.1	1	350	1048	20.8	23.0
Rock Creek	ROCK3	3.0	2018	1/1/2018	8/9/2018	221	5293	4650	25.1	1	117	1084	23.3	1.0

Stream	Location Name	River mile	Year	Start date	End date	# of Days Deployed	# Hours in Deployment Period	# of Hours for Analysis	Max Temperature (° C)	Hours >=25 ° C	Hours >=20 ° C	Hrs. at 10 - 15.6 ° C	% at 10 - 15.6 ° C	Mean daily >=17.8 ° C (# days)
Rock Creek	ROCK4	4.5	2018	1/1/2018	10/3/2018	275	6609	5621	24.8	0	105	1557	27.7	3.0
Winter Canyon	Winter Canyon 1	0.6	2018	1/1/2018	9/17/2018	260	6229	6230	19.7	0	0	2753	44.2	0.0
Winter Canyon	Winter Canyon 2	1.4	2018	3/13/2018	9/17/2018	189	4525	4526	21.4	0	36	2085	46.1	3.0

Lessons Learned/Adaptive Management

The Grande Ronde Subbasin is one example of efforts to learn and adapt management programs through time. Historically, basin partners developed projects in an opportunistic approach. Projects were largely identified and developed with willing landowners based on course scale planning established through the Grande Ronde Subbasin plan completed in 2004.In 2013, basin partners initiated a strategic planning process (ATLAS) for Catherine Creek and the upper Grande Ronde watershed based on salmon and steelhead life history requirements to stratify the watersheds by biological significant reaches, assign relative importance of limiting factors, define key actions to address limiting factors, and develop a ranking and prioritization system to clearly identify geographic and reach priorities and both short and long term strategies to focus watershed restoration actions in areas with the most biological need and the highest probability of benefit.

The process engaged multiple basin partners and leveraged the best available science and local expertise available to develop a road map that all partners can utilize to identify, develop, and implement strategic watershed and fish habitat restoration and enhancement projects. Transitioning opportunistic to strategic planning may be one of the most important adaptive management changes employed in the basin for prioritizing and strategizing work in Catherine Creek and the Grande Ronde river to address survival gaps for Snake River Spring-Summer Chinook and Summer Steelhead populations in the Grande Ronde Subbasin.

Additionally, the CTUIR Grande Ronde Fish Habitat Project continues to monitor and evaluate performance of projects and conservation measures developed to improve watershed and fishery resources in the Grande Ronde Subbasin. Post project construction and monitoring data, along with staff experience and collaboration with basin partners, collectively informs and helps improve our understanding of how different techniques and approaches to watershed and habitat restoration respond as well as develop new and innovative approaches to addressing habitat limiting factors for salmon and steelhead populations.

Literature Cited

Anderson, J.W., and others. 1992. Upper Grande Ronde River Anadromous Fish Habitat Protection, Restoration, and Monitoring Plan. USFS, PNWFRS, ODFW, CRITFC, CTUIR, NPT, OSU.

CBFWA. 1990. Columbia Basin Fish and Wildlife Authority. Integrated System Plan for Salmon and Steelhead Production in the Columbia River Basin.

CHaMP Scientific protocol for salmonid habitat surveys within the Columbia Habitat Monitoring Program. [Report]. - [s.l.] : Columbia Habitat Monitoring Program., 2015.

Costi K, Shippentower, G and A. Wildbill. 2016. Fish Habitat Enhancement Biological Effectiveness Monitoring 2016 Annual Report. Confederated Tribes of the Umatilla Indian Reservation. Project # 2009-014-00; BPA contract# 71934.

CRITFC. 1995. Wykan Ush Me Wa Kush, Spirit of the Salmon. Columbia River Basin Salmon Policy. Columbia River Inter-Tribal Fish Commission. Columbia Basin Salmon Policy, 1995.

CTUIR. 1983. Confederated Tribes of the Umatilla Indian Reservation. Summary Report: Salmon and steelhead habitat improvement initiatives--John Day, Umatilla, Grande Ronde and Imnaha drainages.

CTUIR. (2019, February 12). Retrieved from CTUIR GIS (Public) Geographic Information Systems: http://gis.ctuir.org/

Grande Ronde Model Watershed Program, et. al. 2004. Grande Ronde Subbasin Plan. Northwest Power Planning Council Fish and Wildlife Program.

Henjum, M. G., J.R. Karr, D. L. Bottom, D. A. Perry, J. C. Bennarz, S. G. Wright, S. A. Beckwitt and E. Beckwitt. 1994 Interim Protection for Late-Successional Forest, Fisheries, and Watersheds: National Forest East of the Cascade Crest, Oregon and Washington.

Huntington, C. H. 1993. Clearwater BioStudies. Final Report. Stream and Riparian Conditions in the Grande Ronde Basin. Grand Ronde Model Watershed Operations-Action Plan, Appendix A and B.

Independent Scientific Group. 1996. Return to the River: Restoration of Salmonid fishes in the Columbia River Ecosystem. September 1996.

Issak, D. J., Horan, D.L and S.P.Wollrab. 2013. A simple protocol using underwater epoxy to install annual temperature monitoring sites in rivers and streams. Gen. Tech. Rep. RMRS-GTR-314. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 21 p.

Johnson D H [et al.] Salmonid Field Protocols [Journal] // American Fisheries Society. - 2007. - pp. 325-340.

McCullough, D. A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to Chinook salmon. Environmental Protection Agency 910-R-99-010.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wismar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management history of eastside ecosystems: Changes in fish habitat over 50 years, 1935-1992. General Technical Report, PNW-GTR-321, Report. USDA, Forest Service

Mobrand, L. and L. Lestelle. 1997. Application of the ecosystem diagnosis and treatment method to the Grande Ronde Model Watershed Project. BPA Task Order Number 95AT61148.

Mobrand, L. 2003. Application of the Ecosystem Diagnosis and Treatment Method to the Grande Ronde Subbasin.

https://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/section4d/electro2000.pdf

Huntington, C. (1993). Stream and Riparian Conditions in the Grande Ronde Basin. Grande Ronde Model Watershed.

Jones K L [et al.] Physical Habitat Monitoring Strategy (PHAMS) for reach-scale restoration effectiveness monitoring [Report] = PHAMS: Open-File Report 2015-1069 / U.S. Department of the Interior. - Reston, Virginia: U.S. Geological Survey, 2013.

Jones, K. L., Poole, G. C., Quaempts, E. J., O, D. S., & Beechie, T. (2008). The Umatilla River Vision. Mission: Confederated Tribes of the Umatilla Indian Reservation Department of Natural Resources.

Lyons, E., & McAfee, R. (2017). Work Plan for Field Exploration. Boise: Bureau of Reclamation.

Mobrand, L. (2003). Application of the Ecosystem Diagnosis and Treatment Method to the Grande Ronde Subbasin. .

Newbury, R., & Gasboury, M. (1994). Stream analysis and fish habitat design: A field manual. Gibson: Newbury Hydraulics LTD.

Newbury, R., Gaboury, M., & Bates, D. (1997). Restoring habitats in channelized or uniform streams using riffle and pool sequencies. Canadian Ministry of Environment, Lands and Parks. Vancouver: Watershed Restoration Program.

NMFS. (1997). Snake River Salmon Recovery Plan (8/97 draft),. National Marine Fisheries Service.

NRC. (1996). Upstream. Salmon and society in the Pacific Northwest. Washington D. C.: National Research Council.

NMFS. 1997. National Marine Fisheries Service. Snake River Salmon Recovery Plan (8/97 draft), Chap.4, pg. 61, 1997.

NMFS. 1995. National Marine Fisheries Service. Snake River Salmon Recovery Plan.

Noll, W., Williams, S., and R. Boycce. 1988. Grande Ronde river basin fish habitat improvement implementation plan. Oregon Department of Fish and Wildlife.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries Bulletin, American Fisheries Society, Bethesda, Maryland.

NPCC. 1994. Columbia River Basin Fish and Wildlife Program. Northwest Power Conservation Council.

NPPC. 2001. Grande Ronde River Subbasin Summary. Northwest Power Conservation Council.

NPCC. 2004a. Grande Ronde Subbasin Plan. Prepared for Northwest Power and Conservation Council by Grande Ronde Model Watershed Program. Pgs. 491. Available from www.nwcouncil.org/fw/subbasinplanning/granderonde/plan/

NPCC. 2004b. Imnaha Subbasin Plan. Prepared for Northwest Power and Conservation Council by Wallowa County Natural Resources Advisory Committee. Paged by section. Available from www.nwcouncil.org/fw/subbasinplanning/imnaha/plan/

NPCC. 2004c. Grande Ronde Subbasin Plan Supplement. Prepared for Northwest Power and Conservation Council by Grande Ronde Model Watershed Program. Pgs. 51. Available from www.nwcouncil.org/fw/subbasinplanning/granderonde/plan/

NPCC. 2004d. Imnaha Subbasin Plan Supplement. Prepared for Northwest Power and Conservation Council by Wallowa County Natural Resources Advisory Committee. Pgs. 20. Available from www.nwcouncil.org/fw/subbasinplanning/imnaha/plan/

NPPC. 2000. Columbia River Basin Fish and Wildlife Program. Portland, OR. Available from www.nwcouncil.org/library/2000/2000-19/Default.htm

NRC. 1996. Upstream. Salmon and society in the Pacific Northwest. National Research Council, Washington D.C. 452 pp.

ODEQ. 1999. Grande Ronde Section 319 National Monitoring Program Project. Temperature Monitoring Summary Report, 1993-1998. Oregon Department of Environmental Quality.

ODFW. (1990). Past and present abundance of Snake River sockeye, Snake River Chinook, and lower Columbia River coho salmon. A report prepared for Senator Mark Hatfield, U. S. Senate. Oregon Department of Fish and Wildlife.

ODFW, 1990. Oregon Department of Fish and Wildlife and four other agencies. 1990. Grande Ronde River Subbasin, salmon and steelhead production plan. Northwest Power Planning Council, Portland, Oregon.

ODFW, 1996. Oregon Department of Fish and Wildlife. 1996. Grande Ronde Basin Fish Habitat Enhancement Project. 1996 Annual Report.

OWRD. (2019, February 5). Near Real Time Hydrographics Data. Retrieved from Oregon Water Resource Deparment: https://apps.wrd.state.or.us/apps/sw/hydro_near_real_time/display_hydro_graph.aspx?station_nbr=13318960

Rosgen, D., 1996 Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Rosgen, D.L. 1998. The reference reach – a blueprint for natural channel design. Presented at the ASCE, Denver, Co

Stillwater Sciences Biological effectiveness monitoring and evaluation plan for fisheries [Report]. - Portland, Oregon: Stillwater Sciences, 2012.

Thurow, R.F. 1994. Underwater Methods for Study of Salmonids in the Intermountain West. General Technical Report. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station.

USFS et. al. 1992. Upper Grande Ronde River Anadromous Fish Habitat Protection, Restoration, and Monitoring Plan, USFS, PNFRES, ODFW, CRITFC, CTUIR, NPT, OSU.

USFWS. 2002. Bull Trout Draft Recovery Plan. U. S. Fish and Wildlife Service. Paged by section. Available from http://ecos.fws.gov/docs/recovery_plans/2002/021129.pdf

Warren D. R., C. J. Harvey, M. M. McClure & B. L. Sanderson. (2014) Use of an Ecosystem-Based Model to Evaluate Alternative Conservation Strategies for Juvenile Chinook Salmon in a Headwater Stream, North American Journal of Fisheries Management, 34:4, 839-852

White, S., C. Justice, and D. McCullough. 2011. Protocol for Snorkel Surveys of Fish Densities. A component of Monitoring Recovery Trends in Key Spring Chinook Habitat Variables and Validation of Population Viability Indicators. Columbia River Inter-Tribal Fish Commission, Portland, OR.